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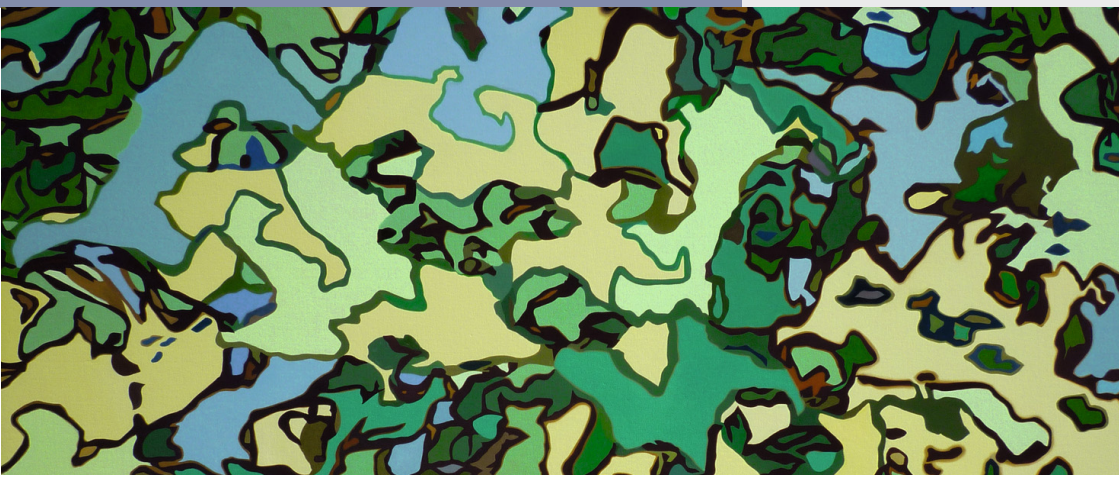

Eva Wittenberg

With Light Verb Constructions from Syntax to Concepts

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Contents

1 Introduction

1.1 Light Verb Constructions: Form to Meaning[1]

The mind is an amazing machine: It learns to decode linguistic signals according to their form, and then puts these signals together to map onto a meaning. Once the regularities in the mapping are known, the road from form to meaning is quite straightforward: The sentence *The woman kisses the man* has a subject and an object, which directly map onto an Agent and a Patient, making it easy to figure out a scene in which, well, a woman kisses a man (see Figure 1.1). This uniformity in the mapping is incredibly pervasive and reliable, providing a major source of stability both in language acquisition and processing, and has thus made it into an axiom of countless linguistic theories (Baker, 1988; Bencini and Goldberg, 2000; Chomsky, 1981; Hale and Keyser, 1993, 2002; Hoekstra, 2000; Johnson and Goldberg, 2013; Larson, 1988).

Figure 1.1: Examples of Mapping Uniformity.

[1] This chapter is based on work previously published in Eva Wittenberg (2009). "German Light Verb Constructions as a Testing Battery for Linguistic Theory". MA thesis. Universität Potsdam and Eva Wittenberg, Ray Jackendoff et al. (2014). "The Processing and Representation of Light Verb Constructions". In: *Structuring the Argument*. Ed. by A. Bachrach, I. Roy, and L. Stockall. Amsterdam/Philadelphia: John Benjamins Publishing Co, pp. 61–80.

This dissertation looks at what happens when the mapping uniformity breaks down. How does the mind construct meaning when it cannot take the syntactic configuration as a cue? Is the architecture of linguistic representation and processing stable enough that it can create meaning from the interaction of all linguistic levels, even when there is a mismatch between syntax and semantics? If so, which cognitive faculties will be recruited to do so? And will the meaning generated from sentences that violate the mapping uniformity be different from meaning generated when the mapping uniformity is not violated?

I will examine questions of mental representation, cognitive processing, and event construal to provide insights into the architecture of the language system. For this purpose, I will use one construction, the light verb construction, which is a prime example of a mismatch between semantic and syntactic levels of representation. In particular, I will ask how the light verb construction is processed and represented, and how the violation of the mapping uniformity affects the conceptualization of an event described by a light verb construction.

To this end, I will be using different psycholinguistic techniques: With the help of a reaction-time study and an experiment using Event-Related Potentials, I show that light verb constructions are processed differently from non-light constructions (Chapter 2). A priming study helps zoom in to the questions of mental representation and will point to differences in the semantic structures of light and non-light constructions (Chapter 3). Finally, a conceptual sorting study generates data suggesting that we categorize events differently, depending on whether a light or a non-light construction encodes them (Chapter 4). Together, these experiments paint a picture of how syntax, semantics and event structure interact in comprehending and producing light verb constructions, providing important insights for linguistic theory; and they show how different methodologies can be put to best use in order to answer pressing questions in linguistics and psycholinguistics.

1.2 Short Overview of Light Verb Constructions

Light verb constructions are complex predicates in which the verb is semantically bleached ('light'), and merely expresses aspect, directionality or aktionsart of the predicate (Butt, 2003; Fabricius-Hansen, 2006; Jespersen, 1954; Wiese, 2006). Most of the predicative meaning comes from an event nominal within the construction (Beavers, Ponvert, and Wechsler, 2009). For example, in a sentence like *The woman is giving the man a kiss*, the character associated with the subject (the woman) is not transferring a concrete thing into the possession of the character described by the object (the man), as the verb *to give* conventionally implies. Instead, *give a kiss* describes the same kind of event as the base verb *to kiss*. The event nominal *kiss* is part of the predicate and assigns semantic roles to the subject, just like *give*. Thus, the subject of the sentence is not only understood as the Agent of the verb *give*, but also as the Agent of the event nominal *kiss* – a phenomenon known as 'argument sharing' (Baker, 1988; Durie, 1988; Jackendoff, 1974; see also Alsina, 1996; Butt, 1993, 2010; see Table 1.1 for an illustration).[2]

Syntactically, however, light verb constructions behave just like their non-light counterparts. That is, the sentence *The woman is giving the man a kiss* is ditransitive, just like its non-light counterpart *The woman is giving the man a book*: There is a subject, and two direct objects, put into a relation by the verb *give*. In short, the linguistic structure of light verb constructions looks syntactically like in non-light constructions, but semantically like in base verbs (Figure 1.2).

[2] Since this is a light verb construction-centered thesis, I will employ light verb construction-centered terminology: All constructions using the same verb (for example, *give* in *give a kiss*) as a particular light verb construction, but with a non-eventive noun, will be called 'non-light', and all verbs of which the light verb construction's noun (for example, *kiss*) is derived from, will be called 'base verbs'.

	Non-Light Construction	**Light Verb Construction**
Example:	*Henry gave a rose to Elsa*	*Henry gave a kiss to Elsa*
Syntax:	in both cases: SUBJ - VERB - OBJ 1 - OBJ 2	
Correspondence between syntactic element and semantic role:		
SUBJ:	Agent of *give*	Agent of *give* and *kiss*
OBJ 1:	Theme of *give*	Theme of *give* + part of complex predicate
OBJ 2:	Recipient of *give*	Recipient of *give* and *kiss*
Syntax- Semantics Mapping	*Henry gave a rose to Elsa* ag_1 pred-1 $theme_1$ rec_1 [DP] [VP [DP] [PP]]$_1$	*Henry gave a kiss to Elsa* $ag_{1,2}$ pred-1 pred-2/$theme_1$ pat_2/rec_1 [DP] [VP [DP] [PP]]$_{1,2}$

Table 1.1: Illustration of argument sharing in a light verb construction, as opposed to no argument sharing in a non-light sentence. Glossary: ag = Agent, pred = predicate, rec = Recipient, and pat = Patient. Table from Wittenberg, Paczynski et al., 2014.

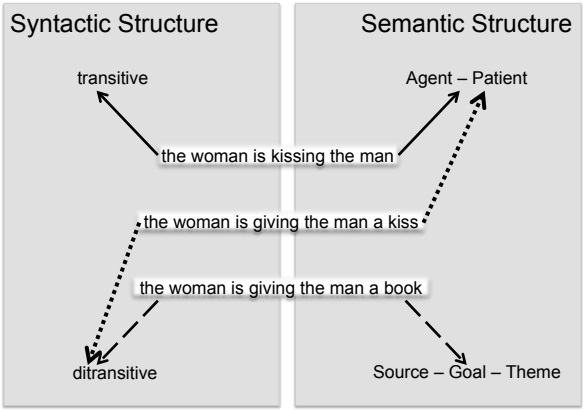


Figure 1.2: Usually, a transitive syntactic structure maps onto a two-role semantic structure such as Agent-Patient (*the woman is kissing the man*), and a ditransitive syntactic structure maps onto a three-role-semantic structure, such as Source-Goal-Theme (*the woman is giving the man a book*). However, this mapping uniformity is violated in light verb constructions: Light verb constructions with *give* have a ditransitive syntactic structure, yet express an Agent-Patient event (*the woman is giving the man a kiss*).

Light verb constructions have inspired research in a large number of languages, from a vast array of theoretical perspectives, and with a variety of goals, resulting in a heterogeneous set of terminology, definitions, and analyses (Butt, 2010; Winhart, 2002). Here, I focus on the syntactic and semantic structure of some of the most clear-cut cases of light verb constructions in English and German.

For a long time, in both the English and German research tradition, light verb constructions have been mainly discussed in style guides. Most often, the complaint was that what can be expressed by a light verb construction (such as *to give assistance*) can also easily be expressed with its base verb (*to assist*; Kane, 1983; for a discussion on light verb constructions in German language criticism, see Bruker, 2008; Polenz, 1963). Starting with modern linguistics in the 1960s, however, it has become clear that light verb constructions offer a wider range of expressive possibilities than many base verbs do, for example differentiation in verbal type, perspective and aktionsart, and information structural strategies. This point will become important again in Chapter 4, which will focus on the subtle semantic distinctions between light verb constructions and their base verbs.

In German, light verb constructions have been grammatically productive since Old and Middle High German (So, 1991; Tao, 1997). Yet, as discussed in Wittenberg (2009), there is no consensus in the literature about the range of constructions that is covered by the notion of light verb construction: Some approaches only include NP_{ACC}+VP combinations (Zifonun, 1997), while others also include PP+VP combinations (Eisenberg, 2003), or combinations with genitive or dative case nouns (Helbig, 1979). In many definitions, only constructions with deverbal or deadjectival nouns count as light verb constructions (Helbig, 1979). A few others though, for instance Wiese (2006), Heidolph, Flämig, Motsch et al. (1981) and Erbach and Krenn (1994) also include cases in which the noun is not deverbal and has no argument structure of its own (e.g. Example 1.1):

(1.1)

Martin	*trägt*	*Krawatte*	*bei*	*seinen*	*Auftritten.*
M	carries	tie	during	his	performances.

'During his performances, Martin (usually) wears a tie.'

While in English, the label 'light verb constructions' is relatively uncontested, the German literature exhibits a variety of labels for them, for example *Verbaufspaltungen* ('verbal dispartments', Lüger, 1995), *nominale Umschreibungen* ('nominal paraphrases', Keller and Mulagk, 1995), *Streckformen des Verbs* ('stretched forms of a verb', Schmidt, 1968), *feste Verbindungen* ('fixed combinations', Klappenbach, 1980), or, most prominently, *Funktionsverbgefüge* ('function verb constructions', Polenz, 1963). In this thesis, I will use the English expression 'light verb construction' (Jespersen, 1954; for a critical discussion regarding the terminology see Pottelberge, 2000, 2001).

When it comes to syntax, light verb constructions show considerable variation as well. Some of them are easily passivized, modified by adjectives, show free choice of negation form or determiners, and can freely be moved around according to general principles of German grammar. Others are clearly restricted in these points (Eisenberg, 2003; Helbig, 1983). As Winhart (2002, p. 15) points out, this variation might largely be due to the degree of the verb's semantic contribution.

1.3 Theoretical Puzzles

Light verb constructions are difficult for linguistic theories for a variety of reasons. One problem is how to theoretically model the fact that light verb constructions are semiproductive, that means, each potential light verb combines with only certain semantic noun classes. Within each noun class, the combination can be productive, but it does not have to be. For example, in English it is possible to combine the light verb *give* with contact nouns, such as *kiss, kick, punch, hug, tap, snuggle, scratch, tickle*, or *slap* (some of these might not sound familiar, but all are attested; there seem to be considerable regional differences in productivity patterns). *Give* also combines with stimulus-experiencer nominalizations, for example *scare* or *fright*. But here, the pattern is more restricted: **give a please* or **give an interest*, for example, are unacceptable. This puzzle has mainly been noted in Construction Grammar and Cognitive Linguistics frameworks (Brugman, 2001; Family, 2006, 2008; Newman, 1996).

Another theoretical problem is the assignment of semantic roles in light verb constructions. When speakers talk about events, they talk

about concepts, concrete things, or people, and how these interact and relate to each other with respect to an action or state. These relations are meant when I refer to "semantic roles". In most flavors of linguistic theory, as discussed under the mapping uniformity hypothesis, it is assumed that each syntactic element corresponds to one semantic role, which is licensed by the verb. Each argument "bears one and only one Θ-role, and each Θ-role is assigned to one and only one argument" (Chomsky, 1981, p. 15).

In light verb constructions, this canonical one-to-one correspondence between syntactic positions and semantic roles is suspended. German light verbs may not differ from their non-light counterparts in their syntactic properties, but they do differ in how they distribute semantic roles. This is exemplified in the contrast between *give* as a non-light verb, and *give* as a light verb. Compare (1.2 a-e).

(1.2) (a) *Julius gave a book to Anne.*
(b) *Julius described a kiss to Anne.*
(c) *Julius gave a kiss to Anne.*
(d) *Julius kissed Anne.*
(e) *Anne received a kiss from Julius.*

Semantically, in (1.2 a), the direct object is a physical object, but in the following two examples (1.2 b and c), it is an event. However, (1.2 b) refers to two independent actions, a describing and a kissing (which is being described), while the light verb construction (1.2 c) describes one action, the kissing, just like (1.2 d; see Wittenberg, Jackendoff et al., 2014, for more detailed discussion).

There has been an ongoing debate in the literature about how, and which, semantic roles are assigned in light verb constructions. According to Jackendoff's Parallel Architecture (Culicover and Jackendoff, 2005, discussed in Wittenberg, 2009), the combination of a light verb and a particular noun leads to the creation of a complex predicate, composed out of the meaning and arguments of the noun, and at least the argument structure and probably some semantic features of the light verb. The complex predicate as a whole assigns the semantic roles outside of itself – that is, the semantic roles of the subject, and any remaining NPs outside of the light verb construction: In the light verb construction with *give* (1.2 c), for example, the referent of the subject is the kisser; in the light verb

construction with *receive* (1.2 e), the referent of the subject is being kissed.

Unclear, so far, is the nature of the semantic roles themselves. It seems intuitively likely that the referent of the subject of *to give a kiss* is the kisser, and thus the Agent, and that the referent of the object is being kissed, and thus the Patient; and the Light noun denotes the action and does not receive any semantic role. However, this intuition needs to be empirically tested (see Chapter 4).

Many theoretical proposals have tried to integrate this puzzling assignment of semantic roles into a larger linguistic theory. Broadly, there are structure-preserving accounts, which argue for mapping uniformity between syntax and semantics (Goldberg, 1995; Hale and Keyser, 1993, 2002); and those who allow for some flexibility between linguistic levels of representation and for some independence within levels, governed by linking rules (Jackendoff, 2002; Müller, 2010).

There are two prominent variants of the structure-preserving model. The first one is Generative Grammar, exemplified here by the work of Hale and Keyser (1993, 2002). In this model, argument structure is configurationally defined, and the semantic roles in a sentence are assigned based on the arguments' position in the syntactic tree. Thus, the correspondence between syntactic and semantic roles is strictly homomorphic (Levin and Rappaport Hovav, 2005). According to the model proposed in Hale and Keyser (1993, 2002), verbs like *to order* start out in the lexicon as *to give an order*, which is a light verb construction (presumably with Argument Sharing in place qua syntactic configuration). However, the verb in *to give an order* is an "abstract V" – the equivalent to Larson's (1988) "little *v*". By incorporation, or "conflation", *to give an order* becomes *to order*: the abstract V *give* is deleted, and *give* moves into a position where it can function as a full verb. Thus, light verb constructions consist of a light verb and a pre-conflated nominal. In light verb constructions such as *to give an order*, the operation $order_N \rightarrow order_V$ does not occur, whereas in all sentences with non-light verbs, several syntactic transformations take place (see Example 3.1 on page 50 for an illustration).

There are several problems with this account, as I already argued in Wittenberg (2009). One problem concerns the determiner: Either, the determiner is in the structure before incorporation, then it has to be deleted when the noun gets incorporated into the V position;

or, it has to be inserted into the light verb construction at or before spell-out. The treatment in Hale and Keyser (1993, 2002) does not provide a solution for this.

Another question regards the status of the non-light verbs *give*, *take*, *make*, and so on. Since the proposed derivation of non-light verbs from light verbs is assumed to be universally applicable, one has to assume that non-light *give*, for example, is derived from something like *do a give*. Alternatively, the derivation is not applicable to all verbs, in which case one would have to represent light verbs entirely separately from their non-light counterparts – a solution that bears on the most important question about this approach. This question concerns the locus of the proposed transformations. Hale and Keyser (1993, 2002) do not state whether the transformation from Light to non-light configuration would take place in the lexicon, or after lexical insertion and before spell-out. If it is in the lexicon, then this amounts to saying that light *to give* is a different lexical item from non-light *to give*, associated with different semantic and syntactic structures. If the process is syntactic, then non-light constructions would be derived by complex syntactic operations, as illustrated later by Example 3.1.

Another account of light verb constructions is rooted in the framework of Construction Grammar. Construction Grammar is an umbrella expression for a range of theories that share a basic assumption, namely, that the primary units of grammar are constructions: stored pairings of form and function, forming an atomic unit (Croft, 2001; Goldberg, 1995; Kay, 1995). There are no independent modules of grammar interacting with each other: grammar is monostratal (Fried and Östman, 2004). Thus, the architecture of Construction Grammar is also homomorphic between syntactic and semantic structure in Levin and Rappaport Hovav's (2005) sense. According to this theory, light verb constructions must be stored as linguistic units: each noun that can enter a light verb construction is stored together with its respective light verb, and each of these stored structures is associated with a distinct meaning (Goldberg, 2003); alternatively, groups of light verb constructions can be represented as sub-constructions of other constructions in an inheritance lattice (Family, 2006, 2008).

An example for an approach that does not take mapping uniformity as an axiom is the Parallel Architecture. As developed in

Culicover and Jackendoff (2005) and Jackendoff (1997, 2002) and amended in Wiese (1999, 2003), this theoretical model straddles the boundary between Generative Syntax and Construction Grammar (for discussion see Gonzalvez-García and Butler, 2006). Here, syntax is not seen as the sole generative component; rather, it is merely a tool for mapping the linear order of speech onto the hierarchical order of conceptual structures (Wiese, 2003). In principle, each lexical item's semantic structure can thus combine and interact with every other lexical item's structure on the level of semantic representation. Consider the example *the woman is giving the man a kiss* again:

(1.3) [The woman$^{\alpha,1}_{i,a}$ is giving the man$^{\beta,2}_{ii}$ a kiss$^{(3)}_{iii,b}$]$^{\gamma}$

As discussed above, both the semantic argument structure and the syntactic argument structure of the nominal constituent and the light verb are »shared«, as indicated by the multiple indices on Example 1.3. Tables 1.2 and 1.3 illustrate that the semantic roles in Example 1.3 are contributed by *to give*, and *to kiss*: The verb provides Source, Goal and Theme (indices 1-3), and the noun, Agent, Patient, and the overall event type (indices α, β and γ). Regarding syntactic structure, the subject (indexed with »ii, a«) and second object (indexed with »iii, b«) are subcategorized by both verb and nominal constituent, whereas the first object (indexed with »ii«) is subcategorized by the light verb alone:

to give			
Semantic Structure:	<Agent>^{1}	<Recipient>^{2}	<Theme>^{3}
Syntactic Structure:	Subject$_i$	Object$_{ii}$	Object$_{iii}$
Example:	*The woman*^1_i *is giving the man*$^2_{ii}$ *a book*$^3_{iii}$.		

Table 1.2: Semantic and syntactic structure of the non-light verb *to give*.

to kiss$^{\gamma}$	
Semantic Structure:	<AGENT>$^{\alpha}$ <PATIENT>$^{\beta}$
Syntactic Structure:	Subject$_a$ Direct Object$_b$
Example:	*The woman*$^{\alpha}_{a}$ *is kissing the man*$^{\beta}_{b}$.

Table 1.3: Semantic and syntactic structure of the base verb *to kiss*.

How is this predicted in the Parallel Architecture? According to that theory, a central feature of linguistic items is that they can be semantically underspecified with respect to the conceptual representations they relate to (Wiese, 1999). Thus, a verb like *to give* can accept a constituent denoting a concrete thing (*book*) as its direct object, but also an action noun (*kiss*). Thus, the action *kiss*, indexed with γ, can be inserted into the object position of *give*. Its semantic and syntactic arguments, the »kisser« α as the Agent and the »kissee« β as the Patient, are unified with those of the verb (indices 1,2), and *kiss* itself may or may not receive a Theme role (index 3).

Crucially, there are no new semantic roles or syntactic arguments inserted, but instead, it is a recycling process: The structure in Example 1.3 is the union of two sets of arguments that are provided by the construction's lexical elements. There are no syntactic transformations involved, and meaning composition is entirely predictable and compositional. Moreover, this formalization creates the possibility of an event conceptualization that depends on the meaning of both the light verb and noun (see Chapter 4).

In short, there are different theoretical approaches to light verb constructions that make different predictions for processing, representation, and conceptualization. Empirical evidence, as will be provided in the next three chapters, will help to test specific predictions made by these theories, but also help to identify predictability gaps within each theory. Especially the latter point is, in my opinion, crucial for the further development of Linguistics as a professional field: Only theories that are falsifiable are scientifically justified.

1.4 Light Verb Constructions in this Dissertation

From a linguistic point of view, the syntactic variability exhibited by light verb constructions calls for a detailed analysis. This analysis has been provided, to a vast degree, in previous work (for instance, see Butt, 2003, 2010; Kamber, 2006; Pottelberge, 2000, 2001; Sommerfeldt, 1980; Winhart, 2002; Wittenberg, 2009). From a cognitive point of view, something else is more pressing: How does the mind assemble the meaning of light verb constructions? What roles does the verb play with respect to the meaning? And why should we use light verb constructions at all? To answer these questions empirically, it is essential to have a relatively homogeneous set of examples to make useful comparisons. As will become apparent, the richness of the problem space within this set prohibits me from moving to more exotic cases (which of course also opens the possibility for future research). Also, even though there are considerable differences between German and English light verb constructions, I will only include those cases that intersect in their grammatical and semantic behavior, across and between languages.

Hence, here I focus on some of the most clear-cut cases of German and English light verb constructions (see also Wittenberg, Jackendoff et al., 2014). Throughout this thesis, I will examine light verb constructions such as *to give a kiss* in contrast to their base verb (*to kiss*) and non-light constructions (*to give a book*, often called 'heavy verb constructions'). This allows me to put the processing and representation of light verb constructions in relation to semantically, lexically or syntactically closely related constructions in both languages.

Thus, I used only those constructions in which the nominal element in the construction was derived from a base verb (for example, *kiss* in *to give a kiss* has its counterpart in the verb *to kiss*), and I excluded constructions like 1.1 (*Krawatte tragen*, 'to wear tie'). The other criteria for the nominal part were that they denoted the event type of the whole predicate, that is, *to give a kiss* has the same semantic relations, and is of the same event type, as *to kiss*. Related to this point, the nominal elements in the light verb constructions I used delivered the semantic roles of the predicate.

The restrictions on the verbs in the light verb constructions I used were that they were formally identical with their non-light

counterparts, that is, *give* in *to give a kiss* has its counterpart in *give* in *to give a book*, with the full meaning of physical transfer. The light verbs supplied aktionsart, tense, aspect, mood, number, and voice, and also determined the placement of the semantic roles provided by the nominal element (see Examples 1.2 c and e).

All light verbs provided the syntactic frame, for example, ditransitive in the case of *to give*. Hence, in the cases examined here, the surface syntax of light verb constructions is the same as the surface syntax of non-light constructions using the same verb. In other words, in a light verb construction with the light verb *give*, there are two arguments (*give [my friend] [a hug]*); or in a light verb construction with the light verb *take*, there is one argument and one prepositional phrase (*take [a walk] [to the store]*); and in a light verb construction with the light verb *make*, there is one argument and an optional prepositional phrase (*make [an announcement] ([to the audience])*). Thus, the subcategorization frame of the verb determines the syntactic argument structure of the sentence, just as in non-light constructions; but the event nominal may provide additional arguments, which can be attached with prepositions. The event nominal occupies the syntactic slot which, in non-light constructions, is filled by an NP that denotes a conventional Theme (*give [my friend] [a book], take [a spoon] [out of the drawer], make [a birthday cake]*; see Wittenberg, 2009, and Winhart, 2002, for discussion).

1.5 Structure of this Dissertation

I will use light verb constructions as informative cases for linguistic theories and psycholinguistics alike. First, I demonstrate that the theoretical status of light verb constructions as special constructions can be psycholinguistically verified: If it is true that light verb constructions present a prime example of a breakdown of mapping uniformity, then this breakdown should have repercussions in processing – resulting in different neural signals, or different processing times, for example.

In the first experimental chapter (Chapter 2), I present two studies that have examined this possibility (published, in slightly different form, as Wittenberg and Piñango, 2011, and Wittenberg, Paczynski et al., 2014), and have found evidence for differences both in processing

time and in neural activity. The nature and pattern of these differences allow some deductions about their source, that is, whether they are semantic or syntactic in nature or maybe stemming from some other cognitive demand.

In order to further investigate the source of processing differences observed in Chapter 2, I present a structural priming study designed to answer whether they are syntactic or semantic in nature (Chapter 3). Since I don't find evidence for the former, I present a conceptual sorting study in Chapter 4 (published as Wittenberg and Snedeker, 2014), which examines whether light verb constructions lead to different event construals than base verbs or non-light constructions. The Conclusion, finally, summarizes the findings, points out open questions, and suggests further research steps.

In this dissertation, one goal is to have psycholinguistic evidence help decide which family of proposals seems more realistic. To this aim, I take the processing proposals made by the theoretical accounts and test them with various psycholinguistic techniques. Another goal, however, is to use psycholinguistics to uncover predictability gaps within and overlaps between those theoretical proposals, to arrive at a more holistic view of how the mind goes from form to meaning, and back again.

To summarize, my dissertation will provide insights into how the light verb construction is processed, represented, and conceptualized. As a byproduct, I will also show how the language faculty interacts and depends on broader cognitive faculties, such as working memory; how linguistic theory can profit from well-tailored experiments, and how theory needs to be made better testable; and how we get from sparse linguistic input to a rich cognitive representation.

2 Processing Light Verb Constructions

2.1 Introduction

As we have seen in Chapter 1, the configuration of light verb constructions poses a challenge for linguistic theory, since syntactic and semantic structures do not align in this construction. If this is true, shouldn't it be a challenge for comprehenders? The fact that *giving a kiss* means *kissing*, and involves a kisser and a kiss-ee, and not (merely) a giver, a giv-ee, and given, should reverberate in how I process these constructions, compared to constructions that do not require this mental computation.

However, introspection, if that accounts for anything, tells us that understanding *giving a kiss* is just as fast and effortless as understanding *giving a book*; frequency data tell us that light verb constructions are just as frequent, if not more, than non-light constructions. It seems, thus, that the processing differences we are to expect are extremely subtle.

In the following, I present two studies that investigate the processing cost of light verb constructions in German. The first one, which has been published as Wittenberg, Paczynski et al. (2014), uses Event-Related Potential (ERP) to measure electrophysiological activity on the scalp in comprehending light verb constructions. Its results point to a strain on working memory that is induced when comprehending light verb constructions. The second study, whose results were published in Wittenberg and Piñango (2011), uses a technique that intentionally overloads working memory. The fact that people perform a secondary task slower when listening to light verb constructions serves as converging evidence for the interpretation of the ERP results as strain on working memory.

2.2 Event-Related Potentials: Light Verb Constructions Elicit Sustained Negativities[1]

As described in the Introduction (Section 1.3), there have been several theoretical attempts to reconcile the lack of a direct correspondence between semantic and syntactic argument structure in the light verb construction (Hale and Keyser, 1993, 2002; Goldberg, 2003). Here, I follow the Parallel Architecture framework (Culicover and Jackendoff, 2005; Jackendoff, 1997, 2002, 2007a), which allows both syntactic and semantic structure to be built independently, though the two are linked through a grammatical function tier (for further discussion, see Müller and Wechsler, 2014; Wittenberg, 2009; Wittenberg, Jackendoff et al., 2014; and Section 1.3). According to this theory, when a verb appears in a light verb construction with certain event nominals, the process of argument sharing is triggered: the arguments provided by the verb (in the case of *give*, the Agent, Patient, and Theme), and the arguments provided by the noun (in the case of *kiss*, Agent and Patient) need to be aligned.

As a result of the mechanisms that, according to the Parallel Architecture, are engaged during argument sharing (Culicover and Jackendoff, 2005, pp. 222–225), I predict that light verb constructions should incur processing costs during comprehension. Note that this hypothesis goes against what might be predicted on the basis of the frequency of light verb constructions, which, despite their complexity, are commonly encountered in everyday language. For example, according to the PropBank corpus (Palmer, Gildea, and Kingsbury, 2005), the most common English verbs appearing within light verb constructions, such as *take, have, make, do*, and *give*, are among the twenty most frequent verbs in English. More importantly, these verbs are more frequently encountered within light than non-light constructions (Wittenberg and Piñango, 2011, see Section 2.3). Thus, in the absence of other factors, these frequency data alone would predict reduced processing costs in association with the more

[1] This section has been published, in very similar form, as Eva Wittenberg, Martin Paczynski et al. (2014). "The difference between 'giving a rose' and 'giving a kiss': Sustained neural activity to the light verb construction". In: *Journal of Memory and Language* 73, pp. 31–42.

frequent light verb construction than the less frequent non-light construction.

There has only been one study investigating neural activity associated with light verb constructions. In an MEG study, Briem et al. (2009) carried out three experiments in German. They contrasted potential light verbs like *geben* ('give') with non-light verbs like *erwarten* ('expect'), either by themselves (Experiment 1), presented together with a subject pronoun (Experiment 2), or in object-verb-subject order (Experiment 3). In all experiments, light verbs (e.g. *geben*/'give') evoked less activity than non-light verbs (e.g. *erwarten*/'expect').

The authors interpreted these findings as reflecting reduced lexical processing due to the semantic underspecification of light verbs. However, there are several confounds that limit the interpretation of Briem and colleagues' study. First, the non-light verbs were both longer and more morphologically complex than the light verbs (the stimuli can be found in the appendix of Briem, 2009); both of these differences can explain the early effects in visual regions observed in all three experiments. Also, in the second experiment, several of the pairings between the non-light verbs and subject pronouns resulted in ungrammatical phrases, which is likely to have contributed to increased neural activity (see Friederici and Frisch, 2000). Finally, the object-verb-subject word order in the third experiment is very uncommon in German, so it is difficult to generalize the results to more naturalistic language comprehension. Moreover, because the authors did not analyze activity after the verb, any effects of argument sharing associated with light verb constructions may have been missed altogether – for example, under the Parallel Architecture, one would expect effects from argument sharing on the post-verbal subject, which would have received a semantic role from the object.

2.2.1 Event-Related Potentials and the Present Study

In the present study, I used a different technique – measuring event-related potentials (ERPs) – to explore the time-course and nature of processing light verb constructions. Of most relevance to this study are three groups of ERP components, summarized below.

First, the N400 is a negative-going potential peaking at approximately 400ms post stimulus onset, and which is thought to reflect the retrieval or access to semantic features associated with an incoming word (Kutas and Federmeier, 2011). In sentence and discourse contexts, the amplitude of the N400 reflects the match or mismatch between the semantic features associated with this word and those activated by context. The N400 therefore tends to be smaller to words that are lexically predictable versus unpredictable in relation to their context, with predictability usually operationalized using cloze probability (Federmeier et al., 2007; Kutas and Hillyard, 1984).

Second, the P600 is a positive-going potential, which usually appears between 500 and 900 ms post stimulus onset. While this waveform was originally characterized as being most closely linked to syntactic violations and ambiguities (Hagoort, Brown, and Groothusen, 1993; Osterhout and Holcomb, 1992), it is also seen when the linguistic input is highly semantically implausible or incoherent (for reviews, Bornkessel-Schlesewsky and Schlesewsky, 2008; Kuperberg, 2007; Van de Meerendonk et al., 2009, and Kuperberg, 2013, for a recent discussion).

Finally, a set of anteriorly-distributed negativities have been associated with working memory operations required to maintain, link and select sentential and discourse constituents during online processing (e.g. King and Kutas, 1995; Müller, King, and Kutas, 1997; Nieuwland and Van Berkum, 2008a). Of most relevance to this study is emerging evidence that a set of prolonged negativity effects, starting at approximately 500 ms post stimulus onset and lasting for several hundred milliseconds, may be associated with the computation of plausible but complex event representations. For example, Baggio, Lambalgen, and Hagoort (2008) reported a sustained anteriorly distributed negativity beginning at approximately 450 ms after the onset of sentence-final verbs that signaled that an anticipated ongoing event (writing a letter) was prematurely terminated (by spilling coffee on the paper).

A similar pattern was observed by Bott (2010) who reported a sustained anterior negativity starting at 500 ms after the onset of critical words that signaled an additional event had taken place. And, in a recent study, Paczynski, Jackendoff, and Kuperberg (2014) observed a late-onset sustained negativity effect in association with iterative aspectual coercion, in which a punctive action (e.g. *pounce*)

must be repeated for a period of time, specified by the preceding context. I will return to a more complete analysis of these studies in the Discussion section. For now, note that in all three studies, the meaning of the events described cannot be derived solely from combining the meanings of the individual words with the surface syntactic structure; rather the elements in the sentence need to be (re)-combined in a non-canonical way in order to arrive at a meaningful final sentence interpretation. In the present study, I measured ERPs as participants read three types of sentences: light verb constructions, non-light constructions, and anomalous constructions (see Table 2.1). I used German sentences with verb-final ordering, which allowed us to examine processing on the verb, after the presentation of all arguments. In the light verb constructions, a light verb was combined with an eventive noun (*eine Ansage machte*, i.e., 'made an announcement'). The non-light sentences used the same light verb, but paired it with a non-eventive noun (*einen Kaffee machte*, i.e., 'made a coffee'), which resulted in a non-light construction. Finally, the anomalous constructions used the same verb, but paired it with an abstract noun that, in most cases, could be combined with a different light verb, but that rendered the overall construction ungrammatical (**ein Gespräch machte*, i.e., 'made a conversation'; note that this construction is unacceptable in German; an English example would be **make a nap*). I examined ERPs evoked by the verb in each type of sentence. As the verb was identical across the three experimental conditions, any effects would necessarily arise from the combination of the verb with its arguments, rather than the lexical properties of the verb itself.

My main focus was the contrast between the light and non-light constructions. As noted above, light verb constructions tend to be more frequent and thus more predictable than non-light constructions, which could potentially make them easier to process. The critical question was whether, despite their higher frequency and predictability, I would see evidence of argument sharing in the light verb constructions, as predicted by the Parallel Architecture (Culicover and Jackendoff, 2005). This might manifest as a late sustained negativity effect, similar to that previously observed in association with complex semantic operations involving the maintenance, computation and/or selection of non-canonical event structure representations within working memory (e.g. Baggio,

Context sentence:	
German:	Das Flugzeug war bereits hoch über den Wolken.
English (literal):	The airplane was already high in the sky.
(1) Non-Light construction:	
German:	Als die Stewardess einen *Kaffee* machte
English (literal):	When the stewardess a coffee made
(2) Light Verb construction:	
German:	Als die Stewardess eine *Ansage* machte
English (literal):	When the stewardess an announcement made
(3) Anomalous construction:	
German:	*Als die Stewardess ein *Gespräch* machte
English (literal):	*When the stewardess a conversation made
Continuation of each sentence:	
German:	…ging gerade die Sonne auf.
English (literal):	...was just rising the sun.
English word order:	"When the stewardess made a(n) coffee/announcement/*conversation, the sun was just rising."

Table 2.1: Example sentences in German, English literal translation, and English SVO word order translation. Note that (3) is anomalous and unacceptable in German, due to semantic restrictions. The sentences within one set only differed at the object noun (italicized here). The critical verb (underlined here), to which ERPs were measured, did not differ between the three types of construction.

Lambalgen, and Hagoort, 2008; Bott, 2010; Paczynski, Jackendoff, and Kuperberg, 2014).

With regards to the contrast between light verb constructions and anomalous constructions, I predicted that the anomalous verbs would produce a P600 effect, similar to that previously observed in association with the detection of other violations of overall propositional coherence (see Kuperberg, 2007, 2013 for reviews), which may or may not be accompanied by an N400 effect.

2.2.2 Methods

2.2.2.1 Materials

One-hundred-and-twenty German scenarios were constructed, each with three conditions, as shown in Table 2.1. In each scenario, the first sentence provided some context and was the same across the three conditions. The second sentence began with a subordinate clause, allowing for verb-last word order. These subordinate clauses contained either (a) a light verb construction, (b) a non-light construction using the same verb, (c) or a noun and a light verb in a combination that yielded an anomalous construction.

Each of the sentences began with a subordinate conjunction, followed by the subject, optionally an adverbial phrase and an indirect object, and finally the critical noun and verb ('announcement made/coffee made/*conversation made'). After the critical verb, the main clause began with its main verb, followed by the rest of the sentence. Thus, the three conditions only varied at the noun; all other words were held constant (see Table 2.1 for example sentences, and Appendix A for a full list of stimuli). Since the number of verbs that can enter light verb constructions is limited, I repeated the verbs up to eight times within a set, in all three conditions.

2.2.2.2 Norming of stimuli

Frequency. The frequencies of nouns and verbs were retrieved from the DWDS corpus (Das Digitale Wörterbuch der deutschen Sprache des 20. Jahrhunderts), which consists of a total of 100 million words (Geyken, 2007). On average, the nouns in light verb constructions appeared 1,314 times (SD=1,709), the nouns in non-light constructions 1,360 times (SD=1,749), and the nouns in anomalous constructions

1,396 times per million tokens (SD=1,710). There were no significant differences in noun frequency between conditions (all comparisons: *t*s<.28, all *p*s>.78).

Noun-Verb Bigram Frequency. I also used the same database to retrieve the co-occurrence frequency of the nouns and the verbs, that is, how often the nouns and verbs occurred together in the same syntactic configuration as in my stimuli: for light verb constructions, this was 1.33 per million tokens (SD=.45); for non-light constructions, it was .1 per million tokens (SD=.21); and for anomalous constructions, it was .18 per million tokens (SD=.65). The nouns and verbs used in the light verb constructions thus occurred more often together than the nouns and verbs used for anomalous and non-light constructions (*t*s>.25, *p*s<.02); there was no difference in noun-verb co-occurrence frequency between the non-light and anomalous conditions (t=.77, p>0.44).

Cloze. A cloze probability study was carried out with 162 German native speakers (58 males; average age: 28) who did not take part in the ERP experiment and who gave informed consent. The scenario stems (the context sentence and the main sentence up to and including the object) were randomized across three lists using a Latin Square design. The lists were then subdivided into three, and every participant was presented with one of the nine lists. Each sentence stem ended with an ellipsis (…) indicating that the sentence continued, and participants were asked to write the most likely next word.

Cloze probabilities for each of the three conditions were calculated based on the percentage of respondents who produced a word that matched the light, non-light, or anomalous verb exactly. As expected, cloze was highest for the light condition, 53(35) %, lower for the non-light condition, 20(28) %, and zero (0) for the anomalous condition. Pairwise contrasts revealed significant differences in cloze probability between each of the three conditions (all *t*s>6, all *p*s<0.0001).

Lexical Constraint. From the cloze data, I also calculated the lexical constraint of the contexts in each construction. This was computed as the number of instances of the most frequent response over all responses (see Federmeier et al., 2007). Lexical constraint differed significantly across the three constructions (F(2, 357)=16.07, p<0.001), because as expected, the contexts of the light verb construc-

tions were significantly more lexically constraining, 62(25) %, than the contexts of both the non-light constructions, 42(24) %, and the anomalous constructions, 45(23) %, *t*s>2.9, *p*s<0.0001. There were no significant differences in contextual constraint between the non-light and anomalous constructions ($t(119)=1.4$, $p>0.15$).

Plausibility Ratings. Plausibility ratings were collected from a different set of 58 German native speakers (18 male; mean age: 26.7 years), who also did not take part in the ERP experiment and gave informed consent. List creation and randomization was the same as for the cloze ratings. Each sentence stem ended with the verb, followed by "..." to indicate that the sentence continued, and participants were asked to rate the scenarios up to and including the verb for plausibility on a scale from 1 (implausible) to 7 (plausible). Sentences with light verb constructions received an average rating of 5.8 (0.98), non-light constructions received an average rating of 5.6 (1.15), and anomalous sentences received an average rating of 2.8 (1.33). There were significant differences across the three conditions ($F(2, 357)=254.67$, $p<0.001$), but this was driven by the implausibility of the anomalous sentences relative to both the light sentences ($t(119)=20.6$, $p<0.0001$) and non-light sentences ($t(119)=-17.2$, $p<0.0001$); there was no difference in plausibility between light and non-light sentences ($t(119)=1.8$, $p>0.5$). Thus, the light and non-light sentences were matched on plausibility.

In the ERP experiment, the 360 scenarios were counterbalanced across three lists, using a Latin Square design. Each participant thus saw 40 instances of each of the three constructions (120 scenarios in total), but never encountered a given scenario more than once. However, across all participants, each scenario was seen in all three conditions. Eighty filler scenarios were then added to each list: 20 were semantically and syntactically normal, and 60 introduced a semantic anomaly in the final part of the second sentence. Thus, in each list, half of the scenarios were normal and half of the scenarios contained a semantic anomaly, the majority of which occurred towards the end of the second sentence, ensuring that participants read to the end of each two-sentence scenario.

2.2.2.3 Participants

Twenty native German speakers (8 male; mean age: 27.3 years) participated in the ERP experiment. All participants were right-handed and had normal or corrected-to-normal vision, were not taking any medication, and were screened to exclude a history of psychiatric or neurological disorders. They provided written consent before participating, as specified by the guidelines of the Tufts University Institutional Review Board, and received $20 for their participation.

2.2.2.4 ERP Procedure

Each participant was randomly assigned to one of three lists and was given six practice trials at the beginning of the experiment. All stimuli were presented visually. Each two-sentence trial began with presentation of a fixation cross at the center of the screen for 450 ms, followed by a 100 ms blank screen, followed by the context sentence, presented as a whole and displayed for 800–1600 ms, depending on length. After the context sentence, a fixation cross was again presented for 450 ms, followed by a 100 ms blank screen, and then the second sentence was presented word-by-word (450 ms per word; interstimulus interval: 150 ms), followed by a question mark. At this point, participants judged whether or not the scenario they had just read was a natural sentence in German. They were told that sentences may not be natural for different reasons, and if sentences seemed odd in any way, they should indicate that it wasn't natural. For the light and non-light constructions and for the normal filler sentences, the expected answer was yes; for the semantically anomalous constructions and for the anomalous fillers, the expected answer was no, so that in total, every participant ideally judged half the sentences to be acceptable, and half to be unacceptable. After making their judgments, participants pressed a button to move on to the next trial. Each list contained four blocks.

2.2.2.5 EEG Acquisition

Twenty-nine tin electrodes were held in place on the scalp by an elastic cap, see Figure 2.1. Electrodes were also placed below the left eye and at the outer canthus of the right eye to monitor vertical

and horizontal eye movements, and on the left and right mastoids. Impedance was kept below 5 kΩ for all scalp electrode sites, 2.5 kΩ for mastoid electrode sites and 10 kΩ for the two eye channels. The EEG signal was amplified by an Isolated Bioelectric Amplifier System Model HandW-32/BA (SA Instrumentation Co., San Diego, CA) with a bandpass of 0.01 to 40 Hz, and was continuously sampled at 200 Hz by an analogue-to-digital converter. A digitizing computer simultaneously monitored the stimuli and behavioral responses.

2.2.2.6 Data Analysis

Response congruency was computed as the percentage of responses that matched my prior classifications. A congruent response was considered a judgment of the light verb, non-light constructions, and normal fillers as acceptable, and the anomalous constructions and the violated fillers as unacceptable.

Averaged ERPs were time-locked to the onset of the critical verbs. They were formed off-line from trials free of ocular and muscular artifact, and were quantified by calculating the mean amplitude (relative to a 50 ms peri-stimulus baseline) in time windows of interest. On the verb, two main time windows were chosen: 300–500 ms to capture the N400 component and perhaps the beginning of an anterior negativity effect, and 500–900 ms (the relevant time frame for sustained negativities and the P600). I also ran analyses for the same time windows from the onset of the preceding noun, to determine whether there were any carryover effects to the critical verbs, and for the 50–200 ms and 200–300 ms time windows from verb onset to determine whether there were any early effects.

The scalp surface was subdivided into regions along the anterior-posterior distribution, at both mid and peripheral sites (each region contained 3 electrode sites, see Figure 2.1). Two omnibus analyses of variance (ANOVAs), one covering mid regions and another covering peripheral regions across the scalp, were conducted in each time window. In the mid-regions ANOVA, Construction and Region were within-subjects factors; in the peripheral regions ANOVA, Hemisphere was an additional within-subjects factor. Significant main effects of Construction or interactions between Construction and Region (and/or Hemisphere) were followed up by carrying out ANOVAs comparing each type of Construction with one another.

Any further interactions between Construction and Region were then followed-up by examining the effects of Construction in each three-electrode Region individually. In all analyses, the Geisser-Greenhouse correction was used in cases with more than one degree of freedom in the numerator (Greenhouse and Geisser, 1959) to protect against Type I error resulting from violations of sphericity. In these cases, I report the original degrees of freedom with the corrected p value, using a significance level of α=0.05.

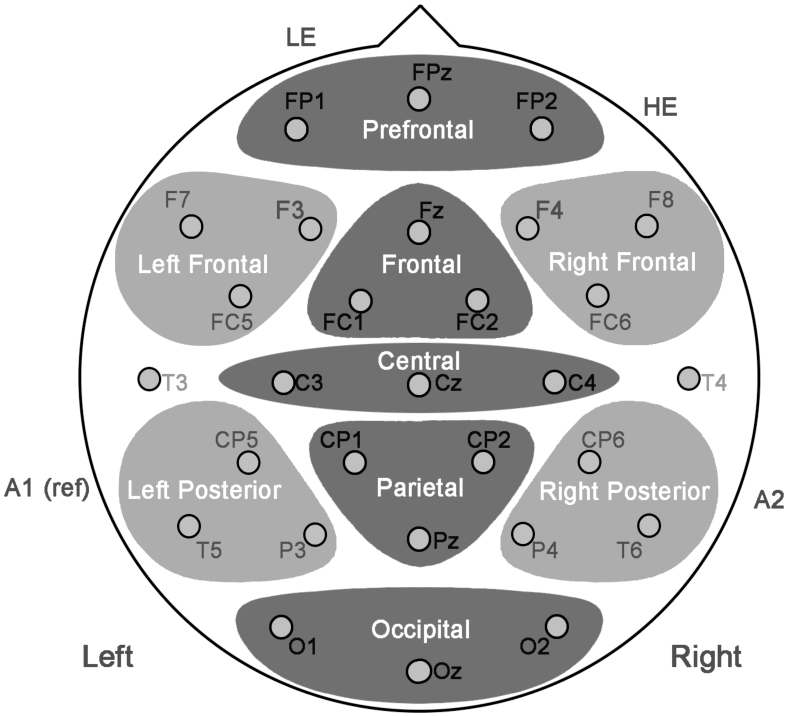


Figure 2.1: Electrode montage with regions used for analysis. Regions in dark grey were part of the mid-regions omnibus ANOVA and regions in light grey were part of the peripheral regions omnibus ANOVA. The Left Frontal and Right Frontal regions together constituted the Frontal Peripheral regions, and the Left Posterior and Right Posterior Regions constituted the Parietal Peripheral regions.

2.2.3 Results

2.2.3.1 Behavioral Data

Response congruency with my a priori classifications did not differ significantly between light verb constructions, 72(4.1) %, non-light constructions, 69(3.9) %, and anomalous constructions, 75(6.2) %, $F(2, 51)=1.54$, $p=0.22$. Similar response congruency was found for the filler scenarios that contained violations, 88(5.5) %, and those that did not contain violations, 76(1.4) %.

2.2.3.2 ERP Data

Approximately 8.8 % of the critical trials were rejected due to artifact. There was no significant difference in rejection rates across conditions, $F(2,51)=0.04$, $p=0.97$. All ERP analyses reported are based on correctly classified trials only. Similar results were obtained when analyses were repeated including all trials. Additionally, I also carried out ERP analyses on a subset of scenarios in which the level of contextual constraint was matched across the three condition; again, these analyses yielded results similar to the main analyses, and are thus not reported separately.

Nouns. ERPs evoked by the object nouns were similar across the three construction types. Omnibus mid-regions and peripheral regions ANOVAs revealed no significant main effects of Construction and no interactions between Construction and Region and/or Hemisphere in either the 300–500 ms window (all Fs<0.44, all ps>0.63) or the 500–900 ms time window (all Fs<0.88, all ps>0.42).

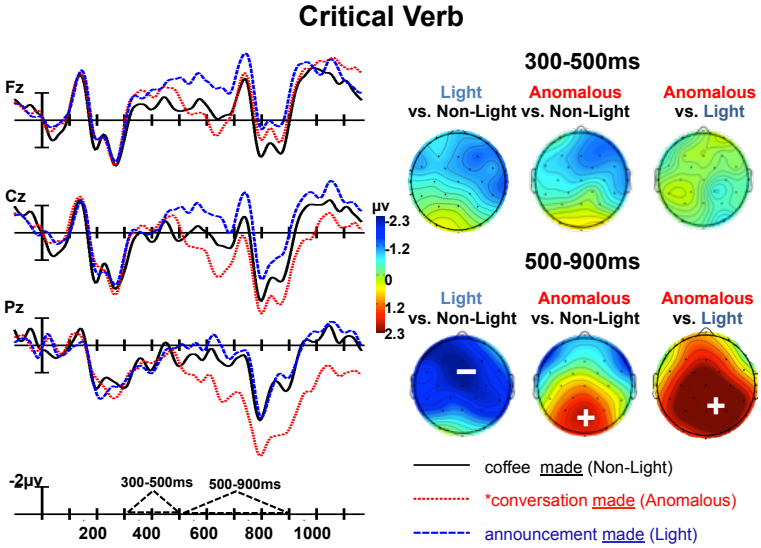


Figure 2.2: *Left:* Grand-averaged waveforms to critical verbs in all three sentence types at Fz, Cz, and Pz. Solid lines indicate non-light sentences; dotted lines indicate anomalous sentences; dashed lines indicate light verb construction sentences. The plots are shown using a 50 ms peri-stimulus baseline. *Right:* Voltage maps show differences between ERPs to critical verbs between 300 and 500 ms and between 500 and 900 ms. The scale is valid for all voltage maps; a minus or plus sign on the voltage map indicates significant differences (see Results section for details).

Verbs.

Early Effects. There were no significant main effects of Construction and no interactions between Construction, Region and/or Hemisphere in either the 50–200 ms (all Fs <0.47, all ps>0.62) or the 200–300 ms (all Fs<1.33, all ps>0.27) time windows.

300–500 ms. As shown in Figure 2.2, there was little divergence between the waveforms evoked by the verbs within the N400 time window, and indeed there were no significant main effects or interactions (see Table 2.2 for statistics). Because previous work on enriched composition has sometimes reported shorter-lived effects within the N400 time window (e.g. Brennan and Pylkkänen, 2008; Kuperberg, Choi et al., 2010), I also carried out analyses in successive 50 ms time windows between 300 and 500 ms, but found no significant main effects or interactions.

500–900 ms. In this time window, the waveforms to verbs in the three conditions diverged from one another (see Figure 2.2). These differences were reflected by main effects of Construction (mid-regions: ($F(2,34)=6.79$, $p=0.01$; peripheral regions: $F(2,34)=5.76$, $p=0.01$), as well as by interactions between Construction and Region (mid-regions: $F(8,136)=7.18$, $p<0.001$; peripheral regions: $F(2,34)=12.5$, $p<0.001$). I followed up these omnibus effects by carrying out pair-wise ANOVAs comparing each type of construction with one other.

The waveform to verbs in the light verb constructions was more negative-going than to verbs in the non-light constructions. This effect was widespread, as reflected by significant main effects of Construction in both the mid-regions and peripheral regions, but its magnitude varied across scalp region, as reflected by an interaction between Construction and Region in the mid-regions. Follow-ups in individual regions showed significant effects in the frontal and central regions, a near-significant effect in the parietal region, but no significant effect in the occipital region (see Table 2.2).

The anomalous constructions evoked a larger positive deflection than the non-light constructions. The magnitude of this positivity effect also varied across the scalp surface as reflected by significant

interactions between Construction and Region in both the mid-regions and peripheral regions. Follow-ups showed significant effects of Construction in the parietal and occipital regions, a near-significant effect in the peripheral parietal regions, but no effect in any other region (see Table 2.2).

As expected, the divergence of the positive-going waveform in the anomalous constructions from the negative-going waveform in the light verb constructions was statistically robust: there were main effects of Construction in both the mid-regions and peripheral regions, as well as a significant interaction between Construction and Region; the effect of Construction was significant in all but the prefrontal and frontal peripheral regions (see Table 2.2).

		300-500 ms		500-900 ms	
	Effect	*F (df)*	*p*	*F (df)*	*p*
A. Light vs. Non-Light					
Midline Omnibus	C	.64 (1, 17)	.43	6.69 (1, 17)	.02
	C × AP	2.03 (4, 68)	.16	4.22 (4, 68)	.03
Peripheral	C	1.62 (1, 17)	.22	10.27 (1,	.00
	C × AP	1.24 (3, 51)	.30	.85 (3, 51)	.43
Anterior Frontal	C	.85 (1, 17)	.37	4.83 (1, 17)	.04
Frontal	C	1.56 (1, 17)	.22	8.55 (1, 17)	.01
Central	C	1.59 (1, 17)	.22	8.22 (1, 17)	.01
Parietal	C	.11 (1, 17)	.75	3.27 (1, 17)	.08
Occipital	C	2.13 (1, 17)	.16	.37 (1, 17)	.55
Frontal	C	2.01 (1, 17)	.17	8.23 (1, 17)	.01
Parietal	C	.66 (1, 17)	.43	7.19 (1, 17)	.01
B. Non-Light vs. Anomalous					
Midline Omnibus	C	.88 (1, 17)	.36	1.71 (1, 17)	.21
	C × AP	2.01 (4, 68)	.15	13.78 (4,	.00
Peripheral	C	2.24 (1, 17)	.15	.11 (1, 17)	.75
	C × AP	1.94 (3, 51)	.15	16.01 (3,	.00
Anterior Frontal	C	1.45 (1, 17)	.24	2.05 (1, 17)	.17
Frontal	C	1.52 (1, 17)	.23	.06 (1, 17)	.81
Central	C	1.36 (1, 17)	.26	1.62 (1, 17)	.24
Parietal	C	.21 (1, 17)	.65	4.84 (1, 17)	.04
Occipital	C	.83 (1, 17)	.37	11.61 (1,	.00
Frontal	C	2.72 (1, 17)	.12	2.45 (1, 17)	.14
Parietal	C	1.06 (1, 17)	.32	4.16 (1, 17)	.05
C. Light vs. Anomalous					
Midline Omnibus	C	.04 (1, 17)	.84	16.13 (1,	.00
	C × AP	.23 (4, 68)	.72	5.67 (4, 68)	.01
Peripheral	C	.04 (1, 17)	.84	9.96 (1, 17)	.00
	C × AP	.32 (3, 51)	.74	7.49 (3, 51)	.00
Anterior Frontal	C	.00 (1, 17)	.94	1.27 (1, 17)	.27
Frontal	C	.00 (1, 17)	.96	11.9 (1, 17)	.00
Central	C	.00 (1, 17)	.96	18.59 (1,	.00
Parietal	C	.04 (1, 17)	.85	17.69 (1,	.00
Occipital	C	.72 (1, 17)	.41	9.17 (1, 17)	.01
Frontal	C	.03 (1, 17)	.86	1.46 (1, 17)	.24
Parietal	C	.04 (1, 17)	.84	19.02 (1,	.00

Table 2.2: ANOVAs comparing ERPs evoked by the critical verb between 300–500 ms and 500–900 ms after their onset. C = main effect of Construction, C × AP = Construction × Anterior-Posterior distribution interaction. Significant effects and effects approaching significance are shaded.

2.2.4 Discussion

In this study, I examined the time-course and nature of processing light verb constructions using ERPs. Using German subordinate sentences with verb-final word order enabled me to directly examine neural activity at the verb – the point at which semantic roles are usually assigned and hence where I predicted the effects of argument sharing in light verb constructions to be most prominent. I contrasted light verb constructions with non-light and anomalous constructions (see Table 2.1). In the N400 time window, there were no significant differences in the waveforms observed to the three types of construction. Within the 500–900 ms time window, however, there was clear divergence in the waveforms evoked in the light verb constructions, relative to the other two conditions: the ERP to the light verb constructions was more negative-going than that to the other two constructions. This effect was widespread but with a frontal focus. The anomalous constructions elicited a posteriorly distributed positivity effect.

2.2.4.1 Light Verb Constructions

The divergence in neural activity to verbs in the light (versus the non-light) constructions cannot be attributed to lexical differences because identical verbs were seen in both construction types. It also cannot be an effect of differences in plausibility, as the two sentence types did not differ from each other in that measure. Spillover effects from the preceding object argument also cannot explain this effect, since there was no divergence between conditions before the verb appeared. The effect also cannot be reduced to differences in the lexical predictability of the verbs across the two constructions; less predictable words usually evoke a larger negativity than more predictable words within the earlier N400 time window (Kutas and Hillyard, 1984). In this study, however, the light verbs were actually more lexically predictable than the non-light verbs, as assessed through cloze ratings, and the divergence in waveforms was seen in a later 500–900 ms time window.

Finally, these findings are not easily explained by differences in lexical constraint between the light and non-light contexts prior to the verb: words that violate highly lexically constraining contexts

can evoke anteriorly-distributed late positivity effects (Federmeier et al., 2007). In this study, however, the lexical constraint of both constructions (49 %) was much lower than the average lexical constraint of the sentences used by Federmeier et al. (2007). Moreover, when I repeated all analyses in a subset of stimuli in which the light and non-light contexts were matched for lexical constraint, the effect remained significant.

One question that arises is whether the ERP effect observed to the light (versus non-light) constructions reflects a larger late anterior negativity effect to the light verb constructions or a larger late anterior positivity effect to the non-light constructions. This study alone cannot distinguish between these two possibilities.

However, there are several reasons why I think that it is more likely to reflect a late anterior negativity effect to the light verb constructions. First, as discussed above, late anterior positivity effects are typically produced by words that violate highly lexically constraining contexts (Federmeier et al., 2007), which was not the case here. Second, in the linguistic literature, light verb constructions are usually seen as the special cases, while the full, non-light versions of those verbs are the point of reference (Butt, 2003; Jespersen, 1954). I follow this theoretical assumption by treating the non-light constructions as the baseline condition. Third, my interpretation of this ERP effect as a late sustained anterior negativity effect is in line with an emerging ERP literature associating similar effects with the processing of plausible but non-canonical event structures, as I discuss next.

There are now several studies reporting late sustained negativity effects in association with processing non-canonical, complex event structures. First, Baggio, Lambalgen, and Hagoort (2008) reported a sustained anteriorly distributed negativity effect, beginning at approximately 450 ms after the onset of a verb that implied the interruption of an ongoing event, e.g. original Dutch: *Het meisje was een brief aan het schrijven toen haar vriendin koffie op het papier (*vs. *tafelkleed) morste*; English translation: 'The girl was writing a letter when her friend spilled coffee on the paper (vs. tablecloth)'. In this sentence, full integration of the verb establishes that the ongoing event (writing a letter) was not completed because coffee was spilled on the paper (rather than on the tablecloth).

Second, Bott (2010) observed a similar effect beginning at 500 ms after the onset of verbs that implied an additional event to the one explicitly stated – so-called additive aspectual coercion (e.g. original German: *In zwei Stunden hatte der Förster die Falle entdeckt*; English translation: 'Within two hours, the ranger had discovered the trap'), compared to the non-coerced control condition (e.g. original German: *Nach zwei Stunden hatte der Förster die Falle entdeckt*; English translation: 'After two hours, the ranger had discovered the trap'). In the first sentence, full integration of the verb establishes not only that the trap has been discovered, but that it was also being searched for.

Finally, in a recent study, Paczynski, Jackendoff, and Kuperberg (2014) observed a prolonged widely distributed negativity effect (also with an anterior focus), beginning at 500 ms after the onset of verbs that implied multiple iterations of a punctive event – so-called iterative aspectual coercion, e.g. *For several minutes (*vs. *After several minutes), the cat pounced on the rubber mouse*. In this sentence, full integration of the verb establishes that the cat did not just carry out a single pounce, but rather several pounces lasting for several minutes.

What all these constructions have in common – and what they also have in common with light verb constructions – is that the interpretation of the events cannot be simply derived from the meaning of the individual lexical items and the syntactic structure of the sentences: rather, the elements in the sentence need to be (re)-combined in a non-canonical way in order to arrive at a meaningful final interpretation of the events. In the case of interrupted accomplishments, there is a need to change the default event representation from a completed event to an aborted event, based on subsequent discourse information (Baggio, Lambalgen, and Hagoort, 2008); in the case of additive coercion, the event representation needs to be modified based on temporal information outside the verb's semantics (Bott, 2010); in the case of aspectual coercion, the aspect of the event is again derived from information outside of the verb's lexical semantics, that is, from the prepositional phrase (Paczynski, Jackendoff, and Kuperberg, 2014). And, finally, in the present study of light verb constructions, the event type and main meaning are not provided by the verb, but rather by the event nominal.

I suggest that, in all these cases, the sustained negativity effect reflects an extended process of integrating the incoming word in order to derive these non-canonical event structure representations. In the present study, I suggest that it involves reconciling the mismatch between semantic and syntactic argument structure so that argument structure of the noun (*kiss*) is layered onto that of the verb (*give*) and the referent of the subject acts both as the Agent of *give* and *kiss*, and the referent of the object acts both as the Recipient of *give* and the Patient of *kiss* – a process of argument sharing (see Chapter 4 for further discussion).

There are several possible mechanisms by which such argument sharing might proceed. One possibility is that it reflects a process of constructing a complex event structure only after attempting to construct a canonical event structure – similarly to encountering a semantic garden path. Another is that both a canonical and non-canonical event structure are active for a short time, and that comprehenders then select the non-canonical light verb construction by enhancing its activation and suppressing the canonical event structure. The latter account would be consistent with the findings presented in Chapter 4 that that light verb constructions can be associated with both canonical and non-canonical mappings between semantic and syntactic structure (two different event structures).

More broadly, it would also be consistent with previous studies that have associated prolonged anterior negativity effects with a process of selecting between alternative event structures, e.g. non-literal over literal event structures in comprehending novel metaphors (e.g. Coulson and Van Petten, 2007), cartoon stories (Nieuwland and Van Berkum, 2006, Experiment 1) and jokes (e.g. Coulson and Kutas, 2001), or between alternative predicted specific events (King and Kutas, 1995; Müller, King, and Kutas, 1997; Nieuwland and Van Berkum, 2008a). On either account, the anteriorly-distributed sustained negativity effect is likely to reflect the additional working memory demands of maintaining and manipulating these event structures to arrive at the final sentence meaning (see Wlotko and Federmeier, 2012, for other examples of anteriorly-distributed sustained negativity effects associated with working memory costs).

Importantly, I am not claiming that the type of sustained anterior negativity observed here, and in these previous studies, is specific to complex semantic operations in coming to event representation.

Sustained anteriorly distributed negativities have also been observed in situations where other types of constituents must be held within working memory to link elements within and across sentences (King and Kutas, 1995; Kluender and Kutas, 1993; Nieuwland and Van Berkum, 2008a,b; Van Berkum, Brown, and Hagoort, 1999; Van Berkum, Zwitserlood et al., 2003).

By the same token, I also do not think that all complex semantic compositional processes are necessarily associated with anteriorly distributed sustained negativity effects. For example, modulation on the N400 component has been reported in association with complement coercion (Baggio, Choma et al., 2010; Kuperberg, Choi et al., 2010): Complement noun-phrases in coerced sentences (e.g. *The man began the book. . .*) evoked a larger negativity between 300–500 ms than in non-coerced sentences (e.g. *The man read the book. . .*), which can be interpreted as primarily reflecting the semantic mismatch between an action-requiring verb like *begin* and the semantic features of the lexical item *book* at the point of the complement noun phrase.

2.2.4.2 Anomalous constructions

The anomalous constructions were created by pairing light verbs with abstract nouns that are usually associated with different light verbs, such as **give a nap* (compare *take a nap*). In contrast to acceptable light verb constructions, which evoked an anteriorly distributed negativity, anomalous constructions evoked a posteriorly distributed positivity – the P600. This P600 was similar to that previously reported by many groups (Hoeks, Stowe, and Doedens, 2004; Kim and Osterhout, 2005; Kuperberg, Caplan et al., 2006; Kuperberg, Kreher et al., 2007; Kuperberg, Sitnikova et al., 2003; Van de Meerendonk et al., 2009; Van Herten, Kolk, and Chwilla, 2005) to selection restriction violations occurring on verbs. A P600 effect is also seen on nouns that violate the selection restrictions of their preceding verbs, particularly in judgment tasks (e.g. Kuperberg, Choi et al., 2010; Paczynski and Kuperberg, 2011, 2012).

Although there is debate about the precise functional significance of this effect, there is some general agreement that it reflects additional analysis or reanalysis that is triggered when the parser computes a proposition, using all available linguistic information, and this is classified as being impossible or incoherent at the critical word

(see Bornkessel-Schlesewsky and Schlesewsky, 2008; Kuperberg, 2007; Paczynski and Kuperberg, 2012; Van de Meerendonk et al., 2009).

More specifically, it has been suggested that it is triggered by a conflict between a strong, high-certainty prediction for one specific type of event structure, and an incoming word whose integration violates this strong prediction, and that it reflects a process of updating the contents of working memory through bottom-up attempts to establish a new event structure (see Kuperberg, 2013, for a recent discussion of the posterior late positivity/P600 effect as being triggered by an event structure prediction error).

In the present study, I take the presence of the P600 to the light verbs paired with the wrong eventive nouns as evidence that the parser tried, but failed, to generate a coherent complex predicate. In other words, when successful, argument sharing was associated with an anterior negativity effect. However, when initial integration of the input yielded an event structure that conflicted with what was anticipated, this triggered additional analysis or reanalysis processes, which manifested as a posterior P600 effect.

2.2.5 Implications

This paper contributes to both the psycholinguistic and theoretical linguistic literatures. With respect to the ERP psycholinguistic literature, the finding that light verb constructions evoke a widely distributed negativity effect with an anterior focus between 500–900 ms adds to a growing body of evidence that certain complex semantic operations can engage quite different neurocognitive operations from the types of semantic feature matching that are thought to be reflected by modulation of the N400 component.

More specifically, I have suggested that it may reflect a process of computing semantically complex event structures, possibly involving the top-down selection of a non-canonical semantic-syntactic mapping (event structure). This is distinguished both from the N400 component, which is thought to reflect facilitated access or retrieval of the semantic features of a specific word that have been activated by the context, as well as from the P600 effect which may reflect a bottom-up attempt to come up with a novel event structure when a

strongly predicted event structure is violated by initial attempts to integrate the input.

At a theoretical level, my findings may help arbitrate between competing linguistic accounts of how light verb constructions are represented. This picture is inconsistent with theories which model light verb constructions as syntactically less complex (Folli, Harley, and Karimi, 2004; Hale and Keyser, 1993, 2002; see Wittenberg, Jackendoff et al., 2014, for detailed discussion): a syntactically less complex structure should result in reduced processing demands, even if one follows a more modern form of the Derivational Theory of Complexity (Lewis et al., 2013). In contrast, these data support models that consider both syntactic and semantic compositionality as contributing to the language architecture (Butt, 2010; Culicover and Jackendoff, 2005; Jackendoff, 1997, 2002; Müller, 2010; Müller and Wechsler, 2014).

In sum, I have shown that light verb constructions evoke a widely distributed, but frontally focused, sustained negativity effect between 500–900 ms after verb onset, despite being more frequent and predictable than non-light constructions. These data show how the study of a syntactically simple and common phenomenon can reveal complex underlying neural processes, yielding insights that are relevant for both linguistic theory and for understanding mechanisms of language comprehension.

2.3 Light Verb Constructions Require More Working Memory: Converging Evidence from a Cross-Modal Behavioral Study[2]

The ERP study described in Section 2.2.1 delivered important information about the neurocognitive processing signals that light verb constructions evoke in real-time. The result pattern, a widespread sustained negativity from 500–900 ms, points to a comprehension process that is demanding on working memory. This hypothesis is worth exploring. If it is true that light verb constructions place

[2] This section has been published, in very similar form, as Eva Wittenberg and Maria Mercedes Piñango (2011). "Processing light verb constructions". In: *The Mental Lexicon* 6.3, pp. 393–413.

high demands on working memory, then people should take longer to perform a secondary task when they are processing light verb constructions than when they are processing non-light constructions.

A previous study in English, Piñango, Mack, and Jackendoff, in press, tested basically this hypothesis, albeit from a different perspective. In Piñango et al.'s study, participants listened to three types of sentences: *Mr. Olson gave an order/gave an orange/typed an order to the produce guy*.

The first construction (*gave an order*) was a light verb construction; the second (*gave an orange*) was non-light, but used the same verb as the light verb construction ('Same Verb' condition); the third (*typed an order*) was non-light, using the same noun as the light verb construction ('Same Noun' condition). After the noun complement was heard, a visual probe, on which the participants were asked to make a lexical decision, appeared on the computer screen.

This methodology assumes that the load incurred by hearing and processing a sentence will interfere with executing the lexical decision task. Accordingly, the more taxing the primary task (sentence comprehension) is for working memory, the longer it should take to press the 'yes' button to make the lexical decision (secondary task).

Piñango et al.'s results showed that when comprehension is probed right at the offset of the object noun (e.g., *order*), participants were equally fast at simultaneously making a secondary lexical decision after hearing the light verb construction (*give an order*) as after hearing the non-light construction *type an order*. However, when the lexical decision probes were placed 300 ms after the offset of the object noun, reaction times to the lexical decision were significantly increased after hearing the light verb construction *give an order*, compared to after hearing the non-light construction *type an order*. This difference in reaction times was interpreted as the effect of increased semantic processing required by the additional integration of the argument structure of the verb and noun in the light verb construction (argument sharing).

Building on these findings, the present study, like the ERP study presented in Section 2.2, takes advantage of the Subject-Object-Verb (SOV) word order in German, which is the default word order in subordinate clauses. As mentioned before, SOV word order makes it possible to obtain reaction times at the verb ('an order give') instead of at the object noun ('give an order'). Since presumably, the

choice of verb determines whether the argument structures of noun complement and verb need to be integrated, argument sharing is expected to be observable after the verb has been retrieved.

2.3.1 Methods

Following Piñango, Mack, and Jackendoff (in press), the same cross-modal lexical decision task was used. As explained, the premise of this task is that the processing load incurred by interpreting the light, Same Noun, and Same Verb sentences (primary task) will interfere with executing the lexical decision (secondary task). The greater the computational complexity of a given primary task, the longer it should take to perform the corresponding lexical decision. Hence, the dependent variable was the reaction time (RT) to the lexical decision as a proxy for the processing load of a given condition.

The sentences were presented auditorily. RTs were obtained at two positions for each sentence at a given time, either immediately (right at the offset, 'Immediate Probe'), or 300 ms after the verb was heard ('Delayed Probe'). At either position, a letter-string (probe) was flashed on a computer screen for 400 ms. The participants then had to decide whether the probe was a German word or not. The time it took the participants to make this decision was recorded and constitutes the RT, the dependent measure of processing load (see Figure 2.3 for an illustration of the task).

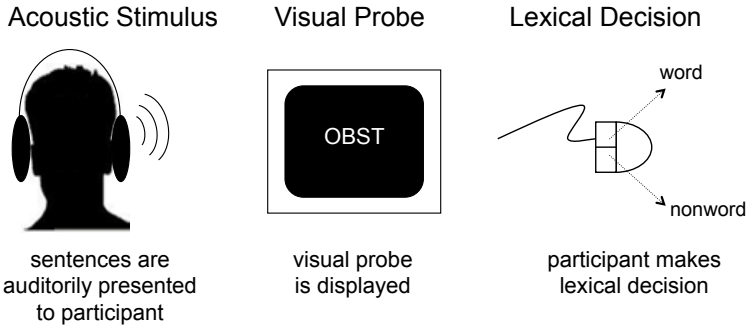


Figure 2.3: Illustration of the cross-modal lexical decision task. The subject hears a sentence; at the critical point, a visual probe is flashed on a computer screen, on which the subject performs a lexical decision.

2.3.1.1 Materials

I controlled for frequency of the critical verbs and nouns used (MacDonald, Pearlmutter, and Seidenberg, 1994). To this end, I used the German COSMAS II Corpus, which is a collection of written documents from Germany, Austria and Switzerland. I restricted the corpus to about 19 million words, excluding anything but newspapers from the past twenty years. The newspapers sample represented all regions of Germany (Institut für Deutsche Sprache, 1991–2010).

The corpus analysis of the selected verbs and nouns showed that overall the nouns of the light and Same Noun condition occurred more often than those used in the Same Verb condition (see Table 2.3). Also, the verbs in the light or Same Verb condition were much more frequent than the verbs in the Same Noun condition. In addition, the verbs were checked for numeric frequency and for sense frequency. The selected verbs occurred significantly more often in the light sense than in the literal sense (manually counted): Mean_{light}=127, $\text{Mean}_{SameVerb}$=20.3, Pearson correlation: .829, p>.05.

Moreover, the noun-verb co-occurrence frequency in the light interpretation was significantly higher than that of the other object-verb combinations: on average, the light verb interpretation occurred 51 times in the corpus, the Same Verb and Same Noun combination never or just once. In line with the findings for English, German frequency of the light condition was significantly higher than the Same Noun or Same Verb counterparts, both for the noun complement and verb separately, and in co-occurrence of the object and the verb.

	Object		Verb	
	Light/Same Noun	Same Verb	Light/Same Verb	Same Noun
Frequency	1441	282	4,250	712
Reaction Times	1,052ms	1,016ms	1,043ms	1,012ms

Table 2.3: Frequencies and reaction times to noun complements and verbs in isolation. While the differences in frequencies were significant, the differences in reaction times were not.

All verbs and nouns were pre-tested in an auditory lexical decision task, to get lexical decisions on them in isolation. Two-hundred-

fourteen letter strings, half of them existing German lexical items – among those all the verbs and nouns employed in the three conditions –, half of them nonce-words that respected German morpho-phonological restrictions, were recorded and presented to twenty native German speakers. The subjects were between 18 and 25 years of age with self-reported normal hearing. Reaction times for the lexical decision were measured from the onset of the word, using TEMPO (Motta et al., 2000–2004). Wrong answers and outliers more than three standard deviations from each subject's individual mean reaction time were removed from the data set, resulting in a 2.1 % loss.

Table 2.3 shows the mean reaction times to the lexical decision to nouns and verbs across conditions. An ANOVA revealed that the difference between mean reaction times to verbs in the light or Same Verb conditions compared to verbs in the Same Noun condition was not significant ($F(1, 19)=.21$, $p=.65$), and neither was the difference between the mean reaction times to objects in the light or Same Noun condition compared to verbs in the Same Verb condition ($F(1, 48)=1.04$, $p=.32$). These results show that reaction times for the relevant noun complements and verbs did not correlate with frequency measures across conditions (noun complements: Pearson correlation: 0.116, $p=.321$; verbs: Pearson correlation: 0.119, $p=.311$). Given that the experimental task is based on lexical retrieval, lack of correlation with frequency measures reassures us that any potential difference to be found between sentential conditions from the cross-modal lexical decision task cannot be attributed to unintended co-occurrence frequency, sense frequency, or morpho-phonological frequency factors.

The experimental sentences were composed into a script of 25 sets, as in shown in Table 2.4. (A full list of the stimuli can be found in Appendix B). For each set, verbs and noun complements were selected on the basis of the word pretest and the corpus analysis. Pretest reaction times of verb and noun complement were added to get an approximation of an accumulated processing load. If the conditions in a triplet were to differ in terms of this composed RT, this difference was always in favor of the light verb construction ($RT_{light}<RT_{nonlight}$), and never greater than 40 ms. This was done to avoid a potential confound created by differences in reaction time from the object noun and or from the verb in isolation, rather

than from the compositional process itself of building the light verb interpretation.

(1) Light Verb Construction:	
German:	*Weil der Student seiner Kommilitonin vor dem Seminar eine Zusammenfassung gab, spendierte sie ihm letzte Woche einen Kaffee.*
English (literal):	"Because the student to his fellow student before class a summary gave, she bought him coffee last week."
(2) Same Noun Construction:	
German:	*Weil der Student seiner Kommilitonin vor dem Seminar eine Zusammenfassung kopierte, spendierte sie ihm letzte Woche einen Kaffee.*
English (literal):	"Because the student for his fellow student before class a summary copied, she bought him coffee last week."
(3) Same Verb Construction:	
German:	*Weil der Student seiner Kommilitonin vor dem Seminar einen Kugelschreiber gab, spendierte sie ihm letzte Woche einen Kaffee.*
English (literal):	"Because the student to his fellow student before class a pen gave, she bought him coffee last week."
SVO:	"Because the student gave/copied an abstract/pen to his fellow student before class, she bought him coffee last week."

Table 2.4: Example Sentences in German, English literal translation, and English SVO word order translation. Note that the German dative (*seiner Kommilitonin*) can be translated into English both as 'for his fellow student' and 'to his fellow student'.

To maximize homogeneity within the light verb construction, all sentences had to meet the following criteria (see Chapter 1): First, the sentences could undergo passivization, second, the noun complement could be modified by adjectives or adverbs, and third, the verb phrase could undergo negation by the word *kein* ('none'). Additionally, all light sentences had to have a corresponding base

verb (e.g. *Kuss geben – küssen*; 'give a kiss' – 'to kiss'). Meeting these requirements ensured that the light verb constructions were syntactically minimally different from their non-light counterparts (Helbig and Buscha, 2001; Pottelberge, 2001; Zifonun, 1997).

The experimental stimuli were subjected to an acceptability test. Ten German native speakers judged them acceptable in a randomized questionnaire (acceptance rate: 98 %, with no significant difference between construction types; $p>.05$).

As required by the cross-modal lexical decision task, each sentence appeared with a different probe word. The probe words, which were matched within sets, were German words for which reaction times based on lexical decision had already been obtained (Wiese and Piñango, 2001). For each triplet, the probes were matched for reaction time within each set, and selected in a way that they were not semantically related to the sentence. Lack of semantic relatedness was confirmed to 99 % by 15 German native speakers in a separate test (see stimuli list in Appendix B for all experimental sentence-probe pairings).

Approximately half of the probes presented were words (including those created for the filler sentences) and half were nonce words that were created according to the phonotactics of German. Altogether this resulted in a final script of 250 sentences, half of which was paired with words (experimental sentences and filler sentences) and half with non-words (filler sentences).

Two pseudo-randomized lists for each position were constructed. The lists were created based on the following constraints: a) for each list, sentences of the Same Verb/Same Noun Constructions preceded the light verb construction only half of the time; b) three filler sentences were placed at the beginning of the list (to give the subject time to adjust to the rhythm of the task); c) no more than three consecutive sentences were followed by a filler with a nonword probe, and d) at least one filler sentence appeared between any two experimental sentences. Twenty comprehension questions were inserted into the script, each querying the immediately preceding filler sentence. Before and after each question there was at least one filler sentence.

In the Immediate Probe position, the probes to the experimental sentences were placed at the offset of the verb. In the Delayed Probe position, the probes to the experimental sentences were placed

300 ms after the offset of the verb. For all other sentences (fillers), the probes (word and nonword) were placed at various random points including the offset of the verb. Probes were triggered using TEMPO. A male native speaker of standard German recorded the sentences. All sentences were digitized at 22,000 samples per second.

2.3.1.2 Participants

Forty-four native speakers of German between the ages of 18 and 35 participated in this study. Twenty-two of them were randomly assigned to the Immediate Probe list (where probes appeared immediately after verb offset), and twenty-two of them were assigned to the Delayed Probe list. Eight of the subjects were tested in one position only, either Immediate Probe or Delayed Probe position. Sixteen of them were tested twice, i.e. in both positions; half of these were presented with the Immediate Probe position first, and half of them with the Delayed Probe position. For those subjects who were tested for both positions, at least three weeks passed between the two sessions. Each session lasted about 45 minutes.

2.3.2 Results

Participants were allowed a maximum of two seconds to respond to the probes. Two participants had to be excluded from the data analysis because their performance in word probes and comprehension questions was lower than 60 % (suggesting that they were not paying the required attention to the task). Eight data sets were also excluded due to problems with the word probes.

Figure 2.4 plots reaction times in for both probe positions. A repeated measures ANOVA reveals that the mean reaction time to lexical decisions after light verbs is similar to lexical decisions after Same Verb and Same Noun verbs ($F(2, 816)=.08$, $p=.91$).

For the delayed probe, the data show no significant difference in reaction time between conditions Same Noun and Same Verb. However, the reaction time for lexical decision in light verb constructions is significantly longer than that in the Same Noun and Same Verb Constructions. A repeated measures ANOVA reveals a significant main effect of condition between light, Same Noun, and Same Verb Constructions ($F(2, 798)=3.23$, $p=.04$), as well as between light and

Same Noun ($F(1, 532)=4.64$, $p=.03$) and light and Same Verb ($F(1, 532)=4.87$, $p=.03$).

For each position, and to rule out any idiosyncratic subject bias, we performed an ordinary least squares multivariate regression that decomposes individual subjects, each set and every condition into separate factors by including dummies for each of these variables. The results pattern with those from the ANOVAs: At the Immediate Probe position, no difference in RT is found for light, Same Noun, and Same Verb ($F(34,784)=11.61$; $p_{SameNoun}=.65$; $p_{SameVerb}=.69$). At the Delayed Probe position, however, there was a statistically significant effect showing that the light condition resulted in significantly slower reaction times than the Same Noun and the Same Verb conditions, RTs to which were similar to each other ($F(34,766)=7,15$; $p_{SameNoun}=.015$; $p_{SameVerb}=.013$).

The interaction between probe positions for the light verb constructions was significant (albeit marginally), which suggests that the difference in reaction times between Immediate Probe position and Delayed Probe position is robust ($F(40, 661)=6.86$; $p=.06$). No such effect was found for the Same Verb ($F(40, 661)=7.12$; $p=.99$) or the Same Noun conditions ($F(40, 661)=6.61$, $p=.38$). This confirms that the reaction times to light verb constructions were significantly different between Immediate Probe position and Delayed Probe position, but not those to Same Verb or Same Noun constructions.

2.4 Discussion

This study investigated people's reaction times to a secondary task while they were processing light verb constructions, or non-light constructions using the same verb, or the same noun. When the secondary task, a lexical decision, appeared immediately after the construction was heard, no differences in reaction times could be observed. When the lexical decision was triggered 300 ms after the construction was heard, reaction times after the lexical decisions were significantly longer than after the other two construction types.

This latter point, namely longer reaction times to the light verb construction, indicates that processing these constructions slows down working memory, so that the execution of a secondary task

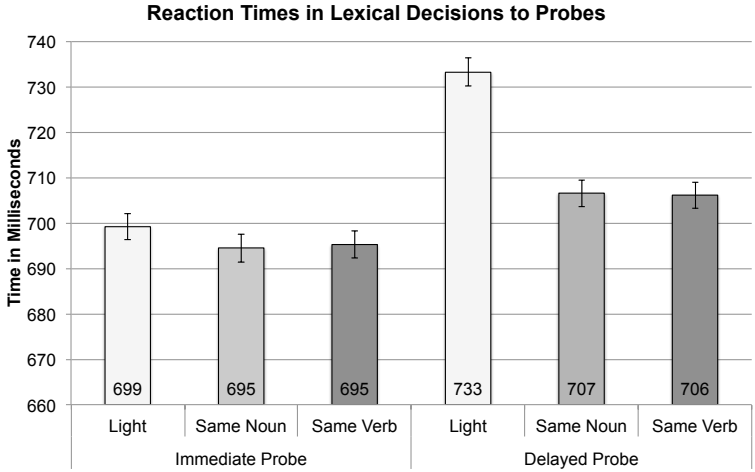


Figure 2.4: Reaction Times in Lexical Decisions to Probes, with Standard Errors.

is decelerated (see also Wittenberg, 2013, for detailed discussion). The other notable point, namely that this difference only showed up when the secondary task appeared 300 ms after construction offset, is interesting and warrants further study. In Wittenberg and Piñango (2011), we interpreted the absence of a difference at the Immediate Probe position, and the presence of the effect at the Delayed Probe position, as a reflection of the cost of light verb construction as being semantic in nature, as opposed to syntactic. From today's point of view, I have to concede that there are no definitive reasons that this might be the case. In particular, it is not entirely clear that syntactic complexity of any kind would lead to an increase in reaction time at an Immediate Probe position.

However, I do think that this data is valuable, since it delivers converging evidence for the interpretation of the ERP findings. I interpreted the sustained negativity elicited by light verb constructions as reflection of an increased demand in working memory, parallel to several studies that found similar result patterns after constructions that all taxed working memory. However, this interpretation was

based on purely observational grounds: The ERP study did not manipulate working memory demands in any way, to investigate whether this would influence processing. Now, the cross-modal lexical decision task did exactly this. In this task, working memory was engaged with processing sentences, when the lexical decision was demanded. The fact that processing light verb constructions, but not processing non-light constructions, resulted in longer reaction times, is indeed solid evidence that light verb constructions require more working memory than non-light constructions (another argument for this interpretation are the results presented in Wittenberg, 2013, using a simple self-paced reading task without additional demands on working memory).

This convergence of evidence translates even into the ERP findings. Light verb constructions were associated with a sustained negativity, starting at 500 ms after the verb was displayed. The reaction times to the lexical decision in the Delayed Probe position were measured 300 ms after verb offset; that is, assuming a length of 200–300 ms of the auditory presentation of the verb, the timing of the negativity effect, and the timing of the lexical decision in the Delayed Probe position, are roughly similar. Thus, although further testing would certainly be required to validate this conjecture, my interpretation of the ERP and lexical decision results is that they are both likely two branches of the same tree: An indication of an increased demand on working memory associated with the light verb construction.

Obviously, if there are different demands on working memory, these demands have to have their source somewhere in the mental encoding of the two constructions. The next section is presenting a structural priming study designed to locate these sources.

3 The Mental Representation of Light Verb Constructions

3.1 Introduction[1]

The experimental data in the previous chapter suggested that light verb constructions are processed differently than non-light constructions: When people listen to a sentence containing a light verb construction, they take longer to execute a secondary task than if they listen to a non-light construction. Reading light verb constructions as opposed to non-light constructions elicits a sustained, widespread negativity, something that has been associated with an increase in working memory demand.

Thus, as we have seen, light verb constructions are processed differently from non-light constructions. The question now is, where does this difference come from? There are indications that the processing difference might stem from the semantic level of representation, based on the semantic nature of the phenomenon: *giving a kiss* describes the same type of event as *kissing*, while *giving a book* is not even related to a *booking* event. Furthermore, the nature of the previous results points towards a more semantic explanation of the processing difference, too.

Nonetheless, there has been a long tradition in linguistics to describe the semantic differences between light and non-light constructions as a result of an underlying syntactic difference. For example, Hale and Keyser (1993, 2002) for English, or Gallmann (1999) for German, analyze the underlying syntactic representation for light verb constructions as fundamentally different from non-light constructions.

[1] This section draws from Eva Wittenberg, Ray Jackendoff et al. (2014). "The Processing and Representation of Light Verb Constructions". In: *Structuring the Argument.* Ed. by A. Bachrach, I. Roy, and L. Stockall. Amsterdam/Philadelphia: John Benjamins Publishing Co, pp. 61–80.

In Hale and Keyser's (1993; 2002) configurationally defined approach to argument structure, the correspondence between syntactic and semantic roles is strictly homomorphic with syntax as the generative engine (Levin and Rappaport Hovav, 2005) – that is, any difference between syntactic and semantic argument structure must be reflected in the syntax. This model views a surface verb like *jump* with an underlying structure [$_V$ [$_{DP}$ *jump*]], glossed as a light-verb-like construction like *do a jump* or *give a jump*. The verb (*do* or *give*) is regarded as 'abstract V' or, in some formulations, Larson's 1988 'little *v*'. By head-to-head raising, the nominal *jump* is incorporated or 'conflated' with the abstract verb to form the surface verb in its surface position.

Notice how in this approach, syntactic operations combine the abstract verb, whose only semantic content is its specification of argument roles, with the nominal, which provides the meat of the surface verbs' semantic content. It is not entirely clear whether these syntactic operations are seen as pre- or post-lexical insertion; one model by Folli, Harley, and Karimi (2004) for Persian light verb constructions assumes that it takes place after lexical insertion, and before spell-out (see also Jung, 2002, on Korean). A simplified derivation under Folli, Harley, and Karimi's (2004) mechanism is given in Example (3.1; see Wittenberg, Jackendoff et al., 2014):

(3.1) (a) Non-light verb *order*:

[V [$_{DP}$ *order*]] ⇒ [[V *order*$_i$] [$_{DP}$ t_i]] [by head movement]

(b) Light verb construction *give an order*:

[V [$_{DP}$ *order*]] ⇒ [[*give*] [$_{DP}$ *(an) order*]] [by spell-out]

(c) Non-light construction *give an orange*:

[V [$_{DP}$ *give*] [$_{DP}$ *an orange*]] ⇒ [[V *give*$_i$] [$_{DP}$ t_i] [$_{DP}$ *an orange*]]

[by head movement]

Example (3.1) emphasizes that in this approach, non-light and light verb constructions have fundamentally different syntax – both on the underlying pre-operational form (left of the arrow), and on the form that enters spell-out (right of the arrow). Thus, the degree of structural overlap is reduced between light and non-light constructions.

Gallmann (1999) comes to a similar conclusion for German light verb constructions. He argues that most light nouns are head adjuncts to the verb (Figure 3.1), while non-light nouns are arguments of the verb (Figure 3.2):

Figure 3.1: Gallmann's (1999) light verb construction analysis.

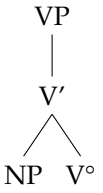


Figure 3.2: Gallmann's (1999) non-light construction analysis.

Thus, again, it is assumed that the difference in the semantics of light and non-light constructions is the result of syntactic differences, and the two constructions are structurally different from each other (different-syntax hypothesis). This viewpoint is without alternative if one assumes a one-to-one correspondence between syntactic and semantic levels; however, if one allows for independent yet connected mechanisms on these levels, then it would be unproblematic to assume that whilst two constructions might have the same syntactic representation, they can convey very different semantic structures (different-semantics hypothesis).

This chapter presents an experimental study to disentangle the different-syntax hypothesis and the different-semantics hypothesis. I am using the paradigm of structural priming (for an overview, see Pickering and Ferreira, 2008). In recent years, researchers have increasingly turned to that paradigm in order to identify the abstract representations that are used during sentence comprehension and production.

3.2 Structural Priming: A Paradigm to Test Shared Representations

Structural priming makes use of the fact that in language use, people tend to automatically repeat structures that they have encountered shortly before, which had been observed in linguistic corpora (Gries, 2005) and naturalistic dialogues (Branigan, Pickering, and Cleland, 2000; Pickering and Garrod, 2004). Through a series of studies, Bock and colleagues found evidence that syntactic representations can be primed independently of semantic influences, on an autonomous level, and based on surface syntax (Bock, 1986, 1989; Bock and Loebell, 1990; Bock, Loebell, and Morey, 1992).

For example, participants in Bock and Loebell's (1990) study heard and repeated sentences that contained different grammatical constructions; then, they described target pictures that could be described with a prepositional or a double-object dative construction. Bock and Loebell (1990) found that locative prepositional phrases, such as *The wealthy widow drove an old Mercedes to the church*, made people use more prepositional-object sentences, even when said object was not a locative, but a benefactive (*. . . gave an old Mercedes to the church*), compared to double-object datives (*. . . gave the church an old Mercedes*; lexical items were not repeated).

Also, numerous studies showed that syntactic priming happens independently, even though other factors, such as the amount of lexical overlap, animacy of the arguments and information structure do have an influence on priming effects (Bernolet, Hartsuiker, and Pickering, 2009; Bock and Loebell, 1990; Cleland and Pickering, 2003, 2006; Corley and Scheepers, 2002; Ferreira, 2003b; Hartsuiker, Pickering, and Veltkamp, 2004; Loebell and Bock, 2003; Pickering and Branigan, 1998; Scheepers, 2003; Schoonbaert, Hartsuiker, and Pickering, 2007; Thothathiri and Snedeker, 2008; Tooley and Bock, 2014; Traxler, 2008). Interestingly for the study presented here, the order of thematic roles and event semantics may influence priming effects as well (Chang, Bock, and Goldberg, 2003; Chang, Dell, and Bock, 2006; Pappert and Pechmann, 2013; Salamoura and Williams, 2007). However, this effect has only been observed when the order of semantic roles also overlapped with consistent morphosyntactic markers, such as case.

Thus, there is ample evidence that in structural priming, the driving factor is syntactic form, with indications of some lexical and semantic-conceptual influences. Thus, only if light verb constructions and non-light constructions differ in their syntactic representation should there be syntactic priming.

To test this, I used the dative alternation light and non-light constructions. Consider Examples (3.2) and (3.3):

(3.2) (a) *The mother is giving her son a hug.*
(b) *The mother is giving a hug to her son.*

(3.3) (a) *The mother is giving her son a book.*
(b) *The mother is giving a book to her son.*

First, the question is whether light and non-light constructions share the same syntactic structure. If their syntactic structures are different, then we should see no priming effect. If they are the same, we would expect robust, statistically significant bidirectional priming from light to non-light constructions, and vice versa (see white bars, Figure 3.3). If we do not find this pattern, there is strong reason to believe that light verb constructions and non-light constructions have no or little structural overlap in their syntactic configurations.

Second, it might be the case, as in Chang, Bock, and Goldberg (2003), Chang, Dell, and Bock (2006), and Salamoura and Williams (2007), that priming gets a boost when prime and target share the order of semantic roles. If this is the case, priming should be stronger within constructions: A non-light Source-Goal-Theme DO sentence should prime a Source-Goal-Theme picture description to be DO, too, but the semantic roles should have no effect on Agent-Patient picture descriptions. Conversely, a light Agent-Patient prime sentence should not exert any influence over Source-Goal-Theme picture descriptions on the level of semantic roles, but boost priming of other Agent-Patient pictures. This pattern is illustrated with the dark shaded bars in Figure 3.3.

Finally, it is possible that the structural priming paradigm profits from consistent mapping between the syntactic and semantic levels of representation. This hypothesis hinges on the task used in this priming study: In order to produce a prime, participants not only

had to read a sentence out loud, but also fully comprehend its meaning in order to successfully execute the memory distractor task. Then, the target pictures needed to be processed, in order to be described in a meaningful way, and the provided verbs (always *give* in the case of the critical pictures) provided a starting point for syntactic and semantic structure-building. Thus, a reasonable participant would likely focus on the meaning of a given prime, in order to recall whether she has seen it before, and not retain the syntactic form, if it does not support the semantic structure.

If this is true, then non-light sentences should be 'better' primes in general: Their syntactic structure (ditransitive) matches their semantic structure (Source-Theme-Goal; recall Figure 1.2). For a rational experiment participant, it would make sense to retain the syntactic structure in working memory because it supports the mental representation of the semantic structure. This, in turn, would lead to a higher priming effect due to higher residual activation in working memory: for 'non-light' Source-Goal-Theme picture descriptions both on the semantic and syntactic level, and for 'light' Agent-Patient picture descriptions at least on the level of syntax. I illustrated the 'mapping boost' with the lightly shaded bars in Figure 3.3.

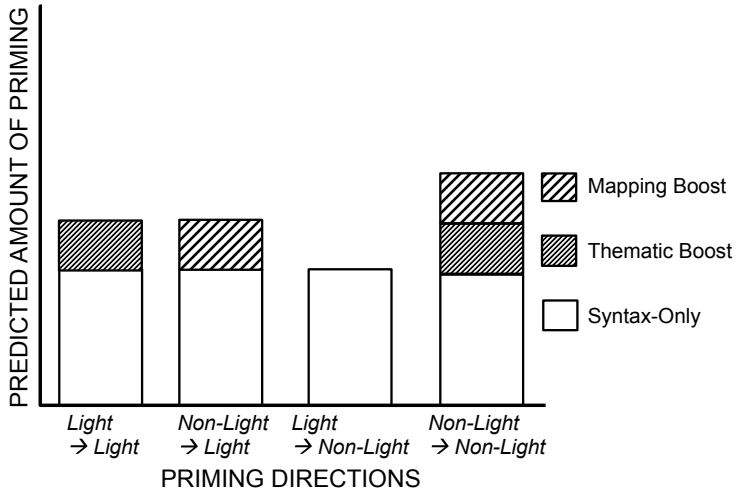


Figure 3.3: Predicted amount of priming depending on potential contributing factors. If syntactic structures between these constructions are the same, there is no difference in the predicted amount of priming (white bars, without thematic boost or mapping boost). If shared semantic roles boost priming (dense shading), such as Agent-Patient within *kissing* events, or Source-Theme-Goal within *giving* events, then there is increased within-constructions priming. Finally, if syntactic structure is only preserved in working memory when it supports the representation of meaning, then we would expect a 'mapping boost' (light shading) from non-light primes only.

Figure (3.3) illustrates the potential contributors to priming effects within and between constructions. Note that for simplicity's sake, I assumed additive effects that can occur in isolation, or together. Thus, if there is no shared syntactic structure that leads to priming, we could in principle still see priming effects from light to light, non-light to light, or non-light to non-light constructions, due to thematic or mapping boosts. If there is neither syntactic priming, nor a mapping boost, we can only expect within-construction priming (dark shaded bars). If there is only priming if syntactic and semantic structures match, then we can only expect priming if the primes are non-light (light-shaded bars).

3.2.1 Methods

3.2.1.1 Participants

Sixty-four English native speakers (22 male and 42 female; mean age: 21) were recruited from the Harvard student population and received study credit for their participation.

3.2.1.2 Materials

I constructed 20 non-light and 20 light sentences as primes. All sentences used *give* as their main verb. For the targets, we commissioned 20 pictures that showed a ditransitive scene, and 20 pictures that showed an Agent-Patient scene that could be described with a light verb construction.

Prior to the experiment, I obtained acceptability judgment on potential prime sentences. 60 English native speakers, recruited by Amazon Mechanical Turk, rated sentences on a scale from 1 to 5, where 1 was ungrammatical. We then matched light and non-light sentences, such that each sentence had a rating of 3.0 or higher in both PO and DO form. Only these sentences were included in the set of experimental items.

Each prime sentence was matched up with two pictures, one of which showed a transfer scene, and the other a contact scene. All pictures could be described using *give* as a main verb. Since it is very difficult to elicit light verb constructions, all pictures were displayed with the desired verb (*give*). The participants were instructed to use exactly the verb provided. Thus, for all experimental trials, both the prime sentence and the target picture used the same verb (see Figure 3.4 for illustration, and Appendix C for a full list of primes).

All pictures were black-and-white drawings, similar to Bock and Loebell's (1990 target pictures, and uniformly formatted to 640 x 480 pixels. To make sure that they were interpreted in the way I anticipated, I had 30 English native speakers, recruited by Amazon Mechanical Turk, name them. For the naming task, the pictures were displayed without the verb. Naming scores for each of the three conditions were calculated based on the percentage of respondents who produced a sentence that described the picture exactly, using the correct action, and naming the participants in the action accurately. The descriptions were coded as exact matches regardless of the

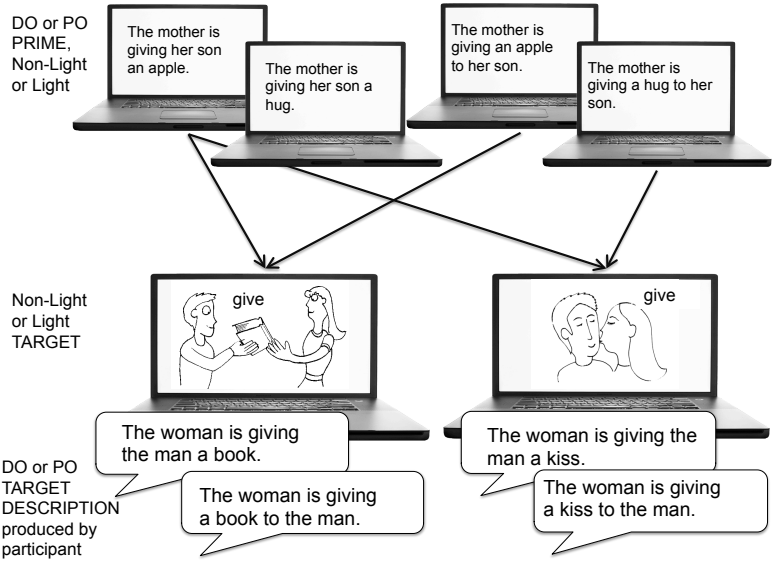


Figure 3.4: Method and materials for the priming experiment. PO = Prepositional Object, DO = Double Object.

syntactic construction used, e.g., *the boy is giving the girl a letter*, and *the girl gets a letter from the boy* were both coded as exact matches. For the 'light' pictures, the descriptions were scored as an exact match both if they were stated in a light verb construction (*the boy is giving the girl a kiss*), and in a non-light construction (*the boy kisses the girl*), since I was only interested in whether the depicted scene was correctly identified. The scores did not differ significantly between pictures with 'light' scenes (89 %) vs pictures with transfer actions (83 %), as an ANOVA confirmed ($F(1, 38)=2.6$, $p=.11$).

All manipulations were within subjects. The independent variables were prime form (PO or DO), prime condition (light or non-light), and target condition (light or non-light). The dependent variable was the proportion of DO structures produced on targets,

out of all dative constructions ($\frac{DO}{DO+PO}$). Every participant was exposed to every target picture, which was preceded by any of the four possible sentence forms. I constructed eight lists in which sentence forms and sentence types were fully crossed and counterbalanced, using two different pairings (see Figure 3.4).

Fifty-three filler pictures and 65 filler sentences were added to each list. The filler pictures depicted random scenes, containing both animate and inanimate objects, and events as well as states (see Figure 3.5 for examples). Similarly, the filler sentences varied in length, subcategorization frames, animacy of the participants, and event and state types. Each participant encountered 22 of the pictures and 35 of the sentences twice during the course of the experiment to support the cover story that the participants' primary task was to remember the pictures and sentences. Thus each participant saw a total of 140 sentences (including the 40 primes) and 115 pictures (including the 40 targets). The fillers were interspersed randomly between critical pairs.

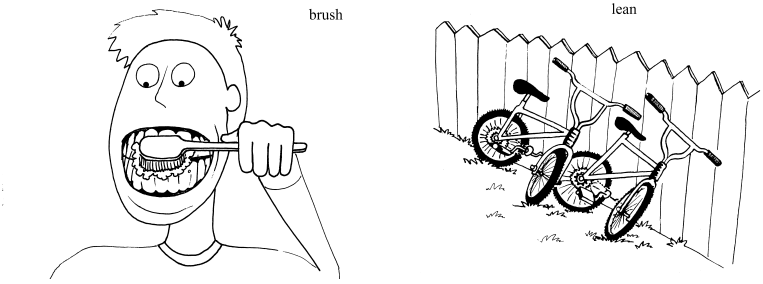


Figure 3.5: Examples of filler pictures for the priming study. Notice the verbs (*brush* and *lean*) that were provided with the pictures to elicit picture descriptions.

3.2.1.3 Procedure

Each participant was randomly assigned to one of the eight counterbalanced lists. Participants sat in front of a monitor and a microphone. Their task was to read out loud each sentence, and to give an accurate description of each picture using the verb that was provided with the picture. Participants were told not to use pronouns, to mention

every depicted character, and to be as precise as possible (see Figure 3.4 for an illustration of the procedure).

In order to mask the true purpose of the experiment, participants were asked to perform a distractor memory task and indicate whether they had seen the item before or not, by pressing an appropriate key on the keyboard. Each participant was given ten practice trials at the beginning of the experiment.

The sentences and pictures were presented on a computer monitor using ePrime (Schneider, Eschman, and Zuccolotto, 2002). Participants' verbal responses were recorded using a digital microphone. Responses to critical trials were also live-coded by the experimenter, who sat in a chair behind the participant. The responses to the memory distractor task were recorded by ePrime.

3.2.1.4 Coding

Following Bock and Loebell (1990), I coded a description as a prepositional dative (PO) if it contained a ditransitive verb followed first by the Theme as the direct object and then by the Recipient as a prepositional object, and I coded it as a double-object dative (DO) if it contained a ditransitive verb followed by the Recipient first, and then the Theme, with neither occurring in a prepositional phrase. All other forms were discarded from the analysis. In total, 2,338 of the 2,560 produced target descriptions (91.3 %) were dative constructions and thus entered our analysis. The variables were contrast-coded.

The data were analyzed by a generalized linear mixed effects model for binomial distributions (Baayen, Davidson, and Bates, 2008), with prime condition (light or non-light), target condition (light or non-light) and prime form (DO or PO) as fixed effects. Including random intercepts for subjects and items, and linear slopes for both prime form and condition by prime form for both participants and items, significantly improved model fit ($\chi^2(25)=56.28$, $p<0.0001$). With these, the effective overall model fit was $R^2=0.21$.

3.2.2 Results

No participants, and no items, were excluded for the analysis. A post-test questionnaire confirmed that none of the participants doubted the cover story, or realized the true purpose of the experiment.

As Table 3.1 and Figure 3.6 show, there was a substantial priming effect from DO primes to DO targets, regardless of the prime and target conditions: DO targets were produced more often after DO primes (70–88 %) than after PO primes (43–66 %). Accordingly, the regression model finds a main effect of prime form (z=4.5, p<.0001). Thus, I have demonstrated that priming can occur across constructions with different degrees of semantic transparentness.

In addition, the model shows that the target condition (non-light or light) had a significant influence on priming, too (z=2.8, p<.005). Also, there was a marginally significant three-way interaction between prime condition, target condition, and prime form (z=1.8, p=.06). That is, there was most priming from non-light primes to non-light targets (41 %, p<.0001), still a large priming amount from non-light primes to light targets (24 %, p<.001) and from light primes to light targets (21 %, p<.0001), and a smaller, yet robust priming amount from light primes to non-light targets (11 %, p<.01). The prime condition, however, had no significant influence on the target form (z=.53, p>.58), and there were no other interactions between the fixed effects.

Target Condition	Prime Condition	Prime Form	Mean % of DO	SD	Amount of Priming
Light	*Non-Light*	*DO*	88 %	33 %	
		PO	64 %	48 %	24 %
	Light	*DO*	85 %	36 %	
		PO	66 %	48 %	19 %
Non-Light	*Non-Light*	*DO*	85 %	36 %	
		PO	43 %	50 %	42 %
	Light	*DO*	70 %	46 %	
		PO	59 %	49 %	11 %

Table 3.1: Percentage of Double-Object target descriptions (DO), with Standard Deviations (SD) in the last column. The amount of priming indicates the difference between DO target descriptions following DO primes and DO target descriptions following PO primes.

However, applying the regression equation (without target condition as fixed effect) to non-light targets only, there were main effects and an interaction of prime form and prime condition (prime form: z=-3.1, p<.002, prime condition: z=2.12, p<.04, interaction: z=-2.6, p<.01), confirming the visual impression that priming was stronger from non-light primes to non-light targets than from light primes; thus, the difference between the 42 % and the 11 % priming effects in Table 3.1 is significant. For light targets, however, there was only a significant effect of prime form (z=-3.9, p<.001), but no effect of prime condition (z=1.1, p>.27) and no interaction (z=-1.3, p>.17). Thus, it did not influence the production of light targets whether the prime had been light or non-light (19 % vs 24 % priming, Table 3.1).

Considering only light primes, the regression (without prime condition as fixed effect) reveals that there were significant effects of both the prime form (z=-4.3, p<.001) and the target condition (z=-2.8, p<.01), but no significant interaction of prime form and target condition (z=1.31, p>.25). Thus, priming from light primes to light targets (19 %) was significantly more than from light primes to non-light targets (11 %). The same goes for priming from non-light primes to non-light targets (42 %), which was significantly more than from non-light primes to light targets (24 %; effect of prime form: z=-5.9, p<.0001; effect of target condition: z=1.91, p<.05; no significant interaction: z=-0.6, p>.53).

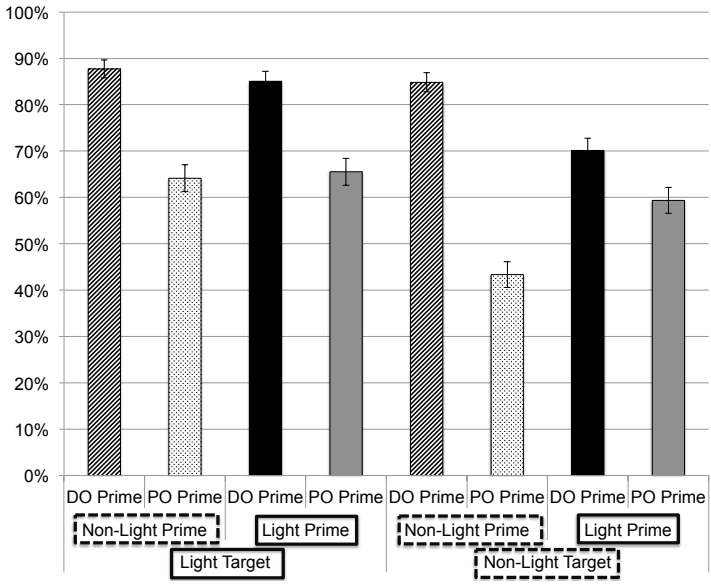


Figure 3.6: Percentage of Double-Object (DO) target forms used, out of all dative constructions. Notice that robust priming was found both across and within constructions.

In sum, there was significant priming for each prime-target pair, both within and across constructions. Then, it only made a difference on non-light targets whether the prime had been light or non-light. Finally, light targets were not more efficiently activated by light primes, and non-light primes resulted in larger effects overall.

3.3 Discussion

This experiment investigated the level of structural overlap between non-light and light verb constructions in English, such as *give a book* and *give a kiss*. Amending a standard paradigm priming (Bock and Loebell, 1990), I used non-light and light prime sentences that the study participants read out loud, and then I presented pictures as targets, providing the verbs which should be used to describe

them. Pictures either showed typical Source-Goal-Theme scenes (for example, non-light *give an apple*), or Agent-Patient events that could be described with a light verb construction (for example, *give a kiss*). The dependent measure was the proportion of double-object constructions over all dative constructions produced on the target trials.

I have found robust, statistically significant priming across constructions, which constitutes the first demonstration of such an effect between constructions of different semantic types. This finding suggests that there is considerable structural overlap between light and non-light constructions. Thus, there is no evidence for a difference in syntactic representations between them.

In addition to a syntactic priming effect, the results also indicated that there are likely two other mechanisms involved in priming within and across non-light and light constructions: A boost from overlapping semantic roles, and a boost from uniform syntax-semantics mapping. The boost from overlapping semantic roles was observed as increased priming within constructions, and the boost from mapping uniformity, as increased priming from non-light targets to both construction types (see Figure 3.7 for a comparison of predicted and observed effects).

Thus, these results suggest that light and non-light constructions share the same syntactic representation. However, one question is whether the results could be interpreted differently – say, that the priming effect is due to overlapping lexical items. Another question is whether the priming results really point to the same syntax, as opposed to the same *surface* syntax. Both points are related in that they highlight the limits of the method, and the theory alike.

It is true that there was lexical overlap both between light and non-light constructions: All primes, and all targets, used the verb *give*. I agree that this may have contributed to the large priming effect found for all prime-target combinations – but the lexical boost was only made possible by the fact that light and non-light *give* are attached to the same subcategorization frame, and the same syntactic structure (see Cleland and Pickering, 2003, 2006; Corley and Scheepers, 2002; Pickering and Branigan, 1998 for similar observations).

This point leads us to another limiting factor of this study: It might be the case that light and non-light *give* have the same surface syntax, but different deep structure, and priming might not

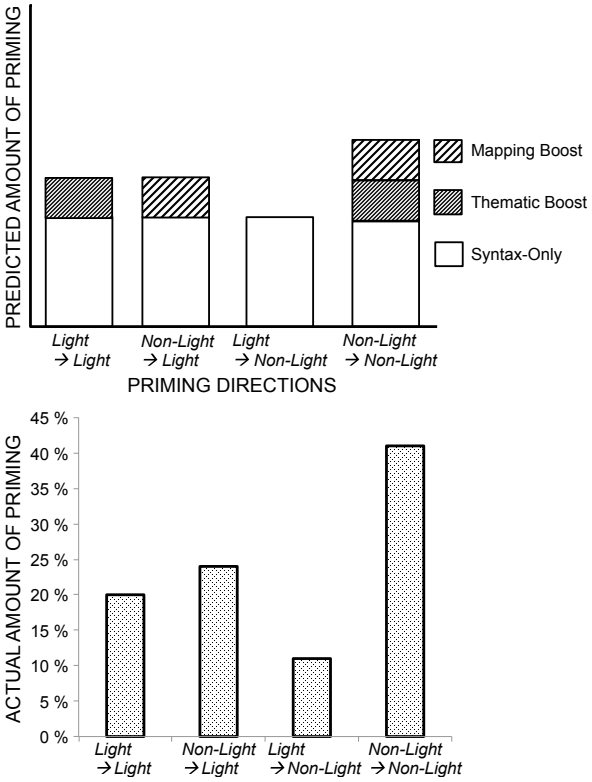


Figure 3.7: Comparison of priming predictions (Figure 3.3) with the observed amount of priming in the results (Table 3.1). Despite visual appearance, there was no significant difference in priming between light primes to light targets and non-light primes to light targets (the two bars on the left in each diagram).

be tapping deep structure, a central piece of theory-building for generative syntax hypotheses (for light verb constructions, see for example Folli, Harley, and Karimi, 2004; Hale and Keyser, 1993, 2002; Jung, 2002). Of course, this would be an obvious limitation of the priming paradigm, and the fact that we do not exactly know

which levels of representation the method *is* tapping is unfortunate, and a limitation for interpretation.

However, every method is limited by the degree of testability of the theoretical concepts it is supposed to test. In order to definitely dismiss the results of the study presented here, one would have to come up with a paradigm that does unequivocally show that it taps deep structure, and shows that light and non-light constructions have differing syntactic structure before spell-out.

As far as I can tell, this paradigm is yet to be discovered in psycholinguistics – not surprisingly so, since all linguistic concepts like 'deep structure', 'semantic roles', 'case' or 'derivation' can only be approximations to mental representations and do not easily yield themselves to empirical observation. In addition, it is unclear from a theoretical standpoint whether deep structure is actually a useful concept to understand the mental representation of syntactic structure at all (see for discussion and alternatives Culicover, 1999; Culicover and Jackendoff, 2005, 2006; Goldberg, 1995, 2003, 2006; Jackendoff, 2002, 2007b).

In short, in order to refute the evidence that this study provides, indicating that there is no reason to believe that light and non-light constructions have different syntactic structures, it is necessary to build a theoretical model that is empirically testable with psycholinguistic means, and thus truly useful for research on the mental representations of linguistic knowledge. For many linguistic phenomena, much progress has been made in this respect, but for light verb constructions, there is still a gap in predictability.

This gap does not only present itself for generative linguistics approaches (Folli, Harley, and Karimi, 2004; Hale and Keyser, 1993, 2002; Jung, 2002) with respect to how to test for deep structure representations, but also for its two main alternatives, Construction Grammar and Parallel Architecture (Culicover and Jackendoff, 2006; Goldberg, 1995, 2006; Jackendoff, 2002). The fact that priming occurs both within and across constructions may be taken as an indication that the two constructions share the same syntactic structure.

But it does not solve the question of whether one construction is a sub-construction of the other, whether they are sisters of one superordinate constructions, or whether they constitute two comparable classes of constructions at all, as opposed to lots of constructional islands. The way that the priming effect is modulated suggests that

the semantics between the two constructions, mentioned above as potential mapping boost and thematic boost, differ, and this is captured nicely by the idea of constructional hierarchies (though there is no evidence for constructional islands). However, this alone does not make for a clear prediction for priming.

In sum, the interpretation of structural priming between constructions relies heavily on theoretical assumptions both within linguistic theory and the experimental method. This is obviously more or less the case for all experiments, but it is an important reminder that this experiment provides: A theoretical model is only useful if it can be empirically falsified.

The well-known problems of the intricacies of linguistic theory-building aside, this experiment clearly falsified the hypothesis that there is no shared syntactic (surface) structure between light and non-light constructions. In addition, the modulated priming pattern suggests that the key to understand differing processing and priming patterns between light and non-light constructions lies in their semantic and conceptual representations. The following chapter will address this issue.

4 From Syntax to Concepts: Event Categorization

4.1 Introduction

In Chapter 2, we saw that light verb constructions like *give a kiss* are processed differently from non-light constructions like *give a book*: They are associated with a different neural signature, and slow down reaction times to a secondary task. In Chapter 3, we asked what the mental representation of light vs. non-light constructions looked like: Were the differences in processing a result of a difference within the syntactic representation, or the semantic representation of the constructions?

While the data gained from the priming study leave some aspects open, what can be gained from them is the insight that on the semantic level, these two constructions are structured quite differently. In short, what we know until now is that light verb constructions are processed differently – but what we do not know is, what is it that is actually being processed? Which event representation does *give a kiss* convey that is different from *give a book* – and especially, what is the difference between *giving a kiss* and *kissing*?

Throughout this thesis I have talked about argument sharing, and overlapping semantic roles. I explained that when we hear *The woman is giving the man a kiss*, the woman is the kisser, the man is the kissed person, and the kiss identifies the predicate. This is undoubtedly true for the event structure of *kiss*. But how about the semantic roles assigned by *give* – are these still active, or are they completely replaced by the semantic roles of *kiss*?

If the semantic roles of *give* are active at the same time as those of *kiss*, we can think of the distribution of semantic roles as shown in Table 4.1, but if only the *kiss* semantic roles are active, Table 4.2 would be the correct representation. Finally, another possibility would be if people would not at all think of *giving a kiss* as predominantly a

kissing event, but rather as a metaphorical *give* event. In this case, only the semantic roles of *give* would be active; this possibility is illustrated in Table 4.3:

	The woman	*is giving*	*the man*	*a kiss*
roles of *give*	Source		Goal	Theme
roles of *kiss*	Agent		Patient	

Table 4.1: The example *giving a kiss* with argument sharing

	The woman	*is giving*	*the man*	*a kiss*
roles of *give*				
roles of *kiss*	Agent		Patient	

Table 4.2: The example *giving a kiss* with two roles

	The woman	*is giving*	*the man*	*a kiss*
roles of *give*	Source		Goal	Theme
roles of *kiss*				

Table 4.3: The example *giving a kiss* with three roles

In short, light verb constructions might encode and highlight different aspects of an event in such a way that a listener construes an event as either having overlapping roles (4.1), two roles (4.2), or three roles (4.3). In the theoretical literature, there is some debate on the correct description (Butt, 2003, 2010; Eisenberg, 2003; Grimshaw and Mester, 1988; Heidolph, Flämig, Motsch et al., 1981; Helbig, 1979; Heringer, 1968; Müller, 2010; Polenz, 1963; Sommerfeldt, 1980; Wiese, 2006), but so far, these possibilities have not been explored by psychological investigation.

In the following, I report a study on event categorization, published as Wittenberg and Snedeker (2014), that was designed to close that gap. For practical reasons, we used only light verb constructions in which the light verb was *give*. This allowed us to ask: Does the syntactic ditransitive structure influence how people categorize an event, i.e., event construal?

4.2 A Study on Event Categorization[1]

Languages are characterized by robust mappings between the structure of a sentence and its meaning. One manifestation of this is the systematic mapping between the syntactic roles in a sentence and the semantic roles of the participants in the event. For example, transitive sentences such as *The woman is kissing the man* have a subject and an object argument, which denote the Agent and the Patient. Likewise, a ditransitive frame with a subject and two objects, such as in *The woman sent a letter to the man* encodes a Source, a Theme, and a Goal. These canonical mappings allow us to quickly identify who did what to whom and thus are helpful both in acquisition and in processing.[2]

The uniformity in the mapping between syntactic arguments and semantic roles is so pervasive that many linguistic theories take it as an axiom (Baker, 1988; Chomsky, 1981). For example, Construction Grammar (Bencini and Goldberg, 2000; Johnson and Goldberg, 2013) argues that merely encountering a transitive syntactic frame already reliably steers listeners towards assigning Agent and Patient to subject and object.

But curiously, as we have seen in the previous chapters, in addition to these broad and systematic regularities, languages also feature a class of narrower but very frequent constructions that violate these patterns: light verb constructions. Coming back to our light verb construction example *the woman gave a kiss to the man*, there is a subject, a direct object, and a prepositional object. These syntactic arguments correspond to *the woman*, *a kiss*, and *the man*. But what are their semantic roles?

The syntactic frame would suggest that the event is an instance of *giving* that has a Source, Theme, and Goal. However, given that the same event can be described by the paraphrase *The woman kissed the*

[1] This section has been published, in very similar form, as Eva Wittenberg and Jesse Snedeker (2014). "It takes two to kiss, but does it take three to give a kiss? Categorization based on thematic roles". In: *Language, Cognition and Neuroscience* 29.5, pp. 635–641.

[2] By »canonical« I simply mean the mappings that preserve a one-to-one correspondence between semantic roles and noun phrases. I do not intend to imply that these mappings are privileged in processing or acquisition.

man, one might conclude that *giving a kiss* is simply a *kissing* event in disguise, which still only has an Agent and a Patient.

Which of these semantic structures is correct? Three possibilities come to mind, the first two of which we already encountered in the previous chapter:

1. The different-syntax hypothesis: differences between the ditransitive light and non-light constructions stem from the syntax: *giving a kiss* is syntactically different from the standard ditransitive *giving a book* in a way that makes *kiss* part of the predicate and thus inaccessible to semantic role assignment (Hale and Keyser, 1993, 2002). As a result, *give a kiss* is syntactically transitive and subject to a canonical mapping from transitive sentences to Agent-Patient events.

2. The different-semantics hypothesis: the syntax of *giving a kiss* is the same as *giving a book*, and the standard semantic role assignments apply. As a result, *The woman is giving a kiss to the man* is actually a Source-Theme-Goal event, instead of an Agent-Patient event like *The woman kisses the man*.

3. The different-mapping hypothesis: the syntax of both ditransitive constructions is the same, but the light verb construction maps onto an Agent-Patient event, resulting in a non-canonical mapping.[3]

A prediction of the different-syntax hypothesis has been explored using syntactic priming (see Chapter 3). We tested whether light ditransitives would prime non-light ditransitives as effectively as other non-light ditransitives would. If light verb constructions had had a different syntactic structure from non-light constructions, they should have been less effective primes for non-light constructions, since the degree of representational overlap is decreased. However, there was robust priming both from light to non-light constructions and also vice versa, suggesting that light and non-light constructions have the same syntactic form.

[3] For the sake of simplicity, I will assume that a semantic structure gets translated directly into an event representation, while acknowledging that the latter is much richer than the former. This discussion will be agnostic about the semantics-conceptual structure divide, since this does not directly bear on the question.

The present study explores the different-semantics and different-mappings hypotheses. The different-semantics hypothesis states that the syntactic form of the ditransitive leads to the conceptualization of *give a kiss* as a Source-Theme-Goal event. The challenge for this hypothesis is to explain how *kissing* and *giving a kiss* can have different semantic interpretations when they often pick out the same spatio-temporal chunks of experience. One possibility is that a given piece of experience can be construed in different ways resulting in distinct event structures which are expressed with different syntactic frames. For example, the ditransitive construction may pick out a construal of kissing that involves transfer.

Similar changes in event construal have been found with other syntactic alternations. Using the locative alternation (*fill the glass with water/fill water into the glass*), Gropen et al. (1991) found that subtle changes to the structure of an event affected which syntactic form was used to describe that event. They asked adults and children to describe scenes where an object moved onto a surface. Whenever the motion itself was made more salient, participants tended to encode the object as direct object; whenever the surface was made more salient, participants tended to encode the surface as direct object. Thus, even though these constructions refer to many of the same event types, changing subtle aspects of the event structure can affect which form of the locative people use.

The different-semantics hypothesis proposes that comparable light and non-light constructions also have different meanings. When using the ditransitive form of *give a kiss*, according to this hypothesis, people construe kissing as a Source-Theme-Goal event, with the kiss as a third entity that is transferred from the woman to the man, while the transitive encoding in *kiss* results in an Agent-Patient construal of the event.

The different-mapping hypothesis, in contrast, assumes that the light and base verb constructions express the same event representation. On this hypothesis, the mapping mechanism between syntax and semantics must be flexible enough to assign Agent and Patient onto the woman and the man, just as the usual mapping of Agent to subject and Patient to object can be overridden in passive voice, or with experiencer-stimulus verbs such as *fear* (Hartshorne and Snedeker, 2013).

To explore these hypotheses, we used an event-categorization task. A similar task was used by Bencini and Goldberg (2000). In their study, participants were asked to sort sentences that varied in both the verb that was used and the construction in which it appeared. For example, the verb *throw* appeared in a transitive (*Anita threw the hammer*), ditransitive (*Chris threw Linda the pencil*), caused motion (*Pat threw the keys onto the roof*) and resultative construction (*Lyn threw the box apart*). They found that participants relied on both verb meaning and construction type to sort the stimuli, indicating that both factors influence event categorization. Crucially, in Bencini and Goldberg's (2000) study, the different constructions had meanings that were uncontroversially distinct (they conveyed different information and picked out different categories of events). In the case of light verb vs. base verb constructions, it is not clear whether the meanings of the two forms are truly different.

In the present study, we asked participants to sort non-linguistic events according to the number of semantic roles involved. After a purely non-linguistic training phase, we introduced sentences that had three roles (*Anne is giving Julius a book*), two roles (*Walter is eating an apple*), one role (*Charles is sleeping*), or were either light verb constructions (*The woman is giving the man a kiss*) or their corresponding base verbs (*The woman is kissing the man*).

If light verb constructions are given a meaning that is consistent with their syntax, then participants should interpret the event noun as a separate role in the event and categorize events described by light verb constructions with three-role Source-Goal-Theme events (different-semantics hypothesis). However, if light verb constructions have the same semantic roles as the base verb constructions, despite their syntactic form, then participants should not treat the event noun as a separate role in the event, and should categorize light verb constructions with two-role Agent-Patient events (different-mappings hypothesis).

These predictions assume that participants can be trained to sort on the basis of semantic structure rather than syntax. To ensure that this is true, we included two additional types of stimuli: Sentences that described joint actions either in a transitive (*Julius meets Nils*) or intransitive form (*Julius and Nils meet*; *The brothers meet*). These symmetrical actions involve at least two people. While there is considerable dispute as to the nature of the semantic roles involved

(Carlson, 1998; Gleitman et al., 1996), these verbs necessarily require two participants (**Julius is meeting*). Thus if semantic structure is driving categorization, we expected that they would both be grouped with two-participant events. If syntax alone is driving categorization, participants should sort these items in the two-role group when they occur in transitive syntax and into the one-role group when they are in intransitive syntax.

It is also important to rule out sorting based on the number of concrete entities involved in the event, rather than the number of semantic roles. For this reason, we included items where the number of roles and the number of concrete entities were inconsistent, with more than one entity playing a given role (for example, *The traffic lights are flashing*).

4.2.1 Methods

4.2.1.1 Participants

Thirty-six English native speakers from the Harvard study pool (12 male, mean age: 19.8) participated for study credit. Four of these participants were excluded from the analysis, since their performance was lower than 66 % on the filler items.

4.2.1.2 Materials

We constructed ten pairs of light verb (4.1a) and base verb sentences (4.1b) and ten pairs of transitive (4.1c) and intransitive joint actions (4.1d):

(4.1) (a) *The teenager is giving his rival a kick.*
(b) *The teenager is kicking his rival.*
(c) *The father is cuddling the baby.*
(d) *The father and the baby are cuddling.*

The light verb constructions all used *give* as main verb, but one of the objects constituted the main semantic predicate of the sentence (such as *kiss* in *give a kiss*). The base verb sentences used the same Agents as their light verb counterparts, but instead of having a Theme, the Theme's base verb served as the main predicate for the sentence.

One factor that could influence event construal is frequency. To take this possibility into account, we conducted a Google search for the light and base verb pairs. Most of the material indexed in Google is not edited, providing global input statistics about everyday language use. My search strings were the exact form of the respective construction, but with either either *me* or *him* as object (*is kissing me/him*; *is giving me/him a kiss*). This search revealed that among all relevant descriptions of one event (*kissing*), light verb constructions were used between 1 % and 50 % of the time (mean: 28 %, SD: 25 %; see Appendix E for per-item numbers).

We created ten examples of one-role, two-role, and three-role sentences to serve as a baseline for evaluating participants' performance. In half of the sentences, the number of semantic roles and the number of entities converged (consistent sentences), and in the other half, there were more entities than roles (inconsistent sentences). All three-role sentences had animate Agents, animate Goals, and inanimate Themes of varying concreteness.

All two-role sentences used change-of-state verbs that cannot enter light verb constructions. We also commissioned 20 pictures showing three-role scenes, 20 pictures showing two-role scenes, and 20 pictures showing one-role scenes (see Figure 4.1 for examples). Three additional pictures were created for the introduction, and 12 for the training phase (one consistent and one inconsistent example each for the one-, two-, and three-role picture categories).

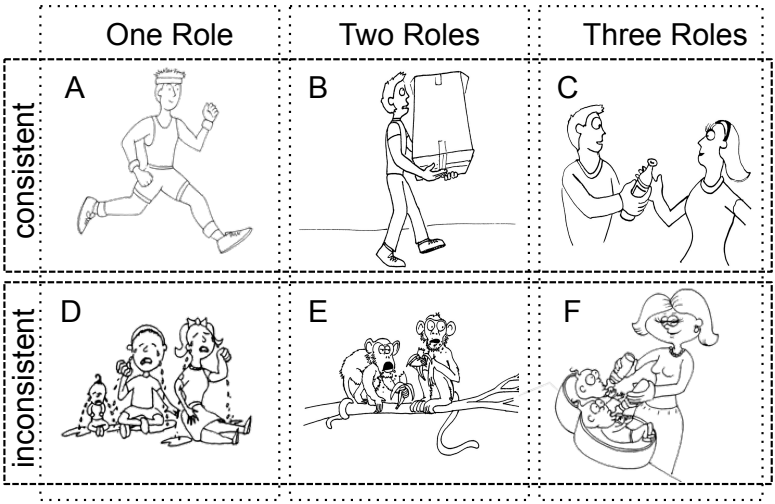


Figure 4.1: Examples of consistent one-role (A), two-role (B), and three-role pictures (C), as well as their inconsistent counterparts (D, E, F). The inconsistent pictures contained more characters than there were roles: For example, in D, the crying event has one role (Agent), played by three characters (the three children).

40 native English speakers, recruited via Amazon Mechanical Turk, rated the sentences for naturalness on a scale from 1 to 9 (9 was most natural). There were no differences in rating scores between sentence types (M=8.0, F(9,60)=1.60, p=.13).

To make sure that participants interpreted the pictures as we intended, 15 workers on Amazon Mechanical Turk wrote a sentence to describe each one. A trained research assistant coded the sentences as correct if they encoded both the intended action and the intended participants, but included no additional participants. The average score across pictures was 84 %, and the scores did not differ significantly between picture types, (F(5,72)=.83, p=.53). Critically, there were no differences between consistent and inconsistent pictures (one-role pictures: F(1,24)=.71, p=.79; two-role pictures: F(1,24)=.77, p=.39; three-role pictures: F(1,24)=.00, p=.99).

We created two lists that showed half of the critical pairs as base verbs and half of them as light verb constructions and showed half of the joint action pairs in transitive form, and the other half in in-

transitive form. Lists were counterbalanced such that no participant saw both items in one pair. In total, each list consisted of 60 pictures and 50 sentences.

4.2.1.3 Procedure

The experiment was executed using ePrime (Schneider, Eschman, and Zuccolotto, 2002). Figure 4.2 illustrates the stimuli for each phase. First, participants were introduced to the concept of semantic roles, and were told that they should base their sorting behavior on how many semantic roles were involved in the event, not how many entities were involved (see Appendix D for instructions).

This short introduction was followed by a training phase consisting of twelve pictures, which could be sorted by clicking on one of three reference pictures at the bottom of the screen. Participants had to sort all training pictures correctly before advancing to the test phase. In the test phase, the participants continued sorting the items, which now randomly included both pictures and sentences, into the three categories by clicking on the appropriate example picture, without any feedback from the experimenter. There were no pictures paired with the test sentences. Post-test questionnaires showed that no participant guessed the goal of the experiment.

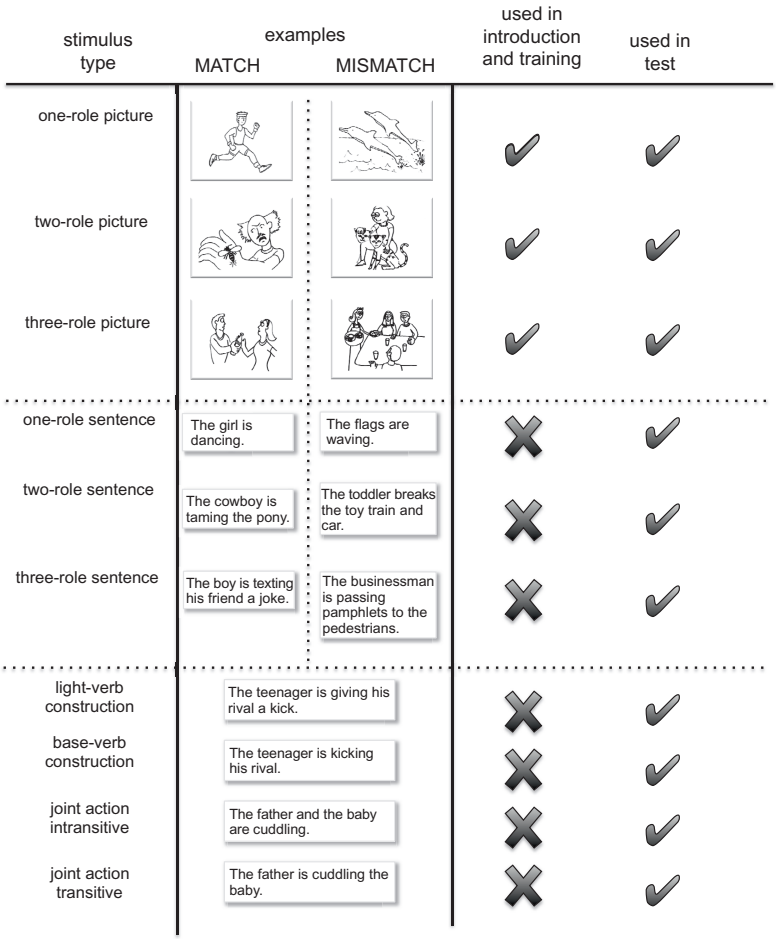


Figure 4.2: Procedure of the experiment: Participants were introduced to and trained on pictures only. In the experimental phase, they also saw sentences.

4.2.2 Results

4.2.2.1 Accuracy on Fillers

During the test phase, inconsistent pictures were sorted less accurately than consistent pictures (77 % vs 87 %, $F(1,68)=21.3$, $p<.001$), but performance was well above chance for both (consistent pictures: $F(1,190)=1,197.2$, $p<.001$; inconsistent pictures: $F(1,190)=379.3$, $p<.001$), showing that participants primarily responded based on the number of arguments rather than the number of entities.

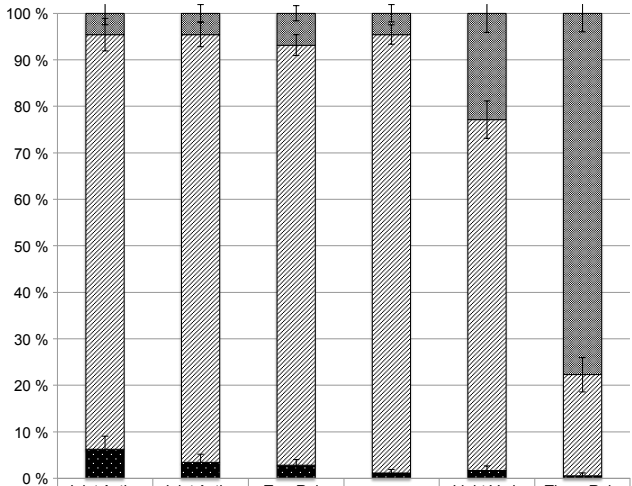
Performance on the baseline sentences was also good: Participants correctly sorted 92 % of the consistent sentences and 84 % of the inconsistent sentences, again with a significant difference between the two categories ($F(1,68)=10.3$, $p<.001$), but above chance performance in both cases (consistent sentences: $F(1,68)=1,458.7$, $p<.001$; inconsistent sentences: $F(1,190)=923.3$, $p<.001$).

4.2.2.2 Sorting of Critical Items

Figure 4.3 shows how critical items were sorted. The data were analyzed using separate multilevel logistic regression models to predict the probability of sorting items into a given group (e.g., the one-role, two-role, or three-role group), with random slopes for subjects and items, and sentence type as a fixed effect. For the light verb constructions, we also included the relative frequency of the light verb construction in the corpus as a predictor (light verb construction/light verb construction + base verb, see Appendix E). We found that proportional frequency of the light verb construction was not a reliable predictor of sorting behavior (zs<.38, ps>.69) and thus we removed it from subsequent analyses.

Both types of joint actions were consistently sorted into the two-role group (intransitive: 89 %, transitive: 92 %; $z=-1.34$, $p>.18$). Thus, participants were able to ignore syntactic variation and sort on the basis of semantic roles.

Light verb constructions were significantly more likely to be classified as three-role events than base verb sentences (23 % vs. 5 %; $z=3.35$, $p<.001$). They were also significantly less likely than base verb sentences to be categorized as two-role events (75 % vs. 94 %; $z=-4.06$, $p<.001$). Thus the use of the light verb construction affects sorting behavior.



	Joint Action (Intransitive)	Joint Action (Transitive)	Two Role Inconsistent	Base Verb	Light Verb Construction	Three Role Consistent
…sorted as Three Role	0.05	0.05	0.07	0.05	0.23	0.78
…sorted as Two Role	0.89	0.92	0.90	0.94	0.75	0.22
…sorted as One Role	0.06	0.03	0.03	0.01	0.02	0.01

Figure 4.3: Categorization patterns for the critical sentences, with Standard Errors. The differences between light verb constructions, and base verb, two role inconsistent, and three role consistent sentences were significant; the differences between the two types of joint actions were not.

Crucially, light verb constructions were not simply treated as ditransitives: they were far less likely to be treated as three-role events than the three-role consistent sentences (z=-8.51, p<.001), which were placed in this group 78 % of the time. There was also a difference between light verb constructions and two-role inconsistent sentences (z=2.88, p<.01), which were sorted as three-role events only 7 % of the time, despite having three participants. Thus, the sorting of light verb constructions with three role events was not simply the result of counting nouns.

In addition, we correlated the number of three-role sortings of light verb constructions with the number of one-role sortings for Joint Action Intransitives across participants. If our results reflected the use of syntax as a sorting strategy (on a per participant basis), then these two measures should be related. However, the corre-

lation coefficient was not significant and small (r=0.0016; t=0.009; p>.99). Thus, it is unlikely that the results were driven by particular participants sorting according to syntactic structure.

4.3 Discussion

In this study, we found that participants sorted light verb constructions differently from both base verb sentences and three-role events, suggesting a three-way distinction between canonical transitive Agent-Patient events, events denoted by light verb constructions, and canonical ditransitive Source-Theme-Goal events.

This particular pattern, by itself, could have been interpreted as evidence of a strategy to sort based on syntactic structure alone. This possibility, however, is ruled out by the joint action conditions: participants consistently sorted intransitive joint actions as two-role events, despite their syntactic similarity to other intransitives. Also, it is clear that participants did not sort based on the number of entities or nouns, as shown by the reliable difference between light verb and three-role consistent sentences, as well as performance on the two-role inconsistent sentences.

These findings have two limitations. First, we explicitly trained participants to pay attention to semantic roles and provided extensive instructions (on the effect of instructions, see Bencini and Goldberg, 2000), thus we cannot say how sorting would occur in the absence of training. Nevertheless, this method is commonly used to understand how learners conceptualize potentially ambiguous stimuli (see e.g., Chambers, Onishi, and Fisher, 2010; Hommel, Alonso, and Fuentes, 2003). When participants are trained using one type of stimuli (e.g., transparent one-, two- and three-argument pictures) and then tested with very different stimuli (e.g., light verb constructions), we can learn how they generalize their training. Second, participants' performance when sorting on one semantic dimension (semantic roles) cannot tell us about other semantic differences between light and base verbs, such as aspect or telicity. While we suspect that other differences exist (see Butt, 2010), the current data speak only to differences in the number of semantic roles in the event representation.

Taken at face value, this data seems to provide some support for both the different-mappings and different-semantics hypotheses. The evidence for different mappings is clear: on 75 % of the trials, participants interpreted light verb sentences as Agent-Patient events despite their ditransitive syntax. The evidence for different semantics is more subtle: on a minority of the trials, participants classified light verb sentences as having three arguments, despite the event structure of the base verb.

We see three ways to reconcile these effects:

1. Both hypotheses could be true. light verb constructions could typically involve non-canonical mappings to the event structure of the base verb, but there could also be some cases where they are interpreted with a canonical mapping via the light verb, resulting in a categorically different interpretation.

2. Encountering the verb *give* causes a semantic garden-path effect; that is, the reader assigns Source, Theme and Goal roles before reconsidering the nature of the event, and this representation lingers on (cf. Ferreira, 2003a).

3. Light verb constructions may intrinsically have two different, shared argument structures that are active at the same time: Agent-Patient (from the noun) and Source-Theme-Goal (from the verb). This view, sometimes called *argument sharing* (Butt, 2010; Jackendoff, 1974), is supported by studies that find that light verb constructions incur processing costs even when the event nominal precedes the verb, and thus the verb cannot lead the reader down the garden path (cf. Chapter 2). Specifically, processing light verb constructions leads to longer reaction times in cross-modal lexical decision tasks and a sustained negativity in ERP, compared with non-light constructions.

Our findings contribute to a small literature on the relationship between the conceptualization of events and their syntactic encoding. In some cases, these effects reflect the information that is present or absent in the sentence. For example, when Agents are expressed, they are seen as more causally responsible (Fausey and Boroditsky, 2010). In other cases, the effects reflect differences in the event structures encoded by sentences that might otherwise seem to be synonymous (e.g. Gropen et al., 1991). The present

study also examines apparently synonymous sentences and finds subtle differences in conceptualization: light verb constructions are sometimes interpreted as having three participants. This difference suggests that canonical mappings play a role in interpretation, even for non-canonical constructions where the result of this mapping is implausible.

Converging evidence for the subtle influence of syntactic structure on conceptualization comes from a study by Majid, Sanford, and Pickering (2007), which investigated the influence of verb frame on story continuations. These continuations were coded for whether participants mentioned causes or effects of the event described. Transitive base verbs elicited few effect continuations, and ditransitive non-light verbs elicited many. Curiously, the light verb constructions fell between the others. Like the current study, this suggests a role for syntactic structure in how people conceptualize linguistically-encoded events.

Such effects are surprising given the frequency of light verb constructions; adults have ample practice with these collocations, and yet they still appear to experience some influence from the canonical ditransitive mapping.

5 Conclusions and Future Directions

5.1 Insights from this Dissertation

This dissertation has presented experimental explorations into the representation and processing of German and English light verb constructions. Light verb constructions are constructions like *give a kiss*, where the semantic bulk of the predicate is delivered by the event nominal (*kiss*), while the light verb (*give*) delivers grammatical features, as well as traces of its full semantic function. Light verb constructions are interesting for linguistic theory because they violate the mapping uniformity commonly assumed in theoretical models, and formalized, for example, in Chomsky's Theta-Criterion (1981). The uniformity is violated because in a sentence like *The woman gives the man a kiss*, not every noun phrase (*the woman*, *the man*, *a kiss*) receives a semantic role from the verb; instead, *a kiss* and *give* together form a complex predicate which seems to be assigning shared semantic roles from both the verbal and the nominal part of the predicate (i.e., *the woman* is both a kisser and a giver, and *the man* both the kiss-ee and the giv-ee). So far, it is unclear, even within different branches of shared linguistic theories, how to accommodate this behavior.

Three open questions posed major problems for any linguistic theory so far: First, it was even unclear whether light verb constructions are represented and processed differently from non-light constructions at all. Second, the source of the mapping inconsistency was up for debate – syntax, semantics, or the mapping itself? Third, researchers had differing intuitions about the role of the verb, for example, how much semantic content *give* really provides, and, in this context, whether it also provides any semantic roles at all. This dissertation has now provided empirical data that help answer these three open questions.

In Chapter 2, the question of how light verb constructions are processed was answered with the help of two studies: an ERP study, and a behavioral, cross-modal lexical decision task (Wittenberg, Paczynski et al., 2014; Wittenberg and Piñango, 2011). The ERP study looked at these cognitive processes using light verb constructions, non-light constructions with the same verbs, and unacceptable light noun-light verb combinations (e.g. German: **Weil der Student seiner Kommilitonin. . . einen Spaziergang gab,. . . ;* i.e. *'Because the student to his fellow student. . . a walk gave,. . . '). These unacceptable combinations led to a P600, compared to non-light constructions, which might reflect an attempt to construct a meaningful interpretation, and its failure. light verb constructions, however, evoked a widespread yet frontally centered, sustained negativity between 500 and 900 ms post verb onset.

In the behavioral study, participants were slower to make a lexical decision about probes appearing after light verb constructions, compared to after non-light constructions. Thus, the processing of light verb constructions in working memory influenced how people performed a secondary task: The reaction times were longer, hence it is plausible that light verb constructions are associated with higher demands on working memory.

This result pattern corresponds to the ERP findings: Sustained negativities have been found in processing various constructions that heavily rely on working memory, and point to complex semantic processes, such as aspectual coercion, frame shifting, or discourse restructuring (see Chapter 2, Wittenberg, 2013; Wittenberg, Paczynski et al., 2014). Importantly for the questions asked above, however, both studies show that light verb constructions are processed differently from non-light constructions, and thus should be represented differently from each other.

Chapter 3 aimed to answer the question of whether this processing difference has its source in light verb construction syntax or in its semantics, with the help of structural priming. Structural priming exploits the fact that during language production, people tend to repeat syntactic structures that they have recently encountered. Light verb constructions like *give a kiss* can occur in Double Object (DO) word order, or Prepositional Object (PO) word order: *The woman gave the man a kiss* is equally acceptable, and describes the same situation, as *The woman gave a kiss to the man*.

If the syntactic structure of light verb constructions differs from their non-light counterpart, then there should be less priming between light verb constructions and non-light constructions than within constructions. The data do not support this hypothesis: There was significant cross-constructional priming in both directions, and light targets were not preferably activated by light primes. Yet, shared thematic structure boosts priming: Non-light construction to non-light construction priming was higher than light verb construction to non-light construction priming. This indicated that the processing difference observed in Chapter 2 was to be found in the semantic structure of light verb constructions, and thus, in the differences of what the verb contributes to the light verb construction, and in particular, whether it provides semantic roles.

With the help of a conceptual sorting paradigm (Chapter 4, Wittenberg and Snedeker, 2014), this last question was approached. Does the light verb in *give a kiss* provide semantic roles? In the study, participants were trained to sort nonverbal pictorial scenes into one-role, two-role, or three-role categories, and then sorted both pictures and sentences. If light verb constructions with *give* had three roles (a Source, a Goal, and a Theme), then they would belong in the three-role category. If, however, *kiss* provided the semantic roles (an Agent and a Patient), then they would belong in the two-role category.

The results showed a three-way distinction: Classical three-role transfer events were sorted into the three-role category significantly more often than events described by light verb constructions, which in turn were sorted into the three-role category significantly more often than two-role events. Thus, the conceptualization of light verb constructions with *give* is a mixture of three- and two-role events, indicating that listeners comprehend them as Agent-Patient events, but this representation is influenced by the argument structure of the three-role verb: Colloquially put, *giving a kiss* is both *giving* and *kissing*.

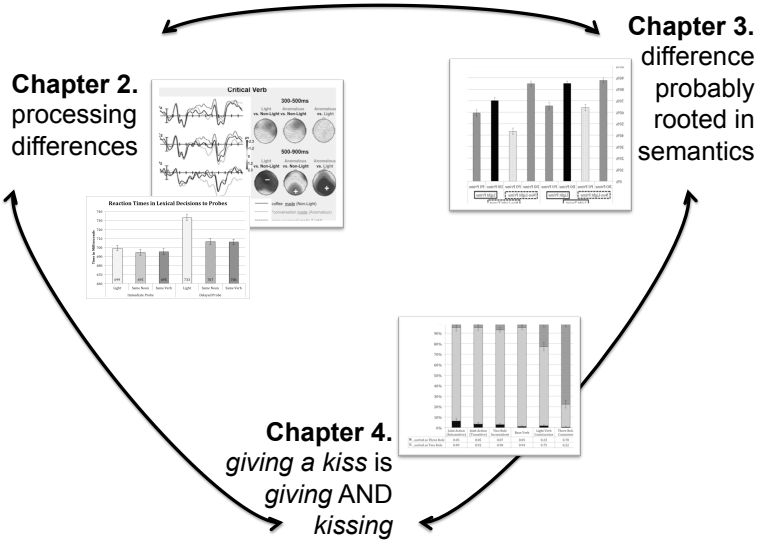


Figure 5.1: Visual Structure of this Dissertation.

In sum, the following picture emerges (see Figure 5.1): Light verb constructions such as *give a kiss* are processed differently from non-light constructions, which have the same syntactic structure. A likely source of this processing difference is the violation of mapping uniformity found in light verb constructions, which leads to a noncanonical conceptualization of events described by light verb constructions. This noncanonical conceptualization is likely a decisive factor for the processing differences reported in Chapter 2.

5.2 Open Questions and Future Research

In any research program, every solid result delivers one valuable answer, but its interpretation poses ten new questions. While I do think that the studies presented here have made an important first step in exploring the puzzles and mysteries of light verb constructions, I am aware of the fact that this is only the tip of the

iceberg – which, in turn, belongs to a vast glacier. Thus, I am looking forward to continuing this line of research, or reading work and insights of others on light verb constructions and what they can tell us about the inner workings of language in the mind.

On top of the to-do list, in my mind, are the following points: First, one would wish for a replication of both the ERP and cross-modal lexical decision experiments, using only light verb constructions with *give*, in order to arrive at a clean picture about this construction in particular, and then later with only *take*, *make*, etc. One reason this has not been done is that, especially for ERP studies, a very high number of experimental stimuli is needed, while the number of light verb constructions with any verb is restricted. However, with advanced statistical and methodological techniques, this constraint might be overcome at some point. Similarly, one would wish for a replication of the ERP study in English, perhaps using the same noun, and using English SVO order. These replications would achieve a higher degree of generalizability of the effect, over syntactic frames and specific meanings.

Second, the detailed instructions and very conscious task of the categorization paradigm in Chapter 4 might have prevented more spontaneous processing and categorization; and also, the time course of decision-making would be informative about whether people simultaneously entertain different event representations, or whether they commit early to a three-role Source-Goal-Theme categorization and then shift their commitment after it is clear that the light verb construction describes a two-role Agent-Patient event. Thus, a different method such as eye tracking, combined with an implicit learning task, might complement and enhance this task. A start has been made in which I have replicated the behavioral findings described in Chapter 4 with the help of an eye-tracking study, and gained first insights into the time-course of categorization (Wittenberg, Khan, and Snedeker, 2014).

Third, the results presented here all point to a major role of working memory, which seems to be particularly challenged when light verb constructions are processed. As I have also stated elsewhere (Wittenberg, 2013), I would be interested to see whether effects increase in populations with reduced working memory, such as dementia patients, aphasics, insomniacs, or children.

Fourth, the acquisition of light verb constructions is fascinating as well. If light verb constructions are so hard to process and encode such a complex event structure as my data suggest, then why are they so frequent in child-directed speech or second language acquisition? One explanation could be connected to the high frequency of the light verb: Once you know the light verbs of a language, they lend themselves to combinations with nouns, which allows for exponential expressive power while reducing the number of inflections one has to acquire (Wiese, 2006). Another possible hypothesis is that the syntactic form of light verb constructions, especially in English, presents advantages for acquisition: On the one hand, the action (such as *kiss* in *give a kiss*) is prominent in information structure (Wiese, 2006); on the other hand, it might be the nominal form of the action itself that could present an advantage for acquisition, since nouns tend to be acquired before verbs. Studies on these questions are in preparation.

Fifth, much more research is needed into other contributions of the light verb, in addition to whether it contributes semantic roles. For example, the aspectual properties of *giving a kiss* are different from *kissing*: While *giving a kiss* is telic, *kissing* is atelic (compare *she kissed him until dawn*, vs. ?*she gave him a kiss until dawn*), *kissing* is ambiguous between singular and repeated events, the light verb construction is not (*she kissed him (once/repeatedly)* vs. *she gave him a kiss/many kisses*). Also, a related question is which other factors drive the use of light verb constructions, as opposed to the use of their base verb forms. One factor could be information density (Levy, 2011). These questions will, in my opinion, best be answered by employing a combination of experimental work and corpus data, to which a research program is in preparation.

Finally, research on light verb constructions has natural connections to other constructions that share features of these constructions. Idioms, for example, are just one step further out on the scale from fully transparent to fully opaque sentential expressions, and studying idioms and light verb constructions at the same time can give important insights into semi-productivity as well as storage and retrieval. Next, coercion constructions are similar to light verb constructions as examples for complex semantic operations and noncanonical mapping structures. Particle verbs share properties with light verb constructions because of their semantic complexity

which is distributed between two parts, and often, across a sentence; and finally, light verb constructions could not exist were it not for nominalizations, which have been studied extensively in theoretical research, but not nearly enough by experimentalists.

5.3 Conclusion

All in all, the study of light verb constructions opens the door to a whole arsenal of exciting research questions. One insight gained from the studies presented here seems especially intriguing to me: Events described by light verb constructions lead to unusual conceptualizations. This is interesting for speakers, writers, and poets, whose job it is to draw upon the full range of possibilities that language offers, and who have probably always subconsciously used this advantage of light verb constructions. It is interesting for philosophers, who still and again like to debate the validity of the Sapir-Whorf hypothesis, and have few nuanced data to work with. It is interesting for linguists, who have been passionately debating light verb constructions for almost a hundred years, knowing lots about their theoretical properties, but little about their representation and processing; and it is interesting for brain scientists, who, thankfully, can always rely on us linguists for asking the hard question of how the mind creates, uses, and manipulates language.

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Appendix

A Stimuli for ERP Study

Complete list of ERP Stimuli. For a sample with English translations, see Gina Kuperberg's homepage or `http://tinyurl.com/qg7k8o5`.

1. *Es war der perfekte Tag für eine Hochzeit. Als der Pfarrer ihnen endlich den Segen / die Ringe / die Predigt gab waren die Verlobten glücklich.*

2. *Auf der Buchmesse wurde der beste Roman gekürt. Als der Preisträger stolz den Vortrag / die Medaille / die Hymne hielt war die Veranstaltung einigermaßen unterhaltsam.*

3. *In der Akademie stellte sich der Bildhauer seinen Kollegen vor. Da die Malerin gerade eine Vorlesung / eine Palette / einen Farbton hielt konnte sie ihm nicht die Hand schütteln.*

4. *Der Unternehmensberater hatte Parkinson. Als er neulich eine Präsentation / eine Kaffeetasse / eine Anweisung hielt zitterten seine Hände.*

5. *Der Musiklehrer bereitete die Prüfung vor. Nachdem er zum Klavier Aufgaben / Mikrofone / Zensuren stellte zitterten seine Hände.*

6. *In der Kaserne waren alle in heller Aufregung. Als der Soldat gestern die Wache / die Waffen / den Befehl hielt verletzte sich sein Kamerad mit einem Gewehr.*

7. *Der Taufgottesdienst war etwas ganz Besonderes. Weil der Bischof die Predigt / das Baby / den Segen hielt freuten sich die jungen Eltern.*

8. *Das Flugzeug war bereits hoch über den Wolken. Als die Stewardess eine Ansage / einen Kaffee / ein Gespräch machte ging gerade die Sonne auf.*

9. *Die Familie wohnte in einem Haus. Weil die Oma diesen Sonntag einen Spaziergang / einen Apfelkuchen / ein Kinderlied machte mussten die Kinder zuhause sein.*

10. *Der Trompeter liebte die Arbeit in der Musikschule. Wenn er den Schülern Unterricht / Zeugnisse / Vorträge gab fühlte er sich glücklich.*

11. *Die Hausbesitzerin hatte den Architekten mit der Renovierung beauftragt. Als sie ihm gestern eine Anweisung / einen Bauplan / eine Diskussion gab war er ein bisschen überfordert.*

12. *Der junge Anwalt war ehrgeizig und selbstbewusst. Als er im Gerichtssaal die Initiative / die Anklageschrift / die Angaben ergriff nickte ihm sein Chef anerkennend zu.*

13. *Auf der Demonstration protestierten Tausende Menschen. Während der Gewerkschaftsführer eine Rede / ein Banner / ein Gespräch hielt wurden Protestlieder gesungen.*

14. *Die Malerin war aus Teheran nach Berlin gezogen. Bevor sie dort allerdings eine Ausstellung / eine Wohnung / ein Interview hatte wurde sie von Kollegen durchgefüttert.*

15. *Im Gefängnis gab es viel Gewalt. Weil der Häftling einen Streit / ein Messer / eine Strafe hatte schritten die Wärter ein.*

16. *Am Tag der Offenen Tür halfen alle mit. Während der Personalchef Werbung / Kaffee / Gespräche machte grillte die Buchhalterin Würstchen.*

17. *Die Journalistin interviewte den Musiker und machte Fotos von ihm. Indem sie zu dem Bericht viele Fragen / Bilder / Zeilen stellte wurde es ein interessantes Interview.*

18. *Tourismus ist wichtig für das Allgäu. Als der Alpenverein kürzlich eine Wanderung / einen Wanderweg / einen Wanderschuh machte haben sich die Touristen nicht verlaufen.*

19. *Der junge Mann hatte seine erste Woche bei der Polizei. Als ihm seine Chefin einen Befehl / einen Ausweis / ein Problem gab war er mächtig stolz.*

20. *Das Stipendium ging langsam zu Ende. Als der Dichter seinem Geldgeber einen Bericht / ein Gedicht / einen Streit gab war er zufrieden mit sich.*

21. *Die junge Frau wollte sich eine Wohnung im Stadtzentrum kaufen. Als der Makler ihr eine Beschreibung / eine Broschüre / eine Schwierigkeit gab kalkulierte sie ihr Budget neu.*

22. *Die Studentin kam zu spät in die Vorlesung und hatte auch noch ihre Tasche vergessen. Weil der Kommilitone ihr netterweise eine Zusammenfassung / einen Kugelschreiber / das Kernproblem gab spendierte sie ihm danach einen Kaffee.*

23. *In der Presse wurde überall über die neue Therapie berichtet. Als der Forscher allerdings vor Kollegen die Angaben / die Medizin / die Daten machte stellte sich der Betrug heraus.*

24. *Der Ingenieur beschloss, auf das Klassentreffen zu fahren. Gerade als er seine Vorbereitungen / Schulfreunde / Flugbuchung traf rief seine Frau an.*

25. *Die Violinistin war ein neues Mitglied im Streichquartett. Obwohl sie recht oft Kritik / Geige / Noten übte fühlte sie sich eigentlich nicht gut genug.*

26. *Die Museumsdirektorin begrüßte die Kuratoren sehr herzlich. Als sie auf dem Meeting eine Ansprache / einen Kugelschreiber / eine Diskussion hielt ging plötzlich der Feueralarm los.*

27. *Die Medizinstudentin war gerade in der Kinderabteilung der Uniklinik. Als sie gestern dort ein Referat / ein Kleinkind / eine Diagnose hielt wurde ihr plötzlich schlecht.*

28. *Der junge Mann verwöhnte seine Freundin gerne. Bevor er ihr gestern einen Kuss / ein Geschenk / ein Lied gab hatte er sie massiert.*

29. *Der Winterspaziergang war unglaublich romantisch gewesen. Bevor der Mann seiner Freundin dann zuhause einen Antrag / einen Kakao / ein Verhältnis machte musste er erst einmal auftauen.*

30. *Der Staatsanwalt holte sich Rat bei seinem Vorgesetzten. Obwohl er bei dem Mordfall genug Unterstützung / Dokumente / Anschuldigungen fand bezweifelte er seine eigenen Untersuchungsergebnisse.*

31. *Die Unterhändler gingen in das feindliche Dorf. Während der Häuptling das Gespräch / das Reitpferd / die Vorwürfe führte schwiegen seine Begleiter.*

32. *Die Mutter kaufte ihrem Sohn ein Eis. Während der Junge eine Wahl / einen Freund / einen Geschmack traf telefonierte sie.*

33. *Die Nachbarn hatten sich über die Lautstärke beschwert. Wenn der Mitbewohner aber Zurückhaltung / Blockflöte / Lautstärken übte waren sie zufrieden.*

34. *Das Ehepaar stritt sich unausgesetzt. Während die Gattin heimlich eine Entscheidung / einen Liebhaber / eine Schwangerschaft traf räumte der Gatte die Konten leer.*

35. *Der Schreiner war schon alt und zittrig. Als er in seiner Werkstatt Ordnung / Spielzeug / Unfälle machte musste er sich oft ausruhen.*

36. *Die Mutter entdeckte das Feuer zuerst. Bevor sie panisch die Flucht / das Kind / das Feuer ergriff weckte sie noch ihren Mann.*

37. *Die Verkäuferin ging oft mit ihrem Chef Kaffeetrinken. Als sie mit ihm eine Verabredung / eine Kollegin / ein Rendezvous traf brodelte aber die Gerüchteküche.*

38. *Das Schiff war von Piraten entführt worden. Solange die Besatzung aber noch Hoffnung / Essen / Angst hatte war nicht alles zu spät.*

39. *Nach der Geburt lag die junge Mutter noch ein paar Tage im Krankenhaus. Als sie von Verwandten Besuch / Blumen / Gespräche bekam freute sie sich sehr.*

40. *Auf der Party wollte keiner tanzen. Nachdem der alte Onkel den Anfang / die Cocktails / einen Kuss machte lockerte sich die Stimmung auf.*

41. *Die Sonne strahlte durch die Kirchenfenster. Nachdem der Priester dem Brautpaar den Segen / die Ringe / die Predigt gab ertönten die Kirchenglocken.*

42. *Die Nobelpreis-Verleihung ging dem Ende zu. Als der Preisträger gerade den Vortrag / die Medaille / die Hymne hielt klickten die Fotoapparate.*

43. *Die Lokalpresse berichtete über die Malschule. Als der Dozent gerade eine Vorlesung / eine Palette / einen Farbton hielt wurde er fotografiert.*

44. *Der Manager litt an Kokain-Entzugserscheinungen. Als er gestern eine Präsentation / eine Kaffeetasse / eine Anweisung hielt bekam er Schweißausbrüche.*

45. *Vor der Prüfung waren alle Musikschüler aufgeregt. Nachdem der Lehrer zum Klavier Aufgaben / Mikrofone / Zensuren stellte musste jeder vorsingen.*

46. *Der Rekrut war suspendiert worden. Als er am Montag die Wache / die Waffen / den Befehl hielt stahl sein Kumpel Munition.*

47. *Das Kind weinte ununterbrochen in der Kirche. Während der Pfarrer die Predigt / das Baby / den Segen hielt schlief es endlich ein.*

48. *Die Stewardess fühlte sich ein bisschen krank. Als sie während des Flugs eine Ansage / einen Kaffee / ein Gespräch machte wurde ihr sogar schwindelig.*

49. *Die Pensionärin war ziemlich fit für ihr Alter. Als sie am Samstag einen Spaziergang / einen Apfelkuchen / ein Kinderlied machte pfiff sie munter vor sich hin.*

50. *Die Lehrerin hatte sich eindeutig den falschen Beruf gesucht. Wenn sie den Schülern Unterricht / Zeugnisse / Vorträge gab wurde ihr schlecht vor Aufregung.*

51. *Letzte Woche rief der Architekt seine Mitarbeiter zusammen. Als er ihnen kurz angebunden eine Anweisung / einen Bauplan / eine Diskussion gab protestierten sie nur wenig.*

52. *Fassunglos beobachtete der Richter das Chaos im Gerichtssaal. Als er endlich mit gehobener Stimme die Initiative / die Anklageschrift / die Angaben ergriff kehrte langsam Ruhe ein.*

53. *Die Studentendemonstration war die größte in Jahrzehnten. Während der Medizinstudent eine Rede / ein Banner / ein Gespräch hielt warfen seine Kommilitonen Steine.*

54. *In München konnte der französische Maler schnell Fuß fassen. Weil er dort sofort eine Ausstellung / eine Wohnung / ein Interview hatte musste er einige bürokratische Hürden nehmen.*

55. *In dem Roman gibt es eine besonders gewaltsame Szene. Während die Hauptperson des Buches einen Streit / ein Messer / eine Strafe hatte benutzten seine Gegner einen Schlagstock.*

56. *Das Firmenjubiläum war ein voller Erfolg. Während der Abteilungsleiter Werbung / Kaffee / Gespräche machte schenkte der Azubi Bier aus.*

57. *Drei Wochen lang hatte der Journalist die Zirkusartisten begleitet. Indem er zu der Reportage einige Fragen / Bilder / Zeilen stellte konnten sich die Leser über deren Alltag informieren.*

58. *Im Harz gibt es viele Trekking-Urlauber. Nachdem der Wanderclub dieses Jahr eine Wanderung / einen Wanderweg / einen Wanderschuh machte stieß das bei den Touristen auf Begeisterung.*

59. *Der Schulabbrecher fand einen Job als Nachtwächter. Als ihm sein Vorgesetzter allerdings einen Befehl / einen Ausweis / ein Problem gab wollte er am liebsten wieder nach Hause gehen.*

60. *Jahrelang war die romantische junge Frau in ihren Chef verliebt gewesen. Als sie ihm neulich aber in seinem Büro nervös einen Bericht / ein Gedicht / einen Streit gab sah sie ein Bild von seiner neuen Freundin.*

61. *Die Kinder wollten den dementen Opa nicht mehr pflegen. Als die Pflegerin ihnen für ein Altenheim eine Beschreibung / eine Broschüre / eine Schwierigkeit gab griffen sie zu.*

62. *Die Lektorin war kurzfristig in das Meeting gerufen worden. Indem der Kollege ihr schnell eine Zusammenfassung / einen Kugelschreiber / das Kernproblem gab half er ihr.*

63. *Die Patienten hofften auf wenige Nebenwirkungen. Als der Apotheker allerdings die Angaben / die Medizin / die Daten machte zerstörte er diese Hoffnung.*

64. *Die Autorin hatte sich auf das Klassentreffen gefreut. Gerade als sie ihre Vorbereitungen / Schulfreunde / Flugbuchung traf rief ihr Mann auf dem Handy an.*

65. *Der Geiger war ziemlich eingebildet. Doch obwohl er regelmäßig Kritik / Geige / Noten übte konnte er auch nicht besser spielen als die anderen.*

66. *Die Professorin wurde langsam heiser. Als sie bei der Institutsversammlung eine Ansprache / einen Kugelschreiber / eine Diskussion hielt brachte sie keinen Ton heraus.*

67. *Der junge Arzt unterrichtete in der Kinderklinik. Als er vorhin dort ein Referat / ein Kleinkind / eine Diagnose hielt wurde ein neuer Patient eingeliefert.*

68. *Der Bräutigam schwebte auf Wolke 7. Nachdem er seiner Verlobten heute Morgen einen Kuss / ein Geschenk / ein Lied gab strahlte sie ihn an.*

69. *Der Mann hielt seine Freundin im Arm. Bevor er ihr dann einen Antrag / einen Kakao / ein Verhältnis machte musste er erst einmal auftauen.*

70. *Der Detektiv zündete sich eine Zigarette an und grübelte. Obwohl er eigentlich genug Unterstützung / Dokumente / Anschuldigungen fand kam er in dem Fall nicht weiter.*

71. *Die Rancher verhandelten über den Preis des Viehs. Während der ältere Mann das Gespräch / das Reitpferd / die Vorwürfe führte betrachteten seine Söhne die Tiere.*

72. *Die beiden Mädchen suchten Kleider für den Abschlussball. Während eine von beiden eine Wahl / einen Freund / einen Geschmack traf probierte die andere noch an.*

73. *Das Mädchen war extrem schüchtern. Indem sie meist Zurückhaltung / Blockflöte / Lautstärken übte kapselte sie sich von der Welt ab.*

74. *Die Eltern dachten über Scheidung nach. Während die Mutter bereits eine Entscheidung / einen Liebhaber / eine Schwangerschaft traf war sich der Vater noch nicht sicher.*

75. *Der Großvater bastelte oft für seine Enkel. Als er gestern in seinem Schuppen Ordnung / Spielzeug / Unfälle machte kam ihm eine kreative Idee.*

76. *Der Vater wachte von dem Gasgeruch auf. Bevor er in Sekundenschnelle die Flucht / das Kind / das Feuer ergriff rief er die Feuerwehr.*

77. *Der Lehrer hatte ein Auge auf die Referendarin geworfen. Nachdem er mit ihr eine Verabredung / eine Kollegin / ein Rendezvous traf wusste die ganze Schule davon.*

78. *Der Segler kam in eine Flaute. Solange er aber noch Hoffnung / Essen / Angst hatte bewahrte er einen klaren Kopf.*

79. *Die Operation war gut verlaufen. Als der Patient Besuch / Blumen / Gespräche bekam freute er sich.*

80. *Die Tanzfläche auf der Hochzeit war gähnend leer. Nachdem der Bruder der Braut aber den Anfang / die Cocktails / einen Kuss machte schwangen mehr Gäste das Tanzbein.*

81. *Die Orgel ertönte im Kirchenschiff. Als der Pastor dem Brautpaar den Segen / die Ringe / die Predigt gab erhoben sich die Gäste.*

82. *Auf der Physiker-Konferenz wurden auch Preise vergeben. Als der Theoretiker gerade den Vortrag / die Medaille / die Hymne hielt erhob der Quantenmechaniker Einspruch.*

83. *Die berühmte Künstlerin suchte immer nach Motiven. Als sie vorhin an der Uni eine Vorlesung / eine Palette / einen Farbton hielt kam ihr eine gute Idee.*

84. *Der Berater bewunderte die schönen Hände seiner Kollegin. Als sie heute morgen eine Präsentation / eine Kaffeetasse / eine Anweisung hielt fiel ihm das wieder auf.*

85. *Die Aufnahmeprüfung für das Konservatorium war hart. Während ein Helfer zum Klavier Aufgaben / Mikrofone / Zensuren stellte scharrten alle schon nervös mit den Füßen.*

86. *Der Soldat erzählte, was passiert war. Als er in der vergangenen Nacht die Wache / die Waffen / den Befehl hielt hörte er eine laute Explosion.*

87. *Der junge Vater war sehr emotional. Während die Pfarrerin die Predigt / das Baby / den Segen hielt zerdrückte er manche Träne.*

88. *Die Stewardess war besonders gut gelaunt. Während sie kurz nach dem Start eine Ansage / einen Kaffee / ein Gespräch machte scherzte sie mit Kollegen.*

89. *Der Frühling war endlich gekommen. Als die Großmutter einen Spaziergang / einen Apfelkuchen / ein Kinderlied machte kam die Sonne durch die Wolken.*

90. *Endlich war die Woche zu Ende. Als der Lehrer den Schülern Unterricht / Zeugnisse / Vorträge gab wollten alle nur noch ins Wochenende.*

91. *Die Architektin arbeitete immer fleißig. Als der Chef ihr heute eine Anweisung / einen Bauplan / eine Diskussion gab lobte er sie gleichzeitig.*

92. *Alle Reporter berichteten über den Skandalprozess. Als der Staatsanwalt die Initiative / die Anklageschrift / die Angaben ergriff schrieben alle eifrig mit.*

93. *Die Studenten hielten die Uni besetzt. Gerade als der Politikstudent eine Rede / ein Banner / ein Gespräch hielt kam die Polizei.*

94. *Die kubanische Künstlerin konnte endlich ausreisen. Bevor sie in Paris allerdings eine Ausstellung / eine Wohnung / ein Interview hatte gingen einige Monate ins Land.*

95. *Vor dem Drogendealer fürchteten sich alle. Da er immer einen Streit / ein Messer / eine Strafe hatte machten alle einen Bogen um ihn.*

96. *Die kleine Firma stellte sich auf der Messe vor. Während der Geschäftsführer Werbung / Kaffee / Gespräche machte sprach der Techniker mit den Kunden.*

97. *Die Redakteurin der Schülerzeitung schrieb über den neuen Lehrer. Indem sie zu dem Artikel einige Fragen / Bilder / Zeilen stellte wurde der Artikel sehr interessant.*

98. *Die Pfadfinder kümmerten sich um das Naturschutzgebiet. Als die Gruppe im Frühling eine Wanderung / einen Wanderweg / einen Wanderschuh machte entdeckte sie eine neue Vogelart.*

99. *Der Sicherheitsbeauftragte inspizierte den Flughafen. Als er einer Beamtin einen Befehl / einen Ausweis / ein Problem gab bemerkte er eine verdächtige Person.*

100. *Der Schriftsteller arbeitete für das Magazin. Als er dem Chefredakteur einen Bericht / ein Gedicht / einen Streit gab kritisierte dieser seinen Stil.*

101. *Der Professor wollte eine Lebensversicherung abschließen. Bevor die Bankberaterin ihm eine Beschreibung / eine Broschüre / eine Schwierigkeit gab hatte er ihr seine Finanzen gezeigt.*

102. *Der Vertrag sollte heute unterschrieben werden. Bevor der Notar den Anwesenden eine Zusammenfassung / einen Kugelschreiber / das Kernproblem gab war er offen für Fragen.*

103. *Der Chemiker hatte ein neues Medikament erfunden. Als er im Labor für Kollegen die Angaben / die Medizin / die Daten machte nickten diese anerkennend.*

104. *Die Studentin wollte zu Weihnachten nach Hause fliegen. Als sie am vierten Advent ihre Vorbereitungen / Schulfreunde / Flugbuchung traf stahl ihr jemand das Flugticket.*

105. *Der Geiger war ein schrecklicher Besserwisser. Doch obwohl er oft Kritik / Geige / Noten übte war er nicht besser als die Kollegen.*

106. *Auf der Vorstandssitzung waren alle vollständig. Als der Geschäftsführer eine Ansprache / einen Kugelschreiber / eine Diskussion hielt hörte man von draußen Demonstranten.*

107. *Die angehende Kinderärztin war sehr gestresst. Als sie heute ein Referat / ein Kleinkind / eine Diagnose hielt klingelte auch noch ihr Telefon.*

108. *Der Schauspieler wurde von Paparazzi verfolgt. Nachdem er seiner Freundin heute einen Kuss / ein Geschenk / ein Lied gab stand eine Stunde später ein Foto davon im Internet.*

109. *Der Koch und seine Freundin waren sehr verliebt. Als er ihr gestern einen Antrag / einen Kakao / ein Verhältnis machte strahlte sie glücklich.*

110. *Der Steuerfahnder war unter Zeitdruck. Obwohl er durch die Polizei Unterstützung / Dokumente / Anschuldigungen fand reichte es noch nicht für eine Anklage.*

111. *Die Eingeborenen kamen mit den Siedlern zusammen. Während der alte Mann das Gespräch / das Reitpferd / die Vorwürfe führte schützten ihn seine Söhne.*

112. *Die beiden Brüder gingen in das Spielzeuggeschäft. Während der ältere Junge dort eine Wahl / einen Freund / einen Geschmack traf probierte der jüngere ein Computerspiel aus.*

113. *Die Brüder machten immer Krach. Selbst wenn einer von ihnen Zurückhaltung / Blockflöte / Lautstärken übte war der andere laut.*

114. *Die Frau war unglücklich in ihrer Beziehung. Als sie heimlich eine Entscheidung / einen Liebhaber / eine Schwangerschaft traf unterstützten ihre Freundinnen sie.*

115. *Der Schreiner bekam langsam schlechte Augen. Als er heute in der Werkstatt Ordnung / Spielzeug / Unfälle machte übersah er einige Kleinigkeiten.*

116. *Das Kidnapping ging gründlich schief. Als der Verbrecher panisch die Flucht / das Kind / das Feuer ergriff hörte man draußen schon die Polizei.*

117. *Die Beamtin hatte sich in einen Kollegen verliebt. Als sie mit ihm eine Verabredung / eine Kollegin / ein Rendezvous traf wusste es das ganze Büro.*

118. *Das Schiff war in Seenot geraten. Solange die Crew aber noch Hoffnung / Essen / Angst hatte verfiel niemand in Panik.*

119. *Die Schülerin hatte den Unfall überlebt. Als sie von Mitschülern Besuch / Blumen / Gespräche bekam war sie aber noch nicht ansprechbar.*

120. *Niemand wollte auf der Party tanzen. Erst als ein junger Mann den Anfang / die Cocktails / einen Kuss machte trauten sich die anderen Gäste.*

B Stimuli for Cross-Modal Lexical Decision Task

German Original, PROBE, (English translation)

1. *Als die Mutter ihrem Sohn für den Schulausflug die Erlaubnis / Thermoskanne gab / reichte, war dieser schon genervt von ihren ständigen Ermahnungen. GEBÄCK, RAUCH, RINDER* (When the mother gave / handed the permission / thermos flask for the school excursion, he was already annoyed by her repeated admonitions. pastries, smoke, cattle)

2. *Obwohl die Angestellte nach dem Produktionsausfall den Kunden sofort die Mitteilung / Einkaufsgutscheine gab / schickte, waren diese mit dem Service nicht zufrieden. ERDBEEREN, TÖCHTER, BLUMEN* (Although the employee gave / sent immediately notice / vouchers to the customers after the production downtimes, they were not happy with the service. strawberries, daughters, flowers)

3. *Als der feindliche Spion auf der Diplomatenparty dem mysteriösen Gast schnell einen Bericht / Ausweis gab / zeigte, wurde er vom Geheimdienst beobachtet. GEPÄCK, GEFLÜGEL, ZWEIGE* (When the adversarial spy gave / showed a report / a passport to the mysterious guest at the diplomat's party, he was observed by the secret service. luggage, poultry, twigs)

4. *Als der bestechliche Polizist dem inhaftierten Verbrecher vor der Gerichtsverhandlung eine Warnung / einen Lageplan gab / zeigte, bereitete dieser seine Flucht vor. ERBSEN, SEKT, MARMOR* (When the corrupt policeman gave / showed a warning / floor plan to the arrested criminal before the trial, he prepared his escape. peas, champaign, marble)

5. *Weil der Student seiner Kommilitonin vor dem Seminar eine Zusammenfassung / einen Kugelschreiber gab / abschrieb, spendierte sie*

ihm letzte Woche einen Kaffee. OBST, TRINKWASSER, FLEISCH (Because the student gave / copied an abstract / pen to his fellow student before class, she bought him coffee last week. fruit, drinking water, meat)

6. *Während der erschöpfte Chirurg seinem Assistenten nach der Operation eine Anweisung / eine Schere gab / reichte, wachte der Patient wieder aus der Narkose auf. SPIELZEUG, SPEICHEL, KIES* (While the exhausted surgeon gave / handed an assignment / scissors to his assistant after the surgery, the patient came out of anesthesia. toys, saliva, gravel)

7. *Während die Assistentin in der Kinderklinik für den erkälteten Professor gestern einen Vortrag / ein Kleinkind hielt / kopierte, dachte sie an etwas ganz anderes. ZINK, ESSIG, MEHL* (While the assistant in the children's hospital held (=gave) / copied a speech / a baby for the ill professor, she though of something completely different. zinc, vinegar, flour)

8. *Als der gestresste Theologiestudent vorhin im Klassenzimmer für den Religionslehrer die Predigt / das Lesebuch hielt / abschrieb, klingelte plötzlich laut sein Handy. VIEH, SAUERSTOFF, GETREIDE* (When busy theology student held / copied the sermon / the school book for the religion teacher a little while ago in the classroom, suddenly his cellphone rang loudly. livestock, oxygen, grain)

9. *Als die langjährige Sekretärin für ihren scheidenden Chef gestern mittag im Büro eine Ansprache / eine Akte hielt / abschrieb, freute sie sich schon auf ihre eigene Rente. KLEINGELD, BESTECK, LAUB* (When the longtime secretary held(=gave) / copied a speech / a file for her retiring boss in the office yesterday at noon, she was already happy for her own retirement. coins, silverware, foliage)

10. *Als die umweltbewusste Studentin bei der Kundgebung für Solarenergie eine Rede / ein Spruchband hielt / hörte, entdeckte sie eine alte Schulfreundin in der Menge. BLEI, BETTWÄSCHE, SCHRÄNKE* (When the environmentalist student held(=gave) / heard a speech / banner at the demonstration for solar energy, she saw an old classmate in the crowd. lead, bed sheets, cupboards)

11. *Während der Schüler auf der Versammlung vor dem Rathaus gestern früh ein Referat / eine Flagge hielt / hörte, stahl eine Mitschülerin sein Fahrrad. KLEE, ROSENKOHL, FRÜCHTE* (While the pupil held(=gave) / heard a presentation at the gathering in front of the city hall yesterday morning, a fellow student stole his bike. clover, brussel sprouts, fruits)

12. *Als die Studentin nach einer durchfeierten Nacht im Hörsaal die Präsentation / die Kaffeetasse hielt / hörte, entdeckte sie einen Rotweinfleck auf ihrer Jacke. SCHMIERÖL, KISTEN, SELLERIE* (When the student held / heard a presentation / coffee cup in the classroom after a party night, she saw a stain of red wine on her jacket. grease, boxes, celery)

13. *Nachdem der überarbeitete Musiklehrer in der Übungsstunde zur Gitarre genervt Aufgaben / Lautsprecher stellte / verteilte, konnte jeder Schüler selbst einmal spielen. LEHM, SCHLAGSAHNE, GRÄSER* (After the overworked music teacher in the lesson about / next to the guitar irritatedly put / distributed assignments / loudspeakers, every pupil could play by herself. mud, whipping cream, grasses)

14. *Seit die bekannte Künstlerin in der Staatsoper endlich seit dieser Saison eine Aufführung / einen Schreibtisch hatte / leitete, beantwortete sie zuverlässig Fanpost. NEKTAR, NACHWUCHS, BAUSTEINE* (Since the famous artist finally had / directed a performance / desk in the opera since this season, she reliably answered fan letters. nectar, offspring, building blocks)

15. *Als der vorbestrafte Demonstrant auf der illegalen Demonstration vor dem Bundestag letzte Woche die Initiative / das Spruchband ergriff / plante, schritt die Polizei sofort ein. SCHREIBPAPIER, MAGERMILCH, SCHWEFEL* (When the previously convicted demonstrator seized / planned the initiative / banner at the illegal demonstration in front of the parliament last week, the police intervened immediately. stationary, skim milk, sulfur)

16. *Als der exzentrische Künstler in seinem Atelier zum Thema "Irakkrieg" eine Bemerkung / eine Skulptur machte / hörte, geriet er mit seinem Assistenten in Streit. UNKRAUT, MÖHREN, GABELN* (When the eccentric artist made / heard a remark / sculpture

about the Iraq war, he got into a fight with his assistant. weeds, carrots, forks)

17. *Als der geständige Verbrecher in der Talkshow vor laufender Kamera die Flucht / das Kleinkind ergriff / berichtete, riefen Hunderte Zuschauer beim Sender an. SCHMUCK, SPARGEL, PRALINEN* (When the confessing criminal seized / reported the escape / the baby in the talk show on air, hundreds of viewers called the TV station. jewellery, asparagus, chocolates)

18. *Als die geduldige Lehrerin mit den Kindern nach der Pause ein Spiel / einen Tee machte / aufräumte, fingen zwei Jungen einen Streit miteinander an. MOBILIAR, PETROLEUM, BAUHOLZ* (When the patient teacher made / cleaned up a game / tea with the children after the break, two boys started a fight. furniture, petroleum, timber)

19. *Als der erfahrene Therapeut mit der nervösen Patientin gestern einen Spaziergang / eine Bastelarbeit machte / plante, kam ein wirklich gutes Gespräch zustande. GESCHOSSE, SPARBÜCHER, LAVA* (When the experienced therapist made(=took) / planned a walk / handicrafts with the nervous patient yesterday, a really good conversation came about. bullets, savings, lava)

20. *Weil die Frau nach dem Lesen der Frauenmagazine immer für nur drei Tage begeistert eine Diät / eine Bastelarbeit machte / lobte, lachte ihr Mann sie aus. ANSCHAUUNG, LANDKARTE, SCHRANK* (Because the woman made / praised a diet / handicrafts only for three days after reading the women's magazines at the hairdresser's, she was laughed at by her husband. opinion, map, cupboard)

21. *Als die gelangweilte Praktikantin ihrer Freundin während der Arbeit für ihren Geburtstag einen Vorschlag / eine Collage machte / schickte, kam ihr Chef ins Büro. MUNITION, ZUGLUFT, LATTEN* (When the bored intern made / sent a proposal / collage to her friend for her birthday during work, her boss came into the office. ammunition, draft, slats)

22. *Weil die Schülerin in der Pause immer Hausaufgaben / Papierflieger machte / abschrieb, ass sie ihr Pausenbrot auf dem Heimweg. KLIPPEN, KALZIUM, BÜGELBRETTER* (Because the pupil always

made(=did) / copied homework / paper planes during the break, she ate her sandwich on the way home. cliffs, calcium, ironing boards)

23. *Während der neue Angestellte der Firma auf dem Tag der offenen Tür Werbung / Brötchen machte / verteilte, spielten seine Kollegen Skat im Bierzelt. NEUSCHNEE, HENNEN, HELIUM* (While the new employee of the company made / distributed advertisement / sandwiches at the open house, his colleagues played cards in the beer tent. fresh snow, hens, helium)

24. *Als der berühmte Arzt in seinem Labor dem Patienten zur neuen Therapie Angaben / Arzneien machte / zeigte, wirkte er sehr zuversichtlich. GESINDE, MÄGDE, SIRUP* (When the famous physician made / showed statements / medicaments for the patient about the new therapy in his lab, he was very optimistic. servants, maidservant, sirup)

25. *Bevor die Apothekerin im Labor letzten Montag die Änderungen / Arzneien machte / entdeckte, hatte sie mit ihrem Chef telefoniert. POSTER, VILLA, ZEITUNG* (Before the pharmacist made / discovered the changes / drugs in the lab last Monday, she had talked to her boss on the phone. poster, villa, newspaper)

C Stimuli for Priming Study

1. Non-Light Primes (DO / PO)
   (1) *The smoker gives the pedestrian a cigarette. / The smoker gives a cigarette to the pedestrian.*
   (2) *The man gives the neighbor his key. / The man gives his key to the neighbor.*
   (3) *The brother gives his sibling a toy. / The brother gives a toy to his sibling.*
   (4) *The young man gives his date a bouquet. / The young man gives a bouquet to his date.*
   (5) *The mother gives the child an apple. / The mother gives an apple to the child.*
   (6) *The researcher gives the journalist an article. / The researcher gives an article to the journalist.*
   (7) *The girl gives the stranger her number. / The girl gives her number to the stranger.*
   (8) *The suspect gives the investigators his gun. / The suspect gives his gun to the investigators.*
   (9) *The girl gives the boy a ball. / The girl gives a ball to the boy.*
   (10) *The boy gives the girl a flower. / The boy gives a flower to the girl.*
   (11) *The coach gives the player a towel. / The coach gives a towel to the player.*
   (12) *The teacher gives the students books. / The teacher gives books to the students.*
   (13) *The girl gives the boy a pen. / The girl gives a pen to the boy.*
   (14) *The father gives his son a present. / The father gives a present to his son.*

(15) *The man gives the woman a necklace. / The man gives a necklace to the woman.*

(16) *The husband gives his wife a diamond. / The husband gives a diamond to his wife.*

(17) *The nurse gives the patient medicine. / The nurse gives medicine to the patient.*

(18) *The child gives her mother a gift. / The child gives a gift to her mother.*

(19) *The boy gives his classmate a pen. / The boy gives a pen to his classmate.*

(20) *The man gives the woman a rose. / The man gives a rose to the woman.*

2. Light Primes (DO / PO)

(1) *The kidnapper gives the government an ultimatum. / The kidnapper gives an ultimatum to the government.*

(2) *The mechanic gives the driver directions. / The mechanic gives directions to the driver.*

(3) *The singer gives the drummer a signal. / The singer gives a signal to the drummer.*

(4) *The officer gives the squadron a command. / The officer gives a command to the soldiers.*

(5) *The professor gives his students advice. / The professor gives advice to his students.*

(6) *The ocean gives the artist inspiration. / The ocean gives inspiration to the artist.*

(7) *The teacher gives the students encouragement. / The teacher gives encouragement to the students.*

(8) *The insider gives the police a tip. / The insider gives a tip to the police.*

(9) *The researcher gives the journalist an example. / The researcher gives an example to the journalist.*

(10) *The smoker gives the pedestrian a light. / The smoker gives a light to the pedestrian.*

(11) *The barber gives the customer a haircut. / The barber gives a haircut to the customer.*

(12) *The culprit gives the attorney a reply. / The culprit gives a reply to the attorney.*

(13) *The grandfather gives his grandchild a lesson. / The grandfather gives a lesson to his grandchild.*

(14) *The nurse gives the patient aid. / The nurse gives aid to the patient.*

(15) *The neighbor gives the man a nod. / The man gives a nod to the neighbor.*

(16) *The boy gives his sister a wink. / The boy gives a wink to his sister.*

(17) *The coach gives the player a massage. / The coach gives a massage to the player.*

(18) *The lady gives the man an order. / The lady gives an order to the man.*

(19) *The criminal gives the judge a glare. / The criminal gives a glare to the judge.*

(20) *The teenager gives his rival a beating. / The teenager gives a beating to his rival.*

D Instructions for Categorization Study

Participants were given the following instructions:

In this study, we are interested in different types of actions and events that involve different types of roles in the event. Your task here is to classify events.

Just imagine a theater play, where in one scene, a bishop crowns a king: If you are the director, you need to cast for the role of the one getting crowned, and the crown-er. It doesn't really matter though whether you have one or two crowners – the play is still about the crowning event. Or, you have a chasing scene, with a policeman (or even a group of policemen!), chasing one or more criminals. No matter how many people are involved, you need to cast for two roles: The chasers and the chas-ees.

Now, events in the real world are a bit different from plays, because not only people can have roles, but also things – or even abstract things, like ideas or thoughts!

Look at this picture of jumping. There is one role involved, namely one or more people jumping. You don't need anything else or anyone else for this to be a jumping event!

Look at this picture of chopping: We have two roles, a chef who's doing the chopping, and the onion who is being chopped. Now, you need both roles for it to be a chopping event – if the chef is missing, the onion is doing nothing, and if the onion is missing, the chef isn't doing anything that makes sense. Note though that it doesn't matter how many chefs chop how many onions – there are two roles involved, the chopping role and the role of the one(s) being chopped.

Finally, look at this picture of serving, where we need three roles: one doing the serving, one being served, and one, what is served. In

this particular picture, there's only one participant playing the role of serving (the waitress), but the role of what is served is played by several plates of food. Also, the role of "being served" is played by several customers. You need all three roles being cast for it to be a serving event!

Your job is now to sort all one-role events into one pile, all two-role events into another pile, and all three-role events into a third pile. You have to be careful though: Sometimes, there are lots of things in the picture that don't contribute much to the event. For example, it doesn't matter if the chef chops the onions at a table, or at the countertop; or whether the waitress serves people at the bar or while they are hanging out at a reception. So try to ignore the background, and focus on the bigger type of event!

Let's start with a training phase. Here are the cards you sort as training for the actual experiment. Whenever you get one card wrong, we start all over again. Do you have any questions?

E Frequencies of Stimuli for Categorization Study

Category	Sentence	Search with exact form ("is kissing") and "is (is giving + a kiss")	L/(L+B)	COCA search "kissing" (pause) or "giving (1-4) kiss"	L/(L+B)	Google search exact apart from subject DP	L/(L+B)	sum of "is giving him/me a kiss" and "is kissing him/me"	L/(L+B)
Base	*The boy is kissing the girl.*	55,000		2990		216,000		1,095,000	
LVC	*The boy is giving the girl a kiss.*	7,100	11%	53	2%	86	0%	2,820,000	72%
Base	*The aunt is hugging the child.*	25,900		2061		3070		1,523,000	
LVC	*The aunt is giving the child a hug.*	5,540	18%	93	4%	4	0%	1,496,000	50%
Base	*The boxer is punching his opponent.*	27,200		1354		7630		522,000	
LVC	*The boxer is giving his opponent a punch.*	27,600	50%	8	1%	0	0%	10,809	2%
Base	*The teenager is kicking his rival.*	170,000		4785		5		288,000	
LVC	*The teenager is giving his rival a kick.*	64,600	28%	13	0%	0	0%	275,000	49%
Base	*The manager is calling his business partner.*	873,000		32245		6		35,070,000	
LVC	*The manager is giving his business contact a call.*	296,000	25%	43	0%	0	0%	11,330,000	24%
Base	*The detective is warning the criminal.*	170,000		2235		0		723,000	
LVC	*The detective is giving the criminal a warning.*	13,600	7%	53	2%	0	0%	201,100	22%
Base	*The coach is massaging the player.*	5,110		435		6		1,045,000	
LVC	*The coach is giving the player a massage.*	6,730	57%	30	6%	0	0%	1,062,000	50%
Base	*The wife is supporting her husband.*	427,000		9769		653,000		4,770,000	
LVC	*The wife is giving her husband support.*	226,000	35%	194	2%	1	0%	684,000	13%
Base	*The mother is scolding the child.*	1,630		365		5,510		895,000	
LVC	*The mother is giving the child a scolding.*	609	27%	3	1%	0	0%	5,660	1%
Base	*The headmaster is encouraging the graduates.*	158,000		2425		54		8,820,000	
LVC	*The headmaster is giving the graduates encouragement.*	214,000	58%	28	1%	0	0%	143,800	2%

Figure E.1: Per-item frequency data for the Base and Light Verb Constructions used in the Categorization Study.

F Stimuli for Categorization Study

1. Three Roles Consistent:
   (1) *The grandfather is reading the toddler a story.*
   (2) *The millionaire sells his friend a yacht.*
   (3) *The boy is texting his friend a joke.*
   (4) *The thief steals the purse from the woman.*
   (5) *The farmer is taking a sheep from the barn.*
2. Three Roles Inconsistent:
   (1) *The man buys a couch and sofa for the living room.*
   (2) *The nanny is tucking the children into their beds.*
   (3) *The grandmother is feeding the grandchild milk and cookies.*
   (4) *The businessman is passing pamphlets to the pedestrians.*
   (5) *The brother and sister lend their mother money.*
3. Two Roles Consistent:
   (1) *The man is calming the barking dog.*
   (2) *The muscle man is bending the rod.*
   (3) *The husband is cooking the pasta.*
   (4) *The cowboy is taming the pony.*
   (5) *The electrician repairs the wiring.*
4. Two Roles Inconsistent:
   (1) *The preacher marries the couple.*
   (2) *The wind is blowing the curtains.*
   (3) *The teacher grades the tests.*
   (4) *The witches brew a potion.*
   (5) *The toddler breaks the toy train and car.*

5. One Role Consistent:
   (1) *The girl is dancing.*
   (2) *The frog is jumping.*
   (3) *The dog snores.*
   (4) *The snow melts.*
   (5) *The child is crying.*
6. One Role Inconsistent:
   (1) *The brothers are fighting.*
   (2) *The dolphins are swimming.*
   (3) *The traffic lights are flashing.*
   (4) *The flags are waving.*
   (5) *The chickens are clucking.*
7. Light Verb Constructions/Base Verbs:
   (1) *The boy is giving the girl a kiss. / The boy is kissing the girl.*
   (2) *The aunt is giving the child a hug. / The aunt is hugging the child.*
   (3) *The boxer is giving his opponent a punch. / The boxer is punching his opponent.*
   (4) *The teenager is giving his rival a kick. / The teenager is kicking his rival.*
   (5) *The manager is giving his business contact a call. / The manager is calling his business partner.*
   (6) *The detective is giving the criminal a warning. / The detective warns the criminal.*
   (7) *The coach is giving the player a massage. / The coach is massaging the player.*
   (8) *The wife is giving her husband support. / The wife is supporting her husband.*
   (9) *The mother is giving the child a scolding. / The mother is scolding the child.*
   (10) *The headmaster is giving the graduates encouragement. / The headmaster is encouraging the graduates.*

8. Joint Action Intransitive/Transitive:
   (1) *The boy and the girl are meeting. / The boy is meeting the girl.*
   (2) *The activist and the politician are battling. / The activist is battling the politician.*
   (3) *The girl and her friend are hugging. / The girl is hugging her friend.*
   (4) *The salesgirl and the bank teller are dating. / The salesgirl is dating the bank teller.*
   (5) *The father and the baby are cuddling. / The father cuddles the baby.*
   (6) *The judge and the politician are divorcing. / The judge is divorcing the politician.*
   (7) *The count and the princess are courting. / The count is courting the princess.*
   (8) *The teacher and the psychologist are marrying. / The teacher is marrying the psychologist.*
   (9) *The senator and the governor are debating. / The senator is debating the governor.*
   (10) *The student and his cousin are boxing. / The student is boxing his cousin.*

Light verb constructions (e.g., ‚give a kiss') are a common phenomenon both in German, and in English. What makes them interesting is that there is a mismatch between the syntactic form and the semantics: ‚giving a kiss' means ‚kissing'. This dissertation presents different theoretical analyses of light verb constructions, and tests their respective predictions in the realms of processing, representation, and event construal, using different experimental paradigms.

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