

Hitting playfully but hard:

Conceptual effects of verb-adverb modification
in the domain of force

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Conceptual effects of verb-adverb modification
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Speels maar hard slaan:
Hoe de conceptuele structuur van bijwoorden
en contactwerkwoorden modificatie beïnvloedt
(met een samenvatting in het Nederlands)

Proefschrift

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door

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CHAPTER 1

Introduction

The meaning of a sentence is determined by the meaning of its parts and their mode of composition. This is the Principle of Compositionality, going back to Gottlob Frege. The mode of composition is determined by the syntactic structure of a sentence. But adhering to the syntactic structure, while being necessary for building meaningful and felicitous sentences, is not by itself sufficient, as is illustrated in the sentence in (1), going back to Chomsky (1957).

(1) Colourless green ideas sleep furiously.

The sentence in (1) is syntactically well-formed: an intransitive verb taking a subject and an adverb as modifier. But the sentence is not semantically well-formed, i.e. it is not meaningful. Ideas are inanimate and as such they do not enter states such as sleeping. Further, the event of sleeping may be light or deep, or it may be done in a restless or peaceful manner, but it is not done furiously. Also, ideas are abstract entities, which do not have a colour, and while there are shades of green that might be described as *light green* or *pale green*, there are no shades of green that can be described as *colourless green*.

There are a variety of processes determining semantic well-formedness. Verbs impose restrictions on their arguments, for example that they need to be animate, i.e. living beings. Certain aspects of verbs can be modified, such as the location or time at which the described activity takes place. Verbs also have inner parameters or components. In the case of *sleep* this could be deepness, which can be modified by adverbs as in *to sleep lightly* or *to sleep deeply*. Finally, the activity described by verbs can be done in certain manners, which are expressed through adverbs as in *to sleep restlessly* or *to sleep peacefully*.

Such conceptual modification restrictions on verbs, though important in determining the semantic well-formedness of a phrase or sentence, have received relatively little attention. For example, why is it possible to say *sleep restlessly* or *sleep in a restless manner*, but not *sleep furiously* or *sleep in a furious manner*? This dissertation is intended to make a contribution to the study of verb-adverb modification and the restrictions that determine semantic well-formedness. I argue that the conceptual structure of verbs and adverbs is crucial for the understanding of semantic well-formedness in verb-adverb modification.

1.1 Modification

The phenomenon of modification and the conceptual restrictions on word combinations at play during modification have been studied most in the domain of adjective-noun modification. In contrast, modification in the verb-adverb domain is well-studied in the framework of Event Semantics, but very little has been said on modification restrictions in verb-adverb modification. In the following, I present a brief review of studies on conceptual effects in adjective-noun modification and show how the main insights can be applied to verb-adverb modification.

1.1.1 Modification restrictions in the adjective-noun domain

Studies on modification restrictions in the domain of adjective-noun modification include that of Kamp & Partee (1995), who discuss a number of context principles that can account for the meaning shifts observable in phrases such as *midget giant* versus *giant midget*, taking into account prototype effects. Gärdenfors (2000) gives an account of conceptual combination within the theory of conceptual spaces, proposing that conceptual spaces are rescaled, e.g. the specific colour red in *red wine* versus *red hair* versus *red skin* needs to be rescaled according to the noun concept. Bemis & Pylkkänen (2011) study the neurological processes underlying composition of adjective-noun pairs. And Schulpen (2016) discusses the conceptual restrictions on adjectival modification of weakly referential nouns.

One study deserves special mention: Smith et al. (1988) have developed a model of selective modification to account for certain conceptual effects in adjective-noun modification. In a nutshell: Adjectives specify the value of an attribute, e.g. *red* specifies the value of the attribute *colour*. When the adjective *red* is combined with the noun *apple* to form the phrase *red apple*, the value of the attribute *colour* must be shifted to *red* (where before it might also have been e.g. *yellow* or *green*). Interestingly, Smith et al. note that if the adjective *brown* is used to modify the noun *apple*, it shifts not only the value of the attribute *colour*, but presumably also that of the attributes *taste* and *texture*.

The colour brown on an apple usually signifies that the apple is rotten, which in turn influences the apple's taste and texture.

Please note that the modified noun phrase *brown apple* gives rise to meaning components or meaning effects which are not part of either constituent: nothing about the adjective *brown* specifies anything about taste or texture, and a non-brown apple has a different taste and a different texture than a brown apple, therefore the 'brown apple taste' and the 'brown apple texture' cannot be due to the noun *apple* either. Rather, the composite concept *brown apple*, with its prototypical taste and texture, is based on world knowledge (about the decaying process of fruit) linked to the meaning of the words *apple* and *brown* and their interaction.

1.1.2 Modification in the verb-adverb domain

Verb-adverb modification is most commonly analysed in the framework of Event Semantics. In that framework, verbs are analysed as referring to sets of events. For example, the verb *sleep* refers to all sleeping events, i.e. all activities in the world that are described by the verb *sleep*. Adverbs are also analysed as referring to sets of events, so for example the adverb *peacefully* refers to all peaceful events, i.e. all activities that can be described by *peaceful(ly)*. The phrase *sleep peacefully* then refers to the intersection of the set of sleeping events and the set of peaceful events. This is called intersective modification (Parsons, 1990).

Event Semantics has many advantages over previous accounts of verb-adverb modification (see also Chapter 4), but it does not by itself provide an answer to why *sleep peacefully* is semantically well-formed, yet *sleep furiously* is not. I argue that the conceptual structure of verbs needs to be taken into account, just like Smith et al. (1988) built their Selective Modification Model on the conceptual structure of nouns. For example, the verb *sleep* has a meaning component of *deepness*, similar to the noun *apple* having a meaning component of *colour*. An adverb such as *deeply* modifies the deepness component of the verb *sleep*, just like the colour-adjective *red* modifies the colour component of the noun *apple*. The semantic well-formedness of the phrase *sleep deeply* can thus be explained.

In order to explain why *sleep furiously* is not semantically well-formed, one needs to consider the agent. The adverb *furiously* modifies the manner in which the agent does the activity described by the verb, and it requires a volitional agent who is in control of the activity. After all, one can only do something in a furious manner by consciously acting furiously. Sleepers cannot consciously influence the manner in which they sleep, therefore, *sleep furiously* is not semantically well-formed. The adverb *peacefully* has no such requirement for a volitional agent (though it can be combined with one), therefore the phrase *sleep peacefully* is semantically well-formed.

1.2 Conceptual effects of verb-adverb modification

Verb-adverb modification includes not only modification of properties of the event, such as the deepness component of *sleep*, but also of properties of the participants with respect to the event, e.g. doing something furiously or peacefully. Verbs thus allow a different array of modification than nouns. In order to systematically uncover the mechanisms that determine the well-formedness of verb-adverb combinations, I will have to limit the scope of this dissertation.

I chose the domain of verbs that involve force, for three main reasons. Firstly, force is perceivable. The difference between a light hit and a hard hit, for example, can be felt; the same object hitting you feels different when it hits you lightly than when it hits you hard, i.e. the force is felt, not just the object (Wolff, 2007). This is an important point, since perception can influence what is expressed in language (cf. the colour example discussed in Section 1.1.1 above).

Secondly, the use of force depends on the agent and can be controlled by the agent. The presence of a volitional agent is what licenses the use of adverbs such as *furiously* with verbs that have a force component (and makes it an unsuitable modifier for verbs such as *sleep* where the agent has no control).

And thirdly, force and force interactions have been analysed as the driving factor underlying many (causal) interactions described by verbs (Talmy, 1988, 2000; Wolff, 2007). This suggests that force interactions are a basic component of verb meaning and as such influence admissible modification.

Yet despite the centrality of force in verb meaning, the modification behaviour of verbs with a force component is still puzzling. In the following, I will introduce initially puzzling observations concerning modification by agent-oriented adverbs and the interaction of causation and modification. In addressing these puzzles, this dissertation will contribute to a better understanding of well-formedness conditions of verb-adverb combinations.

This section will finish with a note on the choice of languages.

1.2.1 Agent-oriented adverbs and force modification

Consider the sentences in (2).

- (2) a. Joan hit Mary playfully. →
 Joan hit Mary lightly.
 b. Joan hit Mary playfully but still rather hard.

The adverb *playfully* in (2-a) is licensed by the presence of the agent: Joan. It modifies the manner in which Joan does the hitting. But it also gives rise to the inference that the force of the hit was low (light). This becomes evident when considering the sentence in (2-b): *hitting playfully* can be contrasted with *hard*, the opposite of *lightly* with respect to force (as will be seen during the discussion

of the results of the corpus study in Chapter 2). The contrast suggests that *hitting playfully* gives rise to a meaning component similar to *hitting lightly*. Yet at the same time, the sentence in (2-b) shows that the low force inference can be cancelled. The use of the adverb *hard* indicates that the force of the hit was high.

This low force inference is similar to the *brown apple* case discussed in Section 1.1.1 above. Remember that the resulting change in the taste and texture of the apple cannot be traced to either the adjective *brown* or the noun *apple*. In the case of the low force inference of *hitting playfully*, the inferred low force magnitude cannot be traced to either the adverb, which specifies the manner of the hitting, or the verb, which is unspecified with respect to the force magnitude (as will be seen from the questionnaire results in Chapter 3).

I argue that the low force inference is due to the interaction of the underlying conceptual structure of the modifier and the verb. In a nutshell: the force of the hitting can be controlled by the agent. The adverb *playfully* suggests that the agent is not serious. Therefore, if *playfully* is combined with *hit*, this gives rise to the inference that the agent does not want to hit seriously and adjusts the force of the hit accordingly. This can be formalised in Event Semantics by assuming a defeasible inference triggered by adverbs such as *playfully* when they are combined with verbs containing a force component (the details of the analysis will be presented in Chapter 4).

1.2.2 Causation and force modification

Another puzzling observation about the modification behaviour of verbs with a force component is that once a result of the force is specified, the force magnitude can no longer be modified. Consider the German sentence in (3).

- (3) Maria schlägt den Nagel (#hart) in die Wand.
 Maria hits the nail (#hard) into the wall.

In order to move the nail into the wall, Maria needs to have hit it hard enough. Yet using *hart* (hard) as a modifier results in an infelicitous sentence (as will be seen from the questionnaire results presented in Chapter 5). I propose to extend the Event Semantic approach with a more detailed analysis of the force component based on a vector model like that proposed by Wolff (2007) to account for the representation of causation (the analysis will be presented in Chapter 6).

In a nutshell: The force generated by the agent is modelled via force vectors with an origin, a magnitude and a direction. Verbs with a force component are analysed as referring to events that contain paths of motion with force dynamic properties: paths are treated as sequences of force vectors. These vectors can have a zero magnitude (no length) to model the phase of hitting when the agent exerts no force (the phase preceding the impact when the agent or part of the agent, such as their hand, is moving towards the patient). Vectors with a non-

zero magnitude are used to model the phase of force transmission, when the agent is in contact with the patient. The length of the vector then corresponds to the magnitude of the force exerted by the agent. In this model, the motion of the agent, or part of the agent, towards the patient can be traced via the origins of the force vectors, which form the path.

The sentence in (3) describes a complex event: the verb *schlagen* (to hit) and the prepositional phrase *in die Wand* (into the wall) express separate events. The first event describes the motion of Maria's hand towards the nail and the impact, the second event describes the motion of the nail into the wall. The two events are linked by a causal relation: Maria causes the nail to move into the wall by hitting it. I suggest that once the complex event has been composed, the force properties of the individual events are inaccessible for modification. This explains why the adverb *hart* can no longer be used to modify the verb *schlagen*.

This detailed analysis of the force component in a vector-based model can also account for a number of other previously puzzling observations, for example why certain verbs select specific prepositions, or why some verbs can be modified by *lightly* but not by *hard* (more details will be provided in Chapter 6).

1.2.3 The choice of languages

I will study verb-adverb modification in English, German and Dutch. This choice of languages is motivated by the fact that in order to study verb-adverb modification, one needs to study languages that have the word class *adverb*, as do these three languages (more in Chapter 2). Further, there is a lot of research into German adverb classes (most prominently Schäfer 2005, 2013). The same is true for English (Ernst, 2002), also with respect to verbs. And remember that I choose as the domain of study verbs involving force. In order to delimit this domain of verbs involving force, I will take as a starting point Levin's 1993 book, which is about English verb classes.

Finally, I chose these specific languages also for reasons of research logistics. German is my native language, and studying examples from this language allows me to rely on my own intuition. Closely related to both English and German is Dutch, which is not only the language spoken in the environment where this research was carried out and therefore the language of the participants recruited for the experiment reported in Chapter 3. Dutch is also a major West-Germanic language, and therefore in a sense completes the picture with English and German.

1.3 The structure of this dissertation

In Section 1.2 I have introduced the main research puzzles to be addressed in this dissertation. Answering these puzzles will ultimately contribute to a

better understanding of the semantic well-formedness conditions of verb-adverb modification.

In order to address these puzzles, this dissertation is structured as follows: In Chapters 2 - 4 I address the puzzle concerning the force inferences that arise in modification of verbs with a force component through agent-oriented adverbs and model these findings in Event Semantics, the most common framework for analysing verbs and adverbs. In Chapters 5 and 6 I address the puzzle concerning the interaction of causation and modification of the force component and refine the Event Semantic model from the previous chapters. Finally, in Chapter 7 I show how the conceptual structure of verbs and adverbs can be modelled in Frame Semantics, a framework more suitable to model conceptual structure than Event Semantics.

In the following, I will give a more detailed summary of Chapters 2 to 7.

In order to find admissible modifiers of verbs with a force component (selected with the help of Levin's 1993 book), I conducted two corpus studies on English and German. The results of the corpus studies are reported in Chapter 2. The underlying idea is that the adverbs serve as a probe into the meaning of the verbs, i.e. an adverb can only modify a verb if that verb has a corresponding meaning component. Adverbs can thus tell us something about the conceptual structure of verbs. Accordingly, Chapter 2 also contains a classification of the adverbs according to their modification target in the verb: force or some other aspect of the event, or one of the participants. The classification is based on Schäfer 2005, 2013 for German and Ernst 2002 for English. The chapter finishes with the observation that some adverbs modify the force component directly, such as *lightly* and *hard*, while others do so only via an inference, such as *playfully* (cf. the example in (2-a) in Section 1.2.1 above). The adverbs that directly modify the force component are mostly pure manner adverbs, while adverbs that modify the force component via an inference come from a sub-type of agent-oriented adverbs.

It is unclear of what type the observed inference is, and whether it is an incidental example or can be observed with a range of agent-oriented adverbs. Therefore, Chapter 3 contains a classification of the type of inference. I classify the inference as a sub-type of conversational implicature, more specifically as a Levinsonian I-implicature, stereotypical enrichment (Levinson, 2000), or R-implicature according to Horn (1984, 2004). In order to test whether this implicature arises systematically with agent-oriented adverbs modifying verbs with a force component, I conducted a questionnaire study in German. This study confirms the existence of the implicature across a range of verb-adverb combinations. The chapter finishes with the presentation of a self-paced reading experiment in Dutch, which confirms the existence of the implicature in that language. The experiment further shows a reading time delay when participants read sentences where the implicature is cancelled compared to sentences where it is not cancelled. This, I argue, is an indication for the strength of the implicature.

Given the range and strength of the observed implicature, it is desirable

to integrate it into a Neo-Davidsonian Event Semantic account. As explained in Section 1.1.2 above, this framework is still the most commonly used in the domain of verb-adverb modification. Chapter 4 therefore contains an analysis of verb-adverb modification and the observed force implicatures in Neo-Davidsonian Event Semantics. The analysis takes into account the conceptual structure of both the verb and the modifier. Force implicatures, as indicated in Section 1.2.1 above, are modelled as defeasible inferences triggered by agent-oriented adverbs modifying verbs with a force component.

In Chapters 2 to 4, I use a couple of Levin's (1993) verbs of contact by impact, most prominently *hit*, to study modification effects on verbs with a force component. While the selection was well-chosen, there are certainly more verbs with a force component than just those few. In order to find more verbs with a force component, I conducted another corpus study in German, looking for verbs that occur with the German force-modifying adverbs *leicht* (lightly) and *hart* (hard). The idea is that the verbs that can be modified by these force-referring adverbs have a force component. The results are presented in Chapter 5. Based on this study, I develop a definition of a class of force verbs, which contains members from several of Levin's classes. This classification emphasises the fact that the force component can be manifested differently in verbs. For example, the force can be directed towards or away from an object (as expressed in *drücken* (to push/press) or *ziehen* (to pull) respectively), it can be exerted only momentarily or continuously (*schlagen* and *drücken* respectively), and it can be light or hard, i.e. with a low or high force magnitude (*berühren* (to touch) and *pressen* (to press)). The corpus also contains examples of resultative particle verbs. However, these examples indicate that the force component of these verbs does not seem to be open for modification by *leicht* or *hart* (though other readings of these adverbs are available). In order to test whether the fact that *leicht* and *hart* are not admissible modifiers of resultative force constructions is incidental, i.e. a property of the specific verb, or a general pattern, I conducted a questionnaire study. The questionnaire study shows that once a force result is specified in a sentence via a particle or prepositional phrase, the force component can no longer be modified (cf. the sentence in (3) in Section 1.2.2 above).

In order to model the observations about force verbs in Neo-Davidsonian Event Semantics, I developed a more detailed notion of the force component, presented in Chapter 6. This analysis builds on insights from Force Dynamics and makes crucial use of a vector model to represent the force exerted by one person or object on another person or object (see Section 1.2.2 above). This analysis not only accurately models the different force properties of force verbs, such as their different directions or magnitudes, but also explains the force result - force modification incompatibility confirmed in the questionnaire study and illustrated in (3) above.

While Event Semantics can be made to model the modification effects observed in Chapters 2 - 4 (about force implicatures) and 5 - 6 (about causation and force results), it was not developed with conceptual structure in mind. In

Chapter 7, I will therefore provide an analysis of force verb-adverb modification in Frame Semantics. This framework is ideal for modelling conceptual effects that go beyond word meaning and touch upon world-knowledge. Concepts are represented as connected graphs in which all meaning components and their relations are immediately visible in a network of nodes and arcs. By allowing for constraints in this network to model not only logical truth, but also statistical patterns and typicality, this framework nicely captures the effect of the implicature discussed in Chapters 2 - 4 and illustrated in (2) in Section 1.2.1 above. It also shows at one glance the force interactions that lead to a caused event as in (3) in Section 1.2.2 above.

1.4 Background and terminology to the study of concepts

The study of concepts and categories has developed in various fields, ranging from Philosophy (Wittgenstein, 1953/1999; Bartsch, 1998) to Psychology (Rosch, 1973; Rosch & Mervis, 1975; Smith et al., 1988; Barsalou, 1992, 1999), Cognitive Semantics (Lakoff, 1987; Gärdenfors, 2014), Formal Semantics (Jackendoff, 1990; Sassoon, 2013) and Artificial Intelligence (Abelson, 1973; Minsky, 1975), sometimes in collaboration or with reference to each other (Hampton & Winter, 2017), sometimes separately. This wealth of approaches brought with it a variety of different definitions and terminology, so here I would like to clarify the main terms I will use in this dissertation.

Depending on the tradition, one could speak of word meanings or categories on the one hand, and concepts or world knowledge on the other hand. The two terms *word meanings* and *categories* are similar, but not the same. Psychologists such as Eleanor Rosch, who study categorisation, i.e. the classification of items into groups, often use the term *categories* to refer to these groups. Linguists (and also some philosophers) who study word meaning often use the terms *extensions* and *intensions*. The extension of a word is the set of things in the real world that a word refers to (Frege's *Bedeutung* - reference), the intension of a word is its "cognitive content" (Margolis & Laurence 1999: 6) or definition, Frege's *Sinn* - sense.

World knowledge is the knowledge about the world that influences word meaning. The boundaries between word meaning and world knowledge are vague (this is what some people refer to as *dictionary* versus *encyclopedia*). It could be said that *guards sheep on a farm* is part of the world knowledge about the things we call dogs, at least in rural environments. In the city, world knowledge about dogs probably contains something else, maybe *requires cleaning up after when walking outside*. World knowledge thus differs according to context, while word meaning is in a sense more stable. In the case of dogs it contains e.g. *has four legs* and *is furry* (even though there might also be three-legged dogs with no fur). The term *concept* in its widest application covers both

word meaning and world knowledge, it is thus broader than *category* or *word meaning*. It is this broader sense of *concept* that I will assume.

When analysing concepts or categories into smaller parts, researchers working in different fields also use different terminology. Psychologists speak of features or attributes that categories have, such as *four legs* and *fur* for dogs. Some psychologists (Smith et al., 1988; Barsalou, 1992) have refined this notion, and speak of attributes and their values. Take the above example about *apple* (cf. Section 1.1.1): *taste* is one of the attributes of apples, and it can take e.g. the values *sweet* or *sour*. Speaking of attributes and their values thus allows more refinement than simple features.

A similar idea is expressed by the term *dimension*, used by linguists (Kennedy & McNally, 2005; Sassoon, 2013; Bylinina, 2013). This is related to the idea of gradability and scales. The verb *sleep*, for example, can be said to have a deepness dimension, the scale of which goes from *light* to *deep*. Dimensions and their scales are often characterised in terms of their opposite ends, such as e.g. the healthy - sick dimension or the empty - full dimension. The term *dimension* is also used in multidimensional spaces, which are used to model the distance and direction of certain dimensions across concepts. The space of colour (Berlin & Kay, 1969; Gärdenfors, 2000), for example, can be modelled along the dimensions of hue, brightness and saturation, with each colour term corresponding to regions of specific hues, brightnesses and saturations.

Both the terms *attributes* and *dimensions* refer to components of word meanings or concepts. In the following, I will mostly use the general term *component* or *meaning component*, which leaves open the precise structure of the component (with respect to gradability, attribute-value pairs, etc.). In Chapter 7, where I work with the framework of Frame Semantics, which uses the terms *attribute* and *value*, I will give a definition of these terms within Frame Semantics and use them accordingly.

CHAPTER 2

Modification of verbs of contact by impact

In Chapter 1, I explained that in order to uncover some of the mechanisms underlying the semantic well-formedness of verb-adverb modification, I chose the domain of force, and the modification of verbs involving force. I argued that in order to determine semantic well-formedness in verb-adverb modification, one needs to consider the conceptual structure of the verbs and adverbs.

In this chapter, I will make use of adverbs to explore the conceptual structure of verbs involving force. Remember from the introduction that the adverb *furiously* cannot be used to modify the verb *sleep*. I reasoned that this is because *furiously* requires a volitional agent in control of the activity expressed by the verb, and that *sleep* does not provide such an agent. But *sleep* can be modified by for instance the adverbs *deeply* or *lightly* because it has a deepness component. Adverbs that can felicitously be used with a verb thus correspond to a meaning component within that verb, and can tell us something about the conceptual structure of the verb. Adverbs can in a sense be used as a probe into the meaning of a verb. To that end, I conducted a corpus study to map out which adverbs can be used to modify verbs with a force component (selected with the help of Levin's (1993) book), the results of which will be presented in this chapter.

However, in order to understand which meaning component an adverb modifies, one needs to pin down the meaning of the adverb. What I said above about the adverbs *furiously* and *deeply* was mostly based on my own intuitions and reasoning. In order to approach adverb meaning in a more systematic way, as a second step this chapter will also contain a classification of adverbs. Based on work by Schäfer, I will show that the distinction manner versus agent-orientation is not as absolutely linked to the position of an adverb as sometimes

seems to be assumed, and that the meaning of an adverb also plays a role in its classification. An analysis of the different types of adverbs within Event Semantics will be provided in Chapter 4.

This chapter is structured as follows: Section 2.1 contains some background about adverbs and adverbials, including a brief cross-linguistic sketch of this category and introducing some relevant terminology. Following that, in Section 2.2 I present the domain of verbs of contact by impact as laid out in Levin 1993, which I use to choose verbs with a force component. In that section, I also explain in more detail the idea of using adverbs as a probe into the meaning of verbs. Section 2.3 contains the corpus study of the domain of verbs of contact by impact and the results, which show that a variety of manner adverbs and agent-oriented adverbs co-occur with these verbs. Section 2.4 builds on the corpus results by comparing the distinction of agent-oriented adverbs and manner adverbs as found in the literature to the data from the corpus study. In Section 2.5, I will present the adverb classification tests developed by Schäfer (2005, 2013) and apply them to the corpus data, arguing for a distinction between agent-oriented adverbs and manner adverbs that is based on the adverbs' meaning, not on their position. In Section 2.6, I close with the observation that several agent-oriented adverbs trigger a defeasible inference on the force component when combined with verbs of contact by impact. This will lead to Chapter 3, in which I will provide more detailed information on this inference.

2.1 Background to adverbs and adverbials

It is difficult to define what an adverb is, though some handbook chapters provide a good overview, e.g. Maienborn & Schäfer 2011. The following is roughly based on their line of argumentation.

Adverbs form a word class or lexical category, much like nouns or verbs. They add information about the activity or event described by the verb (*sleep soundly*), the proposition expressed in a sentence (*Allegedly, she won the elections*) or the property expressed by an adjective (*very deep*). In other words: adverbs modify anything but a noun. The word class of adverbs is very diverse. Zooming in on adverbs that modify verbs, they can add information about the manner of an activity or event (cf. (1-a)), or relate to the participants, e.g. agent or patient (cf. (1-b)), etc.:

- (1) a. Nancy snored loudly.
- b. Maggy hit him intentionally.

One way of identifying adverbs, at least in English, is via their morphological marking. Most adverbs end with the suffix *-ly*, thereby distinguishing them from the adjectives from which they are derived, though there are of course also some adverbs in English that are not derived from adjectives and do not have the morphological *-ly* marking, e.g. *well*, *hard* or *yesterday* (see Geuder

(2000) for an extensive discussion of the relation between adverbs and adjectives in English). But the English adverb-marking is exceptional. In the closely related languages German and Dutch, adverbs are morphologically unmarked, i.e. they have the same morphological appearance as the underlying adjectives (though in both languages the adjective receives inflection to agree with the noun it modifies, while the adverb is always used in the uninflected form). And among all the languages in the world, even German and Dutch are exceptions. Most languages have no word class for adverbs, and instead code manner and other information expressed through adverbs in languages like English as e.g. a separate coordinated clause (*She laughs and she is cheerful*), a sub-clause (*She laughs who is cheerful*) or as a copula participle (*She laughs, being cheerful*). For more typological information see Loeb-Diehl (2005). But as explained in the introduction in Chapter 1, in order to study verb-adverb modification, I need to study languages that have a separate word class for adverbs. How other languages code adverb information is therefore of little concern here.

Another way of defining adverbs is via their syntactic function as adverbials. Adverbials fall into a class with other syntactic functions like subject or predicate, but unlike these, most adverbials are syntactically optional. This is unsurprising, seeing as they add extra information about the activity/event described by the verb, such as time, location, or manner. Yet caution needs to be exercised with this definition of adverbs, too. While there is a significant overlap between adverbs and adverbials in English, i.e. most adverbs are adverbials and vice versa, they are not the same. In (2-a), the adverbial is a noun phrase (not an adverb), and in (2-b) and (2-c), the adverb is the subject and an adjective modifier respectively (but not an adverbial adding information about the event).

- (2) a. Nancy laughed the whole day.
 b. Yesterday was a beautiful day.
 c. Joan is provocatively stupid.

As discussed in the introduction in Chapter 1, my focus is on verb-adverb modification, and adverbs used to modify verbs are always adverbials. What I am interested in are thus adverbially used adverbs, as in the examples in (1), and not other types of adverbials, as e.g. the noun phrase in (2-a), or adverbs used in a different syntactic function, as a subject or adjective modifier ((2-b) and (2-c) respectively). The examples in (2) are thus outside the scope of my dissertation.

As mentioned above, there is one prominent distinction among adverbially used adverbs, the distinction between agent-oriented adverbs and manner adverbs (Jackendoff, 1972; McConnell-Ginet, 1982; Eckardt, 1998; Geuder, 2000; Ernst, 2002; Piñón, 2010). In a nutshell: when an adverb precedes the verb, it is said to be agent-oriented, when it follows the verb, it is said to be a manner adverb. This is illustrated in (3).

- (3) a. Joan clumsily dropped her cup of tea.

- b. Joan dropped her cup of tea clumsily.

The difference in meaning between these two sentences can be made explicit by paraphrasing them. The sentence in (3-a) can be paraphrased as *It was clumsy of Joan to drop her cup of tea* (and not elegant), focusing on the overall evaluation of Joan's dropping her cup of tea. The sentence in (3-b) can be paraphrased as *It was clumsy how Joan dropped her cup of tea* (what with first tripping over the cat), focusing on the precise manner of Joan's dropping her cup of tea. I will come back to this distinction (and all the sub-distinctions) in Section 2.4, where this will be discussed in some more detail. In that Section I will show, among other things, that agent-orientation versus manner does not depend on word order as much as usually seems to be assumed in the literature.

Finally, please note that the morphological unmarkedness of adverbs in German and Dutch gives rise to a debate about terminology. Some distinguish between adjectives and adverbs and therefore use these two distinct terms, while others claim that there are only adjectives in these languages, and no adverbs. In order to make a terminological distinction between e.g. the two occurrences of *laut* (loud/-ly) in *lautes Singen* (loud singing) and *laut singen* (to sing loudly), they call the latter of these two occurrences adverbially used adjective, or simply adverbial adjective (for a more detailed discussion see Schäfer 2005: §2 and references therein). For the purpose of this work, the terms *adverb* and *adverbial adjective* can be used interchangeably. But for the sake of simplicity and comparison, I will refer to the German and Dutch words as adverbs, just as I do for the English words. The term *adverbial adjective* will come back occasionally in Section 2.5 when I discuss adverbial subclasses as introduced by Schäfer (2005, 2013), who uses this term.

2.2 Verbs with a force component

Having established in Section 2.1 the types of adverbs that are used to modify verbs in the sense I intend, I now turn to the verbs. Remember from the introduction in Chapter 1 that I study adverbial modification of verbs with a force component. In the following, I will introduce Levin's (1993) class of verbs of contact by impact, which I use as a starting point, and then illustrate how I use adverbs as a probe into the conceptual structure of these verbs (remember that I argue that the conceptual structure of both the verbs and the adverbs is instrumental in understanding semantic well-formedness conditions in verb-adverb modification).

2.2.1 Verbs of contact by impact

One natural class of verbs to choose for my purposes of studying modification of verbs with a force component is the class of verbs of contact by impact, as defined by Levin (1993). Examples are *hit*, *kick*, *slap*, *swat*, *punch* or *spank*. The

name, contact *by impact*, already suggests that force is a prominent meaning component in these verbs, since one needs force to generate an impact. Levin describes the class as follows:

These verbs refer to moving one entity in order to bring it into contact with another entity, but they do not necessarily entail that this contact has any effect on the second entity.

(Levin 1993: 152)

Apart from a force component, it stands to reason that these verbs also have a speed or movement component. In fact, in the above definition, Levin explicitly refers to movement: “moving one entity”. It further seems plausible that at least some of these verbs have a sound-volume component. Imagine hitting a spoon against a glass (a gesture often seen at bigger gatherings in restaurants), the intended result is the creation of a sound. In fact, (Levin 1993: 150) states that there is some overlap between verbs of contact by impact and verbs of sound emission.

Yet intuitively, one would expect the force component to be more prominent in verbs of contact by impact than the speed component or the sound-volume component. Compare for instance *hit* with *run* or *sing* with respect to these three components. *Hit* is a verb of contact by impact, *run* is a manner of motion verb (Levin, 1993) and *sing* is a verb of manner of speaking and a verb of sound emission (Levin, 1993). Because of this prominent force component, I choose verbs of contact by impact to study force in verb-adverb combinations.

2.2.2 Adverbs as a probe into verb meaning

As illustrated above, adverbs can serve as a probe into the meaning of verbs and confirm the intuitions about their meaning components. The general idea is that a verb-adverb combination is only felicitous if the verb has a meaning component that corresponds to the meaning of the adverb. Above, I illustrated this point with the infelicity of *sleep furiously*. Another example is given in (4) with the verb *slap*, which is a verb of contact by impact and can be nicely used to illustrate the idea.

- (4) a. ✓ Joan slapped her loudly.
b. # Joan slapped her quietly.

The sentence in (4-a) is felicitous. The adverb *loudly* is an acceptable modifier of the verb *slap*. This tells us that the sound-volume component is a part of the meaning of *slap*. (4-b) on the other hand is infelicitous. The same verb cannot easily be modified by the adverb *quietly*, the sound-volume component of *slap* is not open for modification towards less noise. The adverbs *loudly* and *quietly* are opposite ends of the same scale, related to sound-volume. The minimal pair in (4) suggests that one end of the scale is inaccessible in the semantics of *slap*, while the other is not.

Adverbs thus tell us something about the existence and the structure of certain meaning components in the verbs they modify. But in order to understand which meaning component(s) an adverb modifies, it is necessary to get an idea about the meaning of the adverb. If the meaning of an adverb is known, one can learn about its modification target in the verbs it modifies, and account for effects of conceptual combination such as the *brown apple* example in the adjective-noun domain discussed in the introduction. In the discussion of the corpus study in the next section, I will therefore make explicit the meaning of the adverbs I found, by first looking up their definition in a dictionary and then discussing that definition in relation to their context and use in the corpus data. This only works to a certain extent, however, especially with adverbs that seem to say something about the agent of an event. So in Section 2.5, I will draw on the literature on adverbs for further clarification, specifically with respect to the distinction of agent-oriented adverbs and manner adverbs and their position in the sentence. Finally, in Section 2.6, I will show that agent-oriented adverbs also modify the force component of verbs of contact by impact in a process comparable to that of the *brown apple* adjective-noun example discussed in the introduction.

2.3 Adverbs modifying verbs of contact by impact - a corpus study

In this section, I will present the results from a corpus study on adverbs modifying verbs of contact by impact. The corpus study is carried out in English and in German. English is a natural choice for a starting point, partly because of the vast body of literature on English adverbs, partly because at this stage, I work a lot with Beth Levin's (1993) verb classes. For German, there also exists a lot of literature on adverbs. Additionally, working with German examples will allow me to rely on my own native speaker intuitions to classify examples in the corpus.

As a starting point for the corpus study I made a selection of some verbs of contact by impact and searched for adverbs in their vicinity. For English, I chose the related verbs *to slap*, *to punch* and *to hit*. I chose these verbs because they are conceptually minimally different: both a punch and a slap are specific hits, the former being done with the fist, the latter with the outstretched hand or some other object with a flat surface. Punching someone can do more damage than slapping someone, you can e.g. break someone's nose by punching them, but not by slapping them. I was interested in whether this distinction in 'degree of violence' has any effect on the type of adverb co-occurring with these verbs. Does *punch* co-occur more frequently with adverbs such as *violently*?

For German there is unfortunately no such distinction. All three English verbs are best translated by *schlagen*, even though there are other expressions for *slap* and *punch* in specialised contexts, e.g. *jemand eine runter hauen* and

boxen respectively. But for this corpus study I chose only the verb *schlagen*, since it covers the conceptual domain expressed by the three English verbs. Like English *hit*, which is more general than *slap* or *punch*, German *schlagen* seems to be a general verb in this domain, covering many situations that can be described as “contact by impact”. Both *hit* and *schlagen* therefore seem an ideal starting point for this study.

Above, I reasoned that verbs of contact by impact have a force component, a speed or movement component, and a sound-volume component. The expectation is thus that among the adverbs found in the corpus study there will be some referring to force, to speed (of movement) and to sound-volume. I also said above that the force component seems to be the most prominent of the three. I therefore expect to find a higher number of force related adverbs than speed related or sound-volume related adverbs.

2.3.1 Modification of English verbs of contact by impact

The corpus

For the English data, I searched the *British National Corpus* (BNC). The BNC can be found online at: <http://corpus.byu.edu/bnc/>. The corpus contains 100 million words of both spoken and written British English from the 1980’s and early 1990’s, collected from a.o. newspapers, journals, periodicals, popular fiction, academic books and university essays. The search interface allows to search for the lemma of a word form (thus including e.g. all variants of a verb in the past and present tense), and surrounding word classes, such as e.g. adverbs.

I searched for the lemmas of *slap*, *punch* and *hit*, and for adverbs up to the maximum distance of nine words on either side of the verb. The choice of maximal distance between the verb and the adverb(s) was motivated by wanting to make sure that the highest possible number of instances is found. With a shorter distance between the verb and adverb(s), sentences such as e.g. *She hit my hand from her shoulder, gracefully, but also rather hard* would be missed. This of course also meant a lot of manual work to exclude instances such as e.g. *He slapped her across the face and then angrily turned away*, where *angrily* modifies the verb *turn*, not *slap*. Additionally, I wanted to exclude instances of the relevant verb being used in a different sense. Remember from the introduction that one of the reasons I chose the domain of force is that force is perceivable, at least in the concrete physical sense of contact involving force. I therefore want to exclude social/economical uses as in *The taxes hit the farmers hard*.

Results

The full list of adverbs from the BNC used to modify the English verbs of contact by impact *slap*, *punch* and *hit* can be found in Table A.1 in Appendix

A, Section A.1. The total number of occurrences of each verb with an adverb in the BNC is: *slap* = 82, *punch* = 40, *hit* = 250. The percentages given in the table are calculated based on that number. This is of course not an exhaustive list of all adverbs that can be used to modify the verbs in question (it is exhaustive for the corpus, but not for the language as a whole), but it does give a good impression of the domain and the most prominent co-occurrences. The ten most frequent adverbs used to modify the English verbs of contact by impact *slap*, *punch* and *hit* are listed in Table 2.1.

slap		punch		hit	
adverb	frequency	adverb	frequency	adverb	frequency
hard	37.8%	hard	35%	hard	52%
lightly	7.3%	lightly	15%	badly	8%
suddenly	7.3%	playfully	12.5%	harder	8%
gently	6.1%	gently	5%	suddenly	4%
promptly	4.9%	sharply	5%	worst	3.2%
sharply	4.9%	strongly	5%	violently	2.4%
harder	3.65%	aggressively	2.5%	angrily	1.6%
angrily	2.4%	angrily	2.5%	fast	1.6%
firmly	2.4%	harder	2.5%	immediately	1.2%
playfully	2.4%	painfully	2.5%	properly	1.2%

Table 2.1: The ten most frequent adverbs used to modify the verbs *slap*, *punch* and *hit*, sorted by frequency (with respect to other adverbs occurring with each verb).

A brief overview shows first and foremost a high percentage of what appear to be force-related adverbs co-occurring with *slap*, *punch* and *hit*: *hard*, *lightly*, *gently*, *sharply*, etc. Among these there are both adverbs of ‘low force’ such as *lightly* and adverbs of ‘high force’ such as *hard*. This seems to confirm my expectations as spelled out above. Further, there are also adverbs that seem to relate to the timing of the event such as *immediately* and *promptly*, or to speed: *fast*. Finally, adverbs such as *aggressively* or *angrily* but also *playfully* are found at the top of the co-occurrence list. Intuitively, these last few adverbs do not so much contribute something to the event described by the verb, but rather to the agent or subject (cf. the distinction of agent-oriented adverbs and manner adverbs discussed around the examples in (3) in Section 2.1 above). I will now elaborate on these observations by discussing several corpus examples in detail.

Modification targets of the adverbs

Among the top adverbs co-occurring with *slap*, *punch* and *hit* are *hard* and *lightly*. The entry for *hard* in the *Oxford English Dictionary* (OED, found online at <http://www.oed.com/>) says (among other things) “with a great deal of effort,

energy, or force”. The entry for *lightly* in the OED is “with little pressure, force or violence”. This suggests that *hard* and *lightly* modify the force used in the event/activity described by the verbs. A look at some of the corpus examples confirms this classification.

- (5) a. If you hit that hard with your hammer, it'll just break.
- b. [...] the youth again demanded money before punching her hard in the face. She suffered severe headaches and her face was tender.
- c. A delicious tide of powerful rage surged within her, giving her the courage to slap his face hard [...]
- (6) a. He slapped Harry lightly on the buttocks and as the boy shivered down through the foam into the hot, stinging water [...]
- b. [...] a man who seemed mighty pleased to see me again. He lightly punched my shoulder.

A hard hit can break something, a hard punch results in headaches and one needs enough rage to slap hard. All this provides evidence for “a great deal of force” being part of the meaning of *hard*. Similarly, a light slap sends a child into the bath, and a light punch is exchanged between people pleased to see each other again. I take this as evidence for the meaning of *lightly* being “with little force”. Above I explained that adverbs needs a suitable target of modification in the verb’s meaning in order to make a sentence felicitous, a target that corresponds to the meaning of the adverb. *Hard* and *lightly* being among the most frequent adverbs co-occurring with *slap*, *punch* and *hit* is thus strong evidence that these verbs have a force component.

It is, however, unclear how that force component is manifested in the verb. The co-occurrence with both *lightly* and *hard* suggest that the force magnitude can be low (*lightly*) as well as high (*hard*). But this says nothing about the force magnitude in the bare, unmodified verb. I said above that the name for the class, verbs of contact *by impact*, seems to suggest a high amount of force. If that is indeed the case, the modification through *lightly* would be crucially different from that through *hard*. While *hard* would further increase an already high force magnitude, *lightly* would need to override the verb’s force magnitude specification. I will discuss this issue in more detail in Chapter 3, where I will present questionnaire data suggesting that verbs of contact by impact are *not* pre-specified for a high force magnitude, and that the high force magnitude interpretation is due to an inferential process.

Other adverbs that frequently co-occur with these verbs are e.g. *angrily* or *playfully*. Their lexical entries in the OED are much less informative than those for *lightly* and *hard*; they state “in an angry or wrathful manner, with anger or open resentment” and “in a playful manner, jokingly, in fun” respectively. Intuitively, these adverbs say something about the agent of the sentence, i.e. someone being in an angry or playful mood, even though the definitions explicitly include the word *manner*. If that is indeed the case, these adverbs require the verb to come with an animate agent to whom mental states and moods can

be attributed, i.e. their modification target is an aspect of the verb's subject or agent. Indeed, the examples in the corpus come with an animate agent, cf. (7).

- (7) Steve hit his brother playfully but rather hard on the shoulder.

In the next section I will look at some tests to classify adverbs into agent-oriented adverbs or manner adverbs and their subclasses. This will confirm the intuition about the agent-orientation of *angrily* and *playfully*. In Section 2.6, we will see that these adverbs also modify the force component, but via an inference.

There are also some speed- or time-related adverbs that co-occur with *slap*, *punch* and *hit*, such as e.g. *fast* and *immediately*. The adverb *immediately* refers to the time that passed between some preceding event and the event that is described by the modified verb. This is evidenced by examples such as that in (8), where the preceding event is described in the sub-clause headed by *when*.

- (8) Villa hit the framework again almost immediately when a Richardson corner struck the far post.

Fast is ambiguous between a 'time elapsed' reading like that of *immediately* on the one hand, as in *She was fast to hit back*, and a speed reading as in *She ran fast* on the other (Higginbotham calls the former the thematic interpretation and the latter the manner interpretation, Higginbotham 2000: 57). The corpus data seem to fall in the time elapsed or thematic interpretation, cf. (9).

- (9) a. [...] and drop away quickly because I'm going to hit it so fast he won't know where the ball is [...]
 b. Ignore the fact that they are holding you, and hit them first and fast.

In both examples, some preceding event can be identified, someone dropping away in (9-a) and someone being held (or attacked) in (9-b). Yet in both cases, the speed related reading or manner interpretation cannot be ruled out. In fact, it would be absurd to assume that in (9-a), someone will be very quick to hit the ball, but their movement will not be quick. And similarly in (9-b), it would be surprising if the advice did not extend to the actual movement of the hitting. The evidence from the corpus is thus that the adverb *fast* can receive both a thematic interpretation and a manner interpretation. I therefore conclude that, *hit* has a speed or movement component that is accessible for modification by adverbs (and that *slap* and *punch* therefore very likely also have a speed component).

As concerns the sound-volume component, in Table A.1 in Appendix A, Section A.1, the adverb *loudly* appears in the list for the verb *slap*. The example in the corpus is given in (10). It thus seems that *slap*, at least, also has a sound-volume component. The relatively low frequency of *loudly* compared to *lightly* and *hard* confirms my expectations about the sound-volume component being

less prominent in verbs of contact by impact than the force component. Note that *slap* is also classified as a verb of sound emission according to Levin (1993), which might be why *loudly* occurs with *slap* but not with *punch* or *hit*.

(10) [...] his worn sandals slapping loudly against his feet [...]

Finally, there is some confirmation for my speculations above concerning the difference in degree of violence between *slap* and *punch*, cf. (11), taken from the corpus. Rough treatment is defined as *slapping* a person, but *punching* someone is of a different category.

(11) Usually this was limited to ‘rough treatment’ (defined as pushing, slapping, or roughly handling the victim but not punching or kicking her) [...]

However, the data in Table 2.1 suggest that this difference in degree of violence is not reflected in the type and frequency of the adverbs co-occurring with the two verbs. Both *slap* and *punch* frequently co-occur with *lightly* and *gently*, as well as *hard* and *sharply*, among others. The fact that the difference in degree of violence between these verbs does not seem to influence the type of co-occurring adverb provides further legitimation for my decision to focus only on the one German verb *schlagen* (to hit), and to leave out more specialised expressions such as *jemandem eine runter hauen* (to slap someone) and *boxen* (to punch).

From the range of adverbs co-occurring with the English verbs of contact by impact *slap*, *punch* and *hit* I conclude that these verbs have a prominent force component that is open for modification into both the direction of *lightly*, i.e. little force, and *hard*, i.e. a lot of force. I further conclude that verbs of contact by impact have both a speed or movement and sound-volume component, though the evidence is that these are less prominent than the force component. Finally, these verbs are open for a more general manner modification, connecting the mood of the agent to a certain manner, cf. the modification through adverbs *angrily* and *playfully*. Before I turn to the issue of manner modification and agent orientation in Sections 2.4 and 2.5, I will first report on the results from the German corpus study.

2.3.2 Modification of German verbs of contact by impact

The corpus

For the German data, I searched the *Digitales Wörterbuch der Deutschen Sprache* (digital dictionary of the German language, DWDS). The DWDS is designed to be a dictionary based on a reference corpus. The corpus contains about 100 million words from newspapers, scientific texts, manuals and fiction from the 20th century. The DWDS can be accessed online at <http://www.dwds.de/>

I searched for the lemma of the verb *schlagen*, which yields all verb forms regardless of number, gender or tense, but no nominalisations. I also looked

for adverbials and adjectives¹ in the vicinity of the verb. Unfortunately, the search function I used (Phrasensuche) is not straightforward about the maximal number of intervening items allowed between the verb and the adverb(s), but a cursory inspection shows the results to be comparable to the English data. As with the English data, I manually looked through all examples to verify that the adverb indeed modifies the verb I am interested in, and that the verb is used in the sense I intend (cf. the concrete physical interaction leading to contact between two objects, not any social or economic uses).

Results

The full list of adverbs from the DWDS used to modify the German verb *schlagen* can be found in Table A.2 in Appendix A, Section A.2. The total number of occurrences of the verb *schlagen* with an adverb in the DWDS is 256. The percentages given are calculated based on that number. The 22 most frequent adverbs used to modify German *schlagen* can be found in Table 2.2 below. The complete list can be found in appendix A. As with English, this is not a list of all adverbs that can be used to modify *schlagen*, but it should give a good impression of this domain in German.

A first look at the data shows similarities to the English data. *Hart* (hard) and *leicht* (lightly) are among the most frequent adverbs co-occurring with *schlagen*. Assuming that their meaning is similar to that of *hard* and *lightly*, this would suggest that *schlagen* has a force component, just like *slap*, *punch* and *hit*. This confirms my expectations spelled out above. Another similarity to the English data are adverbs such as *wütend* (angrily) or *unbarmherzig* (mercilessly), which intuitively seem to say something about the agent or subject of the verb. There are also a lot of what appear to be manner of sound adverbs: *dröhnend* (booming), *klatschend* (slapping), *krachend* (crashing), etc. This is different from the English data and might suggest that *schlagen*, in addition to the force component, also has a prominent sound-volume component. *Schlagen* is of course not the exact counterpart of *hit*, it can, for instance, refer to a characteristic sound of a clock, which *hit* can't. This difference might explain some occurrences of manner of sound adverbs with *schlagen*. I will now discuss some observations about the German corpus data in more detail.

Modification targets of the adverbs

There is great diversity among the German adverbs used to modify the verb *schlagen*. As with the English verbs, *leicht* (lightly) and *hart* (hard) are among the most frequent adverbs found with *schlagen*. Their definitions in the DWDS (remember, this is also a dictionary) are as follows: *leicht* - “von geringer Stärke, Kraft, schwach” (with little strength, force, weak); *hart* - “heftig, derb” (severely, roughly). These definitions indicate that *leicht* and *hart* modify force. This is confirmed by looking at some examples in the corpus, cf. (12) and (13).

¹The search category *adverb* does not exist as a search option in the DWDS.

schlagen		
adverb	translation	frequency
plötzlich	suddenly	5.1%
leicht	lightly	3.5%
hart	hard	3.1%
heftig	severely	3.1%
dumpf	dully	2.7%
kräftig	strongly	2.7%
lachend	laughingly	2.7%
wütend	angrily	2.7%
dröhnend	booming	1.9%
wild	wildly	1.9%
klatschend	slapping	1.6%
krachend	crashing	1.6%
langsam	slowly	1.6%
laut	loudly	1.6%
entsetzt	horrified	1.2%
hell	light	1.2%
knallend	banging	1.2%
lieblich	lovely	1.2%
schwer	heavily	1.2%
silbern	silver	1.2%
tüchtig	vigorously	1.2%
unbarmherzig	mercilessly	1.2%

Table 2.2: The 22 most frequent adverbs used to modify the verb *schlagen* (hit), sorted by frequency (with respect to other adverbs occurring with the verb).

- (12) Ungram, der in Wahrheit überhaupt nicht gespuckt hatte, schlug
 Ungram, who in truth anyway not spit had, hit.PAST
 sie lachend leicht auf den spitz ausgestreckten Finger.
 her laughing lightly on the pointy extended finger
 ‘Ungram, who in truth hadn’t spit, laughingly hit her extended finger
 lightly.’
- (13) Scott ist erste Klasse, er ist ein Meister in der Technik und schlägt
 Scott is first class, he is a master in the technique and hits
 überaus hart.
 extremely hard
 ‘Scott is first class, he is a master of technique and hits extremely hard.’

Laughingly hitting an extended finger is done lightly, and a first class (boxing) champion hits extremely hard. This is evidence for the definitions of *leicht* and *hart* as “with little force” and “severely” (with a lot of force) respectively. Given the high co-occurrence frequencies of these adverbs with *schlagen*, this points to the fact that *schlagen*, just like *slap*, *punch* and *hit* has a force component. This is in accordance with the expectations spelled out in Section 2.2 above. Please note that as with the English data, it is unclear whether *schlagen* in its bare, unmodified use is interpreted as describing an event of high force exertion or not. This question is not only relevant when considering the verb’s conceptual structure, but also has implications for modification. If *schlagen* is interpreted as a high force exertion event without a modifier, *leicht* would need to override that specification when modifying that verb. In Chapter 3 I will present questionnaire data that show that the high force interpretation of *schlagen* is due to an inferential process rather than lexical specification.

Again as with the English data, we find adverbs with less clear definitions in the DWDS, such as e.g. *wütend* (angrily) or *unbarmherzig* (mercilessly). The DWDS definition for these adverbs is “von Wut erfüllt” (filled with anger) and “anderen gegenüber kein Mitleid zeigend” (showing others no mercy) respectively. Like *angrily* and *playfully* above, *wütend* and *unbarmherzig* seem to intuitively say something about the agent of a sentence, i.e. attribute to them the property of being angry or merciless. This suggests that the only requirement these adverbs impose on the verb is that it comes with an animate agent to whom the respective property can be attributed, i.e. the modification target in the verb is the existence of an agent (and their mood, state of mind, etc.). A look at some corpus data show that, indeed, these adverbs co-occur with *schlagen* appears with an animate agent.

- (14) Er schlug wütend mit der Hand auf all die Papiere. Da waren
 He hit.PAST angrily with the hand on all the papers. There were
 Zigarrenkistchen für fünfzig Mark, für siebzig Mark, das flog nur
 cigar.bboxes for fifty Mark, for seventy Mark, that flew just
 so!
 so

He angrily hit the papers with his hand. There were cigar boxes for fifty Mark, for seventy Mark, which went flying!

The intuition that these adverbs' modification target is indeed the agent will be confirmed in Section 2.5, where I introduce some tests to classify adverbs into agent-oriented adverbs and manner adverbs and their respective subclasses.

Schlagen also has a high co-occurrence frequency with *plötzlich* (suddenly), comparable to the high co-occurrences of the English verbs with *immediately* and *promptly*. Remember, these adverbs modify the time that passed between the event described by the verb and some preceding event, cf. the discussion in the previous section of Higginbotham's (2000) definition. The adverb *langsam* (slowly) is ambiguous between a thematic, time-elapsed reading like that of *plötzlich* and a reading in which it modifies the speed. In the corpus, it is not clear which reading is intended, cf. (15).

- (15) Er schlägt so langsam, daß selbst wir gute Chancen hätten, das
 he hits so slowly, that even we good chances had, that
 Sparring heil zu überstehen.
 sparring well to survive
 'He hits so slowly that even we would have good chances of coming
 through that sparring unharmed.'

In a boxing context as in (15), *langsam* could modify both the time elapsed between the individual hits or the speed of the individual hits. As with the English examples of the adverb *fast*, the example in (15) seems most plausibly to modify both the time between the hits as well as the speed of each individual hit. If true, this would suggest that the speed or movement component of *schlagen* is accessible for modification.

The German data differ from the English data in that *schlagen* occurs with a broad class of 'manner of sound' adverbs, such as e.g. *dumpf* (dully), *dröhnend* (booming) or *klatschend* (slapping). These are used in contexts of two objects coming into physical contact with each other and emitting a sound (as a result of the contact), cf. (16) and (17).

- (16) Der Grumbach hielt die Augen geschlossen und schlug dröhnend
 the Grumbach held the eyes closed and hit booming
 seine tönerner Trommel.
 his clay drum
 'Grumbach kept his eyes closed and made his clay drum boom.'
- (17) Der Inspektor schmunzelte und schlug ihm bedeutungsvoll
 the inspector smirked and hit.PAST him meaningfully
 abermals klatschend auf die Schulter.
 again clapping on the shoulder
 'The inspector smirked and slapped him meaningfully on the shoulder
 again.'

In English, one would use verbs of sound emission in the sense of Levin (1993) in these contexts, such as e.g. *to boom*. These data thus show us that German *schlagen* has a sound-volume component (though the data might be slightly more complex, if one would allow for *schlagen* to be polysemous).

2.3.3 Conclusion

Using adverbs as a probe into the meaning of verbs of contact by impact has yielded interesting results with respect to the conceptual structure of verbs of contact by impact.

Firstly, I was able to show that verbs of contact by impact in English and German do indeed have a force component. This became clear from these verbs' high co-occurrences with the adverbs *lightly* and *hard*, which are defined as “with little force” and “with a great deal of force” in the OED respectively (and similarly for their German counterparts *leicht* and *hart* in the DWDS). A look at several specific corpus examples supported these definitions: both *lightly/leicht* and *hard/hart* are used in contexts that suggest a low amount of force or a high amount of force respectively. This observation confirms my expectations about a high number of force related adverbs co-occurring with verbs of contact by impact. I have also explained that at this point, it is unclear how the force component is manifested in the verbs. Specifically, are unmodified verbs of contact by impact interpreted as having a high force magnitude? I will address this question in Chapter 3, where I present questionnaire data that show that the high force interpretation of unmodified verbs of contact by impact is due to an inferential process.

Secondly, the adverbs that are used to refer to speed, such as English *fast* or German *langsam* (slowly), are ambiguous between a thematic and a manner reading in the sense of Higginbotham (2000). In the context of concrete examples from the corpus, it seems most plausible that both readings are intended. I thus conclude that verbs of contact by impact in English and German have a movement or speed component which is open for modification by adverbs. Please note that the adverbs relating to speed have lower co-occurrence frequencies with verbs of contact by impact than do adverbs relating to force: compare the 1.6% of co-occurrences of *fast* with *hit* with the 52% of *hard*, or the 1.6% of co-occurrences of *langsam* with *schlagen* (to hit) with the 3.1% of *hart* (almost twice as much). This confirms my expectations about speed related adverbs co-occurring less frequently with verbs of contact by impact than force related adverbs and suggests that the force component is more prominent in these verbs than the speed component.

Thirdly, the high frequency of manner of sound adverbs co-occurring with the German verb *schlagen* provides evidence for the presence of a sound-volume component in *schlagen*. While the English data show no manner of sound adverbs, there is reason to believe that English verbs of contact by impact also have a sound-volume component. The concrete examples from the German corpus are best translated by verbs of sound emission in English, which overlap

with verbs of contact by impact (Levin 1993: 150), i.e. one and the same verb is used in contexts of contact by impact and sound emission (describing an event with both impact and sound). And in Table A.1 in Appendix A, Section A.1, *loudly* is listed as co-occurring with *slap* (cf. also the discussion of the English data above). As with the speed related adverbs, however, the co-occurrence frequencies of sound-volume related adverbs is less than that of force-related adverbs. For German, we find 2.7% of co-occurrences of the most frequent manner of sound adverb, *dröhnend* (booming) and 3.1% of co-occurrences of *hart*. For English, the difference is more drastic: *loudly* co-occurs in 1.2% with *slap*, *hard* in 37.8%. Again, this is in line with my expectations and indicates that the sound-volume component is less prominent in verbs of contact by impact than the force component.

Finally, there were also some adverbs whose modification target was not so clearly identifiable. Adverbs such as e.g. English *angrily* or *playfully* or German *wütend* (angrily) or *unbarmherzig* (mercilessly) don't modify a meaning component such as force, speed or sound-volume. Intuitively, these adverbs modify some aspect of the agent. As stated several times above, there is a rather well-known distinction between agent-oriented adverbs and manner adverbs (Jackendoff 1972; McConnell-Ginet 1982; Eckardt 1998, among others), but that is mostly tied to the position of the adverb in the sentence, rather than the meaning of the adverb (cf. the examples in (3) in Section 2.1 above). Given that the seemingly agent-oriented adverbs occur rather frequently with verbs of contact by impact, I will introduce some classification tests, based on Schäfer (2005, 2013), in order to answer the question whether these adverbs are in fact agent-oriented and confirm my intuitive impression from above.

2.4 Agent-orientation and manner

In this section, I will provide some background about the distinction between agent-oriented adverbs and manner adverbs in the literature (Section 2.4.1), and compare that to some of the examples I found in the corpora (Section 2.4.2). Crucially, it appears that the distinction between agent-oriented adverbs and manner adverbs is not as tightly related to an adverb's position as is usually assumed in the literature.

2.4.1 The distinction agent vs manner in the literature

There is a well-known distinction between adverbs, going back to Jackendoff (1972) and picked up on by a.o. McConnell-Ginet (1982); Eckardt (1998); Geuder (2000); Ernst (2002); Piñón (2010), who state that some adverbs can have two readings or orientations. Above, I illustrated this distinction between agent-orientation and manner with the sentences in (3), where the adverb *clumsily* either followed or preceded the verb, yielding the two different readings.

Another way of illustrating the distinction is with sentences containing quantified direct objects, as the English examples in (18).

- (18) a. Sue carefully sliced all the bagels.
 b. Sue sliced all the bagels carefully.

The two readings of the adverb *carefully* can be distinguished based on the adverb's position in the sentence and its interaction with the quantified phrase *all the bagels*. In (18-a), the adverb has scope over the quantified expression and the sentence means something like *Sue took care to slice all of the bagels*. This reading is alternatively known as the clausal reading (Ernst, 2002), subject-oriented adverb (Jackendoff, 1972), evaluative reading (Eckardt, 1998) or agent-oriented adverb (Piñón, 2010). I will use the term *agent-oriented adverb*. Please note that the agent-oriented reading can also be expressed by a sentence where the adverb is fronted, e.g. *Carefully, Sue sliced all the bagels*. In (18-b), on the other hand, the adverb scopes under the quantified expression that serves as direct object, and the sentence means something like *Sue sliced each bagel carefully*, i.e. the care is directed towards the individual slicing events, not towards the completion of the overall task. This reading is most commonly known as the manner reading.

The same distinction can be expressed in German through the suffix *-weise*, cf. Schäfer (2013: 110/111), based on Bartsch (1972). The adverb with the suffix in (19-a) expresses the agent-oriented reading, the version without the suffix in (19-b) expresses the manner reading:

- (19) a. Sue schnitt sorgfältigerweise alle Brötchen.
 Sue sliced carefully all rolls
 'Carefully, Sue sliced all the rolls.'
 b. Sue schnitt alle Brötchen sorgfältig .
 Sue sliced all rolls careful
 'Sue sliced all the rolls carefully.'

Additionally, German allows the adverbial short form, i.e. without the suffix *-weise*, to appear before the direct object, cf. the example in (20). According to Schäfer (2013), there is no meaning difference between (19-a) and (20), but the version with the suffix is more typical.

- (20) Sue schnitt sorgfältig alle Brötchen.
 Sue sliced careful all rolls
 'Sue carefully sliced all the rolls.'

I will now try to see how the distinction between agent-oriented adverbs and manner adverbs plays out in the corpus data. Remember that there were some adverbs that I judged as specifying an aspect of the agent, such as the English adverb *playfully* or the German adverb *wütend* (angrily). If these adverbs do indeed modify aspects of the agent, i.e. fall into the agent-oriented classes, they should by the above reasoning always appear in a high position in the sentence.

2.4.2 The distinction agent vs manner in the corpus data

A look at examples from the BNC corpus data reveals that there are two positions in the sentence for both *playfully* and *angrily*, two of the most frequent adverbs co-occurring with *slap*, *punch* and *hit*, cf. (21) and (22).

- (21) a. She refused, playfully punching his shoulder [...]
 b. Shiona punched his arm playfully.
- (22) a. Angrily Holmes hit the rock in front of us with his open hand.
 b. Sherlock Holmes hit his knee with his hand angrily.

According to the literature reported above, *playfully* and *angrily* in (21-a) and (22-a) are agent-oriented, while the examples in (21-b) and (22-b) refer to the manner of the event. But unlike the examples with *carefully* above, cf. (18), it is not so clear what the difference in position contributes to the meaning of the sentence. Without a quantified direct object, the difference in meaning between *She angrily punched his shoulder* and *She punched his shoulder angrily* is much harder to spell out. Following the reasoning applied in the examples in (3) in Section 2.1 above, the sentence in (22-a) means something along the lines of *It was angry of Holmes to hit the rock* (as opposed to, say, calm). And the sentence in (22-b) should be paraphrased as *It was angry how Holmes hit his knee*, referring to the manner of the hitting.

But I maintain that intuitively, *playfully* and *angrily* generally refer to some aspect of the agent, independent of their position in the sentence. In the case of *angrily* in both sentences in (22), the modification target of the adverb seems to be the agent's behaviour (caused by a certain mood or state of mind). Geuder (2000: 20) argues that there can be an angry manner of doing something, independent of the agent actually being angry (expressed in the case of the adverb appearing in a low position in the sentence). The example he gives is along the lines of *I kept shouting at them real angrily to make them believe I was a real officer* (see also Ernst 2002: 67 for a similar reasoning). I would argue that whether *angrily* refers to the agent's behaviour as caused by an actual state or some make-believe state is of secondary importance: the adverb refers to the agent's behaviour caused by a certain real or imagined state of mind, i.e. the adverb is agent-oriented.

As for the German data, there are no adverbs with the suffix *-weise* listed in Table 2.2, nor in the complete list in Appendix A.2. But there are some adverbs that are found in the corpus only in a position preceding the direct object, such as *wütend* (angrily), cf. (23). *Unbarmherzig* (mercilessly), on the other hand, only appears in a position following the direct object, cf. (24).²

- (23) Bochow schlug wütend die Faust auf den Lumpenberg.
 Bochow hit angrily the fist on the mountain.of.rags

²This could, of course, be accidental, given the relatively small numbers. But the fact of interest here is that adverbs that I intuitively judged to be agent-oriented can appear in both high and a low positions.

‘Bochow angrily hit his fist onto the mountain of rags.’

- (24) Die sich zur Wehr setzenden Schüler schlug er
 the themselves to resistance setting pupils hit he
 unbarmherzig [...]
 mercilessly [...]
 ‘He hit the pupils who resisted mercilessly.’

Wütend in the sentence in (23) should then be agent-oriented, and *unbarmherzig* as in (24) should be a manner adverb. But remember that in the discussion of the corpus study in Section 2.3.2 I said that intuitively, both of these adverbs refer to an aspect of the agent.

Contrary to the claim in the literature that adverbs in a low position in the sentence are manner adverbs, I seem to have found some examples of adverbs that refer to an aspect of the agent, i.e. are agent-oriented, yet still appear in a low position in the sentence. It is because of this discrepancy that I will make use of the work of Martin Schäfer (Schäfer, 2005, 2013). Schäfer introduces a separate class of pure manner adverbs, to be distinguished from agent-oriented manner adverbs. This distinction will allow me to maintain my intuition about the agent-orientation of adverbs such as *angrily*, and distinguish the intuitively different types of adverbs occurring in a low position, such as *unbarmherzig* and e.g. *kräftig* (strongly), cf. (25).

- (25) und schlagen sich gegenseitig kräftig auf die Schultern.
 and hit themselves mutually strongly on the shoulders
 ‘and they hit each other strongly on the shoulder.’

2.5 Schäfer's adverb tests

In this section, I will introduce Schäfer's (2005) adverb classification. These classification tests give a more fine-grained picture of the relation between the type of an adverb (agent-oriented or manner, including various subclasses) and its position in the sentence. In a nutshell, Schäfer (2005) shows that even adverbs lower down in the sentence can specify aspects of the agent. Applying these insights to the adverbs from the corpus study reported above confirms my intuition about adverbs such as English *playfully* or German *wütend* (angrily), which I said intuitively specify an aspect of the agent.

Martin Schäfer's work (e.g. Schäfer 2001, 2002, 2005, 2008, 2013, 2015) focuses on the different interpretations of German adverbs (adverbial adjectives, in his terminology) in their various positions in the sentence. The overall distinction developed in Schäfer 2005 and Schäfer 2013 is between adverbials preceding the direct object and those following it. Adverbials in the position preceding the direct object (event-related adverbs in Schäfer 2013) are e.g. mental-attitude adverbs such as *widerwillig* (reluctantly) or subject-oriented adverbs such as *klugerweise* (wisely). Adverbials following the direct object

(verb-related adverbs in Schäfer 2013) are manner adverbs, either pure manner adverbs such as *laut* (loudly) or agent-oriented manner adverbs such as *intelligent* (intelligently). Some adverbs are ambiguous, i.e. can have different readings depending on their position (such as in the example in (19) in Section 2.4.1 above with *sorgfältig* (carefully)). But there are also adverbs that allow only one interpretation:

[...] if an adjective allows a manner reading and an event-related reading, then the event-related reading is bound to the pre-object position [...], adjectives that only allow verb-related readings cannot occur in the pre-object position.

(Schäfer 2013: 149)

Schäfer (2013) makes use of the tests introduced and developed in Schäfer 2005 to determine an adverb's subclass. In the following, I will present a classification of the adverbs I found in the corpus study. Schäfer's tests are developed for German, so as a German native speaker, I primarily relied on my own judgments. However, in order to make the classification more solid, I also let at least one other native speaker judge each example where I was not entirely certain. Ernst (2002) provides evidence for very similar subclasses of adverbs in English (and other languages), though he does not provide classification tests like Schäfer (2005, 2013). In the following, I will wherever possible link to Ernst's (2002) classes and examples to give an indication of the classification of the adverbs I found in the English corpus.

A remark on some pre-selection on my part: As explained above and in Chapter 1, I focus on the meaning component of force in verbs of contact by impact. So I will not classify the adverbs relating to the sound-volume or speed components. I will also disregard temporal adverbs such as *immediately* or *plötzlich* (suddenly). Instead I focus on force-related adverbs (e.g. *leicht* (lightly), *hart* (hard) but also *kräftig* (strongly)) and the intuitively agent-related adverbs (e.g. *wütend* (angrily) or *unbarmherzig* (mercilessly)), because it is those adverbs and their modification target in the verb that I am interested in.

2.5.1 Schäfer's manner tests

Schäfer introduces four tests to determine whether an adverb falls into the class of manner adverbs, and two further tests to distinguish between the subclasses agent-oriented manner and pure manner. The primary way to test whether an adverb allows the manner reading is to paraphrase it or to test its interaction with other elements in the sentence, such as negation. The manner tests Schäfer (2005) introduces are of this nature. In these tests, the position of the adverb in the sentence plays less of a role. In general, if a sentence containing an adverb can be paraphrased in a certain way, one can then say that this adverb gets a manner reading when it appears in a post-direct object position. E.g. *Peter*

tanz *wunderbar* (Peter dances wonderfully) can be paraphrased approximately by *Peter tanzt auf wunderbare Art und Weise* (Peter dances in a wonderful manner) (Schäfer 2005: 39). In this sentence, there is no direct object. But based on the evidence from the paraphrase, it can now be said that *wunderbar* (wonderfully) will receive a manner reading when it appears in a post-direct object position in a sentence with several attachment sites for adverbs.³

In the following, I will briefly introduce each manner test, provide an example I used to classify the adverbs from the German corpus, and then give a table with the test results for the selection of adverbs in my sample. Finally, I will provide some indication for this class in English, based on Ernst (2002).

Manner test 1

The first manner test is a paraphrase test. The definition is given in (26), taken from Schäfer 2005: 38, test 3.1:

- (26) A sentence of the form “SUBJECT VERB MANNER ADVERBIAL”, where an adjective serves as the manner adverbial, can be paraphrased by “How SUBJECT VERB, that is PREDICATIVE”, where the same adjective serves as predicative.

I used sentences as the one in (27), based on Schäfer's (2005: 38/39, ex(4)), to determine whether an adverb can be paraphrased in this way.

- (27) a. Emma schlägt Olli unbarmherzig.
 ‘Emma hits Olli mercilessly.’
 b. Wie Emma Olli schlägt, das ist unbarmherzig. (≈ a)
 ‘The way Emma hits Olli is merciless.’

This tests yields a positive result for *unbarmherzig* (mercilessly), i.e. this adverb can be paraphrased in a way that indicates that it can be used as a manner adverb. A list of all adverbs that can be used as manner adverbs can be found in Table 2.3.

Manner test 2

The second manner test is also a paraphrase test. The definition is given in (28), taken from Schäfer 2005: 39, test 3.2, an example sentences can be found in (29), based on Schäfer (2005: 39, ex(7)).

- (28) A sentence containing an adjective serving as manner adverbial can be paraphrased by a sentence where, instead of the adjective, the prepositional phrase “auf ADJEKTIVE Art und Weise” (in an ADJECTIVE manner) is used.

³Schäfer says nothing about the interpretation of the adverb in sentences with only one attachment site. But given that he uses such a sentence as his test sentence, one can assume that he takes the adverb to receive a manner reading in this case also.

- (29) a. Emma schlägt Olli unbarmherzig.
 ‘Emma hits Olli mercilessly.’
 b. Emma schlägt Olli auf unbarmherzige Art und Weise. (≈ a)
 ‘Emma hits Olli in a merciless manner.’

Again, *unbarmherzig* (mercilessly) passes the manner test. Please note that despite being rather widely accepted as a manner test (e.g. Maienborn & Schäfer 2011; Piñón 2008), there are some concerns with this test (Schäfer 2005: 40/41). Firstly, it overgenerates in the sense that some adverbs that can be used in the paraphrase in (29-b) cannot actually be used as manner adverbs, such as e.g. *unglaublich* (unbelievable), cf. (30), based on Schäfer’s (2005: 40, ex(11)). Schäfer (2005: 40/41), based on Ernst (1984), shows that *unglaublich* gets a degree reading when used in a post-direct object position, i.e. it specifies “the intensity of the action referred by the verb” (Schäfer 2005: 40). *Unglaublich* does not pass any of the other manner tests.

Further, the second manner test also passes adverbs that “indicate the methods, principles or style used in doing something [and] are typically derived from nouns” (Schäfer 2005: 49), such as e.g. *alphabetisch* (alphabetically), cf. (31-a), based on Schäfer’s (2005: 50, ex(44d)), who calls these adverbs method-oriented adverbs. Like *unglaublich*, *alphabetisch* does not pass the other manner tests (cf. (31-b) for the first test reported above).

- (30) a. *Sie hat die Karten unglaublich ausgespielt.
 ‘*She put the cards down unbelievably.’
 b. Sie hat die Karten auf unglaubliche Art und Weise ausgespielt.
 ‘She put the cards down in an unbelievable manner.’
- (31) a. Diana hat ihre CDs auf alphabetische Art und Weise sortiert.
 ‘Diana sorted her CDs in an alphabetical manner.’
 b. ?? Wie Diana ihre CDs sortiert hat, das war alphabetisch.
 ‘?? The way Diana arranged her CDs was alphabetical.’

Secondly, the test undergenerates in the sense that some adverbs, which are sometimes described as core manner adverbs, do not pass it, cf. (32), based on Schäfer (2005: 41, ex(13)). These adverbs are adverbs relating to force, speed and sound-volume and are sometimes called pure manner adverbs (Ernst, 2002; Schäfer, 2005), such as *hart* (hard), *leicht* (lightly), *schnell* (quickly), *langsam* (slowly), *laut* (loudly) or *leise* (quietly).

- (32) a. Sie hat das Lied laut/leise gesungen.
 ‘She sang the song loudly/quietly.’
 b. Sie hat das Lied auf laute/leise Art und Weise gesungen. (?? ≈ a)
 ‘She sang the song in a loud/quiet manner.’
 c. Wie sie das Lied gesungen hat, das war laut/leise. (≈ a)
 ‘The way in which she sang the song was loud/quiet.’

Due to these issues, this test will weigh less in the overall determination of whether an adverb falls into the manner class or not.

Manner test 3

The third manner test makes use of the interaction between a manner adverb and negation. The definition is given in (33), taken from Schäfer 2005: 42, test 3.3. (34) contains an illustration of how I applied the test, again with the adverb *unbarmherzig* (mercilessly), based on Schäfer's (2005: 42, ex(15)).⁴ In this example, the adverb cannot be scrambled over the negation.

- (33) If an adjective is used as a manner adverbial, it cannot have scope over negation.
- (34) a. *Emma hat Olli **unbarmherzig** nicht geschlagen.
Emma has Olli mercilessly not hit
b. Emma hat Olli nicht **unbarmherzig** geschlagen.
Emma has Olli not mercilessly hit
'Emma has not hit Olli mercilessly.'

Again, *unbarmherzig* passes the test.

Manner test 4

The fourth manner test is based on the way in which manner adverbs can be elicited via questions. The definition is given in (35), taken from Schäfer 2005: 44, test 3.4. An illustration of how I used this test is given in (36), based on Schäfer's (2005: 44, ex(23)).

- (35) Manner adverbials can be elicited by *How does somebody do something?*
- (36) a. Wie hat Emma Olli geschlagen?
'How did Emma hit Olli?'
Unbarmherzig.
'Mercilessly.'

As with the second manner test, Schäfer lists some concerns with this test (Schäfer 2005: 44): It passes both instrumental adverbials such as e.g. *mit einem Trick* (with a trick), cf. (37) based on Schäfer's (2005: 44, ex(24)), and degree adverbials such as *sehr* (very), cf. (38), Schäfer's (2005: 44, ex(25)).

- (37) Wie hat Frida die Räuber aufgehalten?
'How did Frida delay the robbers?'
Mit einem Trick.
'With a trick.'

⁴The intonation in (34-b) should put focus on the adverb, indicated by bold face. If intonational focus is on the verb, the whole event will be negated (Schäfer 2013: 85-89).

- (38) Wie gefällt dir die Stadt?
 ‘How do you like this town?’
 Sehr/Gut/Schlecht.
 very/well/badly
 ‘Very much/I like it/Not so much.’

Again, as with the second manner test, due to this over-generating, I will assign less weight to this test in the overall determination of an adverb’s subclass.

Pure manner adverbs

Schäfer also identifies two subclasses of manner adverbs: pure manner adverbs and agent-oriented manner adverbs. The first seems to contain among others all of those adverbs modifying force, speed or sound-volume, such as e.g. *leicht* (lightly) or *langsam* (slowly). The definition for this test is given in (39), taken from Schäfer 2005: 46, test 3.5. In (40) and (41), based on Schäfer’s (2005: 47, ex(31)), I show how I apply this test to the adverbs found in my corpus study.⁵ Please note that I used only those adverbs that already passed manner tests 1-4 as reported above. After all, only adverbs that are classified as manner adverbs can be sub-classified as either pure manner adverbs or agent-oriented manner adverbs.

- (39) A sentence of the form “SUBJECT VERB ADVERBIAL” entails the sentence of the form “VERB_NOMINALISATION COPULA PREDICATIVE”, where the ADVERBIAL and the PREDICATIVE are realised by the same adjective.
- (40) a. Emma schlägt Olli unbarmherzig. (??→ b)
 ‘Emma hits Olli mercilessly.’
 b. Das Schlagen ist unbarmherzig.
 ‘The hitting is merciless’.
- (41) a. Emma schlägt Olli leicht. (→ b)
 ‘Emma hits Olli lightly.’
 b. Das Schlagen ist leicht.
 ‘The hitting is light.’

In this case, *unbarmherzig* does not pass the test, the sentence in (40-b) sounds odd. Despite clearly coming out as a manner adverb above, *unbarmherzig* is thus not a pure manner adverb. *Leicht*, on the other hand, is fine in (41), indicating that this is a pure manner adverb.

Agent-oriented manner adverbs

The other manner subclass is formed by agent-oriented manner adverbs. They differ from pure manner adverbs in that “the highest ranked argument of [the]

⁵The → in the examples stands for an entailment relation (Schäfer 2005: 46).

sentence [...] must always contain some sort of agency properties [...]. In particular, the agent must be in control of the action described by the verbal predicate" (Schäfer 2005: 47/48). Apart from failing the test for pure manner adverbs, cf. (40) above, there is another paraphrase test for agent-oriented manner adverbials. The definition is given in (42), taken from Schäfer 2005: 48, test 3.6. An illustration of how I applied this test can be found in (43), based on Schäfer's (2005: 48, ex(37)).

- (42) Sentences with agent-oriented manner adverbials can be paraphrased by "It is ADJECTIVE of X, how X does something".
- (43) a. Emma schlug Olli unbarmherzig.
'Emma hit Olli mercilessly.'
- b. Es war unbarmherzig von Emma, wie sie Olli schlug. (\approx a)
'The way in which Emma hit Olli was merciless.'

Here we can see that *unbarmherzig* falls into the class of agent-oriented manner adverbs.

Manner adverbs in my sample

When these six tests for 'manner-hood' are applied to the adverbs from my sample, many of them come out as pure or agent-oriented manner, cf. Table 2.3.⁶ These tests are insightful in that they confirm my intuition above that adverbs such as *unbarmherzig* (mercilessly) always refer to (an aspect of) the agent of an event, independent of their position in the sentence. Given the classification of *unbarmherzig* as an agent-oriented manner adverb, we can now say that it indeed refers to the agent, even in a post-direct object position, as in the sentence in (24) above, repeated here as (44).

- (44) Die sich zur Wehr setzenden Schüler schlug er
the themselves to resistance setting pupils hit he
unbarmerzig [...]
mercilessly [...]
'He hit the pupils who resisted mercilessly.'

This distinguishes *unbarmherzig* and other agent-oriented manner adverbs on the list in Table 2.3, such as *rücksichtslos* (ruthlessly) or *scherzhaft* (jokingly), from adverbs such as *leicht* (lightly), *hart* (hard) or *kräftig* (strongly). The latter are pure manner adverbs, which Schäfer describes as "specify[ing] only one dimension, [...] sound or speed, of the event in question" (Schäfer 2005: 45).

⁶The classification is based on a 'majority decision', i.e. if an adverb is a manner adverb according to *most* of the tests, then I classify it as a manner adverb. Please note that sometimes there was a tie, in that a given adverb should be classified as a manner adverb according to half of the tests, but not according to the other half. In these cases, manner tests 1+3 received more weight than manner tests 2+4, the reason being that for the latter two, Schäfer lists some concerns about their generalisability (cf. the discussion for each test above). This resolved all such ties.

This seems true for most of the pure manner adverbs on the list in Table 2.3, and also confirms my findings in Section 2.3 above about the meaning of the adverbs *leicht* (lightly) and *hart* (hard): namely “with little force” and “with a lot of force” respectively. Both adverbs are classified as pure manner adverbs.⁷

pure manner		agent-oriented manner	
adverb	translation	adverb	translation
beiläufig	casually	aufmunternd	encouragingly
derb	roughly	brutal	brutally
fest	tightly	freundlich	friendly
gewalttätig	violently	hemmungslos	unrestrained
hart	hard	rücksichtslos	ruthlessly
heftig	severely	scherzhaft	jokingly
herb	harshly	todesmutig	very bravely
kräftig	strongly	unbarmherzig	mercilessly
leicht	lightly	wild	wildly
mächtig	mightily	wohlwollend	benevolently
schmerzhaft	painfully		
schwer	heavily		
schwerfällig	cumbersome		
wuchtig	massively		

Table 2.3: The adverbs from the German corpus that are classified as manner according to the tests in Schäfer (2005).

Manner adverbs in English

There is also a distinction between pure manner adverbs and agent-oriented adverbs in English. Ernst (2002) speaks of “the hard core of pure manner adverbs, lexically restricted to this reading alone” (Ernst 2002: 44). He does not provide tests as the ones from Schäfer above, but as an example, he lists *tightly*. I did not find this particular adverb in the sample I extracted from the BNC. However the German adverb *fest*, translated as *tightly*, appears as a pure manner adverb in Table 2.3 above. I therefore assume that English adverbs corresponding to German pure manner adverbs are to be classified in the same category. That is, *hard*, *sharply*, *strongly*, *gently* and *lightly* (from the list in Table 2.1) can all be assumed to be pure manner adverbs.

⁷A possible exception to this pattern of pure manner adverbs is *schmerzhaft* (painfully), which does not seem to modify the force dimension (something can be painful without a lot of force being applied). One could argue, however, that *schmerzhaft* modifies the dimension of pain (or pain component, in my terminology). Then it could be maintained that it is a pure manner adverb, i.e. specifying only one dimension as Schäfer notes. Or maybe it can be derived historically from the notion of pain as a consequence of too much force. Please note that this adverb also requires an animate patient who can feel the pain.

Ernst (2002) also speaks of agent-oriented adverbs, which “indicate that an event is such as to judge its agent as ADJ with respect to the event” (Ernst 2002: 54). This is related to Schäfer’s class of agent-oriented manner adverbs, in that the label *agent* “refers to entities that can *control* the eventuality in question” (Ernst 2002: 55). As examples, Ernst lists e.g. *foolishly*, *cleverly*, *aggressively*, *graciously*, *wisely*, *rudely* or *craftily*. Of these only *aggressively* appears in my sample from the BNC. However, the German equivalents of the English adverbs *brutally* (*brutal*), *mercilessly* (*unbarmherzig*) and *playfully* (*spielerisch*) are agent-oriented manner adverbs.⁸ It therefore seems reasonable to assume that these and related English adverbs such as *savagely* are also agent-oriented.

Crucially, Ernst (2002) assumes these agent-oriented adverbs to be agent-oriented even in a low position in the sentence. The difference between the high and low position is that in the high position, the event is compared to other relevant events the agent could have done, whereas in the low position, the comparison is narrowed down to the specific events describe by the verb. To illustrate, in the sentence in (45-a), Ernst’s (2002: 57, ex(2.44a)), the rudeness is attributed compared to other events the agent could have done, e.g. not leaving. That is, it was rude to leave as opposed to not leave. In (45-b), Ernst’s (2002: 57, ex(2.44b)), on the other hand, the rudeness is attributed to the specific manner of leaving, e.g. without saying good-bye.

- (45) a. Rudely, she left.
b. She left rudely.

Please note, though, that Ernst takes the adverb to refer to an aspect of the agent in both cases. This is in line with what I reasoned about e.g. *playfully* in Section 2.4 above: independent of in which position in the sentence the adverb appears, it refers to some aspect of the agent.

2.5.2 Schäfer’s non-manner tests

There is also a class of modifiers which Schäfer calls non-manner, which includes mental-attitude adverbs and subject-oriented adverbs. Other than manner adverbs, non-manner adverbs always precede the direct object according to Schäfer (2005, 2013). He puts them in the general class of event-external modifiers (see the overview in the introduction to Section 2.5).

As with the manner tests introduced above, the tests for non-manner adverbs involve the interaction of the adverbs with other elements in the sentence such as negation, or paraphrasing the sentence to make the meaning more explicit. As such, similar to the manner tests, the position of the adverb with respect to the direct object is not the most important criterion in the tests. The example Schäfer uses to illustrate the behaviour of mental-attitude adverbs

⁸These English adverbs were all part of the sample from the BNC, and can be found either in Table 2.1 or on the full list in Table A.1 in Appendix A.

with respect to negation doesn't even have a direct object: *Martha geht widerwillig nicht zur Schule* (Martha reluctantly does not go to school). This sentence entails its unmodified negated version *Martha geht nicht zur Schule* (Martha does not go to school). This is what tells us that *widerwillig* (reluctantly) is a mental-attitude adverb (and not some other modifier that can appear before the direct object).

Below, I will introduce the tests for mental-attitude adverbs and subject-oriented adverbs, illustrate how I applied them to my sample of adverbs, and illustrate a similar class of adverbs in English.

Mental-attitude adverbs

As the name already suggests, mental-attitude adverbs describe the mental attitude of the agent of an event towards that event. They are thus agent-oriented, just like the agent-oriented manner adverbs discussed above. But as already indicated, unlike the agent-oriented manner adverbs, they have scope over negation. This can be made explicit by testing whether a sentence with a candidate adverb that precedes the negation entails the unmodified and negated version of that sentence. If so, the adverb can take scope over the negation and functions a mental-attitude adverb. The sentence in (46), based on Schäfer's (2005: 63, ex(95)), illustrates how I use this fact to find mental-attitude adverbs in my sample (the \rightarrow again represents an entailment relation).

- (46) a. Emma schlägt Olli wütend nicht auf den Arm.⁹(\rightarrow b)
 Emma hits Olli angrily not on the arm
 'Emma angrily does not hit Olli on the arm.'
 b. Emma schlägt Olli nicht auf den Arm.
 'Emma does not hit Olli on the arm.'

This test shows that *wütend* (angrily) can function a mental-attitude adverb.

Subject-oriented adverbs

The term *subject-oriented adverbs* is already familiar from the distinction reported in (18) and (19) in Section 2.4 above, where it was used to refer to the broad class of subject- or agent-oriented adverbs. I have said above that I will refer to this broad class as agent-oriented adverbs. Now I'm looking at finer distinctions within this class of agent-oriented adverbs. When I use the term *agent-oriented adverb*, I thus refer to the broad class of adverbs specifying an

⁹This sentence sounds a bit odd when uttered out of the blue (as does Schäfer's example about Martha reluctantly not going to school). However, the sentence is acceptable in a context where e.g. Olli wants to illustrate how pain-resistant he is and therefore asks Emma to hit him, i.e. he wants her to hit him. But Emma doesn't do it because she is angry at him (maybe because she doesn't like him showing off like this). Emma's anger and her not hitting Olli are then conceptualised as related.

aspect of the agent. And when I use the term *subject-oriented adverb*, I follow Schäfer (2005, 2013) and refer to a subclass of the broad agent-oriented class.

Schäfer (2005) defines subject-oriented adverbs as establishing a link between the subject of the sentence and the event. As reported above, in German, they are typically formed with the suffix *-weise*, cf. (19-a), though they can appear without it. Schäfer provides the following paraphrase test for subject-oriented adverbs (Schäfer 2005: 68, test 9):

- (47) A sentence containing an adjective serving as subject-oriented adverbial can be paraphrased with the help of the following construction: "It was ADJECTIVE of her, that she did something".

The paraphrase test can be applied as in (48), based on Schäfer's (2005: 67/68, ex(108&110)). The adverb *wohlwollend* (benevolently) can get a subject-oriented interpretation.

- (48) a. Wohlwollend hat Emma Olli auf den Arm geschlagen. (\approx b)
 Benevolently has Emma Olli on the arm hit
 'Benevolently, Emma hit Olli on the arm.'
 b. Es war wohlwollend von Emma, dass sie Olli auf den Arm geschlagen hat.
 'It was benevolently of Emma to hit Olli on the arm.'

Non-manner adverbs in my sample

The modifiers from my sample that can be classified as mental-attitude adverbs or subject-oriented adverbs can be found in Table 2.4.

A couple of things need to be mentioned. Firstly, all subject-oriented adverbs can also be mental-attitude adverbs, but not vice versa. At present, I have no way of determining whether this is due only to my particular sample (in that I just happened to not find any subject-oriented adverbs that cannot be used as mental-attitude adverbs), or whether this is some general rule (though see footnote 11 in the next section about English non-manner adverbs). Schäfer (2005, 2013) treats these as separate and independent subclasses of agent-oriented adverbs and does not remark on any such connection.

Secondly, several of the adverbs in my sample seem to be able to appear both in a pre- or post-direct object position. *Scherzhaft* (jokingly) can function as an agent-oriented manner adverb in a post-direct object position and as a mental-attitude adverb when preceding the direct object, while *brutal* (brutally), *freundlich* (friendly), *rücksichtslos* (ruthlessly), *todesmutig* (very bravely), *unbarmherzig* (mercilessly) and *wohlwollend* (benevolently) can all function as agent-oriented manner adverbs in a post-direct object position, and as both mental-attitude adverbs and subject-oriented adverbs in a pre-direct object position. Note, though, that they all appear in only one position in my sample: *brutal*, *rücksichtslos* and *todesmutig* only appear in a pre-direct object position; *scherzhaft*, *unbarmherzig* and *wohlwollend* only appear in a

mental-attitude		subject-oriented	
adverb	translation	adverb	translation
ärgerlich	annoyed	brutal	brutally
belustigt	amused	freundlich	friendly
brutal	brutally	rücksichtslos	ruthlessly
freundlich	friendly	todesmutig	very bravely
fröhlich	cheerfully	unbarmherzig	mercilessly
gelangweilt	bored	wohlwollend	benevolently
gepeinigt	anguished		
grausam	cruelly		
heimlich	secretly		
hysterisch	hysterically		
rücksichtslos	ruthlessly		
scherzhaft	jokingly		
todesmutig	very bravely		
unbarmherzig	mercilessly		
verzweifelt	despairingly		
wohlwollend	benevolently		
wütend	angrily		
zornig	furiously		

Table 2.4: The adverbs from the German corpus that are classified as ‘non-manner’ according to the tests in Schäfer (2005).

post-direct object position (and *freundlich* only appears without a direct object).¹⁰ As stressed above, the important point is that even when they appear in a post-direct object position, these adverbs are agent-oriented (namely agent-oriented manner adverbs). So far the tests thus seem to confirm my intuition about the orientation of *playfully* and *unbarmherzig* and the like.

Let me finish with a remark about the adverb *heimlich* (secretly), which is a mental-attitude adverb (it is in fact also used by Schäfer to illustrate the class of mental-attitude adverbs, Schäfer 2005: 67/68, ex(108&110)). One can imagine a secretive attitude, but secrecy also seems to relate to what others perceive of someone such as trying to avoid attention, etc. A mental-attitude adverb is thus not only related to the mental-attitude of the agent of a sentence, but also to what others might perceive of that attitude (through the behaviour of the agent).

Non-manner adverbs in English

Ernst (2002) also mentions the classes mental-attitude adverbs and subject-oriented adverbs. In his typology, though, these two are related in that mental-attitude adverbs are a subclass of subject-oriented adverbs (the other subclass being agent-oriented adverbs (in Ernst's terminology, agent-oriented manner adverbs in mine), discussed with the manner adverbs above).¹¹ Mental-attitude adverbs differ from Ernst's agent-oriented adverbs in that their comparison class is not (an aspect of) the event, but rather the experiencer. "They describe [...] a state of mind experienced by the referent of the subject of the verb" (Ernst 2002: 63). For example, in sentence (49), based on Ernst's (2002: 63, ex(2.61)), the calmness is attributed to the agent's state of mind, not to other relevant events that the agent could have done (as is the case for Ernst's agent-oriented adverbs, cf. the example in (45-a) repeated here as (50)).¹²

(49) Calmly, she left.

(50) Rudely, she left.

Again, Ernst does not provide classification tests to determine an adverbs subclass. But he lists, among others, the following examples as mental-attitude adverbs: *calmly*, *anxiously*, *absent-mindedly*, *delightedly*, *bitterly*, *eagerly*, *sadly*, *attentively*, *reluctantly* and *willingly*. None of these appear in my sample from

¹⁰The adverbs *ägerlich* (annoyed), *heimlich* (secretely), *hysterisch* (hysterically), *wütend* (angrily) and *zornig* (furiously) in Table 2.4 can only function as mental-attitude adverbs according to the tests. They thus should appear only in pre-direct object position. This is confirmed by my corpus study: where these adverbs appear in a sentence with a direct object, they precede the direct object.

¹¹Note that this is the other way around compared to the pattern in my German corpus data, where subject-oriented adverbs were a subset of the mental-attitude adverbs.

¹²In English, mental-attitude adverbs can also appear in a low position in the sentence, cf. Ernst (2002: 66). However, their interpretation in that case is only marginally different from that of mental-attitude adverbs in a high position in that the focus is more on the manifestation of the mental state of the agent.

the BNC. However, based on the list of German mental-attitude adverbs, it would seem that at least *angrily*, *brutally* and *mercilessly* fall into this class, and maybe also *playfully* and *viciously*.

2.5.3 Schäfer's secondary predicate tests

Schäfer also provides tests for secondary predicates. The class of secondary predicates includes also (subject-)depictives. Just like manner adverbs, subject depictives appear in a post-direct object position, though they are clearly subject-related. Schäfer (2005) includes this class in his discussion because German adverbial adjectives can also be used as secondary predicates. Given the absences of clear morphological marking of adverbs in German, it is likely that I have some subject depictives in my German corpus sample.

Below, I will briefly introduce the tests for subject depictives, provide an example to show how I classify them and then give a list of modifiers in my German sample that are used as subject depictives. There are no subject depictives in my English sample, because the English search function allowed me to clearly narrow down the search to adverbs.

Depictives

Subject-depictives share the post-direct object position with manner adverbs, yet they refer to the subject of the sentence. The test for depictives is also a paraphrase test. The definition is given in (51), taken from Schäfer 2005: 54, test 8. An illustration on how I use this test to classify modifiers in my sample is given in (52), based on Schäfer's (2005: 54, ex(62)). The test shows that *fröhlich* (cheerfully) is a subject-depictive.

- (51) A sentence of the form "SUBJECT VERB OBJECT DEPICTIVE" can be paraphrased by "SUBJECT VERB OBJECT, while SUBJECT is PREDICATIVE", where DEPICTIVE and PREDICATIVE are realised by the same adjective.
- (52) a. Emma schlägt Olli fröhlich auf den Arm.
Emma hits Olli cheerfully on the arm.
b. Emma schlägt Olli auf den Arm, während sie fröhlich ist. (\approx a)
Emma hits Olli on the arm, while she is cheerful.

Schäfer additionally provides two paraphrases to distinguish subject depictives from agent-oriented manner adverbs, cf. (53) and (54), based on Schäfer's (2005: 55, ex(66&67)).¹³

- (53) a. Emma schlug Olli unbarmherzig auf den Arm. (\rightarrow b, c)
'Emma hit Olli mercilessly on the arm.'

¹³The \rightarrow in these examples is again meant to denote entailments (Schäfer 2005: 55).

- b. Ihr Handeln war unbarmherzig.
'Her action was merciless.'
- c. Ihr unbarmherziges Handeln...
'Her merciless acting...'
- (54) a. Emma schlug Olli fröhlich auf den Arm. ($\neg \rightarrow$ b, c)
'Emma hit Olli cheerfully on the arm.'
- b. #Ihr Handeln war fröhlich.
'Her acting was cheerful.'
- c. #Ihr fröhliches Handeln...
'Her cheerful acting...'

As established above, *unbarmherzig* (mercilessly) is an agent-oriented manner adverb (in post-direct object position). It can be used in a paraphrase with a general nominalised action verb (*handeln* - to act) and the possessive article, as in the example in (53). That is, the sentences in (53-b) and (53-c) are entailed by (53-a): If Emma hit Olli mercilessly, then her actions were merciless.

Fröhlich (cheerfully), on the other hand, is a subject depictive. It cannot be used in a paraphrase with the nominalisation, as in the example in (54). If Emma hit Olli cheerfully, it was Emma herself who was cheerful, not her actions.

Subject depictives in my sample

Applying the tests for subject-depictives to my sample from the DWDS gives the list in Table 2.5. The list shows quite a number of subject depictives. Subject depictives are similar to agent-oriented manner adverbs. While agent-oriented manner adverbs impose on the subject to be an agent in control of the event (Schäfer 2005: 47/48), subject depictives denote a state of the subject that holds for (at least) the duration of the event (as already indicated in the test in (52)). That is, Emma was cheerful for (at least) the duration of the hitting event (while hitting Olli). Subject depictives are thus another type of modifier that can appear in a post-direct object position but modify aspects of the agent.

resultatives		subject depictives	
adverb	translation	adverb	translation
besinnungslos	senseless	belustigt	amused
blutig	bloody	fröhlich	cheerfully
nieder	down	gelangweilt	bored
tot	dead	gepeinigt	anguished
windelweich	black and blue (soft)	schläfrig	sleepily
		verzweifelt	despairingly

Table 2.5: The modifiers from the German corpus that are classified as subject depictives according to the tests in Schäfer (2005).

Interestingly, the subject depictives on the list in Table 2.5 have quite some overlap with the mental-attitude adverbs on the list in Table 2.4. Except for *schläfrig* (sleepily), all subject depictives can also be used as mental-attitude adverbs. A quick look at their position in the sentences in my sample shows that with the exception of *belustigt* (amused), all of the modifiers appear only in a position preceding the direct object. This indicates that even though they *can* be used as subject depictives, in my sample they only function as mental-attitude adverbs.

Finally, please note that despite most of the subject depictives in Table 2.5 being able to function as mental-attitude adverbs, none of them can function as subject-oriented adverbs. This might point to some deeper connections between the different modifier classes. Exploring this connection, however, is beyond the scope of this work.

2.5.4 Schäfer's Tests: Summary

To sum up, the tests developed by Martin Schäfer (Schäfer, 2005, 2013) have helped me to get clear on the notion of agent-orientation versus manner as discussed in the literature (cf. Section 2.4). It has been widely claimed that an adverb can either be an agent-oriented adverb (when it occurs in a high position in the sentence) or a manner adverb (when it occurs in a low position in the sentence), cf. the minimal pair in (18), repeated here as (55). A similar contrast has been claimed to exist for German.

- (55) a. Sue carefully sliced all the bagels.
 b. Sue sliced all the bagels carefully.

Looking at adverbs from my German and English samples such as *playfully* and *angrily* or the German *unbarmherzig* (mercilessly) has made me doubt this distinction. For example, I maintained that intuitively, *unbarmherzig* always refers to an aspect of the agent of an event, even though in my sample it appears in a low position in the sentence. It seemed to me to be qualitatively different from other adverbs appearing in a low position in the sentence, such as *kräftig* (strongly).

This intuition has been confirmed by applying the tests developed by Schäfer (2005, 2013) to the adverbs in my sample. The adverb *unbarmherzig* is an agent-oriented manner adverb when used in a position following the direct object, i.e. even though it is in a low position, it is still agent-oriented. In Schäfer's words, it requires "the highest ranked argument of [the] sentence [to] always contain some sort of agency properties" (Schäfer 2005: 47). The adverb *kräftig*, on the other hand, is a pure manner adverb. Pure manner adverbs "specify only one dimension, [...] sound or speed, of the event in question" (Schäfer 2005: 45). Given my focus on the force dimension, my selection of adverbs is such that the pure manner adverbs can all be said to specify the force dimension.

Similarly, subject depictives, which in German are morphologically indistinct from adverbs, also appear in a post-direct object position (Schäfer 2005: 54). Yet they refer to some aspect of the subject of the sentence (the agent of the event described by the verb).

Schäfer developed his tests for German, but similar distinctions are made for English by e.g. Ernst (2002). Ernst distinguishes a class of agent-oriented adverbs that can also appear in a low position in the sentence. When this happens, these adverbs refer to the specific manner of the event described by the verb, i.e. to certain aspects of the event such as leaving without saying goodbye in the case of rude leaving events. But they always indicate that the agent is judged as e.g. rude in relation to the event.

There also seem to be some differences between adverbs appearing in a high position in the sentence, as evidenced by the two subclasses of mental-attitude adverbs and subject-oriented adverbs in Schäfer 2005. Ernst (2002) assumes a similar distinction for English. The pre-direct object position, however, is of less importance here, since adverbs in that position are always said to be agent-oriented and there is no confusion with manner adverbs (which cannot appear in a pre-direct object position).

The following picture thus emerges: In a high position in the sentence (in German a position preceding the direct object), adverbs always belong to one of the agent-oriented subclasses (mental-attitude adverbs or subject-oriented adverbs). In a low position in the sentence (in German a position following the direct object), modifiers can be either agent-oriented (agent-oriented manner adverbs or subject depictives) or pure manner adverbs. The pattern is illustrated in (56), (57) contains some German sentences illustrating this.

- (56) (mental-attitude adverb/subject-oriented adverb) verb subject object
(pure manner adverb)/(agent-oriented manner adverb)/(subject depictive)
- (57) a. **high: mental-attitude adverb, low: pure manner adverb:**
Wütend schlägt Emma Olli kräftig auf den Arm.
angrily hits Emma Olli strongly on the arm
- b. **high: mental-attitude adverb, low: agent-oriented manner adverb:**
Wütend schlägt Emma Olli brutal auf den Arm.
angrily hits Emma Olli brutally on the arm
- c. **high: mental-attitude adverb, low: subject depictive:**
Scherzhaft schlägt Emma Olli schläfrig auf den Arm.
jokingly hits Emma Olli sleepily on the arm

To sum up: adverbs like English *playfully* or *angrily* or German *unbarmherzig* are agent-oriented. And this is independent of their position in the sentence, because both subject depictives and agent-oriented manner adverbs can appear in a low position in the sentence.

Let me finish with the observation that agent-oriented adverbs also imply something about perceptually salient properties of the event/activity described by the verb. The adverb *heimlich* (secretly) can be used as a mental-attitude adverb. Yet in order to judge someone as having a secretive mental attitude, one would most likely refer to perceivable aspects of someone's behaviour, such as walking quietly or avoiding being seen at certain times. This recalls a remark about *angrily* mentioned above: Geuder (2000) states that an angry state of mind is usually deduced through angry behaviour. Mental-attitude adverbs thus not only provide information about the agent's state of mind, but also about the agent's manner of acting. I will now take a closer look at this relation between aspects of the agent and the way in which the agent's behaviour is perceived in relation to force.

2.6 Force inferences by agent-oriented adverbs

Overall, the classification tests provided by Schäfer (2005, 2013) show that there is a class of pure manner adverbs, which Schäfer says are distinguished by the fact that they specify only one meaning dimension (component, in my terminology) in the verb such as e.g. speed or force (Schäfer 2005: 45). A look at the adverbs in my sample that came out as pure manner adverbs in Table 2.3 confirms this: all of these adverbs specify one meaning component, although sometimes it is not immediately clear which component that is, as was seen in the discussion around the adverb *schmerzhaft* (painfully). Adverbs that specify the force component are *hart* (hard), *kräftig* (strongly) or *leicht* (lightly).

The classification tests also showed that there are various subclasses of agent-oriented adverbs (and subject depictives). Modifiers of this broad class are, when in a position following the direct object, agent-oriented manner adverbs or subject depictives, and when in a position preceding the direct object, they are mental-attitude adverbs or subject-oriented adverbs. These subclasses overlap to a large extent, and there seem to be several connections between them. What is common to all these subclasses is that the modifiers provide information about the agent of the event expressed by the verb (standardly the subject of the sentence). Examples are *unbarmherzig* (mercilessly), *scherzhaft* (jokingly), *wohlwollend* (benevolently) or *wütend* (angrily).

Upon closer inspection, one finds examples of agent-oriented adverbs that also seem to modify some perceptually salient properties of the event. In section 2.5.2 above, I discussed the mental-attitude adverb *heimlich* (secretly) and argued that while one can imagine a secretive state of mind, this adverb also expresses something about the behaviour of the agent, about their manner of doing something.¹⁴ These observations relate to the discussion in Geuder 2000 about the English adverb *angrily*, and how the appropriate use of this

¹⁴At least in the context of verbs of contact by impact and other verbs that describe concrete events, this adverb expresses something about the behaviour of the agent. This might be different for verbs such as *think*.

adverb can be deduced from the agent's behaviour. Now consider the German counterpart of *angrily*: *wütend*. The example in (14), taken from my German sample and repeated here as (58), shows how the mental state of the agent manifests itself in a very concrete, perceptual manner.

- (58) Er schlug wütend mit der Hand auf all die Papiere. Da waren
 He hit.PAST angrily with the hand on all the papers. There were
 Zigarrenkistchen für fünfzig Mark, für siebzig Mark, das flog nur
 cigar.bboxes for fifty Mark, for seventy Mark, that flew just
 so!
 so
 He angrily hit the papers with his hand. There were cigar boxes for
 fifty Mark, for seventy Mark, which went flying!

The adverb *wütend* in the above example attributes the mental attitude of being angry to the agent of the sentence. However, the second sentence in the example, *There were cigar boxes which went flying*, reveals that this adverb also expresses something about the force dimension, i.e. the agent was so angry that he hit hard enough to sent cigar boxes flying. The example in (7), taken from my English sample and repeated here as (59), makes this connection between properties of the agent and perceptually salient properties of their behaviour even clearer.

- (59) Steve hit his brother playfully but rather hard on the shoulder.

In the discussion about mental-attitude adverbs above, it was indicated that *playfully* is a mental-attitude adverb (following the definition of this class in Ernst 2002). It thus refers to the mental-attitude of the agent. Yet in the example in (59), *playfully* also modifies the force dimension, it indicates that less force is used in comparison to some average. Otherwise the contrast created through the use of *but* with *hard* (which is lexically specified for “with a great deal of force”, cf. the discussion in Section 2.3.1 above) would be infelicitous.¹⁵ Other examples from the BNC seem to indicate that *playfully* can be used with a verb of contact by impact in joyful (60-a) or teasing (60-b) contexts, which underlines its association with little force.

- (60) a. Sheldukher laughed heartily for the first time since his destruction of the Krongel constellation. He slapped the Doctor playfully across the shoulders.
 b. He teased her by trying to feed her chocolate profiteroles. She refused, playfully punching his shoulder.

Recall from Chapter 1 the discussion about additional meaning effects arising during modification. The example that was discussed there was *brown apple* (Smith et al., 1988). The adjective *brown* specifies a colour, yet when it is used

¹⁵For a more detailed discussion of *but*, see Chapter 3, Section 3.1.1.

to modify the noun *apple*, it not only modifies the colour of the apple, but also its taste and texture (because apples turn brown when they rot). These meaning effects cannot be traced to the meaning of either the adjective *brown* on its own or the noun *apple* on its own, but rather to the interaction of these two words in the compositional process.

The force modifying effect that can be observed about the adverbs *wütend* or *playfully* when they are used to modify verbs of contact by impact seems similar to the *brown apple* case. As I have shown in Section 2.5, these adverbs are agent-oriented adverbs, not pure manner adverbs specifying the force component. The meaning effect on the force component cannot be traced to either the adverbs or the verbs on their own. Compare the phrase *hit playfully* to *suggest playfully*; in the second phrase, no meaning effects about the force component arise, even though the adverb is the same. And similarly in the sentence *Steve hit his brother*, nothing indicates that little force is used, even though the verb is the same. The low force effect in *hit playfully* thus arises out of the compositional process. In Chapter 4, I will provide an analysis of this process in the framework of Event Semantics.

A hint to the nature of the process that gives rise to the additional force meaning effect can be found in the example in (59). The adverb *playfully* can felicitously be combined with the adverb *hard*, which lexically specifies a high force magnitude. This seems to indicate that the force effect of a phrase such as *hit playfully* is a cancellable or defeasible inference. The precise nature and scope of this force inference will be the topic of the next chapter.

2.7 Summary and conclusion

In this chapter, I have set up my domain of study. Based on the classifications in Levin 1993, I have chosen verbs of contact by impact as a starting point, as force seems to be a crucial part of their meaning (cf. the definition Levin gives as reported in Section 2.2). In order to gain a more thorough understanding of the conceptual structure of the domain of verbs of contact by impact, I conducted a corpus study into their co-occurrences with adverbs. The rationale behind this was to use the adverbs as a probe into the meaning of the verbs: if an adverb can be used to modify a verb, there must be something in the meaning of the verb that corresponds to the meaning of the adverb.

I searched the *British National Corpus* (BNC) for co-occurrences of adverbs with the English verbs *slap*, *punch* and *hit*, a sample from Levin's class, and the *Digitales Wörterbuch der Deutschen Sprache* (digital dictionary of the German language, DWDS) for co-occurrences of adverbs with the German equivalent *schlagen*. By looking up individual adverb's definitions in dictionaries and comparing those to the use of these adverbs in the examples I found in the corpora, I was able to show that verbs of contact by impact in English and German do indeed have a force component. They have frequent co-occurrences with the adverbs *lightly/leicht* and *hard/hart*, which are defined as "with little force" and

“with a great deal of force” respectively. Through their co-occurrences with adverbs such as *loudly* or *laut* (loudly) and *fast* or *langsam* (slowly), I was further able to show that verbs of contact by impact have a sound-volume component and a speed component. Finally, there were a large number of adverbs in both English and German that I intuitively assumed to be agent-oriented, i.e. to say something about the agent, such as *angrily* or *playfully* in English and *wütend* (angrily) or *unbarmherzig* (mercilessly) in German. The meaning of this last type of adverb remained unclear to me, the dictionary entries were not illuminating (e.g. “in a playful manner” for *playfully*) and the concrete examples from the corpus were not helpful in this respect either, except for illustrating that these adverbs do indeed occur in sentences with animate agents.

The dominant view in the literature suggests that these adverbs are ambiguous between an agent-oriented reading and a manner reading. The former is usually associated to a high position in the sentence (before the direct object in German), the latter to a low position (following the direct object in German). However, by making use of a number of classification tests introduced by Schäfer (2005), I was able to show that adverbs such as German *unbarmherzig* are always agent-oriented. When they appear in a position after the direct object, they are classified as *agent-oriented* manner adverbs. When they appear in a position preceding the direct object, they can be classified as mental-attitude adverbs or subject-oriented adverbs. By contrast, adverbs such as *lightly* or *hard* are pure manner adverbs. In the words of Schäfer (2005), they “specify only one dimension” (which in the case of *lightly* and *hard* is force).

But the agent-oriented adverbs also seem to have an effect on the force component. Following the discussion in Geuder 2000 about the concrete manifestations of an angry state of mind, I was able to show with some examples from my corpus data that agent-oriented adverbs not only modify aspects of the agent, but also express something about the force component. Specifically, the adverbs *playfully* and *angrily* (the German *wütend*) seem to trigger a cancellable inference on the force component when modifying verbs of contact by impact in that *hit playfully* seems to imply ‘hit with little force’ and *hit angrily* ‘hit with a great deal of force’.

In the next chapter, I will explore this type of inference in some more detail by providing a classification in terms of Neo-Gricean implicatures and reporting on some experimental results that show the extent and generalisability of the inference.

CHAPTER 3

Force implicatures¹

In the previous chapter, I have presented the results of a corpus study into the domain of verbs of contact by impact in both English and German. The results revealed high co-occurrence frequencies between verbs of contact by impact and adverbs modifying force, such as *lightly* or *hard*. Further, a high number of agent-oriented adverbs co-occurred with verbs of contact by impact. Agent-oriented adverbs express properties of the agent of an event, such as their mental attitude (angry), or provide judgments about the agent's behaviour (friendly). However, at closer inspection, it appeared that several of these agent-oriented adverbs also express something about the force component when combined with verbs of contact by impact. For example, *playfully*, when modifying *hit*, seems to indicate that a low amount of force is used; it mostly appears in contexts that indicate low force, such as joking or teasing (examples (60) in Chapter 2). The German adverb *wütend* (angrily), on the other hand, expresses a high amount of force when it modifies *schlagen* (~ to hit); it appears in contexts that describe a high amount of force exertion, like hitting one's fist hard on a table (cf. example (58) in Chapter 2).

This force-reading of agent-oriented adverbs is an additional meaning effect that arises during composition when agent-oriented adverbs are combined with verbs of contact by impact. The effect disappears when these adverbs are combined with other verbs, such as *to suggest*. But this additional meaning effect is cancellable even in combinations of agent-oriented adverbs with verbs of contact by impact. I observed in Chapter 2 that the phrase *hit playfully* can

¹Some of the results from the questionnaire study presented in this chapter have already been published in Goldschmidt, Gamerschlag, Petersen, Gabrovská & Geuder 2017.

feliculously be followed by *but hard*. This indicates that the low force reading of *hit playfully* can be cancelled through the use of adverbs that are lexically specified for high force.

Similar meaning effects have been observed in adjective-noun combinations, such as the *brown apple* case discussed in the introduction. It appears that these effects are due to world-knowledge, i.e. a speaker's mental representation of the world, and especially previous experiences with e.g. angry people and their behaviour. One could therefore speak of a defeasible inference. But it is unclear how this fits into the wider framework of defeasible meaning and conversational implicature as studied by e.g. Horn (1984, 2004) or Levinson (2000), a field which has provided extensive study of inferences like *The candidate is unsuitable for the job* arising from utterances such as *The candidate has a neat handwriting* (in a recommendation letter for a PhD candidate).

I have also so far generalised over just a handful of examples, based on my own intuition. In order to speak of a general phenomenon, a wider range of agent-oriented adverbs in combination with verbs of contact by impact should be judged by a higher number of speakers.

In this chapter, I will address the point of classifying the inference with respect to the wider body of work on conversational implicature. I will also provide empirical evidence that the inference arises over a greater variety of verb-adverb combinations than just the handful of examples mentioned above. The chapter is structured as follows: In Section 3.1, I will discuss various aspects of these inferences, including their classification as I-implicatures in the sense of Levinson (2000). In Section 3.2, I present results from a questionnaire study, systematically testing agent-oriented adverbs for whether they trigger a force implicature with verbs of contact by impact or not. Finally, in Section 3.3, I report the results of a self-paced reading experiment. This serves two purposes: firstly, it shows that the inference also arises from combinations of agent-oriented adverbs and verbs of contact by impact in Dutch. Secondly, it contributes to the debate about reading time delays and implicatures.

3.1 Implicatures

In this section, I will classify the type of inference I observed for *hitting playfully* in relation to the larger body of literature on defeasible meanings and implicature. First, I will introduce the denial-of-expectation test, based on the use of *but*, to show how to detect the inference discovered in the corpus data. In Section 3.1.2 I will then discuss a number of possibilities to determine whether the inference is an entailment, or a presupposition, or if it can be classified as some form of conversational implicature.

3.1.1 Denial of expectation

In Chapter 2, I used examples from the corpora to argue that some of the agent-oriented adverbs result in an inference on the force component of verbs of contact by impact. One of the examples with the adverb *playfully* contained the following construction: *hit [...] playfully but rather hard* (cf. example (59) in Chapter 2, repeated here as (1)).

- (1) Steve hit his brother playfully but rather hard on the shoulder.

This use of the conjunctive coordinator *but* has been classified by Lakoff (1971) as what she calls the denial-of-expectation use. Lakoff identifies two uses of *but*, the semantic opposition use and the denial of expectation use. The semantic opposition use is licensed if two lexical items, one in each part of the conjunct, are antonyms, as in the sentence in (2), based on Lakoff's (1971: 133, ex(57)):

- (2) Joan is tall but Mary is short.

The denial of expectation use of *but* is licensed if there is a presupposition (in Lakoff's terms) of a connection or causal relation between the first part of the conjunct and the negation or opposite of the second part of the conjunct. The sentence in (3-a) illustrates this (based on Lakoff's (1971: 133, ex(59))). The presupposed connection here is that the first part of the conjunct, someone being tall, usually implies the opposite of the second part of the conjunct: not being no good at basketball, that is, being good at basketball (this is the negation of the second part of the conjunct *being no good at basketball*). Lakoff further observes that sometimes, special contextual knowledge is required to license the denial-of-expectation use of *but*. In the example in (3-b) (based on Lakoff's (1971: 133, ex(60))), in order for the sentence to be felicitous, one needs to know that e.g. Mary usually likes things which Joan hates, or that there are not many people like Joan. Otherwise the use of *but* would not make sense.

- (3) a. Joan is tall but she is no good at basketball.
b. Joan hates ice cream, but so does Mary.

It is this second use of *but*, the denial-of-expectation use, which can be observed in the corpus example in (1) above, since there are no lexical antonyms in this example. There is thus an expectation that is denied by the phrase *but hard*. The opposite or negation of *hard*, i.e. not hard, should follow from what precedes *but*. Given the lexical specification of *hard* as "with a great deal of force" as worked out in Chapter 2, the only expectation that could reasonably be denied by this is one of "with little force", i.e. *lightly* (a light hit).

The denial-of-expectation use of *but* can thus be employed to detect whether an agent-oriented adverb triggers a force inference when modifying a verb of contact by impact. I will use this observation in the questionnaire study reported in Section 3.2 below to systematically test with a selection of agent-oriented adverbs from my sample whether or not they trigger a force inference.

But first there is another issue to be addressed. Lakoff speaks of a presupposition that is denied through the denial-of-expectation use of *but*. But is the force inference I observed a presupposition (according to the more recent or modern views on pragmatics)? In the following, I will discuss a number of observations to determine whether the inference I observed in my data is in fact a presupposition, or maybe an entailment, or some type of conversational implicature.

3.1.2 Determining the type of inference

In this section, I will address the question of the type of the observed inference. The most prominent types of inference are entailments, presuppositions (as suggested by Lakoff (1971) for the denial-of-expectation construction) and implicatures.

Entailments?

Entailments are fairly easy to test for, and are included here mostly for completeness' sake. A sentence is said to entail another, if and only if in the case of the first sentence being true, the second sentence is also true. So, for example, if I were to utter (4-a), (4-b) is entailed.²

- (4) a. Joan owns a black motorbike. (\rightarrow b)
 b. Joan owns a motorbike.

If an example containing an agent-oriented adverb and verb of contact by impact is set up in the same way, it is relatively easy to see that the type of inference I discovered is not an entailment. I said above that agent-oriented adverbs such as *playfully* trigger an inference on the force component of verbs of contact by impact, in the case of *playfully* one of low force. The sentence in (5-a) contains the agent-oriented adverb *playfully*, the sentence in (5-b) is the inferred sentence, containing the adverb *lightly*.

- (5) a. Joan hit her brother playfully. ($\neg \rightarrow$ b)
 b. Joan hit her brother lightly.

One can imagine situations in which (5-a) is true, but (5-b) is not. This is in fact precisely the type of situation described in the corpus example in (1): hitting playfully, but hard (not lightly). The force inferences are thus no entailments. Another way of seeing that the force inferences are no entailments is by their ability to be cancelled. The definition of entailment is that the first sentence being true also makes the second sentence true. This is not the case if the second sentence can be cancelled.

²The \rightarrow is used to denote an entailment relation.

Presuppositions?

Next to test is ‘presupposition-hood’. According to Lakoff (1971), what the denial-of-expectation use of *but* does is to cancel a presupposition. There are several means to establish whether a certain sentence gives rise to a presupposition, as specified by Beaver (2001).

“Certain implications of sentences are inherited more freely to become implications of complex sentences containing the simple sentences than are other implications, and such implications are called presuppositions.”

(Beaver 2001: 13)

Presuppositions are thus the type of implications that project out of embedded sentences, such as in sentences containing negation, conditionals, modals or questions. Below, I will test a sentence containing an agent-oriented adverb with each of these constructions. The sentence to use is given in (6) (the same as in (5)). In the examples below, I use the \rightarrow to mean *presupposes*.

- (6) Joan hit her brother playfully.
- (7) **Negation**³
- a. Joan didn’t hit her brother playfully. ($\neg \rightarrow b$)
- b. Joan hit her brother lightly.
- (8) **Conditionals**
- a. If Joan hit her brother playfully, he won’t be upset. ($\neg \rightarrow b$)
- b. Joan hit her brother lightly.
- (9) **Modals**
- a. Joan maybe hit her brother playfully. ($\neg \rightarrow b$)
- b. Joan hit her brother lightly.
- (10) **Questions**
- a. Did Joan hit her brother playfully? ($\neg \rightarrow b$)
- b. Joan hit her brother lightly.

As can be seen in examples (7)-(10), the inference does not seem to survive projection. The evidence presented here thus suggests that the type of inference discovered in Chapter 2 should not be classified as a presupposition.

³There is another issue discussed with respect to examples containing negation. Depending on the intonation of the speaker, it is either the whole event that is negated, i.e. the sentence in (7-a) can mean that Joan did not hit her brother at all. Or it is only the manner of the event that is negated, i.e. Joan hit her brother, but not playfully (this was briefly mentioned in the previous chapter when discussing the third manner test provided by Schäfer, see also Schäfer 2013: 85-89). For the presupposition tests applied to the example with *playfully* and *hit*, it is the latter interpretation I am interested in, the negation of the manner of the hitting as expressed in the adverb. In (7-a), stress should therefore be put on *playfully*.

Conversational Implicatures?

The last type of inference to test are conversational implicatures. Implicatures go back to Grice (1967), but have been refined and extended by among others Horn (1984, 2004) and Levinson (2000).

The origins of implicatures Grice observed that there is a difference between what is said, and what is implicated or meant, by a speaker. What is said is the literal meaning of an utterance. What is implicated can be decoded with the help of the Cooperative Principle and a set of maxims that are derived from that principle. The Cooperative Principle states that you should:

Make your conversational contribution such as is required, at the stage at which it occurs, by the accepted purpose or direction of the talk exchange.

(Horn 2004: 7, based on Grice)

Based on this principle, Grice derives a set of maxims of conversation, which can be employed to systematically generate implicatures, cf. (11), taken from Horn 2004: 7, based on Grice.

- (11) **Maxims of Conversation**
- a. **QUALITY:** Try to make your contribution one that is true.
 - (i) Do not say what you believe to be false.
 - (ii) Do not say that for which you lack evidence.
 - b. **QUANTITY:**
 - (i) Make your contribution as informative as is required (for the current purposes of the exchange).
 - (ii) Do not make your contribution more informative than is required.
 - c. **RELATION:** Be relevant.
 - d. **MANNER:** Be perspicuous.
 - (i) Avoid obscurity of expression.
 - (ii) Avoid ambiguity.
 - (iii) Be brief. (Avoid unnecessary prolixity.)
 - (iv) Be orderly.

Conversational implicatures can systematically be created and decoded or understood by making use of the maxims. Imagine the following dialogue:⁴

- (12) A: I am hungry.
 B: There is a bakery down this street. (\rightarrow The bakery is open.)

If the bakery were not open at the time of the utterance, or rather, if B believed the bakery to not be open at the time of the utterance, her utterance would

⁴In this and the following examples, the \rightarrow is used for implicature.

be irrelevant, since a closed bakery will not help A in overcoming her hunger. The implicature is thus generated by obeying the Maxim of Relation.

Neo-Gricean implicatures Horn (1984, 2004) simplifies Grice's original Maxims of Conversation by rephrasing them as just two principles (plus the Maxim of Quality, which he states cannot be reduced (Horn 2004: 13)).

The first principle, the Q-principle, is based on the first Maxim of Quantity (make your contribution as informative as required) and the first two Maxims of Manner (avoid obscurity of expression & avoid ambiguity). The Q-principle states "say as much as you can". It is mostly used to explain what are called scalar implicatures, i.e. the use of a weaker or less specific term (e.g. *some*) implying that there is not enough evidence to use the stronger or more specific term (e.g. *all*). So the implicature from e.g. *Some of the students passed the exam* to *Not all of the students passed the exam* is explained by the Q-principle, based on an underlying scale of ⟨all, some⟩, with the stronger term on the left.

The second principle, the R-principle, is based on the second Maxim of Quantity (do not make your contribution more informative than is required) as well as the last two Maxims of Manner (be brief & be orderly). The R-principle states "say no more than you must" (and therefore directly opposes the Q-principle). For example, the utterance *Can you close the window?* is usually understood as *Would you please close the window?* (Horn 2004: 13). The R-principle is thus used to enrich the content of an expression. The literal content of the utterance *Can you close the window?* is enriched and understood by the hearer to be a request for action, and not just an enquiry into her abilities.

Levinson (2000) formulates three rather similar heuristics based on Grice's Maxims of Conversation. These heuristics are the Q-heuristic, I-heuristic and M-heuristic (the M-heuristic is not part of Horn's system, but corresponds to his division of pragmatic labour).

The Q-heuristic is based on Grice's first Maxim of Quantity (make your contribution as informative as is required). It reads: "What isn't said, isn't". It resembles Horn's Q-principle in that it is mostly used to explain scalar implicatures of the type *some* → *not all*.

The I-heuristic is based on Grice's second Maxim of Quantity (do not make your contribution more informative than is required) and reads: "What is expressed simply is stereotypically exemplified". According to Levinson, "simple expressions thus encourage, by this heuristic, a tendency to select the best interpretation to the most stereotypical [...] exemplification" (Levinson 2000: 37). In this sense it resembles Horn's R-principle, only with more explicit reference to the stereotypical.

The M-heuristic is based on Grice's Maxim of Manner (be perspicuous) and reads: What's said in an abnormal way isn't normal. This is in a sense the opposite of the I-heuristic: If something is said simply, we can stereotypically enrich it. If something is said in a longer or more complicated way, that longer or more complicated expression signals that this is not the stereotypical case.

This is exemplified in the examples in (13) below, based on Levinson’s (2000: 39, ex(19)).

- (13) a. **I-implicature:** Joan stopped the car.
 → in the stereotypical manner with e.g. the foot pedal
 b. **M-implicature:** Joan caused the car to stop.
 → indirectly, not in the normal way, e.g. with the emergency brake

Determining the type of implicature It seems that the I-heuristic, the stereotypical exemplification of a simple form, or Horn’s R-principle, the enrichment of the content of an utterance, are most suitable for classifying the inference at hand. Especially Levinson’s making explicit the stereotypical as “connotations associated with meanings” (Levinson 2000: 115) seems to capture the type of inference I observed. Levinson gives the following example to illustrate this (Levinson 2000: 117), where *secretary* is stereotypically enriched to *female secretary*:

- (14) John said ‘hello’ to the secretary.
 → John said ‘hello’ to the female secretary.

Similarly, when reading/hearing *Joan hit her brother playfully*, we stereotypically enrich to *Joan hit her brother playfully and (therefore) lightly* (illustrated in (15)). A similar case can be made for *angrily* in the context of *hit*: Upon hearing or reading *Joan hit the papers angrily with her hand*, we stereotypically enrich to *Joan hit the papers angrily and (therefore) hard with her hand* (illustrated in (16)).

- (15) Joan hit her brother playfully.
 → Joan hit her brother playfully and (therefore) lightly.
 (16) Joan hit the papers angrily with her hand.
 → Joan hit the papers angrily and (therefore) hard with her hand.

I thus conclude that the type of inference triggered by agent-oriented adverbs modifying verbs of contact by impact observed in my corpus sample is a ‘Levinsonian’ I-implicature, an inference to stereotype, or R-implicature in the sense of Horn, an enrichment. Stereotypical enrichment is based on world knowledge about e.g. the specific cultural context. In the example in (14), the implicature is due to the fact that secretaries in the so-called Western world of the late 20th and, sadly, still early 21st century are mostly women. In Chapter 4, I will try and pin down the world-knowledge responsible for the force implicatures that arise from combinations of agent-oriented adverbs and verbs of contact by impact.

Crucially, the force implicatures triggered by agent-oriented adverbs modifying verbs of contact by impact are *compositional* in nature, and not lexical as e.g. the implicature arising from the use of the word *secretary* in (14) above. No force implicature would arise from combinations of agent-oriented adverbs

and other verbs such as e.g. *to speak* (though in that case there would probably be an implicature of high sound-volume: *to speak angrily* → *to speak loudly*).

Implications for online processing

I-implicatures or R-implicatures fall into the broad class of Generalised Conversational Implicatures (GCIs), about which Levinson states that they “should be available early, before full sentence-meaning is computed, because of their association with linguistic expressions” (Levinson 2000: 307). I have stressed repeatedly above that it is not individual words which trigger the force implicature, but rather the combination of an agent-oriented adverb with a verb of contact by impact that gives rise to this additional meaning effect.

Applying Levinson’s reasoning to examples like (15) or (16) thus requires a broader understanding of the term *linguistic expression* to include verb-adverb combinations (or, to speak more broadly, combinations of modifiers and the words they modify). In the sentence in (15), the adverb is the last word in the sentence, so by the time the implicature is triggered, we have also reached the end of the sentence (which, incidentally, is also the case in Levinson’s secretary example given in (14) above). In (16), however, the adverb is not the last word of the sentence, which contains another PP: *with her hand*. In this sentence, the implicature is thus “available early, before full sentence-meaning is computed” (Levinson 2000: 307).

There is reason to assume that cancelling such an implicature requires additional processing time, which should be measurable through online experiments (see e.g. Breheny et al. 2006). If the above reasoning is correct and the additional meaning effect observable in combinations of agent-oriented adverbs with verbs of contact by impact is an implicature, it should show up during an online processing task. I will therefore conduct a reading time experiment to test the cognitive reality of the force implicatures.

But first, I will report the results of a questionnaire study in the next chapter, testing whether the implicature arises with more verb-adverb combinations.

3.2 Questionnaire Study

In order to provide further empirical evidence for the existence of the force implicatures triggered by some agent-oriented adverbs modifying verbs of contact by impact, I conducted a questionnaire study with the German data. This questionnaire study is designed to test whether the implicature arises with a variety of agent-oriented adverbs and whether it gets triggered for a majority of speakers (hence a questionnaire study as opposed to only my own intuitions). The first thing to test, given that this construction appeared in the corpus in this form, is the acceptability of various agent-oriented adverbs in the denial-of-expectation construction with *but* (introduced in 3.1.1 above). If an adverb can felicitously be used in the denial-of-expectation construction with a verb

of contact by impact and either *lightly* or *hard*, it can be assumed to trigger an implicature on the force component of the verb. But there are a few other issues that a questionnaire can address.

Firstly, remember that the adverbs that trigger the force implicature with verbs of contact by impact were classified as agent-oriented when using the classification tests provided by Schäfer (2005, 2013), cf. Chapter 2. In order to provide further evidence for this classification, I tested whether these adverbs can only be used felicitously if the sentence has an animate, volitional agent (which would support their classification as agent-oriented), or whether they can also occur in a sentence with an inanimate theme in subject position (which would contradict the classification).

Secondly, concerning the class of verbs of contact by impact, I have established in Chapter 2 that these verbs have a force component. Evidence for this came from the frequent co-occurrence of verbs from this class with force-modifying adverbs such as *lightly*, *hard* or *forcefully*, documented in the corpus study for both English and German. But it remains unclear how the force component is manifested in verbs of contact by impact. Specifically, it is not clear whether in the bare, unmodified use of a verb, the default interpretation is one of a high force magnitude, of a low force magnitude, or unspecified with respect to the force magnitude. This question is interesting because of its theoretical implications: If there is evidence that the verb's force magnitude is *already* specified for a particular value, then one would need to assume that adverbs can *override* this value. If, on the other hand, verbs of contact by impact are not lexically specified for a specific force magnitude, adverbs can be seen as providing crucial extra information that would otherwise need to be inferred from some other source. This question can also be tested via the denial-of-expectation construction. If a sentence of the form *Mary hit Joan, but lightly* is felicitous, where some expectation is denied by *lightly*, then it is reasonable to assume that this denied expectation is one of a high force magnitude (cf. the discussion in Section 3.1.1 and the lexical semantics of *lightly* established in Chapter 2). If the sentence is felicitous, this would also indicate that such a 'high-force' reading can be denied, i.e. is not lexically specified but only an inferred default interpretation in the sense of Levinson (2000) (and as such similar to the force implicature agent-oriented adverbs trigger with verbs of contact by impact).

Related to this second point, it is worth exploring whether such potential default interpretations about the magnitude of the force of unmodified verbs depend on the agent. Specifically, does the default interpretation of an unmodified verb in a sentence with an animate agent differ from the default interpretation in the case of an inanimate theme? This can be tested by using sentences in the denial-of-expectation construction both with animate agents as subject and inanimate themes as subject.

There are thus in total three issues or questions to be tested with the questionnaire, concerning the adverbs' classification as agent-oriented, the manifestation of the verbs' force component in unmodified uses of the verbs and

the implicature triggered by agent-oriented adverbs. In the following, I will first formulate and motivate three hypothesis for testing, based on these three questions, and then report on the questionnaire design and the results of this study.

3.2.1 Hypotheses and Predictions

In the following, I will motivate three hypotheses about the three topics discussed above, based on some initial observations.

The manifestation of the force component in unmodified verbs

Concerning the question of the manifestation of the force component of verbs of contact by impact, the hypothesis is that these verbs describe events with a high force magnitude: contact *by impact*. Given that the sentence in (17) seems felicitous, I expect that this high-force reading of unmodified uses of verbs of contact by impact can be cancelled (cf. the discussion of the denial-of-expectation construction in Section 3.1.1 above). This would mean that the high-force reading is generated by a mechanism similar to that of the force implicature triggered by agent-oriented adverbs on the force component of verbs of contact by impact: if there is no evidence to the contrary (e.g. the adverb *leicht/lightly*), the typical interpretation of verbs of contact by impact is one of high force.

- (17) Emma schlägt Ole, aber leicht.
Emma hits Ole, but lightly.

The other question to explore with respect to the manifestation of the force component is whether this default high-force reading depends on the agent. The sentence in (17) describes a situation taking place between an animate agent, Emma, and an animate patient, Ole. This construction not only expresses a situation of contact (by impact), but also describes a social interaction with a moral dimension (Geuder, 2016). A light hit between two animate beings is a marked situation, one that implies *I have the power to hit you hard, but I choose not to*. A hard hit is the default situation, which is denied in (17).

With inanimate themes in subject position, this social or moral dimension is absent. There can be no social intentions or implications which influence the expectations about the force of the hit. Whether a hit by an inanimate entity is hard or light solely depends on what causes the hit. This can be specified in the context of e.g. a storm, which implies a high force. But if there is no such context, no expectations about the magnitude of the force can arise. This is illustrated in (18). The sentence contains an inanimate agent, the guitar, and inanimate target, the table (the choice for an inanimate target is arbitrary, whether the guitar hits the table or somebody's leg is irrelevant for the current discussion). The adverb *leicht* appears in the denial-of-expectation construction

with *but*, which can only be felicitously used to deny the expectation of high force. The sentence should therefore be infelicitous.⁵

- (18) Die Gitarre schlägt gegen den Tisch, aber leicht.
the guitar hits against the table, but lightly

These observations lead me to formulate the following hypothesis:

- (19) **The Verb Force Hypothesis**
Verbs of contact by impact typically imply a high force magnitude when used with an animate agent as subject, but have no typical value of the force magnitude when used with an inanimate theme as subject.

As said above, in order to test the Verb Force Hypothesis I made use of the denial-of-expectation test with *but*. I tested the acceptability of both *hart* (hard) and *leicht* (lightly) following *aber* (but) with animate and inanimate subjects. For comparison, I also tested the acceptability of the same adverbs in the basic modification construction, i.e. without a *but*-conjunct. An overview of these predictions as well as some example sentences can be found in (20) and (21).⁶

- (20) **Basic construction:**
- a. Emma schlägt Ole ✓ leicht / ✓ hart.
Emma hits Ole ✓ lightly / ✓ hard
 - b. Die Gitarre schlägt ✓ leicht / ✓ hart gegen den Tisch.
the guitar hits ✓ lightly / ✓ hard against the table
- (21) **Denial-of-expectation construction:**
- a. Emma schlägt Ole, aber ✓ leicht / ? hart.
Emma hits Ole, but ✓ lightly / ? hard
 - b. Die Gitarre schlägt gegen den Tisch, aber ? leicht / ? hart.
the guitar hits against the table, but ? lightly / ? hart

The adverb's classification as agent-oriented

In Chapter 2, I presented evidence from the classification tests developed in Schäfer (2005) that adverbs such as *playfully* or *mercilessly* are agent-oriented, even when they appear in a low position in the sentence (in German: a position following the direct object), which is usually said to contain only manner adverbs and not allow agent-oriented readings. It should follow from this that these adverbs require animate agents in subject position (given Dowty's (1991)

⁵Please note that the sentence in (18) does not contain a direct object, but rather a target PP. German *schlagen* only appears in a transitive construction with two animate entities: an agent as subject and a patient as direct object. The implications of the precise syntactic realisation of the entities involved in the hitting are beyond the scope of this dissertation, but I refer the interested reader to Geuder & Gabrovská (2016).

⁶A ? refers to the predicted infelicity of a sentence containing the word preceded by the ?. A ✓ refers to predicted felicity.

characterisation of the proto-agent as animate), an agent about which these adverbs then provide further information. I therefore formulate the following hypothesis:

(22) **The Agentivity Hypothesis**

Adverbs that have been classified as agent-oriented according to Schäfer's (2005) tests can only be used to modify verbs of contact by impact in a sentence with an animate agent as subject.

In order to test this hypothesis, I used agent-oriented adverbs both with animate agents and inanimate themes in subject position. These sentences were compared to versions of the same sentences, but with *leicht* (lightly) or *hart* (hard) as adverbs. These are pure manner adverbs, i.e. not agent-oriented, and should therefore be felicitous with both types of subjects. The predictions and some example sentences can be found in (23) and (24).⁷

(23) **Agent-oriented adverbs:**

- a. ✓ Emma schlägt Ole spielerisch / wütend.
Emma hits Ole playfully / angrily
- b. # Die Gitarre schlägt spielerisch / wütend gegen den Tisch.
the guitar hits playfully / angrily against the table

(24) **Manner adverbs:**

- a. ✓ Emma schlägt Ole leicht / hart.
Emma hits Ole lightly / hard
- b. ✓ Die Gitarre schlägt leicht / hart gegen den Tisch.
The guitar hits lightly / hard against the table

The force implicatures

Lastly, I wanted to test the range or systematicity of the force implicatures triggered by agent-oriented adverbs when combined with verbs of contact by impact. So far, I only have evidence that the adverbs *wütend* (angrily) from the German corpus sample (cf. the sentence in (58) in Chapter 2, repeated here as (26)) and *playfully* from the British corpus sample (cf. the discussion around (59) in Chapter 2, repeated here as (25)) trigger a force implicature when modifying verbs of contact by impact. This could be seen from the context they appear in, most prominently the appearance of *playfully* in the denial-of-expectation construction.

- (25) Steve hit his brother playfully but rather hard on the shoulder.

⁷A # preceding a sentence refers to the predicted semantic anomaly of the sentence (it is in a sense stronger than the ? used for the sentences testing the Verb Force Hypothesis). A ✓ means the sentence should be acceptable and felicitous.

- (26) Er schlug wütend mit der Hand auf all die Papiere. Da waren
 He hit.PAST angrily with the hand on all the papers. There were
 Zigarrenkistchen für fünfzig Mark, für siebzig Mark, das flog nur
 cigar.bboxes for fifty Mark, for seventy Mark, that flew just
 so!
 so
 ‘He angrily hit the papers with his hand. There were cigar boxes for
 fifty Mark, for seventy Mark, which went flying.’

The German adverb *wütend* does not appear in the denial-of-expectation construction in the corpus. However, it is strongly suggested from the context in (26) that the hit was hard because the agent was angry: he hit angrily and there were papers that went flying. The agent’s mental state of being angry thus influences their manner of acting in a way that if force is involved, the magnitude of the force increases.

Based on the evidence from *wütend* and *playfully*, I assume that this correlation between a mental state or mood of the agent and their behaviour also applies to other agent-oriented adverbs. If the agent is described as e.g. being amused or in a joking mood while hitting someone, the hit should typically be done with little force. If the agent is described as e.g. merciless or ruthless, the hit should typically be done with a high amount of force. Based on these observations, I formulate the following hypothesis about force implicatures arising when agent-oriented adverbs modify verbs of contact by impact:

(27) **The Force Implicature Hypothesis**

Adverbs that are classified as agent-oriented typically trigger an implicature on the force component when used to modify a verb of contact by impact (in sentences with animate agents as subjects).

For this hypothesis, I tested the acceptability of agent-oriented adverbs in the denial-of-expectation construction with both *leicht* (lightly) and *hart* (hard) following *aber* (but). The idea is that adverbs triggering an implicature of a decrease in the amount of force (e.g. *spielerisch* (playfully), *belustigt* (amused), *scherzhaft* (jokingly)) are compatible with *hart* in the denial-of-expectation construction as in (28-a), because *hart* should cancel the low-force implicature (deny the expectation of low force). But these adverbs should be incompatible with *leicht* in the denial-of-expectation construction as in (28-b). *Leicht* cannot be used to deny the expectation of low force, since *with little force* is what *leicht* means (cf. the discussion in Chapter 2). A denial of expectation construction with an adverb triggering a force decrease implicature and *leicht* should therefore be infelicitous. The opposite pattern should hold for adverbs triggering an implicature of an increase in the amount of force (e.g. *wütend* (angrily), *unbarmherzig* (mercilessly), *rücksichtslos* (ruthlessly)). That is, these adverbs should be compatible with *leicht* in the denial-of-expectation construction (as in (29-a)), but incompatible with *hart* (as in (29-b)).

In order to have a baseline for comparison, the same sentence construction was used with pure manner adverbs modifying the force component, e.g. *Joan hit Mary lightly, but still rather hard*. These sentences are contradictions and should therefore be judged as unacceptable and can be used to compare the acceptability and infelicity of the other sentence types to (unacceptability is marked by the #, infelicitous sentences are preceded by a ?). Some example sentences testing the Force Implicature Hypothesis can be found in examples (28), (29) and (30).

- (28) **Force decrease implicatures:**
- a. ✓ Emma schlägt Ole spielerisch, aber doch recht hart.
Emma hits Ole playfully, but still rather hard
 - b. ? Emma schlägt Ole spielerisch, aber doch recht leicht.
Emma hits Ole playfully, but still rather lightly
- (29) **Force increase implicatures:**
- a. ✓ Emma schlägt Ole wütend, aber doch recht leicht.
Emma hits Ole angrily, but still rather lightly
 - b. ? Emma schlägt Ole wütend, aber doch recht hart.
Emma hits Ole angrily, but still rather hard
- (30) **Baseline:**
- a. # Emma schlägt Ole leicht, aber doch recht hart.
Emma hits Ole lightly, but still rather hard
 - b. # Emma schlägt Ole hart, aber doch recht leicht.
Emma hits Ole hard, but still rather lightly

The predictions are that sentences preceded by a ✓ are unambiguously good or semantically acceptable sentences, while sentences preceded by a # are unambiguously bad or semantically unacceptable sentences. Sentences preceded by a ? should be somewhere in between, i.e. not entirely semantically unacceptable or anomalous, but infelicitous.

3.2.2 Questionnaire Design and Materials

In order to test these hypotheses in a manageable questionnaire (manageable qua number of items), I limited myself to a selection of the relevant verbs and adverbs.

The adverb selection

I chose the adverbs such that I have two which can get an agent-oriented manner interpretation in a low position in the sentence and a mental-attitude interpretation in a high position (*spielerisch* (playfully) and *kühn* (boldly)); two which function as subject depictives in a low position in the sentence and as mental-attitude adverbs in a high position (*belustigt* (amused) and *verzweifelt*

(despairingly)); and two which cannot get an agent-oriented manner reading but only a mental-attitude reading (*ängstlich* (frightened) and *wütend* (angrily)). Not all of these are taken from the German corpus sample: *spielerisch* is the translation of *playfully* from the prominent English corpus example in (25), *kühn* and *ängstlich* come from a list of adverbs used for experimentally testing the influence of adverbs relating to force (and speed) on the processing of various verbs of contact by impact (Sieksmeyer, 2016).

I tried to make the selection such that one of each of the pairs of adverbs triggers an implicature of an increase in the amount of force and one triggers an implicature of a decrease in the amount of force. I did this by inserting the six adverbs into constructions such as in (28) or (29) above. If an adverb is compatible with *hart* (hard) following *aber* (but) in the denial-of-expectation construction, i.e. if the resulting sentence is felicitous, this points to the existence of a force-decrease implicature, which is cancelled by *hart*. If the same adverb is then incompatible with *leicht* (lightly) in the denial-of-expectation construction, i.e. if the resulting sentence is infelicitous, then I take this as solid evidence that this adverb triggers an implicature of low force. Conversely, if an adverb is compatible with *leicht* in the denial-of-expectation construction, but incompatible with *hart*, I take this as evidence that this adverb triggers a force-increase implicature. Based on my own intuitions, the adverbs *spielerisch*, *belustigt* and *ängstlich* trigger a force-decrease implicature, and the adverbs *kühn*, *verzweifelt* and *wütend* trigger a force-increase implicature.

The verb selection

For the verb I used *schlagen* (~ to hit), since this is a prototypical verb of contact by impact (cf. the classification in Levin 1993 of a hit-verbs as a separate sub-class of verbs of contact by impact, and the discussion in Chapter 2). Additionally, *schlagen* served as my starting point for looking into modification of verbs of contact in German via co-occurrences in the corpus DWDS (cf. also Chapter 2).

The final set-up of the questionnaire

All stimulus items were piloted in a small-scale questionnaire. The full list of stimuli, sorted by hypothesis, can be found in Appendix B. Table 3.1 gives an overview over the different types of stimuli testing all three hypotheses.

The final questionnaire was distributed over several versions of 21-22 sentences, including two control sentences that were direct contradictions (e.g. *Joan hit Mary hard and lightly*). The sentences were randomized, and all questionnaires were distributed among German native speakers in two versions, one of which contained the test sentences in reversed order.

The sentences had to be rated on a 4-point Likert scale, where a 4 means *clearly good*, a 3 *maybe good*, a 2 *maybe bad* and a 1 *clearly bad*. This way, participants were forced to make a commitment as to whether a sentence was on

construction	example sentences
The Verb Force Hypothesis	
basic construction	Emma schlägt Ole $\sqrt{\text{leicht}}/\sqrt{\text{hart}}$. (Emma hits Ole $\sqrt{\text{lightly}}/\sqrt{\text{hard}}$.) Die Gitarre schlägt $\sqrt{\text{leicht}}/\sqrt{\text{hart}}$ gegen den Tisch. (The guitar hits the table $\sqrt{\text{lightly}}/\sqrt{\text{hard}}$.)
denial-of-expectation construction	Emma schlägt Ole, aber $\sqrt{\text{leicht}}/?\text{hart}$. (Emma hits Ole, but $\sqrt{\text{lightly}}/?\text{hard}$.) Die Gitarre schlägt gegen den Tisch, aber $?leicht/?\text{hart}$. (The guitar hits the table, but $?lightly/?\text{hard}$.)
The Agentivity Hypothesis	
agent-oriented adverbs	$\sqrt{\text{}}$ Emma schlägt Ole spielerisch/wütend. ($\sqrt{\text{}}$ Emma hits Ole playfully/angrily.) # Die Gitarre schlägt spielerisch/wütend gegen den Tisch. (# The guitar hits the table playfully/angrily.)
pure manner adverbs	$\sqrt{\text{}}$ Emma schlägt Ole leicht/hart. ($\sqrt{\text{}}$ Emma hits Ole lightly/hard.) $\sqrt{\text{}}$ Die Gitarre schlägt leicht/hart gegen den Tisch. ($\sqrt{\text{}}$ The guitar hits the table lightly.)
The Force Implicature Hypothesis	
opposite force direction	$\sqrt{\text{}}$ Emma schlägt Ole spielerisch, aber doch recht hart. ($\sqrt{\text{}}$ Emma hits Ole playfully, but still rather hard.) $\sqrt{\text{}}$ Emma schlägt Ole wütend, aber doch recht leicht. ($\sqrt{\text{}}$ Emma hits Ole angrily, but still rather lightly.)
same force direction	? Emma schlägt Ole spielerisch, aber doch recht leicht. (? Emma hits Ole playfully, but still rather lightly.) ? Emma schlägt Ole wütend, aber doch recht hart. (? Emma hits Ole angrily, but still rather hard.)
contradiction baseline	# Emma schlägt Ole leicht, aber doch recht hart. (# Emma hits Ole lightly, but still rather hard.) # Emma schlägt Ole hart, aber doch recht leicht. (# Emma hits Ole hard, but still rather lightly.)

Table 3.1: An overview of the predictions and types of stimulus items used for testing the three hypotheses.

the acceptable side or on the unacceptable side. The rating task was preceded by an introduction, which included an example sentence from an unrelated domain (speed, given in (31)) and asked participants to rate the sentences according to their first intuition.

- (31) Mark lief schläfrig, aber doch recht schnell, nach Hause.
Mark walked sleepily, but still rather quickly, towards home.

Following the rating task, information about the participants' language background was collected via four questions relating to their first language(s), other languages they speak, and the place(s) they have been raised/lived.

15-20 speakers were tested in both the original order and the reversed order of all seven questionnaires. Participants who rated either of the direct contradictions in the two control sentences higher than 1, i.e. who thought these contradictions are not completely unacceptable, were excluded from the analysis, leaving a total of 165 participants.

3.2.3 Results and discussion

In the following, I will present the results of the questionnaire study per hypothesis, followed by a general discussion.

The Verb Force Hypothesis

An overview of the results, that is, the combined percentages of ratings 3 (maybe good) and 4 (clearly good), from the questionnaire items concerning the Verb Force Hypothesis can be found in Table 3.2.

At first glance, it seems that the results confirm the predictions. Sentences that contain the verb *schlagen* (\approx to hit) in the basic modification construction, i.e. without the *but*-conjunct, have a high percentage of ratings 3 (maybe good) and 4 (clearly good). This means that it is possible to modify the force component of *schlagen* both in the direction of a lesser amount of force (cf. *leicht* (lightly)) and in the direction of a greater amount of force (cf. *hart* (hard)). This seems to be independent of whether the sentence has an animate agent as subject (e.g. *Emma*) or an inanimate theme (e.g. *die Gitarre* (the guitar)). Both types of constructions fare equally well.

The sentences with *schlagen* in the denial-of-expectation construction (with *aber* (but)) have more diverse ratings. Recall that the prediction was that *schlagen* used with an animate agent typically implies a high amount of force used. Therefore, sentences of the type *Sie schlägt ihn, aber leicht* (She hits him, but lightly) should be felicitous, given that the expectation that is denied through the use of *aber* in this case is one of a high amount of force (*aber leicht* (but lightly)). That seems to be the case, sentence of the type *Sie schlägt ihn, aber leicht* have received no ratings of 1 (clearly bad) or 2 (maybe bad). The evidence from the opposite construction, *Sie schlägt ihn, aber hart* (She hits him, but hard), is not so clear. This construction should be infelicitous, since the

construction	example sentences	%
basic construction	Emma schlägt Ole hart. (Emma hits Ole hard)	95%
	Emma schlägt Ole leicht. (Emma hits Ole lightly)	92.86%
	Die Gitarre schlägt hart gegen den Tisch. (the guitar hits hard against the table)	92.5%
	Die Gitarre schlägt leicht gegen den Tisch. (the guitar hits lightly against the table)	90.41%
denial-of-expectation construction	Emma schlägt Ole, aber hart. (Emma hits Ole, but hard)	65%
	Emma schlägt Ole, aber leicht. (Emma hits Ole, but lightly)	100%
	Die Gitarre schlägt gegen den Tisch, aber hart. (the guitar hits against the table, but hard)	44.12%
	Die Gitarre schlägt gegen den Tisch, aber leicht. (the guitar hits against the table, but lightly)	65.79%

Table 3.2: Combined percentages of ratings 3 (maybe good) and 4 (clearly good) for the sentences testing the Verb Force Hypothesis (observed, not estimated).

expectation that is denied through *aber* in this case is a low amount of force (*aber hart* (but hard)), i.e. the opposite of what should typically be expected. Yet these sentences still received 65% of ratings 3 (maybe good) and 4 (clearly good). Compared to 100% for the *aber leicht* (but lightly) construction, however, I think it is fair to speak of a noticeable difference.

The sentences in the denial-of-expectation construction with *aber* and an inanimate theme as subject (*die Gitarre* (the guitar)) seem to be rated considerably worse than their counterparts in the basic modification construction (without *aber*): 44.12% and 65.79% vs 92.5% and 90.41% for *hart* and *leicht* respectively. This provides evidence for the fact that in the case of an inanimate theme as subject, no typical expectations arise about the amount of force used, i.e. there are no expectations about force that can be denied through the use of either *aber leicht* or *aber hart*.

In order to test whether the observed trend is significant, I ran a general linear mixed effects model on the data, using the packages `lme4` and `lmerTest` in R (Bates et al., 2015). The random effects in the model are participants and items. The fixed effect is condition, including as levels each of the sentence structures in Table 3.2 above (basic construction versus denial-of-expectation construction, animate agent as subject versus inanimate theme as subject). But unfortunately, there were too few observations to create a general linear mixed effects model testing the sentences with animate agents.

The model testing the force-related expectations only in the case of inanimate themes as subject, while confirming the general trend observable in Table

3.2, shows that the differences are not significant:⁸ the odds of rating a sentence with *aber* 3 (maybe good) or 4 (clearly good) are 0.042 times (*aber hart* (but hard), $p = .07$, $SE = 1.7195$) and 0.116 times (*aber leicht* (but lightly), $p = .21$, $SE = 1.7189$) the odds of rating a sentence without *aber* 3 or 4, i.e. worse, but not significantly so. That means that participants like sentences with *aber* and an inanimate subject less than sentences without *aber* and an inanimate subject, only not significantly so. It is thus not entirely clear whether there are any expectations about the amount of force that can be denied through the use of *aber hart* or *aber leicht* with an inanimate theme as subject.

Based on the evidence from the questionnaire items testing the Verb Force Hypothesis I thus conclude that *schlagen* is typically interpreted as involving a high force magnitude when used with an animate agent in subject position, but that the availability of any expectations regarding the force magnitude is not so clear when *schlagen* is used with an inanimate theme in subject position.

The Agentivity Hypothesis

An overview of the results from the questionnaire items testing the Agentivity Hypothesis can be found in Table 3.3.

construction	example sentences	%
agent-oriented adverbs	Emma schlägt Ole spielerisch/wütend. (Emma hits Ole playfully/angrily) Die Gitarre schlägt spielerisch/wütend gegen den Tisch. (the guitar hits playfully/angrily against the table)	88.67% 21.83%
pure manner adverbs	Emma schlägt Ole leicht/hart. (Emma hits Ole lightly/hard) Die Gitarre schlägt leicht/hart gegen den Tisch. (the guitar hits lightly/hard against the table)	95.8% 89.63%

Table 3.3: Combined percentages of ratings 3 (maybe good) and 4 (clearly good) for the sentences testing the Agentivity Hypothesis (observed, not estimated).

The results clearly confirm the predictions. Sentences with an animate agent and agent-oriented adverbs (*Sie schlägt ihn spielerisch* (She hits him playfully)) receive high percentages of ratings 3 (maybe good) and 4 (clearly good), 88.67%, comparable to the sentences with an animate agent and pure manner adverbs (*Sie schlägt ihn leicht* (She hits him lightly)), which received 95.8% of ratings 3 and 4. The situation is different for inanimate theme subjects (e.g. *die Gitarre* (the guitar)). Here, sentences with agent-oriented manner adverbs

⁸I assume significance when $p \leq .05$.

receive only 21.83% of ratings 3 and 4. The comparison class, sentences with inanimate themes and pure manner adverbs, receive considerably better ratings (89.63% of ratings 3 and 4).

Again, I ran a general linear mixed effects model to test whether these observations are significant. The random effects again are participants and items, the fixed effect condition, with each sentence structure in Table 3.3 above as a separate level (agent-oriented adverbs versus pure manner adverbs and animate agents as subject versus inanimate themes as subject). The model for the Agentivity Hypothesis yields significant results: the odds of giving a sentence with *schlagen* ratings 3 (maybe good) or 4 (clearly good) are significantly higher for a sentence with an inanimate theme and a pure manner adverb such as *leicht* ($p < .001$, $SE = 0.4735$) or for a sentence with an animate agent and any adverb ($p = < .001$)⁹ : around 50 times the odds of giving a sentence with *schlagen* plus an inanimate theme and an agent-oriented adverb ratings 3 or 4. That is, participants mostly did not accept agent-oriented adverbs with inanimate themes in subject position (*Die Gitarre schlägt spielerisch gegen den Tisch* (the guitar hits playfully against the table)).

The results from the questionnaire items testing the Agentivity Hypothesis thus confirm the adverbs' initial classification as agent-oriented: adverbs such as *spielerisch* (playfully) and *wütend* (angrily) require an animate agent as subject.

The Force Implicature Hypothesis

An overview of the results from questionnaire items testing the Force Implicature Hypothesis can be found in Table 3.4.

The ratings for sentences testing the Force Implicature Hypothesis seem to confirm the predictions. Sentences of the type *spielerisch, aber doch recht hart* (playfully, but still rather hard) and sentences of the type *wütend, aber doch recht leicht* (angrily, but still rather lightly) received relatively high ratings: 86.15% and 65.75% respectively. Despite the difference in ratings between these two sentence types, I interpret the 65.75% ratings of 3 (maybe good) and 4 (clearly good) for *wütend, aber doch recht leicht*-type sentences as evidence for a force increase implicature. Even though some participants did not think that these sentences are felicitous, more than half *did* think so. The felicity of these sentences confirms the existence of a defeasible inference triggered by agent-oriented adverbs on the force component of verbs of contact by impact. The implicature can be cancelled by a pure manner adverb modifying the force magnitude in the opposite direction when used in the denial-of-expectation construction with *aber* (but).

Sentences containing a construction like *spielerisch, aber doch recht leicht* (playfully, but still rather lightly) provide further evidence for the existence

⁹The p-value is for both pure manner adverbs, with $SE = 0.7865$, and agent-oriented adverbs, with $SE = 0.6333$.

construction	example sentences	%
force decrease implicatures	Emma schlägt Ole spielerisch: (Emma hits Ole playfully): aber doch recht hart. (but still rather hard)	86.15%
	aber doch recht leicht. (but still rather lightly)	33.33%
force increase implicatures	Emma schlägt Ole wütend: (Emma hits Ole angrily): aber doch recht leicht. (but still rather lightly)	65.75%
	aber doch recht hart. (but still rather hard)	33.85%
contradiction baseline	Emma schlägt Ole leicht, aber doch recht hart. (Emma hits Ole lightly, but still rather hard)	10.42%
	Emma schlägt Ole hart, aber doch recht leicht. (Emma hits Ole hard, but still rather lightly)	6.85%

Table 3.4: Combined percentages of ratings 3 (maybe good) and 4 (clearly good) for the sentences testing the Force Implicature Hypothesis (observed, not estimated).

of the force implicatures. Adverbs like *spielerisch* (playfully) cannot felicitously be paired with the force-decreasing adverb *leicht* (lightly) in the denial-of-expectation construction, meaning they already result in a force decrease reading. The same holds for adverbs like *wütend* (angrily) in the denial-of-expectation construction with *hart* (hard). Sentences with these constructions receive only 33.33% and 33.85% respectively of ratings 3 (maybe good) and 4 (clearly good). Finally, the control constructions with a contradiction (e.g. *leicht, aber doch recht hart* (lightly, but still rather hard)) received the expected low percentage of ratings 3 and 4 (10.42% and 6.85%).

To see if these differences are significant, I conducted a general linear mixed effects analysis with these sentence types, too. The random effects are the same as above, and there is again only one fixed effect, condition, with each type of sentence exemplified in Table 3.4 above as an individual level.¹⁰ The models,

¹⁰Unfortunately, given my sample size, i.e. the number of observations, the model testing all the levels of this fixed effect would not converge in R. I therefore split the data and tested sentences with force decreasing adverbs separately from sentences with force increasing adverbs. I am aware of the fact that this might skew the results, but given the data this is the best option known to me for statistical hypothesis-testing.

while confirming the trend observable in Table 3.4, do not show significant results for all the observed differences. The odds of giving ratings 3 (maybe good) or 4 (clearly good) for sentences of type *spielerisch, aber leicht* (playfully, but lightly) are 0.061 ($p = .092$, $SE = 1.663$) times the odds of giving sentences of type *spielerisch, aber hart* (playfully, but hard) ratings 3 or 4, i.e. worse, but not significantly so. The odds of giving ratings 3 or 4 for sentences of the corresponding contradiction baseline, *leicht, aber hart* (lightly, but hard), are 0.010 ($p = .016$, $SE = 1.905$) times the odds of giving sentences of type *spielerisch, aber hart* ratings 3 or 4 (i.e. significantly worse).

The odds of giving ratings 3 or 4 for sentences of type *wütend, aber hart* (angrily, but hard) are 0.244 ($p = .38$, $SE = 1.6113$) times the odds of giving sentences of type *wütend, aber leicht* (angrily, but lightly) ratings 3 or 4, i.e. worse. This confirms the trend, but is unfortunately not significant. Yet again, the difference between the baseline contradiction sentences and sentences containing an implicature cancellation (*wütend, aber leicht*) are significant: The odds of rating 3 or 4 given sentences of type *hart, aber leicht* (hard, but lightly) are 0.025 ($p = .027$, $SE = 1.66581$) times the odds for these ratings for implicature cancellation sentences (*wütend, aber leicht*), i.e. significantly worse.

To summarise: sentences containing a pure manner adverb of the same force direction as the agent-oriented adverb are less acceptable than sentences containing a pure manner adverb of the opposite force direction for both force increase and force decrease adverbs (only just not significantly so). The fact that contradictions are rated significantly worse than sentences where the force implicature is cancelled, provides evidence that these sentences are felicitous and that the force implicature I observed in the corpus data in Chapter 2 is thus not just an artifact of two adverbs, but is in fact triggered by a variety of agent-oriented adverbs modifying verbs of contact by impact.

Discussion

To sum up, the evidence from the questionnaire study is first and foremost further confirmation of the existence of an implicature on the force component of verbs of contact by impact, triggered by modification through agent-oriented adverbs. The acceptability of sentences containing e.g. the phrase *spielerisch, aber hart* (playfully, but hard) provides evidence for the fact that adverbs such as *spielerisch* (playfully) trigger an implicature of low force when used with verbs of contact by impact, an implicature which can be cancelled by force-increasing adverbs such as *hart* (hard). Similarly, the acceptability of sentences containing the phrase *wütend, aber leicht* (angrily, but lightly) provides evidence for the fact that agent-oriented adverbs such as *wütend* (angrily) give rise to a force increase implicature when combined with verbs of contact by impact.

Furthermore, the questionnaire study has confirmed the adverbs' classifications in Chapter 2: the adverbs classified as agent-oriented manner adverbs, subject depictives or mental-attitude adverbs require an animate agent in subject position. Otherwise sentences containing these adverbs will not be seman-

tically well formed.

Concerning the force component in verbs of contact by impact: when a verb is used without a force modifier, there is a preference for an interpretation of a high force magnitude if the sentence contains an animate agent as subject. This preference is less pronounced if the sentence contains an inanimate theme as subject. I take this as light evidence in favour of the predicted typical interpretation of the force magnitude of unmodified verbs of contact by impact: a high force magnitude with an animate agent (potentially no expectations/typical force magnitude with an inanimate theme).

I thus conclude that verbs of contact by impact do not come equipped with a fixed value for the force magnitude, but rather that this value is inserted through a process of inference to stereotype, similar to that of the force implicature arising when verbs of contact by impact are modified by agent-oriented adverbs.

3.3 Reading time experiment¹¹

In Section 3.1.2 above, I showed that the type of inference observed in my data can be classified as an I-implicature, following Levinson (2000), or an R-implicature, following Horn (1984, 2004). That means it is a type of Generalised Conversational Implicature (GCI). Levinson states that “GCIs should be available early, before full sentence-meaning is computed, because of their association with linguistic expressions” (Levinson 2000: 370). Following this view, the expression *hit playfully* should generate a force implicature as soon as it is read, regardless of whether there is more material in the sentence. Consider again the sentence from the BNC, given in (1) above and repeated here in (32).

(32) Steve hit his brother playfully but rather hard on the shoulder.

The low force implicature triggered by the combination of the adverb *playfully* with the verb *hit* should, according to Levinson, be available as soon as *playfully* is processed, i.e. *before* the second part of the conjunct and the PP *but rather hard on the shoulder* are read. This prediction is in line with my observations above. In Section 3.1.1, I have reasoned that the implicature triggered by *hit playfully* in (32) is cancelled by *but hard*. If *but hard* cancels an implicature in (32), then the implicature must have been available *before* encountering *but hard*.

This early availability of the implicature indicates a rapid and almost automatic process. If that is the case, it follows that the cancellation of the implicature, i.e. the undoing of this almost automatic process, requires additional processing time and this should be detectable during online measurements (see e.g. Breheny et al. 2006, who call Levinson’s (2000) view the Default View). In this section, I will report on a self-paced reading experiment in Dutch to

¹¹This experiment was conducted in collaboration with Suzanne Dekker.

test this prediction of additional processing time. If a processing delay can be detected, it will be evidence for the cognitive reality of the observed force implicatures. This section is structured as follows. First, I present a small pilot study on Dutch to provide evidence for the existence of force implicatures in this language, then I will motivate the concrete hypothesis and predictions for the experiment, present the experimental set-up, and then discuss the results.

3.3.1 Force implicatures in Dutch

So far, I have presented evidence from the corpus studies on English and German reported in Chapter 2, and the questionnaire study in German reported above that agent-oriented adverbs in these two languages trigger a force implicature when combined with verbs of contact by impact. In order to conduct a reading time experiment in Dutch to test for the cognitive reality of force implicatures, we first need to ascertain that these implicatures also exist in Dutch. In this section, I will present the results of a small scale pilot questionnaire study, making use of the denial of expectation construction as in the German questionnaire.

The sentence materials for the questionnaire were obtained by translating from the English and German materials discussed in Chapter 2 and Section 3.2 above. Dutch is closely related to English and German, all three falling into the class of West-Germanic languages. Dutch also has a word class *adverb*, a prerequisite for this study.¹² Given the relatedness between German and Dutch, we assume that the general classification of an adverb as agent-oriented, as provided for German in Chapter 2 also holds for Dutch. Two example stimulus sentences are given in (33).

- (33) a. Daphne sloeg Joost boos, maar toch vrij zachtjes, op zijn schouder.
Daphne hit Joost angrily, but still rather lightly, on his shoulder.
b. Daphne sloeg Joost speels, maar toch vrij zachtjes, op zijn schouder.
Daphne hit Joost playfully, but still rather lightly, on his shoulder.

In the sentence in (33-a), the adverb *boos* (angrily) should trigger a force increase implicature on the force magnitude of the verb *slaan* (to hit). This implicature will be cancelled by following up with the adverb *zachtjes* (lightly) in the denial of expectation construction. In the sentence in (33-b), the adverb *speels* (playfully) should trigger a force decrease implicature on the force magnitude of the verb. This implicature, however, will not be cancelled. The adverb that follows in the denial of expectation construction is again *zachtjes*, a force decreasing adverb. If Dutch behaves like English and German with respect to force implicatures, the sentence in (33-a), where an implicature is cancelled, should be judged as felicitous, and the sentence in (33-b) should be judged as infelicitous (the predictions are completely parallel to those for the Force

¹²See the discussion in Chapter 2, Section 2.1 for some background on the word class *adverb* in Dutch.

Implicature Hypotheses tested in the German questionnaire).

The questionnaire consisted of fourteen items which included two contradictions as control items. Just as participants in the German questionnaire, participants in the Dutch pilot questionnaire had to rate the sentences on a 4-point Likert scale, ranging from 1 - *clearly bad* to 4 - *clearly good*. That way, they were forced to make a decision as to whether a sentence was on the felicitous side or the infelicitous side. Participants that rated either of the two contradictory control items higher than 1, i.e. who thought the contradictions might be felicitous, were excluded from the analysis, leaving a total of 35 participants. The results are displayed in Table 3.5.

construction	example sentences	%
implicature cancelled	Daphne sloeg Joost boos, (Daphne hit Joost angrily, maar toch vrij zachtjes, (but still rather lightly, op zijn schouder. (on his shoulder.)	61.43%
implicature not cancelled	Daphne sloeg Joost speels, (Daphne hit Joost playfully, maar toch vrij zachtjes, (but still rather lightly, op zijn schouder. (on his shoulder.)	16%

Table 3.5: Combined percentages of ratings 3 (maybe good) and 4 (clearly good) for the Dutch sentences tested in the questionnaire.

As can be seen in Table 3.5, sentences in which the implicature is cancelled via the denial of expectation construction receive a much higher percentage of ratings 3 (*maybe good*) and 4 (*clearly good*) than sentences in which the implicature is not cancelled: 61.43% versus 16% respectively. The fact that sentences in which the force implicature is cancelled are mostly judged to be felicitous provides evidence for the existence of force implicatures triggered by agent-oriented adverbs on the force component of verbs in Dutch. Further evidence for this comes from the fact that the sentences in which the implicature is *not* cancelled are judged to be infelicitous. Remember that the adverb following *but* in the denial of expectation construction denies some expectation. The fact that the Dutch *zachtjes* (lightly) cannot be used in the denial of expectation construction with *speels slaan* (to hit playfully) thus indicates that *speels slaan* already has a meaning component similar to that of *zachtjes*, i.e. a low force magnitude.

This provides evidence that agent-oriented adverbs in Dutch also result in a force implicature when modifying verbs that have a force component. We take the results from the pilot questionnaire as sufficient evidence to conduct

a self-paced reading experiment on force implicatures in Dutch.

3.3.2 Hypotheses and predictions

There is some debate in the literature about the effects of implicatures during online sentence processing measurements. A line of research investigating scalar implicatures has found a delay in processing time for the computation of scalar implicatures triggered by *or* and *some* (Breheny et al., 2006). Similarly, Alexandropoulou et al. (2016) found that the computing of ignorance effects triggered by the numeral modifier *at least* results in a slow-down measurable during online experiments.

As far as we are aware, no study systematically investigates the effects of the cancellation of Generalised Conversational Implicatures (GCIs) that are not scalar implicatures. However, Breheny et al. (2006) derive some predictions about the cancellation of implicatures based on Levinson’s (2000) view, which they call the Default View. As explained above, Levinson (2000) claims that implicatures should be computed early, as soon as the phrase that triggers them is processed. This seems plausible, given the sentences in which the force implicature is cancelled in the denial of expectation construction in the same sentence, i.e. *before* the whole sentence is computed. In order for the implicature to be cancelled, it needs to have been triggered. Therefore, if an implicature is cancelled before the whole sentence is computed, it certainly got triggered before the whole sentence was computed.

Breheny et al. (2006) state that “the default view predicts a longer reading time in lower-bound contexts” (Breheny et al. 2006: 440), the contexts in which scalar implicatures (if triggered) are cancelled. Breheny et al. (2006) then proceed to show that this is not the case for scalar implicatures, which result in a reading time delay when they are triggered, not when they are cancelled. But the force implicatures under investigation here are not scalar implicatures. Scalar implicatures fall into the category of Q-implicatures (Horn, 1984, 2004), whereas force implicatures, as I have reasoned in Section 3.1.2, are R-implicatures in the sense of Horn or I-implicatures in the sense of Levinson. I have explained above that Levinson’s view about the early availability of implicatures seems plausible given my data. Here, we therefore also follow Levinson’s view as described by Breheny et al. (2006) that the cancellation of an implicature results in a reading time delay and formulate the following hypothesis:

(34) **The Reading Time Hypothesis**

The cancellation of force implicatures triggered by agent-oriented adverbs on the force component of verbs results in additional processing costs, which are detectable in online measurements.

The predictions derived from this hypothesis are that sentences containing an agent-oriented adverb that triggers a force increase implicature and an adverb

that is lexically specified for a force decrease and which cancels the implicature, such as (33-a) above, result in longer reading times than comparable sentences that contain no implicature cancellation. The same should hold for force decrease implicature triggering adverbs and adverbs lexically specified for a force increase, which cancel the force decrease implicature. The concrete stimuli sentences testing these predictions will be presented in the next section.

3.3.3 Experimental design and method

In this section, I will present the materials we used for the self-paced reading experiment and explain the procedure of the experiment.

Materials

Here, I will motivate why we chose the particular verbs and adverbs used in the experiment, and explain what led to the final design of the test items (stimuli and controls) and fillers.

Verbs and adverbs In order to test the predictions derived from the Reading Time Hypothesis in a self-paced reading experiment, we made use of similar stimuli as those employed for the pilot questionnaire study reported in 3.3.1 above. Agent-oriented adverbs that trigger an implicature on the force component of verbs were used in combination with pure manner adverbs that cancel the implicature. The adverbs were taken from a translated sample of the German and English adverbs found in the corpus study reported in Chapter 2. All the adverbs used in the experiment were pre-tested for whether they do indeed trigger a force implicature with the denial-of-expectation construction by a Dutch native speaker.¹³

In order to have a sufficiently big sample (sufficiently big to statistically detect an effect), we needed to find more verbs than were used in the corpus and questionnaire studies so far. The verbs for the stimuli were therefore obtained through another corpus study. Remember from Chapter 2 that the co-occurrence of the adverbs *hard* and *lightly* with a verb indicated that the verb has a force component. In this corpus study, I used this rationale in reverse and looked for verbs co-occurring with these adverbs. The corpus study is described in detail in Chapter 5, where I establish the class of force verbs (which includes Levin's (1993) class of verbs of contact by impact which I have worked with so far, but also e.g. the class of verbs of exerting force.) For now it is important that all the verbs used in the experiments have a force component. The verbs that we selected for the experiment were translated to Dutch and then tested for whether they allow modification of both force increase and force

¹³The Dutch pilot questionnaire already provides evidence that agent-oriented adverbs trigger force implicatures. But for the experiment, we used a bigger set of adverbs, not all of which were used in the pilot questionnaire, and which therefore still needed to be pre-tested.

decrease, i.e. whether they can be combined with both the adverbs *hard* (hard) and *zacht* (lightly).

Problems with the control sentences The final composition of the experimental stimuli was a bit different from those of the questionnaire stimuli. The reason is that in order to detect longer reading times, one needs a control baseline against which to compare this. The additional difficulty in a reading or reaction time experiment is that the sentences in the stimulus condition and those in the control condition should be as similar as possible, otherwise their comparability suffers. If the denial-of-expectation test is used, then the stimulus sentences would have a format as in (35-a), similar to those used in the pilot questionnaire, cf. (33-a). In order to have good comparable control sentences, one could choose pure manner adverbs instead of agent-oriented adverbs in the first adverb position, as in (35-b). Pure manner adverbs don't trigger a force implicature, one would therefore compare sentences where an implicature is triggered and then cancelled to sentences where no implicature is triggered.

- (35) a. (i) Jet sloeg Jan speels, maar toch vrij hard, op zijn arm.
 Jet hit Jan playfully, but still rather hard, on his arm.
 (ii) Jet sloeg Jan boos, maar toch vrij zacht, op zijn arm.
 Jet hit Jan angrily, but still rather lightly, on his arm.
 b. (i) Jet sloeg Jan zacht, maar toch vrij hard, op zijn arm.
 Jet hit Jan lightly, but still rather hard, on his arm.
 (ii) Jet sloeg Jan hard, maar toch vrij zacht, op zijn arm.
 Jet hit Jan hard, but still rather lightly, on his arm.

However, such control sentences are contradictory. As far as we are aware, there has been no study investigating reading time effects of contradictions.¹⁴ But it seems a common assumption in the literature on experimental implicature testing that contradictions result in longer reading times (Alexandropoulou et al. 2016: 800).

If, on the other hand, the controls contain an agent-oriented adverb together with a pure manner adverb that modifies the force magnitude in the same direction, e.g. *angrily* and *hard*, the implicature triggered by *angrily* is not cancelled and the controls could be compared to the stimuli where it is cancelled. But the control sentences would then be the much less felicitous (because slightly tautological) versions used in the pilot questionnaire study, given in (33-b) above and repeated here as (36).

- (36) a. Jet sloeg Jan boos, maar toch vrij hard, op zijn arm.
 Jet hit Jan angrily, but still rather hard, on his arm.
 b. Jet sloeg Jan speels, maar toch vrij zacht, op zijn arm.
 Jet hit Jan playfully, but still rather lightly, on his arm.

¹⁴There is only a study that investigates reading and reaction times of contradictory predicates (not contradictions themselves), cf. Kaup et al. 2006

In order to have a good and fool proof control condition for comparison, we therefore chose a format that would enable us to have true, non-contradictory and non-tautological sentences. Given the requirement of similarity between controls and stimuli, this therefore meant that we needed to make some adjustments to the stimuli as well.

Final design of controls and stimuli Firstly, in order to avoid a contradiction, we used the non-contrastive conjunction *en* (and) instead of the contrastive *maar* (but).

Secondly, to ensure simultaneity, we added the word *tegelijk* (simultaneously) after *en*. This way, participants could not read the sentences as containing two events, one that was done e.g. playfully, and one that was done e.g. hard.

And thirdly, we chose to also use agent-oriented adverbs in the first adverb position in the control sentences. This means that an implicature is triggered in the control sentences as well as the stimulus sentences, but by choosing a pure manner adverb of the same force direction for the second position in the control sentences and weakening the contrast introduced through the conjunction by using *en* instead of *maar*, this implicature will not be cancelled (e.g. *boos en tegelijk vrij hard* (angrily and simultaneously rather hard) instead of the infelicitous *boos maar toch vrij hard* (angrily but still rather hard)). Instead the implicature will be reinforced by the pure manner adverb. To the best of our knowledge, there is no claim in the literature that this process is costly, i.e. requires online processing power which will show up in online measurements.

The final versions of the stimulus and control sentences thus have the form in (37) and (38) respectively. The corresponding stimuli and controls have the same second adverb (which in the stimulus sentences cancels the implicature and in the control sentences doesn't) and spill-over area, the three words following the second adverb. The spill-over area is important in self-paced reading experiments, because the effects that are triggered upon reading a certain word (the second adverb in this case) might 'spill over' onto the following words, i.e. participants might be 'clicking away' too fast and only belatedly slow down due to an increased amount of processing.

A note about about the stimuli and controls corresponding to each other, i.e. the control sentences used for comparison with a specific stimulus sentence: These are (37-a) and (38-a) for force decrease implicatures, and (37-b) and (38-b) for force increase implicatures. This might be confusing, because the force *decrease* control in (38-a) contains no adverbs that modify the force magnitude in the direction of less force. These items are called force decrease control sentences, because they serve as controls for the force decrease stimuli, i.e. they are exactly the same except for the first adverb, and therefore maximally comparable.

(37) **Stimuli sentences:**

- a. Jet sloeg Jan speels, en tegelijk vrij hard, op zijn arm.
Jet hit Jan playfully, and simultaneously rather hard, on his arm.
- b. Jet sloeg Jan boos, en tegelijk vrij zacht, op zijn arm.
Jet hit Jan angrily, and simultaneously rather lightly, on his arm.

(38) **Control sentences:**

- a. Jet sloeg Jan boos, en tegelijk vrij hard, op zijn arm.
Jet hit Jan angrily, and simultaneously rather hard, on his arm.
- b. Jet sloeg Jan speels, en tegelijk vrij zacht, op zijn arm.
Jet hit Jan playfully, and simultaneously rather lightly, on his arm.

The final test items contained 12 stimulus-control pairs with force decrease implicature triggering adverbs in the stimulus sentences, and 18 stimulus-control pairs with force increase implicature triggering adverbs in the stimulus sentences. All test sentences were piloted with Dutch native speakers, using the same 4-point Likert scale as in the Dutch pilot questionnaire study reported above, to confirm that we have indeed managed to find true, non-contradictory and non-tautological sentences. The full list of stimulus and control sentences can be found in Appendix C.

Filler items Additionally, 60 filler items were used, of which 20 were contradictions from the domain of force and speed (such as (39-a)), 20 were slightly tautological sentences from the domain of speed (such as (39-b)) and 20 were felicitous sentences from the domain of sound-volume (such as (39-c)).

(39) **Fillers:**

- a. Contradictions:
 - (i) Jet liep snel, en tegelijk vrij langzaam, naar huis toe.
Jet walked quickly, and simultaneously rather slowly, towards her house.
 - (ii) Jet sloeg Jan hard, en tegelijk vrij zacht, op zijn shouder.
Jet hit Jan hard, and simultaneously rather lightly, on his shoulder.
- b. Slight tautologies:
 - (i) Jet liep langzaam, en tegelijk vrij rustig, naar huis toe.
Jet walked slowly, and simultaneously rather calmly, towards her house.
 - (ii) Jet liep snel, en tegelijk vrij haastig, naar huis toe.
Jet walked quickly, and simultaneously rather hastily, towards her house.
- c. Felicitous sentences:
 - (i) Jet sloeg hard, en tegelijk vrij luid, op de muur.
Jet hit hard, and simultaneously rather loud, against the wall.

- (ii) Jet plaatste het kopje voorzichtig, en tegelijk vrij stil, op de tafel.
 Jet placed the cup carefully, and simultaneously rather quietly, on the table.

Procedure

The experiment was conducted in a Latin Square design, i.e. it consisted of two lists, with no stimulus sentence being on the same list as its corresponding control sentence (that means that since participants were always tested with only one of the lists, no participant saw both a stimulus sentence and its corresponding control). Both lists contained 30 test items, 15 stimuli and 15 (non-corresponding) controls, plus all 60 fillers, making it 90 items in total per list. Both lists were automatically randomised for each participant. The sentences were presented with a moving window, i.e. upon the first button press by a participant, the first word appeared on the left side of the screen. Upon the next button press the first word disappeared and the second word appeared to the right of the position of the first word, and so on. Additionally, after the reading task, every sentence had to be rated on the same 4-point Likert scale as used in the piloting of the experimental items and the German questionnaire study. Apart from a control function (Did the contradiction fillers receive low ratings? Did the stimuli and controls receive high ratings?), we collected these ratings to see if the Dutch data are comparable to the German data I collected before.

After they rated each sentence, participants had to answer a control question about either agent or patient of the event, the activity described by the verb or the information in the prepositional phrase in the spill-over area (or, in the case of the non-contradictory fillers, information about the adverb/s), e.g. *Did Jet walk towards the supermarket?*. The control questions came up randomly with 25% of the sentences and could be answered with a *yes* or *no* button.

A total of 91 Dutch native speakers participated in the experiment and received 5 Euro as payment. The experiment took place in a sound-proof cabin and was run on real-time Linux computers with the programme ZEP. Each participant had a trial round of seven sentences to familiarise themselves with the manner of reading. Following the trial round they were given the chance to ask questions. The experiment proper consisted of 3 blocks of 30 sentences each, with a break after each block. The participants could determine themselves how long they wanted to pause, and then restart the experiment by pressing a button. After the experiment, participants were asked to fill out an exit questionnaire to collect information about their language background and any strategies they might have employed during the experiment.

3.3.4 Results and discussion

In this section, I will first explain how we prepared the data for analysis, i.e. which participants and items had to be excluded. Following that, I will discuss the results of the reading time data and the rating data. Finally, I will discuss the implications of these results.

Preparing the data

Before analysing the data, some items, participants and observations needed to be excluded. Concerning the items, an oversight had resulted in one test item being included with four words in the spill-over area. The verb in question, *aandrukken* (\sim to press on), is a particle verb, meaning the particle *aan-* will appear towards the end of the sentence, e.g.: *Zij drukte het hout boos, en tegelijk vrij zacht, aan na het lijmen* (\sim She pressed angrily, and simultaneously rather lightly, on the wood after gluing it). This item can therefore not be compared to the other items. We also excluded one contradiction from the filler items: *Mark drukte de plinten zacht, en tegelijk vrij stevig, aan na het lijmen* (Mark pressed softly, and simultaneously rather strongly, on the boards after gluing them). This is because that item received a high percentage of ratings 4 - clearly good. Apparently the sentence was not perceived as contradictory. We excluded this item, because the contradiction fillers were one means of checking participants' attention. We therefore needed to be sure that the contradictions really were understood as contradictions.

Concerning participants, the two means for excluding inattentive participants and participants who were over-thinking the test sentences were the control questions and, as already mentioned, the contradictory filler items. We decided on a cut-off of less than 70% of correctly answered control questions, i.e. participants who gave a wrong answer for a control question in more than 30% of the cases were excluded from the analysis due to being inattentive. Nine participants were excluded because of this. For the contradictions, we developed a scoring system, where the rating by a participant is translated into points (rating 1 equals 1 point, etc.). We decided to make 30 points the cut-off point, allowing participants to give high ratings for three to four contradictions due to the length of the experiment. Any participant with a higher score is excluded from the analysis, due to either being inattentive or over-thinking the sentences until they are acceptable. Another nine participants were excluded because of this measure. Additionally, one participant said she had dyslexia and was therefore also excluded, leaving a total of 72 participants.

As a rule, any kind of reaction time data is skewed, i.e. not normally distributed. After all, it is not possible to react faster than zero milliseconds. But one can in principle take as long as one likes over a certain task. There will therefore almost always be more outliers on one side of the curve. This is a problem for inferential statistics assuming a normal distribution (such as the linear mixed effects models which we used for the analysis). One way around

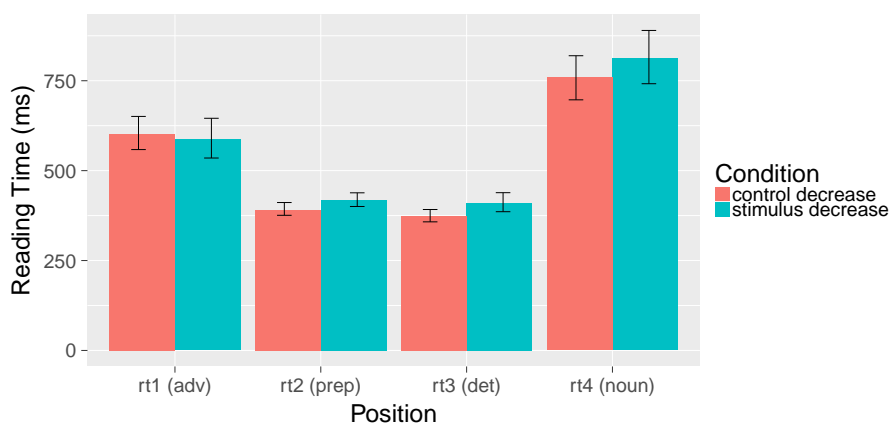


Figure 3.1: Mean reading times and 95% confidence intervals for the last four words of the force decrease test items.

this problem is to log-transform the data, which results in a normal distribution. We additionally cut off all observations smaller than 100 ms, because that is the minimal time required for motor activation (Whelan, 2008), and some far outliers on the other side of the curve.

Reading time data

The overview of the mean reading times and 95% confidence intervals¹⁵ for the last four words (critical adverb plus spill-over area) of the force decrease stimulus and control sentences can be found in Figure 3.1.

As expected, the items from the stimulus condition are read slower than the items from the control condition in most cases. On the critical adverb, which cancels the implicature in the stimulus condition, the stimulus items were read faster instead of slower than the controls.

The overview of the mean reading times and 95% confidence intervals (again, not assuming normality) for the last four words of the force increase stimulus and control sentences can be found in Figure 3.2. In the case of the force increase items, the expectation is confirmed in all instances: the items from the stimulus condition are read slower than the items from the control condition in all four positions, the critical adverb and all three words of the spill-over area.

In order to test whether the observed trend is significant, we conducted a linear mixed effects model in R on the log-transformed data (Bates et al., 2015). The model contained one fixed effect, condition, which included both

¹⁵Before the data were log-transformed, i.e. confidence intervals not assuming normality.

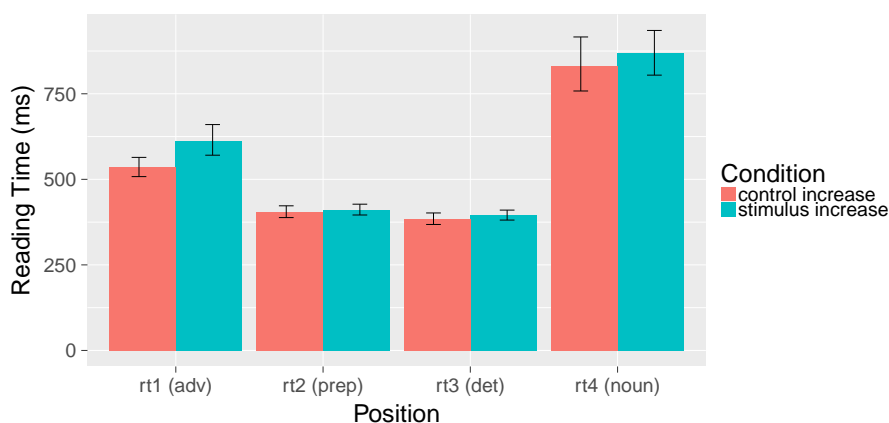


Figure 3.2: Mean reading times and 95% confidence intervals for the last four words of the force increase test items.

force decrease and force increase test items (both stimuli and controls).¹⁶ The random effects were participants and items. An overview of the results can be found in Table 3.6. The table shows the estimates (b-value), t-values and the degrees of freedom (in parentheses) and the p-values, marked * for $<.05$ and ** for $<.01$.

As stated above, it can be seen in Figure 3.1 that stimulus sentences containing an adverb that cancels a force decrease implicature (e.g. *Jet sloeg Jan speels, en tegelijk vrij hard, op zijn arm* (Jet hit Jan playfully, and simultaneously rather hard, on his arm)) are read slower than their corresponding controls on all words in the spill-over area. Table 3.6 shows that this is significant only on the first word of the spill-over area (e.g. *op* (on)), cf. the p-value of .012 (assuming significance at $p = .05$).

Again, as is visible in Figure 3.1, the trend (slower reading times in stimulus condition) is reversed for the critical adverb, the one that in the stimulus condition cancels the implicature, e.g. (*hard* (hard)): the stimuli were read faster than the controls on this adverb. But Table 3.6 shows that this observation is not significant, cf. the p-value of .12 (assuming significance at $p = .05$). Given that the difference is not significant, this should not be interpreted as counter-evidence.

For the stimulus sentences containing a force increase implicature cancelling adverb (e.g. *Jet sloeg Jan boos, en tegelijk vrij zacht, op zijn arm* (Jet hit Jan angrily, and simultaneously rather lightly, on his arm)), Table 3.6 shows

¹⁶Condition, the only main effect, does not explain a lot of the observed variance. In fact, only on the second word of the spill-over area does condition contribute significantly. However, the current concern is not what best explains the observed variance, but whether there is a significant difference between the conditions.

position	force decrease	force increase
rt1 (adverb)	b = -0.05 t(56) = -1.580 p = .12	b = 0.07 t(56.19) = 2.923 p = .005**
rt2 (preposition)	b = 0.06 t(57.44) = 2.601 p = .012*	b = 0.04 t(57.65) = 1.195 p = .24
rt3 (determiner)	b = 0.04 t(55.82) = 1.771 p = .082	b = 0.05 t(56.04) = 2.967 p = .004**
rt4 (noun)	b = 3.415e-02 t(5.640e+01) = 0.765 p = .45	b = 0.11 t(56.59) = 2.885 p = .005**

Table 3.6: The results of the linear mixed effects model. Comparing control condition items to stimulus condition items for both force decrease adverbs and force increase adverbs. Listed are the estimates (b-value), t-values and the degrees of freedom (in parentheses) and the p-values (marked * for $<.05$ and ** for $<.01$).

that they are read significantly slower than their corresponding controls in all instances, cf. the p-values of .005, .004 and .005 for the critical adverb (e.g. *zacht* (lightly)), and second and third words of the spill-over area (e.g. *zijn* (his) and *arm* (arm)) respectively. The only exception to this is the first word of the spill-over area (e.g. *op* (on)), cf. the p-value of .24. But even for that word, the trend as visible in Figure 3.2 confirms the predictions.

In order to make sure that these observed differences between stimulus and control items are indeed due to the cancellation of the force implicature, i.e. the second adverb, we also did a linear mixed effects analysis of the four words preceding the second adverb, cf. the agent-oriented adverb that triggers the implicature, plus *en tegelijk vrij* (and simultaneously rather). There was no significant difference in the mean reading times between stimulus and control items for these four words, which provides evidence that the observed reading time delay is indeed due to the cancellation of the implicature.

Rating data

An overview of the combined percentages of ratings 3 (maybe good) and 4 (clearly good) from the rating task can be found in Table 3.7.

The results from the rating task mostly confirm the predictions. The force decrease and force increase control sentences receive high ratings, 88.5% and 92.2% of ratings 3 and 4 respectively. The same holds for the force decrease stimulus sentences, which received 78.5% of ratings 3 and 4. This gives further credence to the reading time data: In the force decrease condition, both stimuli

condition	example sentence fragment	%
stimuli decrease	speels, en tegelijk vrij hard (playfully, and simultaneously rather hard)	78.5%
controls decrease	boos, en tegelijk vrij hard (angrily, and simultaneously rather hard)	88.5%
stimuli increase	boos, en tegelijk vrij zacht (angrily, and simultaneously rather lightly)	48.4%
controls increase	speels, en tegelijk vrij zacht (playfully, and simultaneously rather lightly)	92.2%

Table 3.7: Combined percentages of ratings 3 (maybe good) and 4 (clearly good) for test sentences (all conditions) from the experiment (observed, not estimated).

and controls are judged felicitous; the observed delay in reading times can therefore plausibly be attributed to the cancellation of the implicature in the stimulus items.

The ratings for force increase stimuli, on the other hand, are surprising. They should have been comparable to those of the force decrease stimuli, yet they receive less than 50% ratings of 3 and 4. Participants seemed to have trouble accepting the predicted felicity of these sentences. In this respect, the experimental rating data differ from the German questionnaire data (the Force Implicature Hypothesis). The German data also exhibit some difference between sentences containing the cancellation of a force decrease implicature and sentences containing the cancellation of a force increase implicature: 86.15% and 65.75% of ratings 3 and 4 respectively. But both types of sentences were judged felicitous by the majority of the participants.

A general linear mixed effects model in R (fixed effect and random effects the same as for the reading time data analysis) shows that this difference in the Dutch data is statistically significant: The odds of giving ratings 3 (maybe good) or 4 (clearly good) over ratings 1 (clearly bad) or 2 (maybe bad) for sentences from the force decrease stimulus condition are 5.5 times the odds of giving ratings 3 or 4 over ratings 1 or 2 for sentences from the force increase stimulus condition ($p < .001$, $SE = 0.30670$), i.e. clearly better.

Discussion

To conclude, the evidence from the reading time experiment is three-fold. The reading time data show that the cancellation of force implicatures is costly and that the increased processing cost is detectable with online measurement tasks. The reading time data thus provide evidence that upon processing agent-oriented adverbs modifying verbs with a force component, default implicatures about the force magnitude arise “before full sentence meaning is computed” (Levinson 2000: 370).

This observation is in part confirmed by the rating data. Of the two types of force implicatures, the rating data firmly confirm the force decrease implicatures. Sentences in which this implicature is cancelled are consistently judged as felicitous. This is in accordance with the data from the German questionnaire study, specifically those that test the Force Implicature Hypothesis.

However, sentences that contain an adverb which should trigger a cancellable implicature of a greater magnitude of the force component of the verb, i.e. force increase sentences, do not receive such clear ratings. On the contrary, they are judged as significantly less felicitous than force decrease sentences: 78.5% ratings 3 (maybe good) and 4 (clearly good) for force decrease sentences versus 48.4% of ratings 3 and 4 for force increase sentences. With less than 50% of ratings 3 and 4, it seems fair to say that force increase sentences are not felicitous.

Since infelicitous sentences might also result in an online processing delay, I will take the combined evidence from the reading time data and the rating data as an indication that something else might be going on with those sentences I previously called force increase sentences. It is possible that prototypicality effects concerning the magnitude of the force component of the verb come into play here. The results from the German questionnaire study, specifically the Verb Force Hypothesis, suggest that if verbs of contact by impact are used with animate agents in subject position (as opposed to inanimate themes), people expect a high force magnitude (cf. the high ratings for *She hit him, but lightly*). In order to cancel the implicature that I thought was triggered by agent-oriented adverbs such as *angrily*, we used a construction that ended on *lightly*. This means that the force increase sentences described somewhat ‘atypical’ events. This might be what causes the mixed ratings for these items, as well as the larger reading time delays in the force increase condition reported in Table 3.6 (and this might also be what causes the difference in ratings between force decrease implicature cancelling sentences and force increase implicature cancelling sentences in the German questionnaire data, cf. Section 3.2).

All things taken together, I have ample evidence that agent-oriented adverbs trigger force implicatures when combined with verbs of contact by impact and other verbs with a force component. The evidence is clear for adverbs such as *playfully*, which trigger a force decrease implicature. Both the German questionnaire data and the Dutch experimental data provide evidence for force decrease implicatures. The evidence is more mixed for adverbs such as *angrily*, which trigger a force increase implicature. Even though a reading time delay is observable, the experimental rating data suggest that participants did not judge these items as felicitous. This might be due to effects of prototypicality, which could also have influenced the observed reading times.

3.4 Summary and conclusion

To conclude, in this chapter I have explored further the nature of the inferences that I observed in Chapter 2. Agent-oriented adverbs such as *playfully* or *angrily* trigger a force inference when combined with verbs of contact by impact such as *hit*: *playfully* implies a low force magnitude, *angrily* implies a high force magnitude.

In Section 3.1, I have shown that such inferences can be classified as I-implicatures in the sense of Levinson (2000) (or R-implicatures in the sense of Horn (1984, 2004)). I-implicatures are based on the heuristics “What is expressed simply is stereotypically exemplified” (Levinson 2000: 37) and they should be defeasible (Levinson 2000: 42).

This ability to be defeasible (or cancelled) can be tested by making use of the denial-of-expectation construction, going back to Lakoff (1971). The contrastive conjunction *but* implies a causal connection between the two parts of the conjunction, such that the first part means or implies the negation of the second part. By means of this construction, the low-force implicature of *playfully* can be demonstrated in a sentence such as that in (40) (repeated from (1) above), the example that I found in the British National Corpus.

(40) Steve hit his brother playfully but rather hard on the shoulder.

Playfully, the first part of the conjunction, implies the negation of the second part of the conjunction (*hard*). *Playfully* thus implies *not hard*, i.e. *lightly*. Yet this implicature can be cancelled, as can also be observed in the sentence in (40): *playfully* implies *lightly*, yet it is compatible with *hard*. The *lightly*-meaning aspect is thus cancelled in (40).

By employing the denial-of-expectation construction in a questionnaire study (cf. Section 3.2), I was able to show that German agent-oriented adverbs systematically trigger a force implicature when combined with the German verb of contact by impact *schlagen* (~ to hit). Apart from recording force implicatures in German, the results from the questionnaire study also show that when verbs of contact by impact are combined with an animate agent in subject position, the default interpretation is one of a high force magnitude: \surd *She hit him, but lightly*. Such a default interpretation doesn't seem to arise when verbs of contact are combined with inanimate themes in subject position. The questionnaire study further confirmed the classification of the adverbs as agent-oriented (cf. the classification tests developed by Schäfer (2005), discussed in Chapter 2), i.e. as providing information about the agent of an event. When these adverbs appear in sentences with an inanimate theme as subject, the sentences are judged to be semantically unacceptable.

Following Levinson (2000), the computing of force implicatures should happen by default, but the cancellation should be costly, i.e. require additional processing time measurable during online tasks. I was able to show in a self-paced reading experiment conducted in Dutch that the cancellation of force implica-

tures does indeed seem to require extra processing time: stimulus sentences in which the force implicature was cancelled were read significantly slower than control sentences where the implicature was not cancelled.

In the next chapter, I will sketch a theory of adverbial modification that takes into account modification through force implicatures. The force implicatures discussed in this chapter are not triggered by a single word (cf. the above discussion that neither an adverb like *playfully* nor a verb like *hit* mean ‘low force’ in isolation), but rather arise due to a specific combination of words, i.e. they are compositional. As such, they should be integrated into a compositional theory.

CHAPTER 4

Building force-implicatures into Event Semantics

This chapter builds on the previous one, where I observed that agent-oriented adverbs trigger an I-implicature in the sense of Levinson (2000) (or R-implicature in the sense of Horn (1984, 2004)) on the force component of verbs of contact by impact. Agent-oriented adverbs like *playfully* trigger a force decrease implicature when modifying verbs of contact by impact, as illustrated in (1).

(1) Joan hit Mary playfully, but still rather hard, on her arm.

In (1), the verb-adverb combination *hit playfully* results in the force decrease implicature. This implicature is then cancelled by the adverb *hard* in the denial-of-expectation construction with the conjunction *but*: The adverb *hard* denies the expectation of a low force magnitude.

Crucially, the force decrease implicature is an effect of composition. If the adverb is combined with another verb, e.g. *suggest*, no force decrease implicature arises. And the verb itself also does not give rise to a force decrease meaning (on the contrary, as the questionnaire results presented in Chapter 3 have shown, the bare, unmodified verb gets a force increase reading).

It is thus particular combinations of verbs with adverbs that result in force decrease implicatures. As it is an effect of composition, the implicature should be modelled in a compositional theory of verb-adverb modification. The most common framework for verb and adverb analysis these days is Event Semantics.

In this chapter, I will therefore show how sentences with agent-oriented adverbs and verbs of contact by impact can be modelled in Event Semantics. This chapter then concludes the part of this dissertation where I address the force implicatures triggered by agent-oriented adverbs. In Chapters 5 and 6,

I will provide a more in-depths study of verb semantics. Chapter 5 contains the results of a corpus and questionnaire study, on which Chapter 6 builds by providing a detailed analysis of force verbs in Event Semantics. The analysis provided in Chapter 6 will refine the analysis provided in the current chapter in several respects. In the following, I will indicate the parts of the analysis that will be refined later.

The chapter is structured as follows: First, in Section 4.1, I will present a general introduction to the study of adverbs and adverbials and the framework of (Neo-Davidsonian) Event Semantics. Section 4.2 then contains a first analysis of agent-oriented adverbs, including the implicature they trigger in combination with verbs of contact by impact. Section 4.3 summarises and concludes.

4.1 Theories about adverbs

In this section, I will briefly explain one of the most common theoretical frameworks for analysing adverbs and adverbials: (Neo-)Davidsonian Event Semantics, which I use for the analysis in Section 4.2. I will also briefly address the argument approach, since it contains some insights I will make use in the analysis.

4.1.1 Event Semantics

Event Semantics is the standard analysis of (action) sentences nowadays (e.g. Parsons 1990; Maienborn & Schäfer 2011). The underlying principle, going back to Davidson 1967, is that both verbs and adverbs are analysed as predicates over an underlying event variable, commonly spelled out as *e*. The event-based approach is extensional, i.e. it makes use of sets of events, about which verbs and adverbs provide more information. To illustrate: in an Event Semantic framework, the sentence in (2-a) receives the analysis in (2-b).

- (2) a. Mary sang loudly in the shower.
 b. $\exists e [\text{sing}(e) \wedge \text{AGENT}(e, \text{mary}) \wedge \text{loudly}(e) \wedge \text{in}(e, \text{the shower})]$

The formula in (2-b) states that there is an event of singing, of which the agent is Mary and which is done loudly and in the bathroom.¹

The event-based approach does not assume scopal hierarchies between adverbials, which are separated by the conjunctive \wedge (in fact, in the above notation, all elements of the sentence are freely coordinated). This free coordination makes Event Semantics a very flexible tool, which can account for the classical features of manner modification, namely that they lack scope and apply intersectively (e.g. Maienborn & Schäfer 2011; Katz 2007).

¹Please note that this notation is the so-called Neo-Davidsonian approach, which goes back to Parsons (1990), who explicitly builds in thematic relations such as agent and treats verbs as one-place predicates over events. Davidson's original notation would be: $\exists e [\text{sing}(\text{mary}, e) \wedge \text{loudly}(e) \wedge \text{in}(e, \text{the bathroom})]$.

4.1.2 The argument approach

The argument approach goes back to McConnell-Ginet 1982. She argues that adverbs (Ad-Verbs in her terminology) should generally be treated as arguments of the verb. This is in part motivated by the observation that some verbs such as *behave* seem to subcategorise for certain adverbials (e.g. *rudely*), cf. (3) taken from McConnell-Ginet 1982: 164.

(3) Joan behaved *(rudely) to Mary.

Based on the evidence in (3), the analysis that the verb *behave* obligatorily subcategorises for an adverb seems convincing. However, McConnell-Ginet extends this analysis to other verbs as well, such as *run* in (4).

(4) Mary runs quickly.

In these cases, the adverb is said to ‘augment’ the verb, i.e. open up an additional argument slot. In a nutshell: verbs have a potential to be further specified with respect to certain meaning components. In the case of *run*, the verb could be further specified with respect to speed. What an (admissible) adverb like *quickly* then does is to activate this potential, i.e. open up an additional argument slot for speed, and then fill it (for the technical details see McConnell-Ginet 1982: 169/170).

This will become important in the next section, where I develop the lexical entry for the verb *hit*.

4.2 An extended Neo-Davidsonian Event Semantics

As explained above, the force decrease implicatures that agent-oriented adverbs trigger when modifying verbs of contact by impact are compositional in nature, i.e. they are the result of the combination of two specific words and do not arise if either of these words is used in isolation. Given this compositional nature of the force decrease implicatures, I will integrate them into a Neo-Davidsonian Event Semantics of verb-adverb modification. Since the implicatures are *force* implicatures, I will need to explicitly model the force component of verbs of contact by impact.

This section is structured as follows: I will first motivate and present the lexical entries for some of the verbs and adverbs discussed in the previous chapters. I take the semantics developed in this section to generally hold for verbs of contact by impact, agent-oriented adverbs and pure manner adverbs relating to force, small adjustments notwithstanding. In 4.2.3, I will then show how these lexical entries come together compositionally, giving an account of the unmodified use of *hit*, the ‘simple’ modification case, i.e. modification by pure manner adverbs as in *hit lightly*, and the case of modification through

an agent-oriented adverb. Finally, I will provide an analysis of the semantic representation of the implicature triggered by agent-oriented adverbs when they are combined with verbs of contact by impact as in *hit playfully*.

4.2.1 The lexical entries for verbs

As an example for verbs of contact by impact, I will give an illustration of the verb *hit*, which I used in the corpus and questionnaire studies in Chapters 2 and 3. I assume *hit* to be a central example of verbs of contact by impact, because Levin (1993) classified a separate (sub)class of hit-verbs.

Most of the evidence from the studies reported in Chapters 2 and 3 concerns languages other than English. But given the close relation between Dutch, German and English, I take the following analysis to apply to all those languages.

The first component that a lexical entry for *hit* needs is a force component. That *hit* does indeed have a force component has been shown numerous times above, not least through the possibility to modify *hit* by the adverbs *lightly* and *hard*. This idea of having meaning components such as force built into the lexical entry of verbs is also not uncommon in the literature. As mentioned in Section 4.1.2 above, McConnell-Ginet (1982) assumes that some verbs have a potential to be further specified with respect to certain meaning components. McConnell-Ginet gives as an example the verb *run*, which according to her has a latent potential to be further specified with respect to speed. I will therefore assume that the lexical entry for verbs of contact by impact such as *hit* includes a force component (among possible other components). The lexical entry for *hit* is given in (5).

$$(5) \quad \text{hit} = \lambda y. \lambda x. \lambda e. \exists f [\text{hit}(e) \wedge \text{AGENT}(e, x) \wedge \text{PATIENT}(e, y) \wedge \text{FORCE}(e) = f]$$

A couple of things need to be said about this lexical entry. Firstly, this lexical entry does of course not cover all instances of *hit*. It is specified for an agent and a patient, and therefore excludes the examples with an inanimate theme in subject position and a PP-target, which I used to test the Verb Force Hypothesis and the Agentivity Hypothesis in the German questionnaire study presented in Chapter 3. I restrict the lexical entry in this way, because the purpose here is to model the force implicatures triggered by agent-oriented adverbs when they modify verbs of contact by impact. Recall that agent-oriented adverbs require an animate agent as subject (cf. the results from the Agentivity Hypothesis in the German questionnaire study). Therefore, the following analysis pertains only in the case of *hit* being used with an animate agent as subject.

Secondly, FORCE is a function from events to forces, assigning a unique force to the event, the force that the agent exerts upon the patient (this notion of the force component will be refined in Chapter 6). Note that while the event is specified for a unique force, the magnitude of that force remains unspecified. As discussed in Chapter 3, cf. the results from the Verb Force Hypothesis in the German questionnaire study, the typical hitting event is associated with a high

amount of force. However, just as with the force implicatures triggered by agent-oriented adverbs, this high force reading can be cancelled. A sentence such as *She hit him, but lightly*, with *lightly* in the denial-of-expectation construction, is felicitous. This means that *lightly* is used to deny the expectation of high force. If the high force magnitude of *hit* can be denied or cancelled, it cannot be part of the lexical semantics of this verb. Rather, it is inferred due to expectations about typical hitting events.

4.2.2 The lexical entries for adverbs

In the following, I will present the lexical entries for pure manner adverbs such as *lightly*, which are lexically specified for force, and the lexical entries for agent-oriented adverbs. I will also mention some general points about events and manners.

The lexical entries for pure manner adverbs

As examples of pure manner adverbs I choose the adverbs *lightly* and *hard*. Both *lightly* and *hard* are highly polysemous, they can, for instance, refer to a little force or a lot of force respectively, or simply mean *a little* and *a lot* as in *She buttered the toast lightly* or *They worked hard* (cf. the discussion in Chapter 2). This makes their precise lexical semantics difficult to define. I do not want to make any claim here as to how their polysemy is best treated. Instead I present lexical entries that contain meaning components related to force, which are unarguably part of the lexical semantics of these words (cf. the results of the corpus studies presented in Chapter 2), while leaving open the possibility of extending the entries.

There is some debate in the literature (see Dik 1975; Piñón 2007, 2008; Maienborn & Schäfer 2011; Schäfer 2013) about the modification target of adverbs such as *lightly* and *loudly*. Some argue that manner adverbs in general should be treated as predicates over manners, rather than events, and that their specific manner is linked to the event via a manner-function (e.g. Piñón 2007). Schäfer (2005, 2013) proposes that German adverbial adjectives are predicates over events only when they appear in a high position in the sentence (his event-related adverbials), and predicates over manners in low positions in the sentence, his verb-related adverbials (see also the discussion of Schäfer's theory in Chapter 2). Others say that the relative awkwardness of the *in an X manner* paraphrase for adverbs such as *quickly*, cf. *?in a quick manner* (see also the discussion on Schäfer's second manner test in Chapter 2) means that these adverbs modify other entities in the ontology, such as e.g. speed in the case of *quickly*, which are to be treated separately from manner (e.g. Dik 1975). Following this line, I treat *lightly* and *hard* as modifying force.

I have argued at length in Chapter 2 that *lightly* and *hard* modify the force component of verbs of contact by impact, specifically that *lightly* means *a low force magnitude* and *hard* means *a high force magnitude*. Implementing that

into an Event Semantic framework would mean treating *lightly* and *hard* as predicates over forces. If they are built into the composition like this to modify verbs, this would result in a type clash, since verbs are predicates over events. In order to avoid that type clash, a type shift needs to be introduced to shift the adverbs from predicates over forces to predicates over events.

However, to simplify things here a bit, I will present the lexical entries for *lightly* and *hard* as though the type shift has *already* been applied, i.e. I treat them as predicates over events. The type shift as well as a refinement of the notion of force as force paths are discussed in detail in Chapter 6. The lexical entries are given in (6) and (7).

$$(6) \quad \text{lightly} = \lambda e [\text{MAGNITUDE}(\text{FORCE}(e)) < \text{average}_C]$$

$$(7) \quad \text{hard} = \lambda e [\text{MAGNITUDE}(\text{FORCE}(e)) > \text{average}_C]$$

The shifted lexical entries in (6) and (7) specify *lightly* and *hard* as predicates over events with a force component: if an event has no force component, $\text{MAGNITUDE}(\text{FORCE}(e))$ does not give a result. In the case of *lightly*, the magnitude of the force is lower than some average for comparison: $< \text{average}_C$. In the case of *hard*, the magnitude of the force is higher than some average for comparison: $> \text{average}_C$.

The lexical entries for agent-oriented adverbs

As examples for agent-oriented adverbs I choose *playfully* and *friendly*. *Friendly* does not seem to co-occur with the English verbs *hit*, *slap* or *punch* very often, since I did not find these constructions in the BNC. Its German counterpart *freundlich*, however, appears quite easily with the German verb *schlagen* (\sim to hit) (although it sounds more natural if it is followed by a prepositional phrase such as *auf die Schulter* (on the shoulder)).

I treat the agent-oriented adverbs as predicates over events. The evidence from the German questionnaire study, specifically the Agentivity Hypothesis (cf. Chapter 3), is that agent-oriented adverbs such as *playfully* and *friendly* can only felicitously be used to modify a verb of contact by impact if the subject of the sentence is an animate agent. To express this obligatory presence of an agent, I include a function $\text{AGENT}(e)$ in the lexical entries for *playfully* and *friendly*, cf. (8) and (9).

$$(8) \quad \text{playfully} = \lambda e [\text{playful}(\text{AGENT}(e))]$$

$$(9) \quad \text{friendly} = \lambda e [\text{friendly}(\text{AGENT}(e))]$$

The lexical entries for *playfully* and *friendly* in (8) and (9) respectively now state that the agent of e is being playful/friendly. That is, the lexical entries correctly express that these agent-oriented adverbs modify the behaviour of the agent of the event. As such, they are crucially different from pure manner adverbs such as *lightly* and *hard*, which modify a meaning component of the event itself (force in the case of *lightly* and *hard*).

4.2.3 Compositional analysis

In this section, I am first going to present the compositional analysis of sentences involving *hit* in its bare use, i.e. without any modification. Following that, I will show how the composition works for pure manner adverbs modifying verbs of contact by impact, and then for agent-oriented adverbs modifying verbs of contact by impact.

“Hit” in its bare use

As explained above, a sentence as in (10) will usually be understood as involving a high force magnitude. However, this high force magnitude is inferred, and not given in the lexical semantics of *hit*. The final step in the derivation given in (11) is therefore underspecified with respect to the precise magnitude of the force. Please note that for the step in (11-c), I assume a process for existentially closing the event.

(10) Mary hit Joan.

- (11) a. $\text{hit} = \lambda y. \lambda x. \lambda e. \exists f [\text{hit}(e) \wedge \text{AGENT}(e, x) \wedge \text{PATIENT}(e, y) \wedge \text{FORCE}(e) = f]$
 b. $\text{hit Joan} = \lambda x. \lambda e. \exists f [\text{hit}(e) \wedge \text{AGENT}(e, x) \wedge \text{PATIENT}(e, \text{joan}) \wedge \text{FORCE}(e) = f]$
 c. $\text{Mary hit Joan} = \exists e. \exists f [\text{hit}(e) \wedge \text{AGENT}(e, \text{mary}) \wedge \text{PATIENT}(e, \text{joan}) \wedge \text{FORCE}(e) = f]$

Pure manner adverbs modifying verbs of contact by impact

Consider the sentence in (12), which contains the pure manner adverb *lightly* modifying *hit* (the derivation works similarly for sentences containing *hard* modifying *hit*). Given the lexical entries above, the sentence can be computed through the derivational steps in (13). The derivation is simplified in two respects. Firstly, as explained above, the lexical entry for *lightly* needs to be shifted from a force modifier to an event modifier. This should be a step of the derivation, but since I do not illustrate the type shift here and have instead given the *already* shifted entry in (6) above, I will not explicitly model the shift in (13) below. When I have refined the notion of force in Chapter 6, I will fully explain the type shift that applies to pure manner adverbs like *lightly*.

(12) Mary hit Joan lightly.

- (13) a. $\text{hit} = \lambda y. \lambda x. \lambda e. \exists f [\text{hit}(e) \wedge \text{AGENT}(e, x) \wedge \text{PATIENT}(e, y) \wedge \text{FORCE}(e) = f]$
 b. $\text{hit Joan} = \lambda x. \lambda e. \exists f [\text{hit}(e) \wedge \text{AGENT}(e, x) \wedge \text{PATIENT}(e, \text{joan}) \wedge \text{FORCE}(e) = f]$
 c. $\text{lightly} = \lambda e [\text{MAGNITUDE}(\text{FORCE}(e)) < \text{average}_C]$
 d. $\text{hit Joan lightly} = \lambda x. \lambda e. \exists f [\text{hit}(e) \wedge \text{AGENT}(e, x) \wedge \text{PATIENT}(e, \text{joan}) \wedge \text{FORCE}(e) = f \wedge \text{MAGNITUDE}(\text{FORCE}(e)) < \text{average}_C]$

- e. Mary hit Joan lightly = $\exists e.\exists f$ [$\text{hit}(e) \wedge \text{AGENT}(e, \text{mary}) \wedge \text{PATIENT}(e, \text{joan}) \wedge \text{FORCE}(e)=f \wedge \text{MAGNITUDE}(\text{FORCE}(e)) < \text{average}_C$]

As said above (see the lexical entry in (5)), the verb *hit* comes equipped with a force component, yet without a specification of the force magnitude. In the case of *hit* being modified by *lightly*, the force magnitude is contributed by the adverb *lightly*. *Lightly* applies to the VP *hit Joan* in the step in (13-d), which is derived through combining the lambda terms (e.g. through some version of predicate modification, Heim & Kratzer 1998) in (13-b) and (13-c).

Agent-oriented adverbs modifying verbs of contact by impact

In the case of agent-oriented adverbs such as *playfully* and *friendly* modifying *hit*, cf. the sentence in (14) with *playfully*, the composition is similar to that of sentences containing a pure manner adverb as in (12). This is illustrated in (15). Please note that I have chosen to apply the adverb *playfully* to the VP, too (just like *lightly*. This corresponds to the use of *playfully* as an agent-oriented manner adverb in a low position in the sentence, as illustrated in (14). If *playfully* is used as a mental-attitude adverb in a high position of the sentence, it applies to the proposition as a whole, i.e. after the arguments of the verb have been saturated.

(14) Mary hit Joan playfully.

- (15) a. $\text{hit} = \lambda y.\lambda x.\lambda e.\exists f$ [$\text{hit}(e) \wedge \text{AGENT}(e, x) \wedge \text{PATIENT}(e, y) \wedge \text{FORCE}(e) = f$]
 b. $\text{hit Joan} = \lambda x.\lambda e.\exists f$ [$\text{hit}(e) \wedge \text{AGENT}(e, x) \wedge \text{PATIENT}(e, \text{joan}) \wedge \text{FORCE}(e)=f$]
 c. $\text{playfully} = \lambda e$ [$\text{playful}(\text{AGENT}(e))$]
 d. $\text{hit Joan playfully} = \lambda x.\lambda e.\exists f$ [$\text{hit}(e) \wedge \text{AGENT}(e, x) \wedge \text{PATIENT}(e, \text{joan}) \wedge \text{FORCE}(e)=f \wedge \text{playful}(\text{AGENT}(e))$]
 e. $\text{Mary hit Joan playfully} = \exists e.\exists f$ [$\text{hit}(e) \wedge \text{AGENT}(e, \text{mary}) \wedge \text{PATIENT}(e, \text{joan}) \wedge \text{FORCE}(e)=f \wedge \text{playful}(\text{MARY}(e))$]

The difference between (13) and (15) is that *playfully*, other than *lightly*, does not provide a (range of) values for the force magnitude of *hit*. The logical form in (15) is thus underspecified with respect to the force magnitude, just like the final derivational step in (11) above. Given the empirical evidence from the questionnaire study and self-paced reading experiment reported in Chapter 3, it is clear that the default magnitude for playful hitting events, as well as for friendly hitting events, is low. But this does not follow directly from the lexical semantics of the words involved. And it shouldn't, since the final specification of the force magnitude is due to an implicature, which is cancellable and can therefore not be located in the lexical semantics.

4.2.4 Computing the implicature

In order to compute the force implicatures that arise when agent-oriented adverbs are used to modify verbs of contact by impact (or when verbs of contact by impact are used without a modifier), I need a way to bring world-knowledge into the formalisation. After all, the force implicatures involve stereotypical enrichment (cf. Chapter 3), and that very much depends on the specific (cultural) context of an utterance. Formalising world-knowledge and other context effects is a notoriously difficult task. In many cases it is not attempted at all, or relegated to the infamous pragmatic wastebasket (Bar-Hillel, 1971).² Given that this dissertation is intended to contribute to the study of meaning and concepts, I find neither solution attractive and will try to make the source of the stereotypical enrichment more explicit.

In order to identify the world-knowledge that is responsible for the stereotypical enrichment in force implicatures, I will look at the contribution of each individual adverb in relation to the verb. Above, I chose *playfully* and *friendly* as examples for agent-oriented adverbs triggering a force decrease implicature. I will now take a closer look at each of them in the context of *hit* and see if I can pinpoint the source of the implicature.

The adverb *playfully* derives from the word *play*, much like its German counterpart *spielerisch* or Dutch *speels* (Goldschmidt et al. 2017: 31). While a play is an activity that takes place in the real world, it creates a fictional representation, and the relevance of activities done as part of a play lie mostly in this fictional world. In the case of *hit playfully*, one can thus speak of an intention to communicate a real, full-fledged hit as a fictional possibility only, as a joke, if you will (Goldschmidt et al. 2017: 31/32). This is where the agent-orientation of this adverb comes into play. It is in the case of the agent's intention (real or assumed) to communicate this fictional possibility that the adverb *playfully* can felicitously be used.

Since the full-fledged hit is communicated only as a fictional possibility, the full-fledged consequences should also be fictional. The real-world consequences of a full-fledged hit are, if done correctly, the infliction of pain and physical damage on the (animate) patient. But these are not be the real-world consequences of a playful hit (which communicates these full-fledged consequences as a fictional possibility only). Therefore, the level of pain and physical damage need to be adjusted for a playful hit. This can be done through adjusting the force of the hit. As Schäfer (2005) observes, for agent-oriented manner adverbs (one type of agent-oriented adverb that *playfully* is classified as, cf. Chapter 2), “the agent must be in control of the action described by the verbal predicate” (Schäfer 2005: 47/48). It is thus through assuming or observing that the agent is in control and intends the full-fledged hit as a fictional possibility only, that we infer that they adjust the force of the hit to a playful level and thereby lessen it.

A similar reasoning can be applied to account for why *friendly* triggers the

²Though see e.g. Maienborn 2003 or Kamp & Partee 1995 for good exceptions to this.

force decrease implicature with verbs of contact by impact. The word *friendly* is related to *friend* (again, this also holds for the Dutch and German counterparts, *vriendelijk* and *freundlich* respectively). A friend is a person with whom one has a close relationship based on mutual trust, not someone you (usually) want to hurt. A friendly hit is thus an interaction between friends, or people fulfilling the (maybe temporary) role of being friends. This is where the agent-orientation of *friendly* comes into the story. It is due to the agent identifying or pretending to identify as a friend towards the patient.³ As with *playfully*, this leads to certain assumptions about the consequences of the hit. By assuming or observing that the agent is in control of the event and hits someone as their friend, we infer that they do not want to inflict harm and adjust the force of the hit accordingly.

For both *playfully* and *friendly*, I identified the world-knowledge responsible for the stereotypical enrichment expressed in the force implicature. In both cases, the force implicatures thus rest on stereotypical representations of play or friendship respectively.

The above reasoning can be formalised as generalisations over playful and friendly events with a force component, as in (16) and (17).

$$(16) \quad \forall e. \forall f [\text{playful}(\text{AGENT}(e)) \wedge \text{FORCE}(e) = f \xrightarrow{\text{def}} \text{MAGNITUDE}(f) < \text{average}_C]$$

$$(17) \quad \forall e. \forall f [\text{friendly}(\text{AGENT}(e)) \wedge \text{FORCE}(e) = f \xrightarrow{\text{def}} \text{MAGNITUDE}(f) < \text{average}_C]$$

(16) and (17) state that for all events and all forces, if the agent of the event is playful or friendly and the event has a force component, then the magnitude of that force will be below a certain average for comparison. The $\xrightarrow{\text{def}}$ stands for a defeasible inference. These generalisations nicely capture the compositional nature of the force implicatures. It is the interaction between the playful part of the event, contributed by the adverb, and the force component, contributed by the verb, that results in the observed force decrease effect (conditional on there being an agent). (16) can now be applied to the final step in (15) to derive the inferred value for the force magnitude.

The force implicature that arises in the case of unmodified uses of *hit* can also be captured in a generalisation. Remember from Chapter 3 that *hit* is understood as having a high force magnitude if it is used with an animate agent. The reasoning behind this is similar to that of the reasoning behind *hit playfully*. If the verb *hit* is used without a modifier, it describes a full-fledged hit, including the full-fledged consequences (cf. also the discussion in Chapter 3 about a light hit being a marked social situation). This inference can be formalised as in (18) (the $\xrightarrow{\text{def}}$ again stands for a defeasible inference).

$$(18) \quad \forall x. \forall e. \forall f [\text{AGENT}(e, x) \wedge \text{FORCE}(e) = f \xrightarrow{\text{def}} \text{MAGNITUDE}(f) > \text{average}_C]$$

³This leads to the prediction that *friendly*, to be used felicitously, not only requires an animate agent, but also an animate patient (or at least a patient that the agent can be said to conceptualise as animate).

The generalisation in (18) states that for all individuals, all events and all forces, if the individual is the agent of the event and the event has a force component, the magnitude of the force component will be above a certain average for comparison. Please note that the generalisation is formulated as holding over all events with a force component. This will be refined in Chapter 6, where, based on the results of the corpus and questionnaire study presented in Chapter 5, some verbs with a force component will be analysed as lexically specified for a fixed (range of) values on the force magnitude.

4.3 Summary and conclusion

In this chapter, I have presented a possible analysis in the framework of Event Semantics of the force implicatures discussed at length in Chapter 3. I did this by formalising generalisations that capture the effects of the implicature. These generalisations are motivated by conceptual considerations. I have tried to capture the world-knowledge that underlies the stereotypical enrichment expressed in the force implicatures by reasoning about the concepts related to the adverbs, such as play or friendship, and laying a link between these concepts and assumptions about the agent's intention and behaviour during hitting events.

The semantics in this chapter is still somewhat preliminary, especially the notion of force as a meaning component of events, but this will be refined considerably in Chapter 6. Based on the corpus and questionnaire study presented in Chapter 5, which show a much more diverse picture of the force component, I will extend the lexical entries of the verbs and adverbs and make their relation to the force component more explicit. These findings will ultimately be modelled in the framework of Frame Semantics, which retains the insights developed here and in Chapter 6, but will allow me to make explicit the effects of conceptual knowledge in more detail (more on this in Chapter 7).

This chapter concludes the part about force implicatures triggered by agent-oriented adverbs when modifying verbs of contact by impact. In the next two chapters, I will build up an in-depth analysis of verb semantics, focusing especially on causation and force modification.

CHAPTER 5

The domain of force verbs¹

In Chapter 2, I have presented results from a corpus study, where I searched for adverbs co-occurring with verbs of contact by impact in English (*slap*, *punch* and *hit*) and German (*schlagen* (~ to hit)). Based on the high co-occurrence frequencies of the adverbs *lightly/leicht* and *hard/hart*, part of whose meaning is *with little force* and *with a lot of force* respectively,² I concluded that verbs of contact by impact have a force component. Verbs of contact by impact are one class of verbs listed in Levin 1993, but there are other verb classes listed by Levin that can be said to have a force component, e.g. verbs of exerting force. It thus seems that there is not one class that contains verbs that have a force component, but that these verbs can be sorted into at least two classes on the basis of Levin 1993.

The question arises how to systematically find and classify verbs with a force component. I have previously used Levin's work as a rough indication, but her classifications are not motivated by the question of the existence of a force component. In this chapter, I will therefore present the results from another corpus study, this time searching for verbs co-occurring with the adverbs *lightly* and *hard*, cf. Section 5.1. The same rationale as in Chapter 2 applies: if a verb can be modified by the adverbs *lightly* and *hard*, it can be said to have a force component. Based on the results of the corpus study, in Section 5.2, I will formulate a working definition for what I will call force verbs and illustrate some of their lexical and compositional properties that will be important in the next chapter. Finally, in Section 5.3 I report on a questionnaire study

¹The results from the questionnaire study presented in this chapter have already been published in Goldschmidt & Zwarts 2016.

²For more information on these adverbs, see the discussion in Chapter 2.

about two issues that have not been satisfactorily answered by the corpus study: the interaction of force modification and force results as well as force magnitude restrictions and their interaction with the adverbs *lightly* and *hard* during modification.

5.1 Finding verbs with a force component - a corpus study

In terms of verb classes, Levin's (1993) book is generally regarded as the standard work for English. In Chapter 2, I have used this work as a starting point for exploring the force component in verbs, taking examples from the class of verbs of contact by impact for further study. By translating these examples to German and Dutch, I was able to study verb-adverb modification and the role of the force component in those languages. But I have not systematically studied verbs for whether they have a force component and how that is manifested. In Chapters 2 to 4, I have primarily used the verb *schlagen/hit*.

In order to extend my analysis to other verbs, I therefore conducted another corpus study. In this corpus study, I limit myself to German. This I do for two reasons: Firstly, for judging the corpus examples I will be able to rely on my own intuition. And secondly, German verbs exhibit interesting interactions with particles and argument structure, as noted by a.o. McIntyre (2007); Roßdeutscher & Pross (2015). I believe, however, that similar classes of verbs exist in English and Dutch, though their properties may be slightly different. To find verbs comparable to *schlagen*, i.e. verbs that also have a force component, I took the adverbs *leicht* (lightly) and *hart* (hard) as a starting point. In Chapter 2, I have presented evidence that these adverbs modify the force component of verbs (see the discussion of the corpus study presented in Chapter 2). The idea is that verbs co-occurring with either of these adverbs must have a force component. Otherwise *leicht* and *hart* could not be used to modify them. For example, the felicity of the phrase *leicht schlagen* (hit lightly) suggests that a) *schlagen* has a force component and b) this force component is open for modification in the direction of less force, cf. the meaning of *leicht* as *with little force*.³

In the following, I will introduce the corpus (5.1.1), present the results (5.1.2) and draw some conclusions (5.1.3).

5.1.1 The corpus

As for the corpus study presented in Chapter 2, I searched the Digitales Wörterbuch der Deutschen Sprache (digital dictionary of the German language, DWDS).

³In the next section, I will provide some remarks on how I deal with the polysemy of *leicht* and *hart*.

I searched for finite and infinite verbs in the vicinity of the adverbs *leicht* (lightly) and *hart* (hard). I was able to define the distance between an adverb and a verb at a maximum of five words away on either side of the adverb, thus making sure to include examples like *Sie schlägt ihn auf den Arm, hart* (She hits him on the arm, hard).

I manually looked through all examples I found to verify that they are indeed examples of *leicht* and *hart* modifying the verb in question. In order to make sure that I only include examples with the intended force-reading of *leicht* and *hart*, I needed to rely on my intuition to sort out other examples. As already explained in Chapter 4, the adverbs *leicht/lightly* and *hart/hard* are highly polysemous. Apart from *with little force*, cf. the evidence presented in Chapter 2, *leicht* can also take the meaning of *ein bisschen* (a little) or *von geringem Gewicht* (of little weight), cf. the specification in the DWDS (remember, the DWDS also functions as a dictionary). The adverb *hart*, apart from its *with a lot of force* reading, cf. the evidence presented in Chapter 2, also has among others the meaning *a lot*, cf. the specification in the DWDS, or *not soft* with respect to surface materials (Geuder, 2016).

Since I am only interested in the force reading of *leicht* and *hart*, I excluded occurrences with verbs such as *verbeugen* (to bow), which occurs with *leicht* in the sense of ‘a little’: *leicht verbeugen* (to bow lightly); or verbs such as *arbeiten* (to work), which occurs with *hart* in the sense of ‘a lot’: *hart arbeiten* (to work hard). This was overall straightforward to do (though see the discussion about the verb *ausdrücken* (to squeeze out) in 5.1.3 below for one example where I accidentally included an unintended sense of *leicht*).

5.1.2 Results

The thirteen most frequent verbs that can be modified by *leicht* (lightly) and *hart* (hard) can be found in Table 5.1. The percentages are calculated based on the total number of verbs occurring with these adverbs (after my exclusions as detailed above). The numbers are 157 verbs with *leicht* and 81 verbs with *hart*. The full list can be found in Appendix D.

The verbs in Table 5.1 are rather diverse. Both *leicht* and *hart* have a high co-occurrence frequency with *schlagen* (~ to hit) and the intuitively comparable verb *stoßen* (to thrust). There are also verbs that differ from *schlagen* in that they seem to require more of a continuous exertion of force, e.g. *drücken* (to push/press). Then there are a number of particle verbs, such as *andrücken* (to press on) and *ausdrücken* (to squeeze out) co-occurring with *leicht* and *aufschlagen* (to hit (on)) co-occurring with *hart*. There are also a number of verbs that intuitively imply a low force magnitude co-occurring with both *leicht* and *hart*, such as *berühren* (to touch), *streichen* (to stroke) or *tippen* (to tap), and verbs that intuitively imply a high force magnitude such as e.g. *pressen* (to press). Finally, there are several verbs of putting, e.g. *legen* (to lay), *setzen* (to set) or *stellen* (to put).

I will now look at these verbs in detail, in order to get an impression of

leicht			hart		
adverb	translation	freq.	adverb	translation	freq.
liegen	lie	14.01%	schlagen	hit	17.28%
stoßen	thrust	12.74%	stoßen	thrust	13.58%
schlagen	hit	10.19%	klopfen	knock	7.4%
legen	lay	8.28%	anfaßen	handle	6.17%
berühren	touch	7.64%	aufschlagen	hit (on)	6.17%
schütteln	shake	7.01%	packen	seize	6.17%
klopfen	knock	5.73%	pressen	press	6.17%
streichen	stroke	5.73%	drücken	push/press	4.94%
stützen	support	5.09%	fallen	fall	4.94%
faßen	grip	4.46%	setzen	set	4.94%
drücken	push/press	3.82%	stellen	put	2.47%
andrücken	press on	2.55%	tippen	tap	2.47%
ausdrücken	squeeze out	2.55%	treten	kick	2.47%

Table 5.1: The thirteen most frequent verbs that can be modified by *leicht* (lightly) and *hart* (hard), sorted by frequency (with respect to other verbs occurring with these adverbs).

how they express force. Section 5.2 then contains a definition of what I will call force verbs, motivated by the observations from the corpus data. Force verbs will then form the object of study for the remainder of this chapter as well as the next chapter (Chapter 6).

5.1.3 Discussion

In this section, I will discuss the results presented above in some more detail, focusing on how the force component is expressed in the different verbs.

The centrality of *schlagen*

The results of the corpus study presented in Chapter 2 indicated high co-occurrence frequencies of *leicht* (lightly) and *hart* (hard) with *schlagen* (~ to hit). It is therefore unsurprising that *schlagen* is among the top three verbs co-occurring with *leicht* and *hart*. This underlines that *schlagen* is indeed a central force verb in German, and that my use of this verb in Chapters 2 to 4 was fully justified. The very similar verb *stoßen* (to thrust) also has a high co-occurrence frequency with both *leicht* and *hart*. The high frequency of this verb in Table 5.1 points to its centrality within the domain of verbs related to force.

Continuous force exertion

In Section 5.1.2 above (the presentation of the results of the corpus study), I said that verbs like *drücken* (to push/press) seem to refer to a continuous exertion of force. The examples in the corpus, e.g. (1) and (2), include *drücken* only in ‘stable’ situations, i.e. situations of an agent or other object continuously exerting a force.

- (1) Der Zeigefinger der rechten Hand drückt leicht von oben auf das
the forefinger of.the right hand presses lightly from above on the
Messer.
knife
‘From above it, the forefinger of the right hand presses lightly on the
knife.’
- (2) Er stöhnte, hob die Fäuste und drückte sie hart in die Höhle
he moaned, lifted the fists and pressed them hard into the cave
der schmerzenden Augen.
of.the hurting eyes
‘He moaned, lifted his fists and pressed them hard into his painful eyes.’

In both examples, the exertion of the force is continuous, i.e. the sentences do not entail the removal of the finger from the knife or of the fists from the eyes. Further evidence for the fact that *drücken* refers to a continuous force exertion comes from its felicitous use with the phrase *for an X amount of time*, cf. (3).

- (3) Sie drückte sich für mehrere Sekunden die Fäuste in die
she pressed herself for several seconds the fists into the
Augenhöhlen.
cave.of.the.eyes
‘She pressed her fists into her eyes for several seconds.’

The examples in (1) and (2) show that verbs that express a continuous exertion of force can also be modified by *leicht* (lightly) and *hart* (hard). That is, the magnitude of the force can be described as low or high *over a longer period of time*. This is not exclusively a property of ‘punctual’ force verbs such as *schlagen* (to hit), i.e. verbs that express a momentary force exertion.

Particle verbs

Both *schlagen* (to hit) and *drücken* (to push/press) optionally appear with particles in Table 5.1. We find *andrücken* (to press on) and *ausdrücken* (to squeeze) co-occurring with *leicht* (lightly), and *aufschlagen* (to hit (on)) co-occurring with *hart* (hard). While related to the bare verbs *drücken* and *schlagen*, there are some differences between these constructions. Below, I will discuss these differences for each verb in turn.

In general, German particles can be classified as locative or temporal (Fleis-

cher et al., 2012). The locative use describes “das Geschehen nämlich zu einem Gegenstand in Beziehung [gesetzt] (etwas ankleben - an die Wand kleben)”, Fleischer et al. 2012: 397 (the event spatially related, put in relation to an object (to glue something on - to glue something on the wall)).

Andrücken The verb *andrücken* is ditransitive. It requires an agent and two objects, one of which the agent presses against the other. Its definition in the DWDS is as follows: “etwas an etwas drücken” (to press/hold something against something). It is the force with which the agent presses one object against the other that can be modified by adverbs such as *leicht* (lightly), as illustrated in (4) (the powder is pressed lightly against the stain).

- (4) Pulver auf den Fleck streuen, leicht andrücken.
 powder on the stain sprinkle, lightly press.on
 ‘Sprinkle the powder over the stain and lightly press against it.’

Ausdrücken The verb *ausdrücken* is a bit different. Its definition in the DWDS is: “Flüssigkeit aus etwas herausdrücken” (to squeeze out the liquid from something). Usually, *etwas* (something) refers to a container of flexible material, such as some fruit, a lemon for example, the content of which can be retrieved by squeezing it (this example is listed in the dictionary entry for *ausdrücken* in the DWDS). The process of squeezing out the liquid is described in relation to the container (the object in Fleischer et al.’s (2012) terminology). McIntyre (2007) states that the German particle *aus* (out) can be said to have holistic semantics, i.e. require that the container is “substantially affected” (McIntyre 2007: 354) or completely empty. In the occurrence of *ausdrücken* with *leicht*, the adverb can thus be said to imply that the container is not substantially affected, not completely empty. Consider the example in (5). The indication is that the hair is not completely dry (not completely ‘emptied of water’) and still needs to be towelled afterwards.

- (5) Drücke die Haare leicht aus und frottiere sie mit einem
 press the hairs lightly out and rub.down them with a
 Handtuch.
 towel
 ‘Lightly wring your hair and then towel it.’

All other examples of *ausdrücken* and *leicht* in the corpus are similar, suggesting that what *leicht* modifies in these cases is the degree of emptiness (or dryness) of the container, and not the force magnitude. Remember that *leicht* also has a meaning component of *a little*. It seems that this is what can be observed here. Given that it is plausible that if you want to wring only a little water out of your hair, you do so by using little force, my initial inclusion of these examples is maybe understandable.

As evidence that *ausdrücken* can indeed not be modified by *leicht* or *hart* in the adverbs' force reading, consider the example in (6) (the judgment is based on my own intuition). The sentence seems to become infelicitous if *leicht* or *hart* are added.

- (6) ? Joan drückte die Zahnpastatube leicht/hart aus.
 ? Joan pressed the toothpaste.package lightly/hard out
 ? 'Joan squeezed the toothpaste package out lightly/hard.'

This is only an initial observation, based on my judgment of one example. In order to see if there is a general restriction of resultative force verb construction to be modified by force targeting adverbs such as *leicht* or *hard*, I conducted a questionnaire study. The results of this study will be presented in Section 5.3.

The observation that resultative force verb constructions cannot be modified by adverbs that target the force component might be related to the so-called manner-result complementarity (e.g. Rappaport Hovav & Levin 2010; Levin & Rappaport Hovav 2013). According to these authors, a verb can either lexicalise a manner meaning component (e.g. *hit*, which “denote[s] activities which might, but need not be used to bring about changes of state” Levin & Rappaport Hovav 2013: 52) or a result meaning component (e.g. *break*, which “denote[s] a change of state” Levin & Rappaport Hovav 2013: 52). The evidence presented here suggests that this manner-result complementarity stretches beyond the lexical semantics of verbs to compositional semantics (modification), in the sense that a verb expressing a result (e.g. *ausdrücken*) can not be modified with respect to manner (force). This is in line with observations made by Gärdenfors (2014), who observes that adverbs that modify the force magnitude can only be used to modify verbs that express a force, not verbs that also express a result (a result path, in Gärdenfors's terminology). The analysis by Gärdenfors will become relevant in Chapter 6, where I will provide a detailed review.

Aufschlagen Finally, *aufschlagen* is different from both particle verbs discussed so far. It is a non-agentive or non-volitional version of *schlagen*, focusing on the moment of forceful contact between two objects or a person and an object, when one of the objects (or a person) is falling onto the other. According to Fleischer et al. (2012), these verbs (verbs with the particle *auf*) “bezeichnen das Herstellen oder Entstehen eines Kontakts”, Fleischer et al. 2012: 405 (express the creation or coming about of a contact). The definition of *aufschlagen* in the DWDS is: “aufprallen, (beim Niederfallen) auftreffen” (to hit, to strike the ground (when falling)). *Hart* (hard) in this case modifies the magnitude of the forceful contact. This is illustrated in the example in (7).

- (7) Maria aber zuckte zusammen, als sie sah, wie der Mann nun hart
 Maria but flinched together, as she saw, how the man now hard
 auf die Erde aufschlug.
 on the earth hit.on

‘But Maria flinched as she saw how the man hit the earth hard.’

Intensity distinctions

In Section 5.1.2 above, I have translated *drücken* as both *push* and *press*. However, there is another German verb that can be translated by *press* and which occurs quite frequently with *hart*: *pressen*. Since *drücken* already covers instances of English *press*, what is the difference in meaning between *pressen* and *drücken*? The answer is intensity. The definition for *pressen* in the DWDS is the following: “etwas durch starken Druck [...] bearbeiten; etwas/jemanden heftig drücken” (to treat something with high pressure, to press/squeeze something/someone fiercely). *Pressen* thus seems lexically specified for a high amount of force.

The examples in the corpus are mostly about people pressing their lips together in dismay, cf. (8). If *drücken* is used instead of *pressen*, the intuitive understanding is one of less force, as illustrated by the minimal pair in (9) (the judgment is based on my own intuition).

- (8) Er preßte hart die Lippen zusammen.
 he pressed hard the lips together
 ‘He pressed his lips together hard.’
- (9) Er drückt/presst gegen die Tür.
 ‘He pushes/presses against the door.’

There are also verbs that lexically require a low amount of force, e.g. *streichen* (to stroke). *Streichen* is similar to *reiben* (to rub) in that both these verbs express a motion with the hand (or some instrument) over a surface (though *reiben* requires repetitive motion over the same spot). But they differ with respect to intensity: *streichen* requires a low force magnitude whereas *reiben* does not have such a requirement. Consider the examples in (10):

- (10) a. Er strich mit einer beinah väterlichen Geste leicht über ihr
 he stroked with an almost fatherly gesture lightly over her
 Haar.
 hair
- b. Er strich leicht mit zwei Fingern über die samtweiche Haut.
 he stroked lightly with two fingers over the soft skin

In both examples there is a strong understanding of softness, of little force: the soft gesture of a father in (10-a) and the softness of the skin that is being stroked in (10-b). Further evidence for this low force interpretation comes from the lexical definition for *streichen* in the DWDS: “mit einer gleitenden Bewegung die Oberfläche von etw. berühren, (mit der Hand) leicht über etwas hinfahren” (to touch the surface of something with a gliding movement, to lightly glide over something (with the hand)). Considering both the context of the corpus

examples as well as the definition in the DWDS, it seems plausible to claim that *streichen* is lexically specified for a low amount of force.

Another example of a low force or non-intensive verb is *berühren* (to touch). In the DWDS, *berühren* is defined as: “mit einer Körperoberfläche eine Verbindung herstellen, jemanden/etwas versehentlich, zufällig, behutsam [...] leicht berühren” (to create a connection with the surface of a body/object, to touch someone/something accidentally, cautiously [...] lightly). *Berühren* also seems to have a lexical requirement for a low force magnitude.

A note on the modification pattern of these verbs: I found no occurrence of *pressen* with *leicht* in the corpus, but it occurs in 6.17% of the cases with *hart*, whereas *drücken* appears in 3.83% of the cases with *leicht* and in 4.94% of the cases with *hart*. And while *streichen* has no co-occurrence with *hart*, it occurs in 5.73% of the cases with *leicht*. Finally, *berühren* occurs in 7.64% of the cases with *leicht*, but only in 1.23% of the cases with *hart*.

The observed high-force requirement for *pressen* and low-force requirement for *berühren* and *streichen* thus seem to influence these verbs' co-occurrence pattern with the adverbs *leicht* and *hart*: verbs that are lexically specified for a high force magnitude co-occur more frequently with *hart* than *leicht*. This trend is reversed for verbs that are lexically specified for a low force magnitude, they co-occur more frequently with *leicht* than with *hart*. No such trend is observable for verbs that are lexically unspecified with respect to a specific force magnitude, such as *drücken*.

A corpus study is of course limited in that the absence of a construction cannot count as evidence for its infelicity or semantic anomaly. So the fact that I found no combinations of the verb *pressen* with the adverb *leicht*, and no combinations of the verb *streichen* with the adverb *hart* might simply be due to the particular examples included in the corpus. In order to test whether the observed co-occurrence frequencies are not merely an artifact of this particular corpus, but rather due to the specific force magnitude requirements of the verbs, I conducted a questionnaire study. A questionnaire study allows me to explicitly test the felicity of a certain verb-adverb combination. The results of the questionnaire study will be presented in Section 5.3.

Verbs of putting

The final issue mentioned in Section 5.1.2 is the high co-occurrence frequency of the verbs *liegen* (to lie) and *legen* (to lay) with *leicht* (lightly) and of the verbs *setzen* (to set) and *stellen* (to put) with *hart* (hard). The verb *legen* involves an agent placing one object on another, as in (11).

- (11) Sibylla erhebt sich, tritt neben den Arzt und legt ihre Hand
 Sybilla raises herself, steps next to the doctor and lays her hand
 leicht auf seinen Arm.
 lightly on his arm
 ‘Sybilla raises, steps close to the doctor and lightly lays her hand on

his arm.’

What *leicht* modifies is the amount of force used by the agent to place one object, her hand in this case, on another, the doctor’s arm in this case. The verb *legen* is related to *setzen* (to set) and *stellen* (to put), both co-occurring with *hart* in the corpus. The configuration is similar: an agent places one object in a spatial configuration to another. In the case of *setzen*, the object has to be in a sitting position; in the case of *stellen*, in a standing position. In both cases, adverbs such as *leicht* or *hart* modify the amount of force used to place the object.

This is different for *liegen* (to lie). Here, the configuration is stable, i.e. does not involve change (of location): one object is lying on another, but the action of putting it there is not described by the verb, cf. (12).

- (12) Die Decke lag leicht auf meinem Körper.
 ‘The blanket lay lightly on my body.’

Two senses of *leicht* interact in this example. One meaning of *leicht* is ‘with little weight’ (cf. Section 5.1.1 above). If a blanket is lying on you lightly, it means that it has little weight. But by virtue of it having little weight, it is also exerting only a little force on you.

5.1.4 Conclusion

In this section, I have presented the results from a corpus study conducted in order to find other German verbs that have a force component besides *schlagen* (~ to hit). Given the semantics of *leicht* (lightly) and *hart* (hard) as developed in Chapters 2 and 4, the underlying idea of the corpus study was that verbs that co-occur with these adverbs can be said to have a force component. After excluding examples with verbs that require another sense of *leicht* or *hart*, such as the *a little* sense of *leicht* in the phrase *leicht verbeugen* (to bow lightly) or the *a lot* sense of *hart* in the phrase *hart arbeiten* (to work hard), I was left with a list of potential force verbs in German, as illustrated in Table 5.1. Here, I summarise the main findings.

Among the verbs with the highest co-occurrence frequency with both *leicht* and *hart* is *schlagen* and the related verb *stoßen* (to thrust). I also found verbs that express a continuous exertion of force, such as *drücken* (to push/press), which is distinct from *schlagen* and *stoßen* in this respect.

Both *schlagen* and *drücken* can appear in a particle verb construction, with the particle verb being related to the bare verb, but with a distinct meaning. In those cases, *leicht* and *hart* are less acceptable as modifiers when the particle expresses a result or change of state, as is the case for *ausdrücken* (to squeeze out)). In Section 5.3, I will present the results of a questionnaire study exploring whether this generally holds of particle verbs that express a result or change of state.

I also observed distinctions with respect to the intensity of the force magnitude. Verbs such as *berühren* (to touch) or *streichen* (to stroke) seem to lexically specify a low force magnitude. And verbs such as *pressen* (to press) lexically specify a high force magnitude. These lexical specifications lead to clear differences in the co-occurrence frequencies of these verbs with the adverbs *leicht* and *hart*, such that intensive verbs co-occur more often with *hart* than *leicht*, whereas this trend is reversed for non-intensive verbs. This might of course be due only to the set-up of this specific corpus, the absence of a certain combination in a corpus does not provide evidence for the infelicity or semantic anomaly of that combination. I therefore tested combinations of non-intensive and intensive verbs with the adverbs *leicht* and *hart*. The results of that questionnaire study will be presented in Section 5.3.

Finally, I found that many verbs of putting, such as *legen* (to lay) or *setzen* (to set) also have a force component. When combined with these verbs, *leicht* and *hart* seem to modify the force that the agent uses to bring an object into a certain position (lying or sitting).

The pattern that emerges from the corpus results is that all these verbs describe situations of contact between two entities, contact that can be brought about with a high amount of force or with a low amount of force. The contact can be momentary (e.g. *schlagen* or *stoßen*) or continuous (e.g. *drücken*), done with a low force magnitude (e.g. *berühren* (to touch)) or a high force magnitude (*pressen* (to press)). Sometimes, the contact is brought about by a third person, as is the case for the verbs of putting or the particle verb *andrücken* (to press on). In the next section, based on the results from the corpus study discussed here, I will provide a definition of force verbs in German, and illustrate their distinct force properties.

5.2 The domain of force verbs

The corpus study presented in Section 5.1 above showed that not only verbs of contact by impact as defined in Levin 1993 have a force component. Instead I also found verbs which can be counted among the classes of verbs of contact (e.g. *berühren* (to touch)), verbs of exerting force (e.g. *drücken* (to push/press)) and even verbs of putting (e.g. *setzen* (to set)). All of these can be modified by the adverbs *leicht* (lightly) and *hart* (hard) and can therefore be said to have a force component.

These verbs and their properties, especially their distinct force properties such as the distinction between a momentary and a continuous force exertion observed between *schlagen* (~ to hit) and *drücken*, will be the object of study in this and the next chapter. It is therefore advisable to have a working definition of force verbs, i.e. verbs in which the force component is prominent. The list presented in Table 5.1 in Section 5.1.2 above is based on an initial corpus study. But while the corpus study has provided a good first overview of verbs that have a force component, it is by no means exhaustive. In order to determine a

verb's status as a force verb it will not do to compare it to the verbs in Table 5.1 or even the more exhaustive list presented in Table D.1 in Appendix D. Rather, a definition is needed that will give an answer for each newly encountered verb of whether it is a force verb or not.

In this section, I will first give such a definition of force verbs in German, based on the result from the corpus study and motivated by some additional considerations about manner and result, and then present some properties of force verbs, including their argument structure, lexical specifications and compositional behaviour. In Chapter 6, I will provide a detailed formalisation of the force component. In order to do this, it is important to be clear about the different properties that need to be modelled with respect to force, such as the intensity distinction discussed in Section 5.1.3 above.

5.2.1 The definition of force verbs

The pattern observed in the corpus study above is that all the verbs co-occurring with *leicht* (lightly) or *hart* (hard) describe situations of contact between two objects, a contact that is characterised by one object exerting force on the other. It is the magnitude of this force that is modified by the adverbs *leicht* and *hart*. The following definition is based on this observation, but also includes some additional considerations. As stated in the introduction to this section above, the definition is intended to delimit the domain of force verbs in German, i.e. to provide a tool to judge each newly encountered verb as to whether it is a force verb or not. As I will illustrate below, this definition will give a division of verbs that very closely corresponds to the division between manner verbs and result verbs as presented in Rappaport Hovav & Levin 2010; Levin & Rappaport Hovav 2013.

- (13) A force verb is any verb of which the root can occur in a sentence that describes a situation in which an object A exerts a physical force through contact on another object B without necessarily implying a change in the properties of B, yet while allowing for that change.

Under the definition in (13), verbs like *schlagen* (to hit), *drücken* (to push/press), *pressen* (to press), *streichen* (to stroke), *hämmern* (to hammer) and *treten* (to kick) all count as force verbs. Verbs like *ausdrücken* (to squeeze out) or *ein-schlagen* (to break) also count as force verbs, because their respective roots, *drücken* and *schlagen*, fulfil the requirements in (13). These verbs are related to manner verbs in the sense of Rappaport Hovav & Levin 2010 and Levin & Rappaport Hovav 2013, that is, they “denote activities which might, but need not be used to bring about changes of state” (Levin & Rappaport Hovav 2013: 52). However, due to German allowing resultative particles such as *aus* (out) to combine with force verbs as in *ausdrücken* (to squeeze out), force verbs can also be used to express results.

Verbs such as *legen* (to lay), *setzen* (to set), *werfen* (to throw) and *brechen* (to break) all “denote a change of state” (Levin & Rappaport Hovav 2013: 52) and as such are comparable to result verbs in the sense of Rappaport Hovav & Levin 2010 and Levin & Rappaport Hovav 2013. These verbs are similar to particle verbs that denote a change of state, such as *ausdrücken*, which expresses a process in which a container changes state from full to empty. But the crucial difference between particle verbs like *ausdrücken* and verbs like *setzen* or *brechen* is that the bare roots of particle verbs, *drücken* in the case of *ausdrücken*, are force verbs: The force verb *drücken* can optionally receive a resultative reading when combined with the particle *aus* (out). Verbs like *legen* or *setzen* are not related to force verbs in this way, their roots are not force verbs, they therefore do not fall into the category of force verbs. Please note that these verbs are excluded from the definition of force verbs despite the results from the corpus study indicating that they have a force component. The reason that these verbs are excluded is because they *also* have an obligatory result component.

Verbs like *liegen* (to lie) or *stehen* (to stand) cannot be used to describe situations that allow a change of state. These are positional verbs and describe static situations (Newman, 2002), and they are therefore not classified as force verbs.

The definition of force verbs thus includes only verbs that can be used to describe situations in which a (forceful) contact between two entities may lead to a change of state.

5.2.2 Lexical and compositional properties of force verbs

In this section, I will lay out the domain of force verbs with respect to the verbs’ argument structure, the lexical distinctions between force verbs and the distinct compositional behaviour. I do this, because in the next chapter, I will provide a formalisation of the force component that includes all these distinct manifestations, for example the force magnitude specifications (as in *streichen* (to stroke) or *pressen* (to press)) or the aspectual distinctions (e.g. the difference between *schlagen* (to hit) and *drücken* (to push/press)). It is therefore important to clearly formulate and present these distinctions here.

Concerning the argument structure of force verbs, several entities can be identified, illustrated below:

- a force exorter (a), expressed by the subject in active sentences;
- a force recipient (b), expressed by the object of the verb or in a prepositional phrase;
- a force instrument (c), expressed by a *mit* (with)-PP or in a verb (e.g. *treten* (to kick), where the instrument is a foot, or *hämmern* (to hammer), where the instrument is a hammer);
- a force zone (d), which is that part of the force recipient that is specifically affected by the force, expressed by a locative (place) PP;

- and a Ground (e), with respect to which the resulting motion of the force recipient is described; expressed by a directional (path) PP (and sometimes promoted to direct object of the verb (McIntyre, 2007)).

- (14) a. Petra (a) schlägt mit einem Hammer (c) auf den Nagel (b).
 Petra (a) hits with a hammer (c) on the nail (b)
- b. Petra (a) zieht die Rübe (b) mit ihren Händen (c) am
 Petra (a) pulls the root (b) with her hands (c) on.the
 Schopf (d) aus der Erde (e).⁴
 tuft (d) out.of the earth (e)

The force exiter and the force recipient are reminiscent of the roles agent and patient or theme. I chose the force-related labels here for two reasons. Firstly, I want to make clear their relation to the force transmission in their interaction: the force exiter is the entity that exerts the force, the force recipient is the entity on which the force is exerted (which receives the force). Secondly, the role agent refers to animate, volitional entities and a patient is also usually animate (Dowty, 1991). However, both force exiter and force recipient may be inanimate, as was the case in some of the test sentences used in the German questionnaire presented in Chapter 3. The labels force exiter and force recipient are thus more suitable than the traditional argument roles.

It is not always the case that all the entities listed above are expressed in a sentence containing a force verb. The force exiter and the force recipient are always expressed or implied, they are the two entities between which the force interaction takes place. But the Ground, for example, is not standardly expressed (see also the discussion in McIntyre 2007 about Ground promotion) or even conceptually or implicitly present. Consider the sentence in (14-a): Here, the Ground is neither expressed nor conceptually present - there is no resulting motion of the force recipient, the nail, which could be described with respect to a Ground. The force zone, on the other hand, is conceptually present in this example, presumably it is the head of the nail. But this is not overtly expressed in the sentence.

The Ground and the force zone and also the force instrument are less prominent entities in force interactions. This is reflected in the status of their syntactic constituents: if they are expressed, they mostly appear as (optional) prepositional phrases (though again, see the discussion in McIntyre 2007 on Ground promotion, which discusses cases where the Ground is a direct object of the verb).

⁴The verb *ziehen* (to pull) is not on the list in Table 5.1 or Table D.1 in Appendix D. It is, however, a force verb according to the definition in (13): it describes a situation in which one entity is in contact with another to exert a force on it, it allows for a change of state (as is in fact the case in this sentence), but does not entail it. The example is inspired by Roßdeutscher & Pross (2015).

Lexical distinctions: aspect, intensity, instruments & direction

In Section 5.1.3 above, I illustrated distinctions between the force verbs found in the corpus: the aspectual distinction between *schlagen* (to hit) - momentary exertion of force, and *drücken* (to push/press) - continuous exertion of force; and the intensity distinctions between e.g. *berühren* (to touch) - lexically specified for a low force magnitude, *drücken* - unspecified with respect to the force magnitude, or *pressen* (to press) - lexically specified for a high force magnitude.

Force verbs also exhibit instrumental distinctions: *treten* (to kick) can only be used if the force is exerted through the use of a foot; the verb *hämmern* (to hammer) usually requires a hammer (though it can also be used in situations where the typical hammering noise is achieved by the hands only, e.g. *Sie hämmerte hart gegen die Tür* (She hammered hard against the door)).

And force verbs differ with respect to directionality. The force can be directed towards the object to which it is applied, as in e.g. *drücken* (to push/press) or *schlagen* (to hit), or away from the force recipient, as in e.g. *ziehen* (to pull).

Compositional distinctions: force modification, preposition selection and the role of prepositional phrases

Force verbs also differ with respect to their compositional semantics and lexical selection. In Section 5.1.3, I observed that verbs that differ in their force intensity also differ in their co-occurrence frequencies with *leicht* (lightly) and *hart* (hard): intensive verbs co-occur more often with *hart* than *leicht*, and the other way around for non-intensive verbs. I also observed that particle verbs like *ausdrücken* (to squeeze out), which entail a result, cannot felicitously be modified by *leicht* or *hart*.

Additionally, force verbs differ in their interactions with prepositions. Compare e.g. **auf/√an etwas ziehen* (to pull *on/√on something) versus *√auf/*an etwas drücken* (to push √on/*on something); *drücken* and *ziehen* have complementary selectional restrictions with respect to prepositions. This is related to the lexical distinction of directionality mentioned above.

Finally, as already observed by Levin (1993) for English and Roßdeutscher & Pross (2015) for German, force verbs show alternations with prepositional phrases, such as in (15) below.

- (15) a. auf den Nagel schlagen
 ‘to hit on the nail’
 b. den Nagel auf den Kopf schlagen
 ‘to hit the nail on the head’
 c. den Nagel in die Tür schlagen
 ‘to hit the nail into the door’

When combined with *auf* (on), as in (15-a) and (15-b), *schlagen* does not entail a result, i.e. whether the hit makes the nail move is left open. In (15-c), on the

other hand, where *schlagen* is combined with *in* (in/into), a change it entailed: it is only possible to truthfully utter (15-c) if the nail moves into the door as a result of the hit. Like the particle *aus* (out) in *ausdrücken* (to squeeze out), the preposition *in*, when combined with a force verb, entails a change of state.

These distinctions will be formalised in Chapter 6, which contains a detailed model of the force component and offers a thorough explanation of the observations about force verbs presented in this chapter.

5.3 Questionnaire study

When discussing the corpus results in Section 5.1.3 above, I argued that the particle verb *ausdrücken* (to squeeze out), which expresses the resulting state of a container (namely the container being emptied), cannot be modified by the adverbs *leicht* (lightly) or *hart* (hard). In order to test whether this trend of not taking force targeting adverbs as modifiers holds for resultative force verb constructions in general, I conducted a questionnaire study.

The questionnaire study should also provide evidence for another phenomenon: In Section 5.1.3 above, I observed that verbs that are lexically specified for a high force magnitude have no co-occurrences with the adverb *leicht*, and verbs that are lexically specified for a low force magnitude have no co-occurrence with the adverb *hart*. But the absence of a construction from a corpus cannot be interpreted as direct evidence for its infelicity or semantic anomaly, since it might be an artifact of the composition of the corpus. I will therefore directly test the felicity of verbs with different intensities modified by *leicht* and *hart* through acceptability judgments in a questionnaire.

5.3.1 Force modification - force result incompatibility

At several points above (Sections 5.1.3 and 5.2.2), I have observed that some force verbs, when they are combined with a resultative particle or preposition, entail a change of state. Examples are the verb *ausdrücken* (to squeeze out) or the phrase *in die Tür schlagen* (to hit into the door).

I have further observed that such a resultative verb or phrase can not felicitously be modified by the adverbs *leicht* (lightly) or *hart* (hard), cf. the discussion of *ausdrücken* in Section 5.1.3 above. As evidence I listed the example in (6), repeated here as (16).

- (16) ? Joan drückte die Zahnpastatube leicht/hart aus.
 ? Joan pressed the toothpaste.package lightly/hard out
 ‘Joan squeezed the toothpaste package out lightly/hard.’

In this example, the particle *aus* (out) expresses the fact that the toothpaste package is emptied of toothpaste as a result of Joan squeezing it. In this case, the adverbs *leicht* and *hart* are less acceptable than in the basic, non-resultative construction with *drücken*, cf. (17).

- (17) ✓ Joan drückte leicht/hart auf die Zahnpastatube.
 ✓ Joan pressed lightly/hard on the toothpaste.package
 ‘Joan pressed lightly/hard on the toothpaste package.’

I have reasoned above that this incompatibility of force results and force modification is related to the manner-result complementarity observed by among others Rappaport Hovav & Levin (2010); Levin & Rappaport Hovav (2013). If the above observation holds for force verbs in general, it would imply that the manner-result complementarity stretches beyond the lexical semantics of individual verbs into the compositional system, as indicated by Gärdenfors (2014).

So far, however, the observation is based only on my reasoning about a handful of examples from the corpus and my own intuition. In order to systematically test whether this observation holds for force verbs in general, and whether my intuition is shared by other German native speakers, I designed a questionnaire study.

5.3.2 Intensity distinctions

In addition to the force modification - force result incompatibility, the questionnaire study should address the compositional implications of the force intensity distinctions observed in the corpus. In Section 5.1.3, I observed that verbs that are lexically specified for a low force magnitude such as *berühren* (to touch) or *streichen* (to stroke), occur much less often with the adverb *hart* (hard) than with *leicht* (lightly). This trend is reversed for verbs that are lexically specified for a high amount of force, such as *pressen* (to press). Verbs that are lexically unspecified with respect to the force magnitude, such as *schlagen* (to hit) or *drücken* (to push/press), appear equally often with *leicht* and *hart*.

However, just because a construction does not appear in a corpus, it does not necessarily mean that it is infelicitous. It might simply be an idiosyncrasy of the corpus composition that this construction does not occur. In order to get direct evidence for the compositional implications of the different force magnitude specifications, I therefore need native speaker judgments of combinations of intensive and non-intensive verbs with the adverbs *leicht* and *hart*. I addressed this question in the same questionnaire study as the force modification - force result incompatibility.

5.3.3 Hypotheses and predictions

In this section, I will motivate the concrete hypotheses and predictions for the force modification - force result incompatibility and the intensity distinctions separately.

Force modification - force result incompatibility

The observations above about the incompatibility of overt force results with force modification can be formulated in the Force Result Hypothesis as in (18).

(18) **The Force Result Hypothesis:**

When a force verb is combined with a particle or prepositional phrase that entails a change of state, the resulting verb cannot be combined with adverbs modifying the force component of the verb.

Sentences such as those in (16) above, repeated here as (19-a), and (19-b), are predicted to be judged as infelicitous according to the Force Result Hypothesis. Sentences such as (17), repeated here as (20-a), and (20-b), which contain force verbs without a resultative particle or preposition, are predicted to be judged as felicitous.

- (19) a. ? Joan drückte die Zahnpastatube leicht/hart aus.
 ? Joan pressed the toothpaste.package lightly/hard out
 ‘Joan squeezed the toothpaste package out lightly/hard.’
 b. ? Joan schlägt den Nagel leicht/hart in die Wand.
 ? Joan hits the nail lightly/hard into the wall
 ‘Joan hits the nail lightly/hard into the wall.’
- (20) a. ✓ Joan drückte leicht/hart auf die Zahnpastatube.
 ✓ Joan pressed lightly/hard on the toothpaste.package
 ‘Joan pressed lightly/hard on the toothpaste package.’
 b. ✓ Joan schlägt leicht/hart auf den Nagel.
 ✓ Joan hits lightly/hard on the nail
 ‘Joan hits the nail lightly/hard.’

Intensity distinctions

The results from the corpus study presented in Section 5.1.2 showed clear differences in co-occurrence frequencies of intensive and non-intensive verbs with the adverbs *leicht* (lightly) and *hart* (hard). Specifically, non-intensive verbs, which are lexically specified for a low force magnitude, such as *berühren* (to touch) or *streichen* (to stroke), have few or no co-occurrences with the adverb *hart*, which modifies the force component in the direction of a higher force magnitude. But non-intensive verbs appear freely with the adverb *leicht*, which modifies the force component in the direction of a lower force magnitude. This pattern is reversed for intensive verbs, which are lexically specified for a high force magnitude, such as *pressen* (to press). These verbs only co-occur with the adverb *hart*, but not with *leicht*.

I argued above that the absence of a construction from a corpus does not provide direct evidence for the infelicity of that construction (this evidence can only come from a questionnaire study explicitly testing the acceptability of that construction). However, given the fact that intensive verbs are lexically specified

for a high force magnitude, it seems implausible that they can felicitously be modified by an adverb which is lexically specified for a low force magnitude.⁵ The resulting combination should be a contradiction. A similar reasoning can be applied to why non-intensive verbs should not be able to be felicitously modified by adverbs lexically specified for a high force magnitude.

I therefore predict that combinations of non-intensive verbs with force increasing adverbs are less felicitous than combinations of non-intensive verbs with force decreasing adverbs. And similarly, sentences that include intensive verbs modified by force decreasing adverbs should be less felicitous than sentences containing intensive verbs modified by force increasing adverbs. I will call this the Intensity Hypothesis, given in (21).

(21) **The Intensity Hypothesis:**

Combinations of non-intensive verbs with force increasing adverbs are less felicitous than combinations of non-intensive verbs with force decreasing adverbs. Combinations of intensive verbs with force decreasing adverbs are less felicitous than combinations of intensive verbs with force increasing adverbs.

The concrete predictions are spelled out for the example sentences in (22) and (23) below. The a-versions are predicted to be felicitous, because the verb and the adverb have the compatible force magnitude specifications. The b-versions are predicted to be infelicitous, because the verb and the adverb have contradictory force magnitude specifications.

- (22) a. ✓ Joan strich Maria leicht über den Arm.
 ‘Joan stroked lightly over Maria’s arm.’
 b. ? Joan strich Maria hart über den Arm.
 ‘Joan stroked hard over Maria’s arm.’
- (23) a. ✓ Joan presste Maria hart gegen die Tür.
 ‘Joan pressed Maria hard against the door.’
 b. ? Joan presste Maria leicht gegen die Tür.
 ‘Joan pressed Maria lightly against the door.’

5.3.4 Questionnaire design and materials

I created thirteen test items that contain force verbs in their bare or basic use, i.e. without a resultative particle or prepositional phrase; and eight test items that contain force verbs in their resultative use, i.e. with a particle or preposition that entails a change of state (when combined with a force verb). Examples are given in (24) and (25) below.

All test sentences contain the modifiers *leicht* (lightly) and *hart* (hard).

⁵Recall the corpus study presented in Chapter 2, which provided evidence for the fact that *leicht* and *hart* are lexically specified for a low force magnitude and high force magnitude respectively.

Additionally, I included the modifiers *langsam* (slowly) and *schnell* (quickly). I did this in order to test whether all modification of force verbs with a resultative particle or PP results in infelicitous sentences, or whether only modification of the force component is problematic. In Chapter 2, I concluded that verbs of contact by impact have a force component, a sound-volume component and a speed or movement component. This latter component is what makes it possible for force verbs to be modified by adverbs referring to speed, such as *langsam* or *schnell*.

In order to test the Intensity Hypothesis, I selected the items with basic force verbs so that they also include intensity distinctions as discussed in Section 5.1.3 above: three intense verbs (in three items), two non-intense verbs (in two items) and four verbs that are lexically unspecified with respect to force (in eight items). Most of these verbs are taken from the corpus study reported in Section 5.1 above. The others I took from examples in the literature, most notably those discussed in Roßdeutscher & Pross 2015.

Two example stimulus items are given in (24) and (25). The full list of stimuli can be found in Appendix E. All stimuli were piloted in a small-scale questionnaire to test whether people understood them or had difficulty with the task.

- (24) a. Alex schlägt leicht/hart auf den Nagel.
 ‘Alex hits the nail lightly/hard.’
 b. Alex schlägt langsam/schnell auf den Nagel.
 ‘Alex hits the nail slowly/quickly.’
- (25) a. Alex schlägt den Nagel leicht/hart in die Wand.
 ‘Alex hits the nail lightly/hard into the wall.’
 b. Alex schlägt den Nagel langsam/schnell in die Wand.
 ‘Alex hits the nail slowly/quickly into the wall.’

The stimuli were distributed over six questionnaires of about 20 items, including two contradictory control sentences to test whether participants were paying attention. All items were randomized, and the questionnaires were distributed in two versions, one of which contained the test sentences in reversed order.

The sentences had to be rated on a 4-point Likert scale, where a 4 means *clearly good*, a 3 *maybe good*, a 2 *maybe bad* and a 1 *clearly bad*. This way, participants were forced to make a commitment as to whether a sentence was (more or less) acceptable or (more or less) unacceptable. The rating task was preceded by an introduction, which included an example sentence from an unrelated domain (speed), cf. (26), and asked participants to rate the sentences according to their first intuition. The introduction also emphasised that this questionnaire is about the force meaning of *leicht* and *hart*, and not the *a little/a lot* meaning, including two examples to make the distinction explicit, cf. (27-a) to illustrate the *a little* meaning of *leicht* and (27-b) to illustrate the low force meaning of *leicht*.

- (26) Mark lief schnell über den Marktplatz.
‘Mark went quickly across the market place.’
- (27) a. Mark öffnete das Fenster leicht.
‘Mark opened the window a little bit.’
b. Marta kniff sich leicht in den Arm.
‘Marta pinched her arm lightly.’

Following the rating task, information about the participants’ language background was collected via four questions relating to their first language(s), other languages they speak, and the place(s) they have been raised/lived.

15-20 German native speakers were tested for both the original order and the reversed order versions of all six questionnaires. Participants who rated either of the direct contradictions in the two control sentences higher than 1, i.e. who thought they are not clearly unacceptable, were excluded from the analysis, leaving a total of 158 participants.

5.3.5 Results and discussion

In this section I will present the results for the Force Result Hypothesis and the Intensity Hypothesis individually.

Force modification - force result incompatibility

The results from the stimuli testing the Force Result Hypothesis are summarised in Table 5.2 (I give example phrases for each construction).

	basic force verb: auf den Nagel schlagen (to hit the nail)	resultative force verb: den Nagel in die Wand schlagen (to hit the nail into the wall)
leicht (lightly)	79.21%	48.95%
hart (hard)	52.55%	31.16%
langsam (slowly)	62.43%	76.35%
schnell (quickly)	62.80%	81.36%

Table 5.2: Combined percentages of ratings 3 (maybe good) and 4 (clearly good) for the sentences testing the Force Result Hypothesis.

The trend observable in Table 5.2 generally confirms the predictions made by the Force Result Hypothesis. Sentences that contain a force verb with a resultative particle or preposition, like *den Nagel in die Wand schlagen* (to hit the nail into the wall), receive a much lower percentage of ratings 3 (maybe good) and 4 (clearly good) when they are modified by either *leicht* (lightly) or *hart* (hard), compared to when they are modified by *langsam* (slowly) or *schnell* (quickly): 48.95% and 31.16% versus 76.35% and 81.36% respectively. The percentages of ratings 3 and 4 is also lower compared to sentences that

contain a force verb in its basic use, i.e. without a resultative particle or PP, and the adverb *leicht* or *hart*, like *leicht/hart auf den Nagel schlagen* (to hit the nail lightly/hard): 79.21% and 52.55% respectively. I can thus tentatively conclude that my intuition as reported in Section 5.1.3 is shared by a larger group of German native speakers: sentences with a force verb in a resultative construction are less felicitous when modified by *hart* or *leicht* than sentences with a force verb in its basic use. But modification by other adverbs such as *langsam* and *schnell* does not seem to be a problem. Below, I will present the results from a general linear mixed effects analysis to test whether the trend is significant.

But first, two things need to be remarked about the numbers in Table 5.2. Firstly, the percentage of ratings 3 and 4 for resultative force verbs modified by *leicht* are still relatively high: 48.95%. While this percentage is lower than that of basic force verbs modified by *leicht* (79.21%), the fact remains that about half of the time, participants thought those sentences were felicitous. My guess is that these numbers are due to the relatively dominant interpretation of *leicht* as *a little*. The majority of the resultative test items allowed the *a little* meaning of *leicht*, which makes the sentences felicitous. Even though I explicitly informed the participants that I am only interested in the force reading of *leicht*, cf. the example sentences in the introduction reported in (27) in Section 5.3.4 above, the high number of ratings 3 and 4 for resultative force verbs modified by *leicht* suggest that the *a little* meaning of *leicht* is so dominant that this was a difficult task to do for all stimuli in the case of many participants. This is confirmed by a look at the data: mostly, participants gave high ratings for only one or two resultative force verb constructions modified by *leicht* (if at all), and low ratings for the other resultative stimuli. It seems plausible to reason that despite the explicit instructions, the dominance of the *a little* meaning ‘took over’ for a couple of the items for some participants, causing them to give higher ratings for those items.

Secondly, the percentage of ratings 3 and 4 for basic force verbs modified by *hart* is relatively low: only 52.55%. This is a little harder to explain. One possible reason is that *hart* can also have a meaning of *fest* (tight). This seems most felicitous in sentences which express continuous contact between two entities (with force applied to direct them towards each other), for this contact can then be said to be tight. The stimulus sentences that do not express such a form of contact could then by comparison seem less felicitous with *hart*, causing the low percentage of ratings 3 and 4. This *tight* meaning of *hart* might also explain the 31.16% of ratings 3 and 4 for resultative sentences containing *hart*. Some of the stimulus sentences do result in contact, e.g. *die Tür zuziehen* (to pull the door close), making *hart* an acceptable modifier when it is interpreted as *tight*. Another reason for the low percentage of ratings 3 and 4 for basic force verbs modified by *hart* might be interaction effects with stimulus items testing the Intensity Hypothesis (see below).

Finally, please also note the relatively low percentage of ratings 3 and 4 for sentences containing a basic force verb and the modifiers *langsam* or *schnell*:

only 62.43% and 62.80% respectively (compared to 76.35% and 81.36% for resultative force verb constructions). There is a difference in the modification target of the modifiers *langsam* and *schnell* in basic force verbs versus force verbs in a resultative construction. In the case of a basic force verb, the modifiers *langsam* and *schnell* modify the speed of the movement that brings about the forceful contact. However, this movement is not explicitly expressed in continuous force verbs such as *drücken*, so that *langsam* and *schnell* have no modification target in these cases. Recall from the discussion in Chapter 2 that both *langsam* and *schnell* can also get a thematic reading (Higginbotham, 2000), i.e. a reading in which they modify the time that has passed between the event described by the verb and some preceding event. The stimulus sentences in the questionnaire, however, did not explicitly mention a preceding event. It appears that for this reason, the thematic reading of *langsam* and *schnell* was just as unavailable for some participants as their speed related reading. This problem disappears in the case of the resultative force verb constructions, where *langsam* and *hart* modify the time it took until the result state was reached. However, this is not too worrisome for the present study. Recall that I am mainly interested in whether *leicht* and *hart* are indeed unacceptable modifiers for resultative force verbs, and whether that is due to a general restriction on modification of resultative constructions with force verbs, or whether this is specific to *leicht* and *hart*. Which other adverbs can or cannot modify basic force verbs is therefore only of secondary interest.

In order to test whether the trend observable in Table 5.2 is significant, I conducted a general linear mixed-effects analysis in R, using the packages `lme4` and `lmerTest` (Bates et al., 2015). The random factors in the model were items and participants, the fixed factor was condition, i.e. basic or resultative force verbs and force or speed modifiers, yielding four levels. The results from the analysis show that the trend is significant:⁶ sentences with a basic force verb and the force modifier *leicht* were judged significantly better than sentences with a resultative force verb construction and the force modifier *leicht*: the odds are 7.3 with $p < .01$ (SE = 0.7278). Sentences with a resultative force verb construction and the modifier *langsam* or *schnell* were also judged significantly better than sentences with a resultative force verb construction and *leicht*: the odds are 6.3 with $p = .02$ (SE = 0.8147) for *langsam* versus *leicht*, and 10.5 with $p < .01$ (SE = 0.8197) for *schnell* versus *leicht*. Unfortunately, I do not have enough observations to calculate the model for sentences containing the adverb *hart*.⁷

In summary, sentences containing force verbs in a resultative construction, such as those in (28), are less felicitous when they are modified by *leicht* or *hart* than sentences containing basic force verbs, such as those in (29).

⁶I assume significance when $p < .05$.

⁷Even though I have the same amount of stimuli for both *leicht* and *hart*, there is a different number of judgments per stimulus due to them being distributed over 12 different questionnaire versions, which were not all filled out by the same number of people.

- (28) a. ? Joan drückte die Zahnpastatube leicht/hart aus.
 ? Joan pressed the toothpaste.package lightly/hard out
 ‘Joan squeezed out the toothpaste package lightly/hard.’
 b. ? Joan schlägt den Nagel leicht/hart in die Wand.
 ? Joan hits the nail lightly/hard into the wall
 ‘Joan hits the nail lightly/hard into the wall.’
- (29) a. ✓ Joan drückte leicht/hart auf die Zahnpastatube.
 ✓ Joan pressed lightly/hard on the toothpaste.package
 ‘Joan pressed lightly/hard on the toothpaste package.’
 b. ✓ Joan schlägt leicht/hart auf den Nagel.
 ✓ Joan hits lightly/hard on the nail
 ‘Joan hits the nail lightly/hard.’

Intensity distinctions

The other hypothesis I tested relates to the intensity distinctions. Remember that the Intensity Hypothesis goes back to the observation that some verbs are lexically specified for a specific force magnitude, such as e.g. *pressen* (to press), which is lexically specified for a high force magnitude; or *berühren* (to touch) and *streichen* (to stroke), which are lexically specified for a low force magnitude. This is in contrast to verbs that are unspecified with respect to the force magnitude, such as e.g. *schlagen* (~ to hit), cf. also the discussion in Chapter 3.

These lexicalised force magnitude specifications correlate with a difference in the frequency of co-occurrence of these verbs with the adverbs *leicht* (lightly) and *hart* (hard). Intensive verbs like *pressen* co-occur with *hart* more often than with *leicht*; this is reversed for non-intensive verbs like *berühren* or *streichen*. Given the contradictory force magnitude specifications of non-intensive verbs and force increasing adverbs as well as intensive verbs and force decreasing adverbs, I expected these verb-adverb combinations to be less felicitous than verb-adverb combinations with compatible force magnitude requirements. I appear to have been partially wrong about this. The results from the questionnaire items testing the Intensity Hypothesis are summarised in Table 5.3 (I give example verbs for each subclass).

	intensive:	non-intensive:	unspecified:
	pressen (to press)	berühren (to touch)	schlagen (to hit)
leicht (lightly)	57.65%	89.1%	55.8%
hart (hard)	66.6%	19.23%	85.2%

Table 5.3: Combined percentages of ratings 3 (maybe good) and 4 (clearly good) for the sentences testing the Intensity Hypothesis.

For non-intensive verbs such as *berühren* or *streichen*, the prediction seems to be confirmed. The percentage of ratings 3 and 4 for non-intensive verbs modified by *leicht* is much higher than the percentage of ratings 3 and 4 for non-intensive verbs modified by *hart*: 89.1% versus 19.23%; more than four times as many! A general linear mixed effects model confirms that this trend is significant: The odds of choosing ratings 3 (maybe good) or 4 (clearly good) over ratings 1 (clearly bad) or 2 (maybe bad) are significantly higher for a non-intensive verb with the adverb *leicht* than for a non-intensive verb with the adverb *hart*: > 100 with $p < .01$ (SE = 1.842).

While the results for non-intensive verbs confirm the predictions of the Intensity Hypothesis, there is still the fact that I found one example in the corpus of *berühren* being modified by *hart*. This example is given in (30) below.

- (30) aber das Heck des Schiffes - wahrscheinlich vom Wind
 but the stern of.the ship - probably from.the wind
 gedrückt - hart den Boden berührte.
 pressed - hard the ground touched
 ‘but the stern of the ship - probably pressed by the wind - touched the ground hard.’

In this example, however, it might be reasonable to assume that *berühren* has some specialist nautical meaning additions which make it unsuitable as a general representative of non-intensive force verbs. Or else that sentence is simply infelicitous. After all, a corpus is not necessarily a collection of only felicitous sentences. Even in the questionnaire study, in 19.23% of the cases, participants thought combinations of non-intensive verbs and the adverb *hart* to be felicitous. One occurrence in a corpus thus presents weak evidence when compared to 80.87% of ratings 1 (clearly bad) and 2 (maybe bad) in a questionnaire study systematically investigating the issue.

This restriction on the modification of non-intensive verbs through *hart* might be another reason for the relatively low amount of ratings 3 and 4 for force verbs in their basic use modified by *hart* (52.55%, when the prediction was that these sentences are felicitous, cf. the discussion above). I reasoned above that this low percentage of ratings 3 and 4 might be due to the *tight* meaning of *hart*, making stimuli that do not entail potentially tight contact between two objects less felicitous by comparison. It now seems that the interaction with intensity distinction also influences the ratings for basic force verbs modified by *hart*. The basic force verbs in my stimuli set included both intensive and non-intensive verbs. Since non-intensive verbs can apparently not easily be modified by *hart*, these stimuli then ‘pull down’ the ratings for basic force verbs modified by *hart*.⁸

⁸Unfortunately, I cannot show whether this interaction effect is statistically significant, since interaction effects require more observations than simple effects to be statistically visible. And there were already too few observations to converge the model of basic versus resultative force verbs modified by *hart* above.

Unlike the results for non-intensive verbs, the results for intensive verbs contradict the predictions from the Intensity Hypothesis. There is only a slight preference for intensive verbs with the adverb *hart* over *leicht*: 66.6% and 57.65% of ratings 3 and 4 respectively. A general linear mixed effects model shows this difference to not be significant: The odds of choosing ratings 3 or 4 for sentences containing an intensive force verb modified by *hart* are 1.72 times the odds of choosing ratings 3 or 4 for an intensive force verb modified by *leicht*, with $p = .7$ (SE = 1.4316).

Please note, though, that the percentages of ratings 3 and 4 are generally not very high for intensive verbs and might point to some reluctance on the part of the participants to have the force component of intensive verbs modified in either direction. But being unable to say more about this, I will simply point out that the majority of the participants judged sentences with intensive verbs and both force increasing and force decreasing modifiers as felicitous.

It might be that the high force magnitude requirement of intensive verbs is less hard-wired in the lexicon than the low force magnitude requirement of non-intensive verbs. In Chapter 6, I will present an analysis of force verbs that includes these intensity distinctions. I will assume that intensive verbs can be coerced to a lower force magnitude by force decreasing modifiers like *leicht*.

To summarise, it seems that non-intensive verbs, i.e. verbs that are lexically specified for a low force magnitude, can only felicitously be modified in the direction of less force, while intensive verbs, i.e. verbs that are lexically specified for a high force magnitude, can be modified in both the direction of less and more force.

Finally, a remark on the difference in the amount of ratings 3 and 4 for the modification through *leicht* and *hart* of force verbs like *schlagen*, i.e. force verbs that are unspecified with respect to the force magnitude: 55.8% and 85.2% respectively. In Chapter 3, I reported on the result of a questionnaire study testing the interpretation of *schlagen* in unmodified use. I found evidence that *schlagen* without a modifier is typically understood as describing a hit with a high force magnitude, as seen by the relatively lower felicity of *schlagen, aber hart* (hit, but hard) compared to *schlagen, aber leicht* (hit, but lightly), where the adverb denies expectations about the force of the hit (cf. the discussion of the denial-of-expectation construction in Chapter 3). Given the difference in the percentage of ratings 3 and 4 for modification of force verbs by *leicht* versus *hart* observed here, I conclude that this typicality effect, i.e. the tendency to interpret unspecified force verbs as hard, makes *leicht* a felicitous but less preferred modifier of force verbs.

5.4 Summary and conclusion

In this chapter, I presented a more elaborate exploration of the domain of force verbs in German. In particular, I was interested in the range of verbs making up this domain. In Chapters 2, 3 and 4, I mostly used the German verb *schlagen*

(~ to hit) as a typical verb of contact by impact in German.

In order to find more verbs with a force component I conducted a corpus study in German. I searched for verbs co-occurring with the adverbs *leicht* (lightly) and *hart* (hard). In Chapter 2, I presented evidence that these adverbs modify the force component of verbs. Verbs co-occurring with these adverbs can therefore be assumed to have a force component.

The results from the corpus study confirm that *schlagen* is a member of the force verb domain. Further, continuous verbs, i.e. verbs that express a continuous exertion of force such as e.g. *drücken* (to push/press), are also included in this domain (in Levin 1993 these verbs are classified as verbs of exerting force). Both *schlagen* and *drücken* can combine with particles to form particle verbs such as *aufschlagen* (to hit (on)) or *ausdrücken* (to squeeze out). Some of these particle verbs entail a change of state, i.e. they form resultative constructions. This is the case for *ausdrücken*, which means that a container is emptied as a result of squeezing it. The evidence from the corpus study is that the adverb *leicht* when modifying a particle verb that entails a change of state does not mean *low force* but rather *a little* (there were no instances of *hart* modifying a particle verb that entails a change of state).

Finally, some verbs found in the corpus are lexically specified for a specific force magnitude, e.g. *berühren* (to touch) requires a low force magnitude and *pressen* (to press) requires a high force magnitude. These lexical specifications influence the co-occurrence frequencies of these verbs with the adverbs *leicht* and *hart*. Intensive verbs like *pressen* co-occur only with *hart*, non-intensive verbs like *berühren* occur more with *leicht*.

In Section 5.2.1, I formulated a definition of force verbs in German that a) takes into account the observations from the corpus study and b) allows one to classify other verbs as force verbs as well. In a nutshell: force verbs can be used to describe the exertion of a force on an object via contact, without implying any change in the position or state of that object, although force verbs can also have a resultative use when combined with a resultative particle or preposition.

Verbs that fall under this definition can differ in a variety of ways. There are lexical distinctions such as the directional distinctions expressed in e.g. *drücken* (to push/press), where the force is directed towards the recipient or *ziehen* (to pull), where the force is directed away from the recipient; the intensity distinctions mentioned above and aspectual distinctions (a continuous force exertion as expressed in *drücken* or a momentary force exertion as expressed in *schlagen*). There are also distinctions with respect to the verbs' compositional or selectional behaviour, such as the complementary selectional restrictions of *drücken* and *ziehen*: $\sqrt{\text{auf}}/*\text{an etwas drücken}$ (to push/press $\sqrt{\text{on}}/*\text{on something}$) and $*\text{auf}/\sqrt{\text{an etwas ziehen}}$ (to pull $*\text{on}/\sqrt{\text{on something}}$).

In Section 5.3, I presented the results from a questionnaire study concerning two observations about force verbs: the force result - force modification incompatibility, and the compositional implications of lexical intensity distinctions.

Concerning the first observation, I wanted to know whether the observed inability of resultative force verb constructions to be modified by the force

adverbs *leicht* and *hart* holds for a wider range of constructions and native speakers. I further wanted to know whether there is a general restriction on modification of force verbs in resultative constructions, or if this restriction only holds for the force component. The questionnaire study confirmed that a) the inability to be modified by *leicht* or *hart* does indeed hold for a wider range of resultative force verb constructions and b) that this modification restriction only holds for the force component. The force-unrelated modifiers *langsam* (slowly) and *schnell* (quickly) result in felicitous sentences when combined with force verbs in a resultative construction.

Concerning the second observation, the different co-occurrence frequencies of the adverbs *leicht* and *hart* with intensive and non-intensive force verbs do not provide direct evidence for the compositional implications of the different lexical force magnitude specifications. After all, the absence of a construction from a corpus does not necessarily mean that this construction is infelicitous. I therefore explicitly tested the acceptability of intensive and non-intensive force verbs with the adverbs *leicht* and *hart*. While non-intensive verbs such as *berühren* can indeed not felicitously be modified by force increasing adverbs, intensive verbs such as *pressen* seem to be more loosely specified for a high force magnitude and can be modified by force decreasing adverbs just as well as by force increasing adverbs.

The observations presented in this chapter show a very diverse picture of the force component. The distinctions between force verbs presented here cannot easily be modelled by assuming a primitive notion of force in the lexical entries of verbs and adverbs, as I have done in Chapter 4. In the next chapter, I will therefore present an extended Neo-Davidsonian Event Semantic analysis, which models the force component as composed of force vectors with an origin, a magnitude and a direction. This allows me to give a more accurate semantics of force verbs and correctly represent their complex force-related properties.

CHAPTER 6

Force vectors in verb semantics¹

In the previous chapter, I have presented the domain of force verbs in German, based on findings from a corpus and a questionnaire study. I defined force verbs as verbs that can be used to describe the exertion of a force by one person or object on another person or object through contact. Force verbs don't imply a change in the position or state of the second person or object, although they can have a resultative use. Examples of force verbs are *schlagen* (to hit) or *drücken* (to push/press). I have shown that force verbs differ from each other in a number of respects. The direction of the force can be towards the person or object on which it is exerted, as in situations described by *drücken*, or it can be away from the person or object, as in situations described by *ziehen* (to pull). Force verbs can also differ with respect to the duration of the force exertion: the force is exerted only momentarily in situations described by *schlagen*, but continuously in situations described by *drücken* or *ziehen*.

In Chapter 4, I modelled the force component in verbs as a primitive, something that cannot be further decomposed. In that chapter, the force component is represented as $\text{FORCE}(e) = f$, which does not allow a systematic integration of direction or duration of the force exertion. The analysis developed in Chapter 4 falls short of accommodating the whole domain of force verbs as laid out in the previous chapter.

In this chapter, I will therefore propose an extended Neo-Davidsonian analysis of force verbs, including not only events, but also paths and force vectors. This allows me to model all of the distinct properties of the force component

¹Parts of the analysis presented in this chapter have been published in Goldschmidt & Zwarts 2016.

via the general vector properties origin, direction and magnitude.

The chapter is structured as follows: in Section 6.1, I will present some theoretical background about Force Dynamics, which goes back to Talmy (1988, 2000), but was picked up and extended by a.o. Wolff (2007); Gärdenfors (2014). This framework will provide the basic notions for the analysis I develop, especially the use of a vector model to explain the representation of forces in the mind. In Section 6.2, I will pick up the analysis from Chapter 4 and show a number of problems that arise with the standard analysis, such as its inability to account for the preposition selection requirements of force verbs or entailment relations between the non-resultative and resultative uses of force verbs. In Sections 6.3, 6.4, 6.5 and 6.6, I will present the extended Neo-Davidsonian analysis, which makes use of force vectors and paths to model the force component. Based on this, Section 6.7 contains the answers to the problems presented in Section 6.2, showing that the refined version of the force component can accurately model the whole force domain, as well as account for the previously puzzling observations like preposition selection or entailment relations.

6.1 Force Dynamics

Force Dynamics as developed by Talmy and others (e.g. Talmy 1988, 2000; Wolff 2007) is a broad framework that aims at analysing causation in physical, psychological and social situations, based on an underlying pattern of two (opposing) forces. This framework is interesting here because it makes use of forces to explain the representation of meaning. In my analysis, I will adopt the idea of modelling forces as vectors, as in Wolff 2007, as well as make crucial use of Wolff's (2007) analysis of causation in terms of vector addition.

Since the scope of my work does not extend beyond the concrete, perceptual, physical domain of forces, in the following I will only review those aspects of this framework that focus on physical situations of force exertion.

6.1.1 Talmy's force-dynamic patterns

Four aspects or components are needed to schematically model the basic force dynamic patterns in Talmy's (2000) framework: the two force entities, agonist (ago) and antagonist (ant); their respective force tendencies, towards action or towards rest; their respective strength, stronger entity or weaker entity; and finally the result of the force interaction, action or rest. With these four components, the basic so-called steady-state force-dynamic patterns can be modelled, cf. Figure 6.1, based on Talmy's Figure 3 (Talmy 2000: 415).

The patterns vary with respect to the four components. In Figure 6.1a, the agonist has a tendency towards rest, marked by the black dot in the circle that represents the agonist. But the antagonist is the stronger entity, marked by the plus in the half box shape that represents the antagonist. Correspondingly, the result of the force interaction is action, marked by the triangle on the line

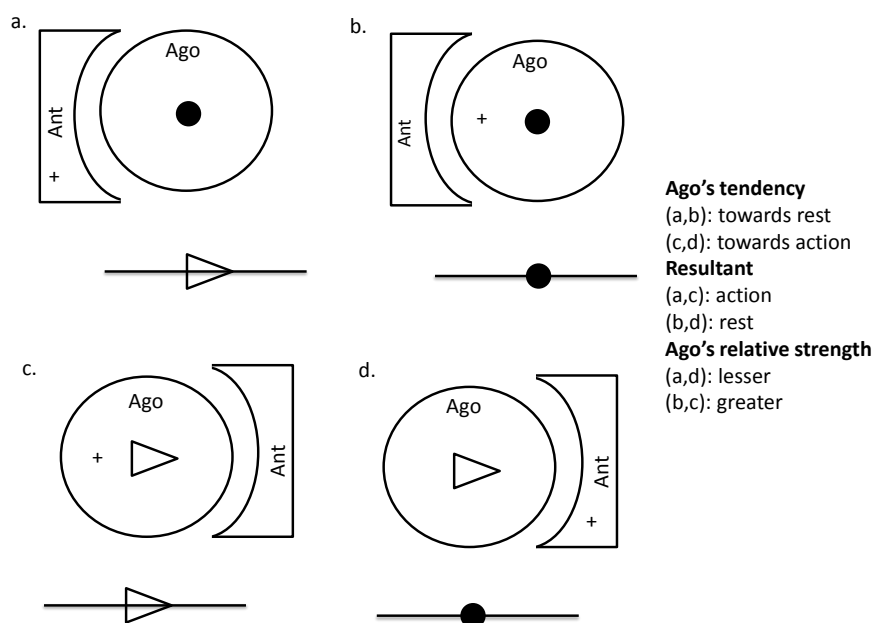


Figure 6.1: The basic steady-state force-dynamic patterns.

beneath the two objects. The force interaction in Figure 6.1b is only minimally different in that the agonist is the stronger entity instead of the antagonist. Consequently, the result of the interaction is rest, not action as in 6.1a.

In Figure 6.1c+d, the force tendencies of the agonist and the antagonist are reversed with respect to the patterns in 6.1a+b. The agonist now has a tendency towards action. In 6.1c, it is the stronger entity, the result of the force interaction is therefore action. In 6.1d, the antagonist is the stronger entity, the result is therefore not action but rest (in accordance with the antagonist's force tendency).

These rather abstract notions can be used to explain the representation of basic, physical causation, as in (1), taken from Talmy 2000: 416.

- (1)
 - a. The ball kept rolling because of the wind blowing on it.
 - b. The shed kept standing despite the gale wind blowing against it.
 - c. The ball kept rolling despite the stiff grass.
 - d. The log kept lying on the incline because of the ridge there.

The sentence in (1-a) describes a situation as modelled in Figure 6.1a. The ball is the agonist, it has a tendency for rest. But because of a stronger antagonist with a tendency for action, the wind, the end result of this force interaction is action, the ball keeps rolling. The opposite pattern is described by the sentence

in (1-c), corresponding to Figure 6.1c. Here, the ball, the agonist, has a tendency for action, maybe because it was kicked or is lying on an incline. The grass, the antagonist, has a tendency for rest. But the ball is the stronger entity, e.g. through being kicked hard enough or the incline being steep enough, so it keeps rolling despite the stiffness of the grass; the result of the force interaction is thus action.

The sentences in (1-b)+(1-d) describe different situations, in that the final result of the force interaction is rest. Sentence (1-b) corresponds to Figure 6.1b. The agonist, the shed, has a tendency for rest. Being the stronger entity, it can manifest this tendency despite the continuous force of the wind, the antagonist, blowing against it. In sentence (1-d), corresponding to Figure 6.1d, the agonist, the log, is in rest despite its tendency for action, because of a stronger antagonist, the ridge, continuously exerting a force on it and preventing it from going into action (rolling down the incline).

The four components as illustrated in Figure 6.1 can thus be used to analyse the meaning of causative prepositions and conjunctions such as *despite* and *because*, modelling them as a basic relation of opposing forces.

Talmy extends this basic analysis in a number of ways, a.o. to what he calls shifting force-dynamic patterns. In those cases, a stronger antagonist is removed from a situation, as in for example *The plug's coming loose let the water flow from the tank*, or appears later, as in *The ball's hitting it made the lamp topple from the table* (Talmy 2000: 418). All these extensions are based on the basic pattern as summarised here.

I will now turn to the work by Wolff (e.g. Wolff 2007), who extended Talmy's basic analysis by incorporating force vectors and vector addition into a model of causation, which will play a crucial role in my own analysis later on.

6.1.2 Force vectors and causation

Wolff (2007) implements and extends Talmy's force dynamic analysis of causation in his dynamics model. Wolff's (2007) dynamics model is a physicalist model of causation and has two levels at which force interactions between two entities are modelled: the category level and the computational level.

The category level is based on Talmy (1988, 2000). Instead of Talmy's four components, Wolff only uses three components: "the tendency of the patient² for the endstate, the presence or absence of concordance between the affector and the patient [(whether their forces have the same direction)], and [the patient's] progress toward the endstate" (Wolff 2007: 87).

These three components are sufficient to capture the semantics of a.o. the above mentioned causative preposition and conjunction/verb *despite* and *(be)cause*.

- (2) a. The river flooded the town despite the dikes.

²Wolff uses the term *patient* for Talmy's agonist, and the term *affector* for Talmy's antagonist.

- b. The wind caused the boat to heel.

To illustrate, the sentence in (2-a) (Wolff 2007: 88, ex(4d)) describes a situation where the river, the patient, has the tendency to flood the town, the endstate. There is no concordance between the river and the dikes (the affector), the dikes are there to prevent the river from flooding the town. However, in the case of the situation described in (2-a), the river reaches the endstate of flooding the town *despite* the dikes.

The situation described by (2-b) (Wolff 2007: 88, ex(4a)) is one of *cause*. The boat, the patient, has no tendency to reach the endstate of heeling. This endstate is reached because of the affector, the wind. There is no concordance between the wind and the boat, therefore, the wind *causes* the boat to heel.

Please note that the component of relative strength that Talmy used as part of his model, as described in Section 6.1.1 above, is missing from the category level in Wolff's dynamics model. This comes back at the computational level.

The computational level implements the category level in terms of force vectors. This is what makes the model a physicalist model: "it holds that people represent causal relations in a manner that partially copies or reproduces the way in which causal relationships are instantiated in the real world" (Wolff 2007: 87). According to Wolff, people represent causation in terms of forces, or rather force vectors.³ Wolff makes a distinction between vectors in the physical world and vectors in people's minds (i.e. representation of the physical-world vectors). He states that:

Vectors in the world are quantities, such as velocity and force, that have a point of origin, a direction, and a magnitude. The vectors in people's representations of causation are more qualitative. Specifically, vectors in people's representations are predicted to be relatively accurate with respect to direction, but are often imprecise with respect to – although they are not completely insensitive to – magnitude. People may sometimes be able to infer the relative magnitude of two vectors, that one is greater than another.

(Wolff 2007: 88)

Even though people are said to be imprecise with respect to the magnitude of the force, Wolff acknowledges that force is a perceptually 'real thing'. One and the same object can feel different, depending on whether it bumps into us gently or hard. That means that the force is felt, not just the object (Wolff 2007: 86).

Using the vector properties of origin, magnitude and direction, Wolff implements the basic force dynamic concepts as specified at the category level. Five

³Wolff extends this beyond the concrete physical causation in the examples discussed so far, by claiming that "people can think about non-physical causal relationships by analogy to physical causation" (Wolff 2007: 87). However, since the scope of my work does not extend beyond concrete, physical situations, I will disregard the role of force vectors in psychological or social causation.

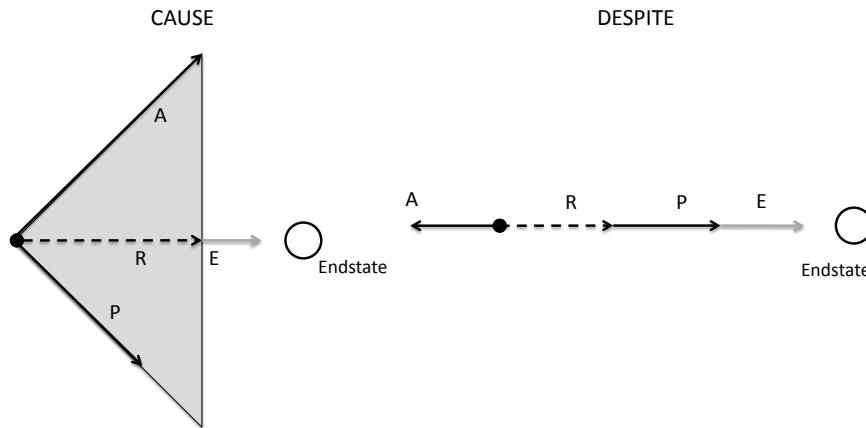


Figure 6.2: Modelling CAUSE and DESPITE with the help of vectors A, P, R and E. The grey area marked in the illustration for CAUSE is the vector span, determining valid resultant vectors R. The vector span for DESPITE is not marked in this Figure (it is collapsed to the line formed by the vectors A and P).

vectors are needed to do this. Four of these are force vectors, of which three are basic: The vectors representing the force exerted by the patient and the affector, P and A respectively, and the vector representing other forces working on the patient, O. Then there is the resultant force vector R. This is the result of the force interaction. It is computed by vector addition, adding vectors P, A and O. Even though this vector addition is predicted to be imprecise in people's representation of real-world vectors, given that the representation of the vectors' magnitude is imprecise, there is a condition attached to the vector addition to which people are sensitive. The resultant vector R must always fall into the span of the other vectors, i.e. into the area demarcated by them (the grey area in Figure 6.2 indicates the span of vectors A and P). This is called the spanning restriction or spanning heuristic. Thus, while people might be unable to compute the precise magnitude of the resultant vector R, they will always be able to tell if it is a true result of the vector addition of P, A and O or not, i.e. whether R meets the requirements of the spanning heuristic.

Finally, there is the position vector E. This vector is used to indicate whether the resultant R points towards the location of the endstate as in situations described by *cause*, or whether it doesn't, as in situations described by for example *prevent* (not discussed here). With the help of these five vectors, situations of a.o. CAUSE and DESPITE can be modelled, cf. Figure 6.2, based on Figures 2, 3 and 4 in Wolff 2007: 89/90.⁴

⁴For simplicity's sake, the force vector modelling other forces acting on the patient, O, is subsumed here under the patient vector P.

The relation between the three aspects of the category level – tendency of the patient towards the endstate, concordance between patient and affector and progress towards the endstate (by the patient) – on the one hand, and the (force) vectors of the computational level on the other hand now becomes clear. If the patient has a tendency towards the endstate, vectors P and E are collinear (as in the illustration for DESPITE in Figure 6.2). If there is concordance between the patient and the affector, vectors P and A are collinear. And finally, if there is progress towards the endstate, vectors R and E are collinear (as in the illustration for both CAUSE and DESPITE in Figure 6.2).

This is all still rather abstract, so let me illustrate this with an example from Wolff. Wolff tests the dynamics model experimentally, making use of visual stimuli where a boat crosses a surface of water with a lighthouse on one side and a set of fans on another. In a situation where the boat was *not* headed towards the lighthouse, but was blown off course by the fans and ended up hitting the light house, Wolff found that people pick the sentence in (3-a) to describe the situation. In a situation where the boat *was* headed towards the lighthouse, and the fans did *not* succeed in blowing it off course, the sentence in (3-b) can be used to describe the situation.

- (3) a. The fans caused the boat to hit the lighthouse.
 b. The boat hit the lighthouse despite the fans.

These situations are perfectly modelled in Figure 6.2. The initial course of the boat corresponds to vector P, the force generated by the patient. The direction of the wind created by the fans corresponds to vector A, the force generated by the affector. The lighthouse corresponds to the endstate, with the spatial vector E pointing towards it to determine the progress towards the endstate. The final course of the boat corresponds to vector R, the resultant of the force interaction. In both cases, the boat reaches the lighthouse, even though in the situation in (3-a), it was not initially headed there. Wolff thus shows how vector semantics can be used to successfully model basic force dynamic interactions.

There is more literature within the field of Force Dynamics, e.g. Copley & Harley (2015), who offer a general compositional framework in which the event argument of any dynamic verb is reanalysed as a force, defined more abstractly as a function from situations to situations. This allows them to analyse even sentences like *Joan baked a cake* in a Force Dynamic framework. Or Roßdeutscher & Pross (2015), who present a force dynamic analysis of the German verb *ziehen* (to pull) in a Distributed Morphology framework, where functional heads introduce discourse referents, such as a region *r* or a force *f*, into the syntax.

However, these authors make a more abstract use of the notion of force, even going beyond force verbs in the case of Copley & Harley (2015), who use the example of *to bake a cake*. Such verbs are beyond the scope of this dissertation, and I will therefore not review these authors in greater detail. Instead, I will now review Gärdenfors (2014), who is not working on causation

and force interactions, but whose work is relevant because of the notion of path and the distinction of force and result that he introduces into the semantics of verbs.

6.1.3 Events and paths in conceptual space

Gärdenfors (e.g. Gärdenfors 2000, 2014) models meaning in conceptual spaces. The underlying idea is that meanings can be represented as regions in a multidimensional space. For example, the colour domain has the three dimensions hue, brightness and saturation. Colour words, or concepts, correspond to convex regions in this domain.⁵ In this system, the term *red* refers to a convex region of specific hues, brightnesses and saturations. The types of concepts Gärdenfors deals with often have prototype structures. That means that the region is defined by distance from a prototype.

Gärdenfors (2014) models verb semantics as based on events which in turn are based on a conceptual space of force patterns. These force patterns consist of force vectors that are reminiscent of those by Wolff (2007); they have an origin, a direction and a magnitude. Event descriptions correspond to specific force patterns. Gärdenfors describes a prototypical event as follows:

A prototypical event is one in which the action of an agent generates a force vector [...] that affects a patient, causing a change in the state of the patient (more generally a path of changes).
(Gärdenfors 2014: 160)

As an example, he discusses the event of pulling a sledge up a hill, cf. (4).

(4) Joan pulls the sledge up the hill.

In this event, Joan, the agent, generates a force vector that is described by *pull*. The change in location of the sledge, the patient, is represented by a result vector starting at the location of the patient before the change and ending at the location of the patient after the change, in this example *up the hill*.⁶ This is modelled in Figure 6.3, based on Gärdenfors's (2014: 161, Fig 9.1).

In this example, again reminiscent of Wolff (2007), Gärdenfors also takes other forces into account that might work on the patient, in the current example e.g. the friction on the sledge and gravity. It is due to these so-called counterforces that the force vector generated by Joan and the result vector of the sledge are not parallel (Gärdenfors 2014: 161). The result is in a sense the result of combining Joan's force with the counterforces (recall the spanning heuristics discussed in Section 6.1.2 above).

⁵Convex regions are defined such that for every two points in this region, the straight line that connects them must also lie in this region. So triangles, circles and squares are all convex, but stars, for example, are not. There can be no gaps in the space, roughly speaking.

⁶Please note that this is different from the vector system developed by Wolff (2007), whose force vectors do double duty in the sense of also modelling motion (of e.g. a boat across a pool of water).

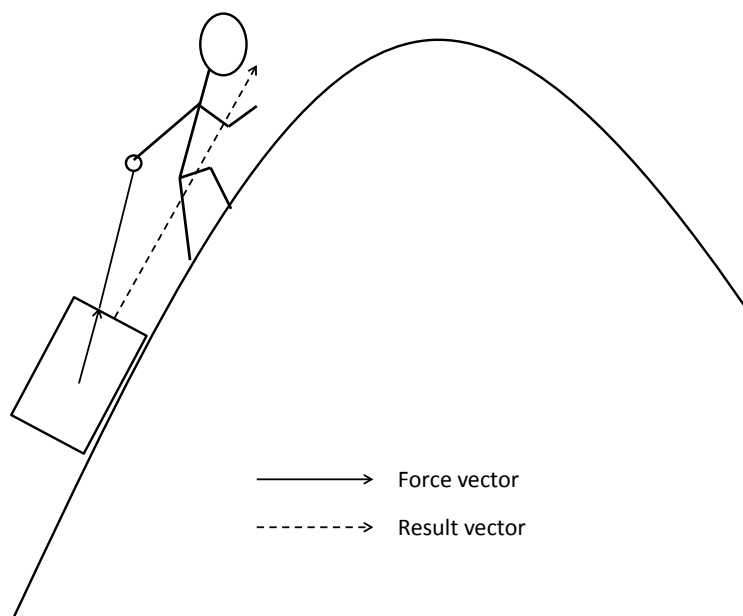


Figure 6.3: A schematic representation including the force and result vectors for the sentences *Joan pulls the sledge up the hill*.

Please note that a result (vector) depends on a non-zero force (vector). If the agent exerts no force, the patient does not change location (or other properties). However, this does not mean that a non-zero force (vector) automatically leads to a result (vector). For example, people can exert a force on a prop to prevent it from falling, e.g. *Joan's holding it prevented the ladder from falling over*. In this case, the result vector is the identity vector, i.e. it has zero length (it is a point), and the event is a state (Gärdenfors 2014: 163).

These event descriptions form the basis of verb semantics. According to Gärdenfors, a verb root lexicalises only one of the vectors, either the force vector or the result vector. This is motivated by the Single-Domain Thesis for Verbs: “The meaning of a verb root is a convex region of vectors that depends only on a single domain” (Gärdenfors 2014: 184). For example, the verb *to push* refers to the force vector of an event and therefore to the force domain. The verb *to move* on the other hand refers to a change of location and therefore to the result vector in the visio-spatial domain.

The Single-Domain Thesis for Verbs corresponds to the manner-result complementarity observed by a.o. Levin & Rappaport Hovav (2013). Gärdenfors says that “manner verbs refer to force vectors of events, while result verbs refer to result vectors” (Gärdenfors 2014: 188).

According to Gärdenfors, adverbs can modify a single force vector, as in (5-a), where *softly* reduces the magnitude of the force vector expressed by *to push*. Or the adverb modifies the result, as in (5-b), where *crookedly* provides information about the form of the resulting path (Gärdenfors 2014: 233), which in Gärdenfors' theory is modelled as a result vector, cf. Figure 6.3.

- (5) a. She pushed the door softly.
b. She crossed the park crookedly.

Crucially, adverbs modifying the magnitude of the force vector should apply to verbs expressing the force vector of the event, such as *to push*, and not to verbs expressing the result vector of the event, such as *to cross*. After all, force vectors are unique to the force domain in Gärdenfors' model. Remember the findings from the corpus and questionnaire studies in Chapter 5, that once a force result is specified via a particle or preposition, modification of the force component is less felicitous. This seems to correspond to the observations made by Gärdenfors (2014). In Section 6.3, I will show how I make use of Gärdenfors' notions to analyse my findings in Neo-Davidsonian Event Semantics.

This concludes my summary of work by Gärdenfors. Please note though that this is not the only work making use of the notion of path in event descriptions (for more on paths in events see Zwarts 2006 and references therein).

In the next section I will illustrate a number of problems arising with the event-semantic analysis of force verbs and adverbs I developed in Chapter 4. Following that, I will take crucial notions from the literature on Force Dynamics and paths as presented above and work them into an extended Event Semantic analysis.

6.2 The (Neo-)Davidsonian starting point

In this section, I will build on the analysis presented in Chapter 4. Remember that I established in Chapter 2 that verbs of contact by impact like *hit* have a force component, the magnitude of which can be determined through adverbs such as *lightly* or *hard*. The lexical entries for *hit* and *lightly* as well as the compositional analysis I gave in Chapter 4 are repeated here as (6), (7) and (8).

- (6) $\text{hit} = \lambda y. \lambda x. \lambda e. \exists f [\text{hit}(e) \wedge \text{AGENT}(e, x) \wedge \text{PATIENT}(e, y) \wedge \text{FORCE}(e) = f]$
 (7) $\text{lightly} = \lambda e [\text{MAGNITUDE}(\text{FORCE}(e)) < \text{average}_C]$
 (8) a. Mary hit Joan lightly.
b. $\exists e. \exists f [\text{hit}(e) \wedge \text{AGENT}(e, \text{mary}) \wedge \text{PATIENT}(e, \text{joan}) \wedge \text{FORCE}(e) = f \wedge \text{MAGNITUDE}(\text{FORCE}(e)) < \text{average}_C]$

Following the example in (8-b), the sentences in (9-a) and (9-b) could get an analysis such as that in (10-a) and (10-b). Please note that I chose to label the thematic roles as force arguments, force exiter and force recipient in this

case, as laid out in Chapter 5, instead of the more conventional labels agent and patient used in Chapter 4. Please also note that I follow the standard in Neo-Davidsonian Event Semantics in treating PPs as event modifiers (see also the introduction to Event Semantics in Chapter 4). A preposition is thus a relation between an event and an object.

- (9) a. Maria schlägt (hart) auf den Nagel.
 Maria hits (hard) on the nail
 ‘Maria hits the nail (hard).’
 b. Maria schlägt den Nagel (*hart) in die Wand.
 Maria hits the nail (*hard) in the wall
 ‘Maria hits the nail (*hard) into the wall.’
- (10) a. $\exists e. \exists f [\text{schlagen}(e) \wedge \text{FORCE EXERTER}(e) = \text{maria} \wedge \text{FORCE}(e) = f \wedge \text{MAGNITUDE}(\text{FORCE}(e)) < \text{average}_C \wedge \text{auf}(e, \text{den-nagel})]$
 b. $\exists e. \exists f [\text{schlagen}(e) \wedge \text{FORCE EXERTER}(e) = \text{maria} \wedge \text{FORCE}(e) = f \wedge \text{FORCE RECIPIENT}(e, \text{den-nagel}) \wedge \text{in}(e, \text{die-wand})]$

However, this analysis leads to a number of problems, which I will now illustrate.

Firstly, (9-b) entails (9-a). Every situation of Maria hitting the nail into the wall is a situation in which Maria hits the nail. But the reverse entailment doesn’t hold: Maria could hit the nail without it moving. This is not accounted for by the logical forms in (10-a) and (10-b), because the part *auf(e, den-nagel)* in (10-a) does not follow from anything in (10-b).

Secondly, *den-nagel* is the argument of the preposition *auf* in (10-a), but the argument of the role FORCE RECIPIENT in (10-b), even though the nail plays a similar role in both, undergoing the hitting force. The distinct functions of the phrase *den-nagel* are problematic if we want to maintain that one sentence entails the other.

Thirdly, remember that in Chapter 5, I observed that force verbs exhibit certain selectional restrictions with respect to prepositions. The verb *schlagen* (to hit) requires the preposition *auf* (on), as in in (9-a), and not *an* (on), whereas for *ziehen* (to pull) this is the other way around. At the moment, this cannot be accounted for, because nothing is specified about the relation between SCHLAGEN and AUF in the analysis in (10) (or *ziehen* and *an*).

Fourthly, the PPs in (9-a) and (9-b) make very different contributions to the meaning of the sentence. In (9-a), *auf den Nagel* (on the nail) describes the movement of an instrument used by Maria (a hammer, presumably) onto the nail. *In die Wand* (into the wall) in (9-b), on the other hand, describes the movement of the nail itself (resulting from the movement of the hammer onto the nail) with respect to the wall, the Ground (see Chapter 5 for definitions on the different force arguments that can be expressed by PPs). These different contributions are not reflected in (10-a) and (10-b).

Fifthly, remember from the corpus and questionnaire studies presented in Chapter 5 that the force magnitude for a.o. *berühren* (to touch) is fixed to a

low range (light), and that *berühren* cannot be modified by *hart* (hard). This is different for *schlagen*, which can be modified by both *leicht* (lightly) and *hart* (though when unmodified, *schlagen* is understood as involving a high force magnitude, cf. the questionnaire results presented in Chapter 3). These force distinctions are at the moment not modelled in (10-a).

Finally, as I already discussed at length in the previous chapter, when a (German) force verb is used in a resultative construction as in (9-b), adverbs modifying the force such as *leicht* (lightly) or *hart* (hard) result in infelicitous sentences. Nothing about (10-b) explains this restriction.

The problems are caused by insufficient analyses of the verbs, adverbs and prepositions. Once all their meaning components are analysed, especially the meaning components relating to force, the relations between these words should become clear. My proposal is therefore to extend the analysis in (10-a) and (10-b) to include not only some unspecified force component, but a fully worked out notion of forces based on force vectors. In other words, the force *f* should play a vital role in the definitions of verbs like *schlagen* and prepositions like *auf*.

More specifically, the internal properties of events are accessed through the paths they describe in real or conceptual space, as in e.g. Zwarts (2006); Gärdenfors (2014). Inspired by the use of force vectors in Wolff 2007 and Gärdenfors 2014, I assume that such a path is constituted by a sequence of force vectors representing the force that the force exiter exerts on the force recipient at each point of time during the event. In the case of Maria hitting the nail once (cf. (9-a)) there is in principle one non-zero force vector that corresponds to the actual, punctual contact (or interval of contact) between Maria's instrument/hammer and the nail. As in Wolff 2007, the length of that vector represents the magnitude of the force exerted through that contact. Before and after this point or interval of contact, no forces are exerted by the hammer on the nail and therefore the corresponding force vectors are zero. Zero force vectors have a zero magnitude, but they are still located in space, i.e. they are points in space. This allows for tracing the movement of the hammer throughout the run time of the event (this will be made more explicit in Section 6.3 below).

Inspired by Talmy (2000), I further assume a rather general notion of path, which includes stationary positions as the limiting case. If a person is pushing against a car without moving it, for example, this is thus also a path: the sequence of force vectors that represent the force that the force exiter exerts on (a particular part of) the car (the force recipient) at each point of time during the event. This means that even in a stationary situation where at every moment a force vector is generated in exactly the same place, I classify the interaction as a path, (and this holds even if all the force vectors of this path have the same length and direction).

Finally, I analyse resultative sentences as involving a representation with two events for caused results (Parsons 1990; Pustejovsky 1991; and many following). In (9-b) above, there is then one event associated to *schlagen* (to hit),

and one event associated to *in die Wand* (into the wall). Resultative PPs will thus also introduce events. The entailment can then be accounted for, because the properties of the event associated to *schlagen* will be the same in both resultative sentences as (9-b) and non-resultative sentences as (9-a). The other problems raised above will be accounted for by the requirement on verbs and prepositions or verbs and adverbs to have matching force properties, in order to be composed into semantically well-formed sentences.

At this point, these notions are all rather informal and brief. In the next section, I will properly define the necessary model-theoretic building blocks, which are used to built up the meaning components (Section 6.4), which are then worked into the lexical definitions (Section 6.5).

6.3 Model-theoretic building blocks for a force-based approach

In the following, I will define all the necessary building blocks in turn.

6.3.1 Forces

In the theory presented here, insights from a non-force based vector model (Zwarts & Winter, 2000) are combined with force vectors in the sense of Wolff (2007). I assume a full set of located force vectors that have (i) an origin, (ii) a magnitude and (iii) a direction (the three properties that Wolff (2007) identified, see Section 6.1.2). This set includes zero force vectors, which have an origin, but zero magnitude and no direction. Each set of force vectors with the same spatial origin constitutes a vector space, i.e. all the vectors originating at that point with all possible directions and magnitudes. A vector space has certain algebraic properties, including addition and scalar multiplication (this becomes important later on, when I define meaning components related to direction in Section 6.4).

Crucially, space is accessed exclusively through located force vectors. A zero force vector is equivalent with an old-fashioned point in space. An object that is not exerting a force on another object can then still be located via the origin of the zero force vector. A non-zero force vector f , on the other hand, can be used to represent a force with a magnitude $|f|$ working at point $\text{ORIGIN}(f)$. Note that objects that are exerting a force can still be located through the point of origin of the non-zero force vector, just as objects that are not exerting a force. The difference between zero force vectors and non-zero force vectors is that the former are used exclusively for locating objects and specify nothing about the force (except that there is none), while non-zero force vectors also contain information about the direction and magnitude of the force. Finally, I assume $\text{END}(f)$ to mark the end point of a vector. For non-zero force vectors, the end point is distinct from the origin ($\text{END}(f) \neq \text{ORIGIN}(f)$). For zero force vectors, which do not have a length, the two points are trivially identical.

6.3.2 Objects and space

Objects are represented with a part-whole structure, e.g. a foot is part of the body. Further, SPACE, BOUNDARY and INTERIOR are defined as follows, assuming for simplification that all objects are convex (cf. Zwarts & Winter 2000):

- (11) For every (material) object x , there is a set $\text{SPACE}(x)$ of spatial points that represents the eigenspace of x with a proper subset $\text{BOUNDARY}(x)$ of boundary points and $\text{INTERIOR}(x)$, the complement of the boundary with respect to the eigenspace.

Imagine a cardboard box: Every point on its outside that can be said to be in contact with the surrounding air is the BOUNDARY according to the above definition. The rest of the box is the INTERIOR. Together, BOUNDARY and INTERIOR form the SPACE of the cardboard box (a visualisation is given later in Figure 6.6).

6.3.3 Events in time and space

I standardly assume some mereological structure of events to allow sums (+) of events (Champollion & Krifka, 2016). Events are mapped to time and space:

- (12) a. For every event e , there is the interval $\text{TIME}(e)$ that represents the run time of e .
 b. For any event e , $\text{PATH}(e)$ is the path that corresponds to e , if defined, and that has $\text{TIME}(e)$ as its domain.

These definitions are crucial to link paths to events. This is important, because a path is constituted by force vectors, that is, forces enter into the event description through paths. I will explain this in the next section.

6.3.4 Paths

A path is a continuous function from a time interval $[t_0, t_1]$ to the set of located force vectors (as described in Section 6.3.1 above). This time interval represents the run time of the event (see definition (12-a) below). Roughly speaking, a path p is a sequence of positions at which forces (possibly zero) are exerted. The definition is as follows:

- (13) For every moment t of the run time of an event e : $p(t)$ is the force vector f representing the force exerted by the force exarter of e on the force recipient of e at time t .

As mentioned in Section 6.2, a path p may be constant, i.e. map every t of its domain to the same vector f . This vector can be non-zero, as for *pressing* in Figure 6.4b, where a force exarter is continuously exerting a force on a force recipient. Or the vector can be zero, as for *in* in Figure 6.4d, where there is no

force recipient and therefore no force exerted on a force recipient (constantly throughout the run time of the event).⁷ Crucially, paths that are said to be constant do *not* represent motion. Every moment t of the run time of the event is mapped to the same force vector f . The same vector means the same origin, i.e. a stationary position. In order to model movement, a sequence of force vectors with distinct origins is needed.

A force path is a path that includes non-zero force vectors in its range, i.e. there must be at least one moment during the event at which the force exiter is exerting a force on the force recipient. For example, when hitting someone, there is a moment of contact during which a force is exerted, represented by a non-zero force vector, the length of which is a representation of the magnitude of the force (Figure 6.4a). When pressing on something or someone, there is a continuous exertion of a force by the force exiter onto the force recipient. The verb *pressing* does not describe situations which include moments of no force exertion. Therefore, every force vector making up the path associated to (the event denoted by) *pressing* must be bigger than zero, with its length representing the magnitude of the force exerted at that moment (Figure 6.4b).

If a path contains only zero force vectors, i.e. if there is no force exerted on a force recipient throughout the run time of the event, then this is a spatial path or path of motion. An event of a nail moving *into* the wall is an event with a path of motion. The nail is exerting no force, all force vectors are zero, i.e. points, and allow the tracing of the nail's movement (Figure 6.4c). Please note that in this case we speak of the nail as the Figure (see definition (14-d) below, where FIGURE is defined as possibly being (part of) the FORCE EXERTER). A spatial path is assigned to events such as those denoted by *in*, where no forces are exerted and the Figure is not moving (Figure 6.4d).

Finally, please note that while I make crucial use of the notions of force exiter and force recipient in the definition of paths in (13) above, and use the definition to model the semantics of force verbs only, this definition holds of paths in general, not just of paths associated to events denoted by force verbs. One such example is *in*, which is not a force verb.

6.3.5 Participants of events

The following specifications define the thematic roles for force verbs, as introduced in Chapter 5, and other participants of events. Please note that I assume forces to always be located at the boundary of an object. This will be necessary in order to define different directions of force vectors (see Section 6.4.2).

- (14) a. If $\text{PATH}(e)$ is a force path, then there is a participant $\text{FORCE EXERTER}(e)$ that is the exiter of the force and a participant $\text{FORCE RECIPIENT}(e)$ that is the recipient of the force. Every non-zero

⁷The three snapshots presented for the selection of paths in Figure 6.4, assigned to the events denoted by *hitting*, *pressing*, *into* and *in*, are a subset of a continuous series of situations taking place over the run time of the events.

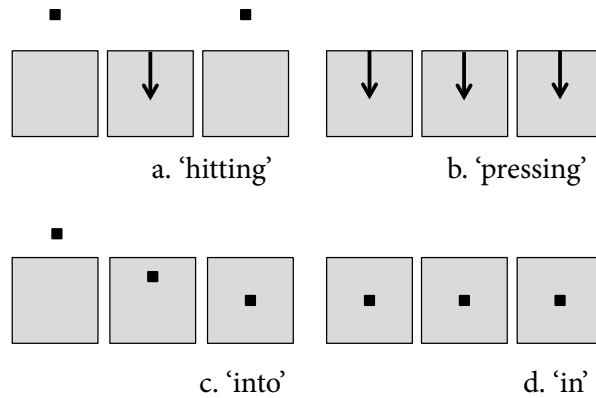


Figure 6.4: Subsequent ‘snapshots’ ($p(t_0)$, $p(t_i)$, $p(t_1)$) from continuous series of situations constituting different paths. The grey box is the force recipient or Ground, the black dot is the force exiter or Figure.

- force vector of the path must be located on the boundary of the eigenspace of $\text{FORCE RECIPIENT}(e)$.
- If $\text{PATH}(e)$ is a force path, then $\text{INSTRUMENT}(e)$ is that part of $\text{FORCE EXERTER}(e)$ that is in forceful contact with $\text{FORCE RECIPIENT}(e)$.
 - If $\text{PATH}(e)$ is a force path, then $\text{ZONE}(e)$ is that part of $\text{FORCE RECIPIENT}(e)$ on which the non-zero force vectors are located.
 - For any event e with $\text{PATH}(e)$, there is a participant $\text{FIGURE}(e)$ that occupies subsequent positions of $\text{PATH}(e)$ during the run time of e . This may be $\text{INSTRUMENT}(e)$.
 - For any event e with $\text{PATH}(e)$, $\text{GROUND}(e)$, if present, is the reference object, that object with respect to which the movement of the $\text{FIGURE}(e)$ is located. If $\text{PATH}(e)$ is a force path, $\text{GROUND}(e)$ is the $\text{FORCE RECIPIENT}(e)$.

Consider the situations described in (15-a) and (15-b).

- (15) a. Maria schlägt mit dem Hammer auf den Nagel.
 ‘Maria hits with the hammer on the nail.’
 b. Maria schlägt den Nagel in die Wand.
 ‘Maria hits the nail into the wall.’

In (15-a), the hammer is the instrument, which together with Maria is the force exiter (the force is exerted *through* the hammer). The nail is the force recipient, which receives the force exerted by the force exiter. But at the same time, there is also a movement component. The hammer is moving towards

the nail before it hits it. The hammer is thus also the Figure, the movement of which is described with respect to the nail, the Ground - the movement is *on the nail*. The different terminology focuses on different aspects of the event: the forceful contact, or the movement that brings about the contact. This is a slight extension of the arguments of force verbs as presented in Chapter 5, where I only briefly mentioned the Ground as the entity which is used to locate the resulting movement, but where the Figure or the movement aspect of force verbs was not discussed.

In (15-b), the nail is the force recipient or Ground, just as in (15-a). But it also serves as the Figure, the thing that moves into the wall. These two roles of the nail in (15-b) are associated to different events, one causing event where the nail is hit (and where it serves as the force recipient), and one caused event where the nail is moving into the wall (and where it serves as the Figure).

Which argument roles are required thus follows from the type of path associated to the event. If the event describes a spatial path or path of motion, the argument roles FORCE EXERTER and FORCE RECIPIENT are not assigned. If the event describes a force path, i.e. a situation of forceful contact, possibly brought about by movement, the force related as well as the motion related argument roles need to be assigned.

6.3.6 Causation

In line with Wolff (2007), I characterise $\text{CAUSE}(e_1, e_2)$ as follows:⁸

- (16) $\text{CAUSE}(e_1, e_2)$: if $\text{PATH}(e_1)(t_i) + \text{TENDENCY}(e_1)(t_i)$ is collinear with $\text{PATH}(e_2)$ while $\text{TENDENCY}(e_1)(t_i)$ is not.

In words: $\text{CAUSE}(e_1, e_2)$ holds if the force recipient's (force) tendency ($\text{TENDENCY}(e_1)(t_i)$) does not point in the direction of the path associated to the second event ($\text{PATH}(e_2)$), but the resultant of the force exorter's force ($\text{PATH}(e_1)(t_i) + \text{TENDENCY}(e_1)(t_i)$) does. This captures Talmy's insight that the force exorter (antagonist, in Talmy's terminology) in a causal interaction overcomes the tendencies of the force recipient (agonist, in Talmy's terminology).

Consider the previous example of a resultative use of a force verb, repeated here in (17). The force interaction in this case can be schematically modelled as in Figure 6.5.

- (17) Maria schlägt den Nagel in die Wand.
'Maria hits the nail into the wall.'

The force exorter's force in this case is the force that Maria exerts on the nail at the moment of contact, represented with the non-zero vector ($\text{PATH}(e_1)(t_i)$)

⁸To keep things simple, I assume that it is possible to single out one moment t_i of event e_1 that gives us the interacting forces of that event. I refrain from a definition of collinearity here, especially one that captures the collinearity between a vector and a path. But the idea should be intuitively clear.

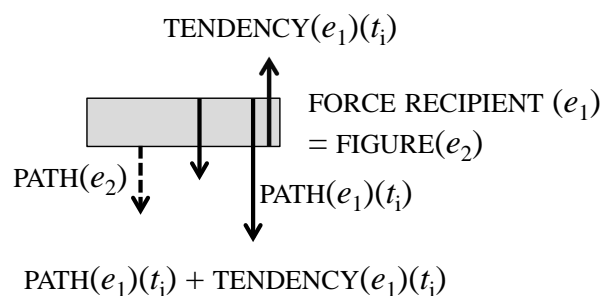


Figure 6.5: Force interaction in $CAUSE(e_1, e_2)$ at moment t_i .

in Figure 6.5. The force recipient's tendency ($TENDENCY(e_1)(t_i)$) subsumes all other forces working on the force recipient (this corresponds to Wolff's vectors O and P, or Gärdenfors's counterforces). These can be for example the density of the material of the wall, blocking the nail from moving into it, or gravity, if one wants to hit a nail into the ceiling. Crucially, the forces subsumed under $TENDENCY(e_1)(t_i)$ do not work in the same direction as the force in $PATH(e_1)(t_i)$. Because the force exorter's force is higher than the force recipient's tendency (modelled through a longer arrow in Figure 6.5), the resultant vector, $PATH(e_1)(t_i) + TENDENCY(e_1)(t_i)$, has the same direction as the path of motion ($PATH(e_2)$) of the force recipient/Figure (the nail). The path of motion is indicated in Figure 6.5 with the dashed arrow (not a vector, but a sequence of zero vectors, i.e. points). The force interaction in e_1 therefore counts as causing e_2 , and in that way I represent that the hitting in event e_1 causes the movement in e_2 .⁹

If the nail is hit without it moving into the wall, the forces subsumed under $TENDENCY(e_1)(t_i)$ have a higher or equal magnitude compared to $PATH(e_1)(t_i)$, and therefore neutralise the effects of the force exerted by the force exorter.

⁹The role of the spanning heuristic as discussed in Section 6.1.2 is not marked in the illustration in Figure 6.5. But I assume it as a condition on $CAUSE(e_1, e_2)$ to determine valid resulting movement (valid with respect to direction). And it is (trivially) satisfied here: $PATH(e_1)(t_i) + TENDENCY(e_1)(t_i)$ is in the same direction as $PATH(e_1)(t_i)$, hence also in the area it spans.

6.4 Meaning components

The model-theoretic building blocks given in Section 6.3 can now be worked into the necessary meaning components. In order to facilitate reading a bit, I will wherever possible indicate what function the meaning components serve, i.e. which aspects of which force verbs they help to distinguish.

6.4.1 Aspectual components

As discussed in Chapter 5, force verbs differ with respect to aspect. The verb *schlagen* (to hit), for example, requires only a momentary or punctual exertion of force, i.e. only one non-zero force vector. But *ziehen* (to pull) or *drücken* (to push/press) denote a continuous exertion of force. I treat the aspectual components PUNCTUAL and CONTINUOUS as properties of the path p :

- (18) a. PUNCTUAL(p) iff $\exists!t [|p(t)| > 0]$
 b. CONTINUOUS(p) iff $\forall t [|p(t)| > 0]$

In words: A path p is punctual if and only if there is exactly one moment t during the run time of the event at which the magnitude of the force vector is bigger than zero.¹⁰ A path p is continuous if and only if for all moments t during the run time of the event the magnitude of the force vector is bigger than zero.

The lexical semantics for *schlagen* will have to contain the meaning component PUNCTUAL in order to correctly model the momentary exertion of force, cf. (19). There is one moment in which the force exarter is in contact with the force recipient, and the force that is exerted through this momentary contact is modelled with one non-zero force vector, the length of which models the magnitude of the force (see Figure 6.4a above for an illustration).

- (19) SCHLAGEN = $\lambda e. \exists p [p = \text{PATH}(e) \wedge \text{PUNCTUAL}(p) \dots]$

Similarly, the semantics for verbs like *ziehen* and *drücken* will have to contain the meaning component CONTINUOUS, cf. (20) and (21) respectively. These verbs describe events in which the force exarter is in continuous contact with the force recipient, exerting a force all the time. Since there is no moment in the event during which no force is exerted, there can be no zero force vectors (see Figure 6.4b above for an illustration).

- (20) ZIEHEN = $\lambda e. \exists p [p = \text{PATH}(e) \wedge \text{CONTINUOUS}(p) \dots]$

- (21) DRÜCKEN = $\lambda e. \exists p [p = \text{PATH}(e) \wedge \text{CONTINUOUS}(p) \dots]$

¹⁰The restriction to one moment is a bit of a simplification. It might actually be a small interval.

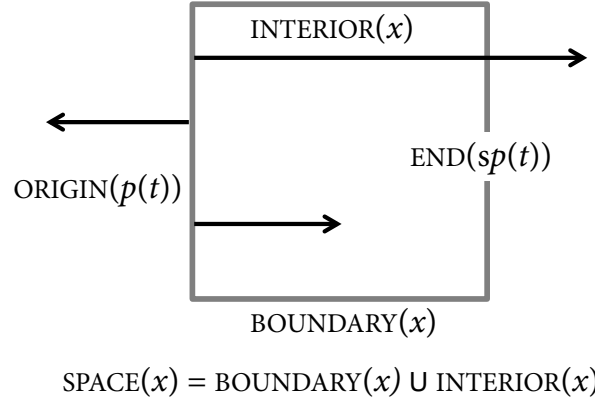


Figure 6.6: Illustration of the directional meaning components $\text{EXTR}(p, x)$ and $\text{INTR}(p, x)$.

6.4.2 Directional components

Force verbs also differ with respect to directionality. There are verbs like *drücken* (to push/press) and *schlagen* (to hit), where the force is directed towards the force recipient (internally directed) and there are verbs like *ziehen* (to pull), where the force is directed away from the force recipient (externally directed). There are also verbs like *reiben* (to rub) and *streichen* (to stroke), which are internally directed (the pressure of rubbing and even stroking is felt on the skin, the force is thus directed towards the skin/force recipient), but require distinct origins for distinct force vectors. This is necessary to model the movement over a surface: at every moment of time, the force is exerted in a different position. The definitions of internally directed force vectors (INTR) and externally directed force vector (EXTR) are as follows (illustrated in Figure 6.6):

- (22) a. $\text{INTR}(p, x)$ iff $\exists t. \exists s [\text{ORIGIN}(p(t)) \in \text{BOUNDARY}(x) \wedge s > 0 \wedge \text{END}(sp(t)) \in \text{INTERIOR}(x)]$
 b. $\text{EXTR}(p, x)$ iff $\exists t. \forall s [\text{ORIGIN}(p(t)) \in \text{BOUNDARY}(x) \wedge s > 0 \wedge \text{END}(sp(t)) \notin \text{SPACE}(x)]$

Additionally, MOVING is defined in (23).

- (23) $\text{MOVING}(p)$ iff $\forall t. \forall t' [t \neq t' \rightarrow \text{ORIGIN}(p(t)) \neq \text{ORIGIN}(p(t'))]$

In words: a non-zero force vector $p(t)$ is internally directed with respect to an object x if and only if there is a multiplied version (by a scalar s greater than zero: $sp(t)$) which has its endpoint in the interior of x . This makes both rightward directed vectors in Figure 6.6 internally directed vectors. For both vectors one can find some positive scalar multiple that brings the endpoint of

the vector within the interior of that box-like object (as is already trivially the case with the shorter of the two vectors). It does not matter that there are other positive scalar multiples that result in the endpoint of the vector being outside of the box-object. The important point is that the vector goes through the box, i.e. that there is some scalar multiple that results in the endpoint of the vector being *inside* the box object (this is expressed by the existential quantifier \exists in (22-a)).

On the other hand, a non-zero force vector $p(t)$ is externally directed with respect to an object x if and only if there is no multiplied version (by a scalar s greater than zero) which has its endpoint inside the space of x . This is true for the leftward directed vector in Figure 6.6. No matter which positive scalar multiple one applies, the endpoint will never be part of the space of the box object (neither boundary nor interior). The important point here is that the vector does not go through the box, i.e. that all scalar multiples result in the endpoint of the vector being outside of the box-like object (this is expressed by the universal quantifier \forall in (22-b)). Please note that the convexity assumption of objects (see Section 6.3.2) becomes crucial here: the definition in (22-b) does not hold for objects with curved shapes, because if you have a vector pointing outwards from e.g. the side of a star, given the right scalar multiple, that vector then has its endpoint in another arm of the star. Note also that both internally and externally directed force vectors have their origin at the boundary of the object x .

The definitions for INTR and EXTR are crucial in the semantics of *drücken* and *ziehen* respectively, cf. (24) and (25). When pushing an object, the force is directed from the force exiter towards that object, as in e.g. pushing against a door. When pulling an object, on the other hand, the force is directed away from the object and towards the force exiter, as in e.g. pulling on a door (when the force is directed away from the force recipient, this requires the force exiter to be somehow attached to the force recipient, see for a discussion Bowerman 1996).

$$(24) \quad \text{DRÜCKEN} = \lambda e. \exists p [p = \text{PATH}(e) \wedge \text{INTR}(p, \text{FORCE RECIPIENT}(e)) \dots]$$

$$(25) \quad \text{ZIEHEN} = \lambda e. \exists p [p = \text{PATH}(e) \wedge \text{EXTR}(p, \text{FORCE RECIPIENT}(e)) \dots]$$

Finally, a path counts as moving if and only if for all distinct moments of time during the event, the force vectors modelling the force exerted at those moments do not have the same origin. Imagine rubbing over a spot in the tablecloth with your thumb. What distinguishes the rubbing from just pressing your thumb onto the tablecloth is that you move your finger, i.e. the force you exert on the tablecloth is exerted in different locations throughout the event described as rubbing. In order to correctly model this in the semantics of verbs such as *reiben*, the definition in (23) is needed, which guarantees that at every moment during the run time of the event, the force is exerted in a different location. That is, the force vectors modelling the force exerted throughout the event have different origins. But please note that (23) defines only one move

from location A to location B, not repeatedly moving between these locations (as would be the case in most rubbing events: usually you repeatedly rub over a spot to make it fade). In order to model multiple moves, plurality needs to be introduced at some level (see Section 6.5.1 below).

In addition, the definition in (22-a) is needed in the semantics of verbs such as *reiben*. Remember, the force vectors for *reiben* are internally directed, as the rubbing is felt on the skin as pressure. A partial definition of *reiben* is given in (26).

$$(26) \quad \text{REIBEN} = \lambda e. \exists p [p = \text{PATH}(e) \wedge \text{INTR}(p, \text{FORCE RECIPIENT}(e)) \wedge \text{MOVING}(p) \dots]$$

6.4.3 Intensity components

Finally, force verbs differ with respect to intensity. Verbs like *berühren* (to touch) and *streichen* (to stroke) are lexically specified for a low force magnitude. Verbs like *pressen* (to press) and *zerren* (to tug/drag) are lexically specified for a high force magnitude. These intensity distinctions are defined as follows:

$$(27) \quad \begin{array}{l} \text{a. INTENSIVE}(p) \text{ iff } \exists t [|p(t)| > M_c] \\ \text{b. NON-INTENSIVE}(p) \text{ iff } \exists t [|p(t)| > 0] \wedge \forall t [|p(t)| < M_c] \end{array}$$

In words: intensive force paths require at least one moment t during the run time of the event that is mapped to a non-zero force vector with a magnitude higher than some average force magnitude for comparison (M_c , which I assume here to be above zero). For non-intensive force paths there needs to be at least one moment during which a non-zero force vector is exerted (otherwise the path would be classified as a spatial path, cf. the definition in Section 6.3.4 above that states that spatial paths have only zero force vectors). But for all moments t of the run time of the event, the magnitude of the force vector needs to be lower than some average. The requirement of at least one *non-zero* force vector is crucial here. If there are only zero vectors, the definition in (27-b) would allow pure spatial paths to be classified as non-intensive. After all, a zero force magnitude is certainly lower than some average force magnitude. But the definitions in (27) are designed to model INTENSIVE and NON-INTENSIVE *force* paths.

The meaning component INTENSIVE needs to be worked into the semantics for *pressen* and *zerren*, cf. (28) and (29). These force verbs require the magnitude of at least one non-zero force vector to be above a certain average. If all non-zero force vectors would have to be above a certain average, this would exclude intensive and punctual force verbs (which I have not documented here, but which might exist) and combinations of punctual force verbs with adverbs like *hart* (hard), the semantics of which will also contain the definition in (27-a), cf. Section 6.5.2 below. As explained above, a punctual force verb is defined by *one* non-zero force vector. The other force vectors are zero (modelling the movement of the force exorter towards the force recipient before the contact

and force transmission). The magnitude of those zero force vectors is then by definition below a certain average magnitude for comparison (for it is zero). If the magnitude of all force vectors needs to be above a certain average in order for a verb or verb-adverb combination to count as INTENSIVE, then those punctual verbs would be excluded.

$$(28) \quad \text{PRESSEN} = \lambda e. \exists p [p = \text{PATH}(e) \wedge \text{INTENSIVE}(p) \dots]$$

$$(29) \quad \text{ZERREN} = \lambda e. \exists p [p = \text{PATH}(e) \wedge \text{INTENSIVE}(p) \dots]$$

For non-intensive force verbs like *berühren* or *streichen*, the problem does not exist. All force vectors need to have a magnitude below a certain average magnitude for comparison. This includes zero vectors. As explained above, an additional condition needs to be defined so that there is at least one non-zero force vector to ensure that the definition does not apply to verbs describing spatial paths or paths of motion.

$$(30) \quad \text{BERÜHREN} = \lambda e. \exists p [p = \text{PATH}(e) \wedge \text{NON-INTENSIVE}(p) \dots]$$

$$(31) \quad \text{STREICHEN} = \lambda e. \exists p [p = \text{PATH}(e) \wedge \text{NON-INTENSIVE}(p) \dots]$$

6.5 Lexical Definitions

In this section, I will show how the meaning components described above come together in the lexical definitions of force verbs and adverbs, particles and prepositions. For each word, I will give the complete lexical entry and illustrate with one example how the meaning components come together to create the desired effects.

6.5.1 Force verbs

With the meaning components properly defined, I am now able to put together the lexical definitions for force verbs. I select the following force verbs in order to illustrate some important properties of and distinctions within the domain of force verbs: *berühren* (to touch), *schlagen* (to hit), *treten* (to kick), *drücken* (to push/press), *pressen* (to press), *ziehen* (to pull), *zerren* (to drag/tug), *streichen* (to stroke) and *reiben* (to rub). All verbs are treated as sets of events.

$$(32) \quad \text{BERÜHREN} = \lambda e. \exists p [p = \text{PATH}(e) \wedge \text{INTR}(p, \text{FORCE RECIPIENT}(e)) \wedge \text{NON-INTENSIVE}(p)]$$

The verb *berühren* is defined as internally directed and non-intensive. As discussed with *reiben* and *streichen* above, the force vectors can be said to be internally directed because the pressure exerted through the force can be felt on e.g. the skin. *Berühren* is unspecified with respect to the aspectual properties, it can be both punctual or continuous.

$$(33) \quad \text{SCHLAGEN} = \lambda e. \exists p [p = \text{PATH}(e) \wedge \text{PUNCTUAL}(p) \wedge \text{INTR}(p, \text{FORCE RECIPIENT}(e))]$$

The verb *schlagen* is defined as punctual and internally directed. It is unspecified with respect to intensity. Remember from the questionnaire results presented in Chapter 3 that unmodified occurrences of *schlagen* usually get interpreted as involving a high force magnitude. But this interpretation is an inference, not hard-wired into the lexical semantics of *schlagen*.

$$(34) \quad \text{TRETEN} = \lambda e. \exists p [p = \text{PATH}(e) \wedge \text{PUNCTUAL}(p) \wedge \text{INTR}(p, \text{FORCE RECIPIENT}(e)) \wedge \text{foot}(\text{INSTRUMENT}(e))]$$

The verb *treten* is very similar to *schlagen*, except that it specifies that the foot is the instrument (remember, the instrument is a part of the force exarter). This verb cannot be used to describe situations where the contact was brought about by anything but the foot of the person who is exerting the force. *Schlagen* is more liberal in this respect, since all manner of instruments can be used: the hand, a hammer, a bat, etc..

$$(35) \quad \text{DRÜCKEN} = \lambda e. \exists p [p = \text{PATH}(e) \wedge \text{CONTINUOUS}(p) \wedge \text{INTR}(p, \text{FORCE RECIPIENT}(e))]$$

The verb *drücken* is defined as continuous and internally directed. *Drücken* is unspecified with respect to intensity, just like *schlagen*. It can be modified to receive both a high force magnitude or a low force magnitude.

$$(36) \quad \text{PRESSEN} = \lambda e. \exists p [p = \text{PATH}(e) \wedge \text{CONTINUOUS}(p) \wedge \text{INTR}(p, \text{FORCE RECIPIENT}(e)) \wedge \text{INTENSIVE}(p)]$$

The verb *pressen* is very similar to *drücken*, except that it is specified for a high force magnitude, i.e. it is intensive. *Pressen* cannot be used to describe situations in which a low amount of force is exerted.

$$(37) \quad \text{ZIEHEN} = \lambda e. \exists p [p = \text{PATH}(e) \wedge \text{CONTINUOUS}(p) \wedge \text{EXTR}(p, \text{FORCE RECIPIENT}(e))]$$

The verb *ziehen* is the opposite of *drücken* with respect to directionality. While *drücken* is defined as internally directed, i.e. the force exarter exerts a force towards the force recipient, *ziehen* is defined as externally directed. The force is directed away from the force recipient (and towards the force exarter). As mentioned above, this definition requires some form of attachment of the force recipient onto the force exarter. Like *drücken*, *ziehen* is unspecified with respect to intensity.

$$(38) \quad \text{ZERREN} = \lambda e. \exists p [p = \text{PATH}(e) \wedge \text{CONTINUOUS}(p) \wedge \text{EXTR}(p, \text{FORCE RECIPIENT}(e)) \wedge \text{INTENSIVE}(p)]$$

The verb *zerren* is very similar to *ziehen*, except that it is lexically specified for a high force magnitude (the same respect in which *pressen* differs from *drücken*).

$$(39) \quad \text{REIBEN} = \lambda e. \exists p [p = \text{PATH}(e) \wedge \text{CONTINUOUS}(p) \wedge \text{INTR}(p, \text{FORCE RECIPIENT}(e)) \wedge \text{MOVING}(p)]$$

The verb *reiben* is defined as continuous, internally directed and moving. As explained above, the force exertion described by *reiben* can be felt (if one imagines oneself as the force recipient), the force vectors can therefore be said to be internally directed (externally directed force would feel different). *Reiben* also expresses a continuous exertion of force, but this force is applied in a distinct location at every moment t of the run time of the event. *Reiben* is thus also specified as MOVING. Please note that in order to capture the repetitive motion that is described by *reiben*, some adjustment needs to be made. For the sake of simplicity, I will not spell this out here, but merely point out some possibilities: plurality could be applied at the level of paths, as done by e.g. Zwarts (2005), or at the level of events (event concatenation) as in done by Rothstein (2004). Finally, *reiben* is unspecified with respect to intensity.

$$(40) \quad \text{STREICHEN} = \lambda e. \exists p [p = \text{PATH}(e) \wedge \text{CONTINUOUS}(p) \wedge \text{INTR}(p, \text{FORCE RECIPIENT}(e)) \wedge \text{MOVING}(p) \wedge \text{NON-INTENSIVE}(p)]$$

The verb *streichen* is very similar to *reiben*, except that it is lexically specified for a low force magnitude, i.e. non-intensive. Please also note that for *streichen*, no plurality needs to be applied to the meaning component MOVING. *Streichen* can be used to describe situations that contain just one move (and not repeated movement over the same spot).

The definitions in (32)-(40) thus show how forces and paths are built into an event-based framework for verbs: a force verb defines a set of events on the basis of properties of the corresponding force paths. All the distinctions that I observed between force verbs in Chapter 5 can now be explained based on distinctions in the force component (modelled here as a path constituted of force vectors): the directional distinctions are explained by differently directed force vectors, INTR, or internally directed force vectors, are part of the path assigned to the event denoted by verbs such as *drücken*; EXTR, or externally directed force vectors, are part of the semantics of *ziehen*. The intensity distinctions between e.g. *pressen* and *drücken* are explained by the length of the non-zero force vectors; the aspectual distinctions between e.g. *schlagen*, which expresses a momentary exertion of force, and *drücken*, which expresses a continuous exertion of force are modelled by making reference to the quantity of non-zero force vectors. All the lexical distinctions between force verbs can thus be captured by distinct properties of the corresponding paths.

6.5.2 Force adverbs

The adverbs *leicht* (lightly) and *hart* (hard) are highly polysemous (see Chapters 2 and 4). The definitions given here are intended only to capture their force related meaning as laid out in Chapter 2. As already indicated in Section 6.4.3 above, the meaning components INTENSIVE and NON-INTENSIVE are used in the semantics of these force adverbs. Note that these force adverbs, unlike the force verbs introduced above, are defined as denoting sets of paths, not sets of events. In Section 6.6, I will introduce a type shift to event denotations.

$$(41) \quad \text{LEICHT} = \lambda p [\text{NON-INTENSIVE}(p)]$$

The adverb *leicht* makes use of the same meaning component as non-intensive force verbs such as *berühren* (to touch) or *streichen* (to stroke): NON-INTENSIVE. A force path counts as LEICHT if it is non-intensive, i.e. all non-zero force vectors have a magnitude below some average for comparison (and there is at least one force vector with a magnitude that is above zero, see also the discussion in Section 6.4.3).

$$(42) \quad \text{HART} = \lambda p [\text{INTENSIVE}(p)]$$

The adverb *hart* needs the meaning component INTENSIVE, just as intensive force verbs. A force path counts as HART if it is intensive, i.e. if there is at least one non-zero force vector whose magnitude is higher than some average for comparison.

Please note that (41) and (42) are crucially different from the semantics I gave for *leicht* and *hart* in Chapter 4. In that chapter, I presented the adverbs as though the type shift that shifts them to sets of events had *already* been applied. I did that, because the notion of the force component I used was primitive. That is, I was unable to specify exactly what these adverbs modify: the force component, but then how is the magnitude built into that? I lacked the systematic analysis of the force component as paths constituted by force vectors with an origin, a direction and a magnitude. Here, the adverbs are treated as sets of (force) paths, and via the properties of the paths, the force magnitude can be accessed. Working force vectors into paths, as done in this chapter, has thus allowed me to formalise the force-related meaning aspects to a much greater detail than was possible with the primitive notion of force used in Chapter 4.

6.5.3 Prepositions and particles

Prepositions and particles are also defined in terms of forces and paths. Like force adverbs, they are defined as denoting sets of paths, and will be shifted to event denotations later. In the following, I will first introduce several prepositions that head prepositional phrases which can combine with force verbs but do not have a resultative reading. Then I will introduce the prepositions and particles that can combine with force verbs to form a resultative reading.

Non-resultative prepositions

I chose the prepositions *auf* (on), *gegen* (against), *an* (on) and *über* (over), as they are used in combinations with force verbs that illustrate some interesting examples (cf. Section 6.6.2). All of these prepositions have multiple usages or meanings. The definitions I give here are intended to capture their uses with force verbs. For other uses of these prepositions, other meaning components might need to be added to their semantics.

$$(43) \quad \text{AUF} = \lambda x. \lambda p [\text{INTR}(p, x)]$$

$$(44) \quad \text{GEGEN} = \lambda x. \lambda p [\text{INTR}(p, x)]$$

The definitions for *auf* and *gegen* are identical, even though they have different uses. The use of *gegen* usually indicates that the force is exerted on the side of the force recipient, whereas *auf* mostly indicates that the top of the force recipient is affected. These prepositions thus pose distinct requirements on the force zone (remember, the force zone is that part of the force recipient on which the non-zero force vectors are located, cf. Section 6.3.5). But for simplicity's sake I assume that the force-related meaning aspects of *gegen* and *auf* are sufficiently similar to be captured by the formula given in (43) and (44). What this formula describes are force paths whose vectors are internally directed, i.e. towards the force recipient, as in a situation where someone is pushing against a door.

$$(45) \quad \text{AN} = \lambda x. \lambda p [\text{EXTR}(p, x)]$$

The preposition *an* is in a sense the opposite of *auf* or *gegen*. *An* is defined as denoting a set of paths with externally directed force vectors, i.e. force vectors pointing away from the force recipient, as in someone pulling on a door.

As the examples already suggest, the requirement of the verb *ziehen* (to pull) for the preposition *an* can be explained by their corresponding force properties: externally directed force vectors. The same holds for the requirement of *drücken* (to push/press) or *schlagen* (to hit) for the prepositions *auf* or *gegen*: internally directed force vectors.

$$(46) \quad \text{ÜBER} = \lambda x. \lambda p [\text{INTR}(p, x) \wedge \text{MOVING}(p)]$$

The preposition *über* is defined as denoting a set of paths with internally directed force vectors, just like *auf* and *gegen*, but additionally contains the meaning component MOVING. Remember from the discussion in Section 6.4.2 that when e.g. rubbing over a spot, force is exerted on the spot, just as when pressing on it. But additionally, the force is exerted in a slightly different location at every moment. Such a situation is described in German as *über einen Fleck reiben* (to rub over a spot).

All the prepositions defined here denote force paths, that is, they require at least one vector to have a magnitude higher than zero. This requirement is met by the definitions for INTR and EXTR in (22-a) and (22-b) respectively. Both

definitions make use of the direction of the force vectors, towards the force recipient or away from the force recipient, with distinct origins and end points (and in order to have a direction, a force vector needs to have a magnitude of higher than zero).

Resultative prepositions and particles

The prepositions *in* (in/into) and *aus* (out of) as well as the particle uses of *aus* and *ein* (\sim in) form a resultative construction when combined with force verbs. In order to describe the resulting movement, they all denote spatial paths or paths of motion, i.e. paths composed only of zero force vectors (remember that movement through space is traced through a sequence of zero force vectors, i.e. points, as discussed in Sections 6.3.1 and 6.3.4).

In the following, I will give and explain the definitions of these prepositions and particles. Just as the non-resultative prepositions discussed above, these particles and prepositions are polysemous and can have different meanings in different contexts. The definitions given here are intended to model their semantics when they combine with force verbs to form a resultative phrase or particle verb.

$$(47) \quad \text{IN} = \lambda x. \lambda p. \forall t [|p(t)| = 0 \wedge p(t_0) \notin \text{INTERIOR}(x) \wedge p(t_1) \in \text{INTERIOR}(x)]$$

The preposition *in* is defined as denoting a path that begins outside of an object (not inside) and ends inside that object. That is, the first zero force vector of the path ($p(t_0)$) cannot be inside the object x , the Ground, whereas the last zero force vector of the path needs to be located inside the Ground, with respect to which the movement is described (see Zwarts (2005) for a more sophisticated definition of *into* as telic and bounded).

While the Ground is expressed by the argument of the preposition, as in *in die Wand* (into the wall), the Figure that moves along the path described by the preposition in e_2 is the force recipient in e_1 , e.g. the nail in *Sie schlug den Nagel in die Wand* (She hit the nail into the wall).

$$(48) \quad \text{AUS} = \lambda x. \lambda p. \forall t [|p(t)| = 0 \wedge p(t_0) \in \text{INTERIOR}(x) \wedge p(t_1) \notin \text{INTERIOR}(x)]$$

The preposition *aus* is defined as the opposite of the preposition *in*. Whereas *in* requires the first zero force vector of the path to be located outside of the Ground, and the last zero force vector to be located inside the Ground, this is reversed for *aus*. The first zero force vector of the path needs to be located inside the Ground, and the last zero force vector needs to be located outside of the Ground. Both *in* and *aus* thus express a change of location, a transition.

The particle use of *aus* is defined in (49). Please note that in this case the variable x is unbound in the definition of *aus*. Other than the preposition *aus*, the particle does not take a (direct) object. However, the argument is conceptually present: it is the Ground, the object inside of whose interior the

first zero force vector of the path needs to be located, i.e. the object of which the Figure is *out of* as a result of the activity described by the verb. This reference object is needed in the definition in (49) to locate the path of motion described by the particle. In the derivation of a sentence containing the particle verb *ausdrücken*, the Ground (the hair in (50)) is then expressed as the direct object of the verb (McIntyre 2007: 353).

$$(49) \quad \text{AUS} = \lambda p. \forall t [|p(t)| = 0 \wedge p(t_0) \in \text{INTERIOR}(x) \wedge p(t_1) \notin \text{INTERIOR}(x)]$$

In the case of *aus* used as a particle, the Figure is not overtly expressed. Consider the sentences in (50), based on McIntyre (2007: 353, ex(6a+b)).

- (50) a. Drücke das Wasser leicht aus den Haaren.
 press the water lightly out.of the hairs
 ‘Lightly squeeze the water out of your hair.’
 b. Drücke die Haare leicht aus.
 press the hairs lightly out
 ‘Lightly squeeze out your hair.’

The two sentences describe the same situation: the water (the Figure) is removed from the hair (the Ground) through the action described by the verb. In (50-a), *aus* is used as a preposition. The Figure is expressed as the direct object of the verb, the Ground is expressed as direct object of the preposition. In (50-b), on the other hand, *aus* is used as a particle and does not take a direct object. Now, the Figure is not expressed and instead the Ground is promoted to direct object of the verb.

In the case of the particle *ein* as in the sentence in (51), there is no Ground relative to which some movement can be described.¹¹ In fact, it is unclear whether one can even speak of literal movement.

- (51) Maria schlägt das Fenster ein.
 Maria hits the window in
 ‘Maria breaks the window.’

How, then, can the semantics of the particle *ein*, as used in (51), be modelled while remaining faithful to the system of force paths and paths of motion as developed here. The answer is that not only ‘real’, i.e. literal, space needs to be considered, but also conceptual space. Recall from Section 6.1.3 that a conceptual space in the sense of Gärdenfors (2000, 2014) is a multidimensional space in which meanings are represented as convex regions. In order to model the semantics of the particle use of *ein* as illustrated in the example in (51), one needs to assume two such convex regions in the space of states (of objects): **whole** and **broken**. The path described by *ein* is thus a path in a conceptual space, whose begin point (or first zero force vector) is an element of the region

¹¹Though there are of course uses of *ein* which require a Ground, cf. the particle verb *eintreten* (to enter), where the Ground is some room which is entered. But to the best of my knowledge, these uses do not occur with force verbs.

whole, and whose end point (or last zero force vector) is an element of the region **broken** (this way of treating paths is not uncommon in the literature, see e.g. Zwarts 2006). The states WHOLE and BROKEN are then conceptualised as holding of the window (the force recipient in e_1).

$$(52) \quad \text{EIN} = \lambda p. \forall t [|p(t)| = 0 \wedge p(t_0) \in \mathbf{whole} \wedge p(t_1) \in \mathbf{broken}]$$

This sense of the particle *ein* resembles Lindner’s (1983) reflexive OUT or OUT-2. Lindner defines the reflexive use of *out* as: “the change of shape of a single object [...]; the change from some initial form [...] to a final form that occupies a greater area than the initial one” (Lindner 1983: 92). There is in fact a German counterpart for Lindner’s reflexive *out*. The use of the German particle *aus* in a construction such as *Sie rollt den Teig aus* (She rolls out the cookie dough) is accurately described by the above. The use of *ein* as in (51) resembles the reflexive *out*, in that the window can be conceptualised as occupying a smaller form when it is broken, i.e. the final form occupies a smaller area than the initial form. In this sense, *ein* can be said to have a reflexive sense which is the opposite of Lindner’s reflexive *out*.

In the next section, I will give the compositional semantics of sentences containing force verbs and adverbs and (resultative) prepositions and particles. Based on those analyses, in Section 6.7, I will address the compositional distinction within force verbs observed in Chapter 5 and Section 6.2 above.

6.6 The compositional semantics

With the lexical entries in Section 6.5 in place, I am almost ready to compositionally build up the sentences containing resultative or non-resultative uses of force verbs. I do not make strong syntactic claims about the way in which the different force arguments are realised as constituents, but assume the simplest constituent structure, without many functional projections. But please note that an elaborate force decomposition as presented here can be represented in a more detailed syntactic structure, such as that by Roßdeutscher & Pross (2015), who combine a DRT structure to model the semantics of force verbs with a Distributed Morphology system; or as Pretorius (2017), who gives a detailed syntax for all the meaning components expressed in particles and prepositions; or Ramchand (2008), who develops a fine structure for the V-domain.

6.6.1 Composition rules

As mentioned several times before, I will introduce a type shift to shift adverbs and non-resultative prepositions from path-denoting to event-denoting expressions, so that they can combine with verbs, which are predicates over events. Without a type shift, PP+V and Adverb+V combinations will result in a type clash. In order to avoid this, I introduce the following type-shift function.

$$(53) \quad \text{MOD:} \\ \lambda P.\lambda E.\lambda e.\exists p [\text{PATH}(e) = p \wedge P(p) \wedge E(e)]$$

The type shift in (53), MOD, takes a set of paths and maps it to a modifier of events, allowing PPs and adverbs to restrict sets of events to those events that are assigned to a particular path, as specified by the preposition or adverb.

Resultative prepositions and particles also denote sets of paths and need to be shifted. But they additionally need to be mapped to the two-event causal structure. I do this by introducing a complex predicate constructor (see Neeleman 1995 and many others).¹²

$$(54) \quad \text{RESULT:} \\ \lambda P.\lambda E.\lambda x.\lambda e.\exists e_1.\exists e_2.\exists p [e = e_1 + e_2 \wedge \text{CAUSE}(e_1, e_2) \wedge E(e_1) \wedge \text{FORCE} \\ \text{RECIPIENT}(e_1) = \text{FIGURE}(e_2) = x \wedge \text{PATH}(e_2) = p \wedge P(p)]$$

The complex predicate constructor in (54) takes a PP or particle denotation P and a V denotation E and maps those to a relation that holds between an object x and an event e if x moves in (the second part of) e along a P path as the result of an E force working on it (in the first part of e). In Section 6.6.2 below, it will become clear how this works with concrete examples, and how the transition defined in the lexical semantics of the resultative particles and preposition ((47), (48), (49) and (52)) will ensure that culmination is entailed. Please note that (54) can be seen as an instantiation of a more general rule that could also involve adjectives (e.g. *hammer flat*).

Finally, I assume a function similar to that of Kratzer (1996) for introducing the external argument corresponding to the force exerter and existentially closing the event variable.

6.6.2 Derivations

In the following, I will show how sentences containing force verbs are compositionally built up. The main illustration at this point is how sentences with a resultative force construction (bi-eventive sentences) differ from sentences with a non-resultative force construction (sentences with only one event). Remember from Section 6.2 that there were a number of observations about resultative - non-resultative sentence pairs that could not be accounted for under the standard analysis. These observations include the entailment relation that exists between these sentences (resultative force constructions entail their non-resultative counterpart), the different roles of the phrase *den Nagel* (the nail) in the sentences in (9-a) and (9-b) in Section 6.2 above, or the distinct functions of the PPs in resultative versus non-resultative sentences. In order to address these puzzles, it is necessary to see how the resultative and non-resultative

¹²Please note that a small-clause analysis could probably do the same work here. The choice for a complex predicate approach or for a small clause approach does not have any further implications as far as this dissertation is concerned.

sentences differ compositionally. In the next section, I will then show how the analysis developed here can account for all the observations from Section 6.2.

For the sake of readability and simplicity, I will use the full words in the derivations, and take their small caps notation (e.g. SCHLAGEN) to refer to the definitions put together in Section 6.5 above ((33) for SCHLAGEN). In the presentation of the examples below, I will first give each sentence or sentence pair, followed by the step-wise derivation and finally a short explanation. The arrows (\Rightarrow) in the derivations indicate that a word or phrase is shifted.

- (55) a. Maria schlägt hart auf den Nagel.
 Maria hits hard on the nail
 ‘Maria hits hard on the nail.’
 b. Maria schlägt den Nagel in die Wand.
 Maria hits the nail into the wall
 ‘Maria hits the nail into the wall.’
- (56) a. schlagen = λe [SCHLAGEN(e)]
 b. auf = $\lambda x.\lambda p$ [AUF(p, x)]
 c. auf den Nagel = λp [AUF($p, \mathbf{den-nagel}$)] $\Rightarrow \lambda E.\lambda e.\exists p$ [PATH(e)
 = $p \wedge$ AUF($p, \mathbf{den-nagel}$) $\wedge E(e)$]
 d. auf den Nagel schlagen = $\lambda e.\exists p$ [PATH(e) = $p \wedge$ AUF($p, \mathbf{den-nagel}$) \wedge SCHLAGEN(e)]
 e. hart = λp [HART(p)] $\Rightarrow \lambda E.\lambda e.\exists p$ [PATH(e) = $p \wedge$ HART(p) $\wedge E(e)$]
 f. hart auf den Nagel schlagen = $\lambda e.\exists p$ [PATH(e) = $p \wedge$ HART(p) \wedge AUF($p, \mathbf{den-nagel}$) \wedge SCHLAGEN(e)]
 g. Maria schlägt hart auf den Nagel = $\exists e.\exists p$ [PATH(e) = $p \wedge$ HART(p) \wedge AUF($p, \mathbf{den-nagel}$) \wedge SCHLAGEN(e) \wedge FORCE EXERTER (e) = **maria**]
- (57) a. schlagen = λe [SCHLAGEN(e)]
 b. in = $\lambda x.\lambda p$ [IN(p, x)]
 c. in die Wand = λp [IN($p, \mathbf{die-wand}$)] $\Rightarrow \lambda E.\lambda x.\lambda e.\exists e_1.\exists e_2.\exists p$ [$e = e_1 + e_2 \wedge$ CAUSE(e_1, e_2) $\wedge E(e_1) \wedge$ FORCE RECIPIENT(e_1) = FIGURE(e_2) = $x \wedge$ PATH(e_2) = $p \wedge$ IN($p, \mathbf{die-wand}$)]
 d. in die Wand schlagen = $\lambda x.\lambda e.\exists e_1.\exists e_2.\exists p$ [$e = e_1 + e_2 \wedge$ CAUSE(e_1, e_2) \wedge SCHLAGEN(e_1) \wedge FORCE RECIPIENT(e_1) = FIGURE(e_2) = $x \wedge$ PATH(e_2) = $p \wedge$ IN($p, \mathbf{die-wand}$)]
 e. den Nagel in die Wand schlagen = $\lambda e.\exists e_1.\exists e_2.\exists p$ [$e = e_1 + e_2 \wedge$ CAUSE(e_1, e_2) \wedge SCHLAGEN(e_1) \wedge FORCE RECIPIENT(e_1) = FIGURE(e_2) = **den-nagel** \wedge PATH(e_2) = $p \wedge$ IN($p, \mathbf{die-wand}$)]
 f. Maria schlägt den Nagel in die Wand = $\exists e.\exists e_1.\exists e_2.\exists p$ [$e = e_1 + e_2 \wedge$ CAUSE(e_1, e_2) \wedge SCHLAGEN(e_1) \wedge FORCE RECIPIENT(e_1) = FIGURE(e_2) = **den-nagel** \wedge PATH(e_2) = $p \wedge$ IN($p, \mathbf{die-wand}$) \wedge FORCE EXERTER(e_1) = **maria**]

The derivations in (56) and (57) follow the standard compositional pattern. In (56), the PP *auf den Nagel* (step (56-c)) is shifted from a set of path to an

event modifier, using the type shift in (53) above. In step (56-d), the shifted PP is then combined with the verb given in step (56-a). The adverb *hart* is also shifted via the type shift in (53), as illustrated in step (56-e). In step (56-f) it can then be combined with the phrase *auf den Nagel schlagen*. Finally, in the last step in (56-g), the event is existentially closed and **maria** is added as the force exarter.

For the resultative use of the force verb *schlagen* in (55-b), the complex predicate constructor in (54) is needed. It shifts the PP *in die Wand* from a set of paths to a complex predicate constructor in step (57-c). This introduces the relation between the causing event e_1 and the caused event e_2 (to which *in die Wand* applies). In step (57-d), *schlagen* is added and applied to e_1 . The nail, the force recipient of e_1 and Figure of e_2 is combined with the phrase *in die Wand schlagen* in step (57-e). Finally, in step (57-f), the event is existentially closed and **maria** is added as the force exarter (just as in (56) above).

- (58) a. Maria zieht hart an der Rübe.
 Maria pulls hard on the root
 ‘Maria pulls hard on the root.’
 b. Maria zieht die Rübe aus der Erde.
 Maria pulls the root out of the earth
 ‘Maria pulls the root out of the earth.’
- (59) a. ziehen = λe [ZIEHEN(e)]
 b. an = $\lambda x.\lambda p$ [AN(p, x)]
 c. an der Rübe = λp [AN($p, \mathbf{der-rübe}$)] $\Rightarrow \lambda E.\lambda e.\exists p$ [PATH(e) = $p \wedge$ AN($p, \mathbf{der-rübe}$) $\wedge E(e)$]
 d. an der Rübe ziehen = $\lambda e.\exists p$ [PATH(e) = $p \wedge$ AN($p, \mathbf{der-rübe}$) \wedge ZIEHEN(e)]
 e. hart = λp [HART(p)] $\Rightarrow \lambda E.\lambda e.\exists p$ [PATH(e) = $p \wedge$ HART(p) $\wedge E(e)$]
 f. hart an der Rübe ziehen = $\lambda e.\exists p$ [PATH(e) = $p \wedge$ HART(p) \wedge AN($p, \mathbf{der-rübe}$) \wedge ZIEHEN(e)]
 g. Maria zieht hart an der Rübe = $\exists e.\exists p$ [PATH(e) = $p \wedge$ HART(p) \wedge AN($p, \mathbf{der-rübe}$) \wedge ZIEHEN(e) \wedge FORCE EXERTER(e) = **maria**]
- (60) a. ziehen = λe [ZIEHEN(e)]
 b. aus = $\lambda x.\lambda p$ [AUS(p, x)]
 c. aus der Erde = λp [AUS($p, \mathbf{der-erde}$)] $\Rightarrow \lambda E.\lambda x.\lambda e.\exists e_1.\exists e_2.\exists p$ [$e = e_1 + e_2 \wedge$ CAUSE(e_1, e_2) $\wedge E(e_1) \wedge$ FORCE RECIPIENT(e_1) = FIGURE(e_2) = $x \wedge$ PATH(e_2) = $p \wedge$ AUS($p, \mathbf{der-erde}$)]
 d. aus der Erde ziehen = $\lambda x.\lambda e.\exists e_1.\exists e_2.\exists p$ [$e = e_1 + e_2 \wedge$ CAUSE(e_1, e_2) \wedge ZIEHEN(e_1) \wedge FORCE RECIPIENT(e_1) = FIGURE(e_2) = $x \wedge$ PATH(e_2) = $p \wedge$ AUS($p, \mathbf{der-erde}$)]
 e. die Rübe aus der Erde ziehen = $\lambda e.\exists e_1.\exists e_2.\exists p$ [$e = e_1 + e_2 \wedge$ CAUSE(e_1, e_2) \wedge ZIEHEN(e_1) \wedge FORCE RECIPIENT(e_1) = FIGURE(e_2) = **die-rübe** \wedge PATH(e_2) = $p \wedge$ AUS($p, \mathbf{der-erde}$)]
 f. Maria zieht die Rübe aus der Erde = $\exists e.\exists e_1.\exists e_2.\exists p$ [$e = e_1 +$

$$e_2 \wedge \text{CAUSE}(e_1, e_2) \wedge \text{ZIEHEN}(e_1) \wedge \text{FORCE RECIPIENT}(e_1) = \\ \text{FIGURE}(e_2) = \mathbf{die-r\u00fcbe} \wedge \text{PATH}(e_2) = p \wedge \text{AUS}(p, \mathbf{der-erde}) \wedge \\ \text{FORCE EXERTER}(e_1) = \mathbf{maria}]$$

The derivations in (59) and (60) are very similar to those in (56) and (57). The event modifier type shift is selected twice in (59), once to shift the PP *an der R\u00fcbe* and once to shift the adverb *hart*. In (60), the complex predicate constructor is selected to shift the PP *aus der Erde* and introduce the second, caused event. Please note that in the example in (58-b), the prepositional, or transitive, use of *aus* is required, not the particle use. The next example illustrates how a particle verb can be derived.

- (61) a. Maria sch\u00e4gt hart gegen das Fenster.
 Maria hits hard against the window
 ‘Maria hits hart against the window.’
 b. Maria sch\u00e4gt das Fenster ein.
 Maria hits the window in
 ‘Maria breaks the window.’
- (62) a. schlagen = λe [SCHLAGEN(e)]
 b. gegen = $\lambda x.\lambda p$ [GEGEN(p, x)]
 c. gegen das Fenster = λp [GEGEN($p, \mathbf{das-fenster}$)] $\Rightarrow \lambda E.\lambda e.\exists p$
 [PATH(e) = $p \wedge$ GEGEN($p, \mathbf{das-fenster}$) $\wedge E(e)$]
 d. gegen das Fenster schlagen = $\lambda e.\exists p$ [PATH(e) = $p \wedge$ GEGEN($p, \mathbf{das-fenster}$) \wedge SCHLAGEN(e)]
 e. hart = λp [HART(p)] $\Rightarrow \lambda E.\lambda e.\exists p$ [PATH(e) = $p \wedge$ HART(p) $\wedge E(e)$]
 f. hart gegen das Fenster schlagen = $\lambda e.\exists p$ [PATH(e) = $p \wedge$ HART(p) \wedge GEGEN($p, \mathbf{das-fenster}$) \wedge SCHLAGEN(e)]
 g. Maria sch\u00e4gt hart gegen das Fenster = $\exists e.\exists p$ [PATH(e) = $p \wedge$ HART(p) \wedge GEGEN($p, \mathbf{das-fenster}$) \wedge SCHLAGEN(e) \wedge FORCE EXERTER(e) = \mathbf{maria}]
- (63) a. schlagen = λe [SCHLAGEN(e)]
 b. ein = λp [EIN(p)] $\Rightarrow \lambda E.\lambda x.\lambda e.\exists e_1.\exists e_2.\exists p$ [$e = e_1 + e_2 \wedge$ CAUSE(e_1, e_2) $\wedge E(e_1) \wedge$ FORCE RECIPIENT(e_1) = FIGURE(e_2) = $x \wedge$ PATH(e_2) = $p \wedge$ EIN(p)]
 c. einschlagen = $\lambda x.\lambda e.\exists e_1.\exists e_2.\exists p$ [$e = e_1 + e_2 \wedge$ CAUSE(e_1, e_2) \wedge SCHLAGEN(e_1) \wedge FORCE RECIPIENT(e_1) = FIGURE(e_2) = $x \wedge$ PATH(e_2) = $p \wedge$ EIN(p)]
 d. das Fenster einschlagen = $\lambda e.\exists e_1.\exists e_2.\exists p$ [$e = e_1 + e_2 \wedge$ CAUSE(e_1, e_2) \wedge SCHLAGEN(e_1) \wedge FORCE RECIPIENT(e_1) = FIGURE(e_2) = $\mathbf{das-fenster} \wedge$ PATH(e_2) = $p \wedge$ EIN(p)]
 e. Maria sch\u00e4gt das Fenster ein = $\exists e.\exists e_1.\exists e_2.\exists p$ [$e = e_1 + e_2 \wedge$ CAUSE(e_1, e_2) \wedge SCHLAGEN(e_1) \wedge FORCE RECIPIENT(e_1) = FIGURE(e_2) = $\mathbf{das-fenster} \wedge$ PATH(e_2) = $p \wedge$ EIN(p) \wedge FORCE EXERTER(e_1) = \mathbf{maria}]

The derivation in (62) is similar to those in (56) and (59). But the derivation of the resultative construction in (63) with the reflexive sense of *ein* as described in Section 6.5 above is a bit different from the resultative constructions with PPs. PPs such as *in die Wand* (into the wall) overtly express the Ground relative to which the movement of the Figure is described (the nail in (55-b)).

In the sentence in (61-b), there is no such Ground object. There is also no Ground promotion as with *die Haare ausdrücken* (to squeeze out the hair), where the Ground is promoted to direct object of the verb. The reflexive sense of *ein* describes a conceptual movement from a state pictured as **whole** to a state pictured as **broken**. These states are conceptualised as holding of the window, the force recipient in e_1 . But the window cannot function as the Ground in e_2 relative to which this conceptual movement is described. The reflexive sense of *ein* describes the change of a single object (Lindner, 1983) as a conceptual path. This object undergoing the change is denoted by the direct object of the verb, and not by the particle *ein*, which in the definition in (52) above and in the derivation in (63) is treated as denoting a set of paths (and then shifted to become a complex predicate constructor in step (63-b) in (63)).¹³

The analysis of the lexical and compositional semantics of force verbs is now complete. In Section 6.5, I have indicated how the meaning components presented in Section 6.4 can be worked into the lexical definitions for force verbs to account for the lexical distinctions observed in Chapter 5. But the observations about the compositional behaviour of force verbs, which pose a challenge for the standard Neo-Davidsonian analysis as presented in Section 6.2, have not yet been addressed. I will do this in the following section.

6.7 Answers to the initial puzzles

Remember that in Chapter 5, I presented a questionnaire study to find further evidence for the observed force result - force modification incompatibility. The evidence from that study points towards the fact that once a force verb is used in a resultative construction (by being combined with a resultative particle or PP), it can no longer be combined with adverbs modifying force such as *leicht* (lightly) or *hart* (hard). I further found evidence that verbs lexically specified for a low force magnitude such as *berühren* (to touch) cannot felicitously be modified by adverbs lexically specified for a high force magnitude such as *hart*. The reverse, however, does not seem to hold, i.e. verbs lexically specified for a high force magnitude (e.g. *pressen* (to press)) can felicitously be combined with adverbs lexically specified for a low force magnitude (e.g. *leicht* (lightly)). Neither of these phenomena can be accounted for if one assumes a standard Neo-Davidsonian analysis as I did in Chapter 4. In 6.7.5 and 6.7.6 below, I will

¹³Though note that there is a discussion as to whether the window in the example in (61-b) is the argument of the verb, the argument of the particle, or shared by verb and particle (McIntyre, 2007). I have chosen here to treat it as the argument of the verb, but this could be adjusted without changing the underlying idea of the semantics of *ein*.

now provide an explanation on the basis of the more detailed analysis of the force component presented in this chapter.

Apart from these two phenomena, in Section 6.2 above, I observed that there seems to be an entailment of the non-resultative use of a force verb (as in (64-a)), by the resultative use (as in (64-b)). But this entailment does not hold in the reverse. This can now be accounted for (see Section 6.7.1).

- (64) a. Maria schlägt hart auf den Nagel.
 Maria hits hard on the nail
 ‘Maria hits hard on the nail.’
 b. Maria schlägt den Nagel (*hart) in die Wand.
 Maria hits the nail (*hard) into the wall
 ‘Maria hits the nail (*hard) into the wall.’

There was also some confusion with respect to *den Nagel* (the nail) in the standard analysis. In (56) (final step), repeated here as (65-a), **den-nagel** is the argument of the preposition *auf*. In (57) (final step), repeated here as (65-b), on the other hand, it is identified as the FORCE RECIPIENT (similar observations can be made about other sentences containing force verbs, such as those whose derivations are given in (59) and (60) about the root). The connection between these two occurrences of the nail can now be explained (see Section 6.7.2).

- (65) a. $\exists e.\exists p [\text{PATH}(e) = p \wedge \text{HART}(p) \wedge \text{AUF}(p, \mathbf{den-nagel}) \wedge \text{SCHLAGEN}(e) \wedge \text{FORCE EXERTER}(e) = \mathbf{maria}]$
 b. $\exists e.\exists e_1.\exists e_2.\exists p [e = e_1 + e_2 \wedge \text{CAUSE}(e_1, e_2) \wedge \text{SCHLAGEN}(e_1) \wedge \text{FORCE RECIPIENT}(e_1) = \text{FIGURE}(e_2) = \mathbf{den-nagel} \wedge \text{PATH}(e_2) = p \wedge \text{IN}(p, \mathbf{die-wand}) \wedge \text{FORCE EXERTER}(e_1) = \mathbf{maria}]$

Thirdly, I observed that force verbs are rather strict with respect to which preposition they can combine with. For example, *schlagen* (to hit) and *drücken* (to push/press) require *auf* (on), whereas *ziehen* (to pull) requires *an* (on). This will be modelled explicitly in Section 6.7.3.

And in Section 6.7.4, I will model the different contributions of PPs such as *auf den Nagel* (on the nail) in (64-a) on the one hand, and PPs such as *in die Wand* (into the wall) in (64-b).

In the following, I will focus mostly on the examples about the nail, given in (64). But I take the analyses to hold of all resultative and non-resultative constructions of force verbs.

6.7.1 Entailment

The first problem is that of the entailment from (64-b) to (64-a), which does not hold vice versa. In order to hit the nail into the wall, Maria must have hit it, yet she could have hit it without it moving into the wall. Previously, I was unable to account for this.

Now, if we unpack the words used in the derivations in Section 6.6 so that

their lexical definitions become visible, it can be seen that the entailment is due to the fact that SCHLAGEN specifies a path with internally directed force vectors with respect to the force recipient (cf. the definition in (33)). These are the same directional requirements that AUF expresses (cf. the definition in (43)). With INTR(p, x) being the only (force-related) meaning component of AUF, my analysis guarantees that *schlagen* always entails *auf* (with respect to the directional properties expressed in the force component).

This can be made explicit as in (66) by taking the final result of the derivation in (57) and dropping a few conditions (via the logical rule of simplification).

- (66) a. $\exists e. \exists e_1. \exists e_2. \exists p [e = e_1 + e_2 \wedge \text{CAUSE}(e_1, e_2) \wedge \text{SCHLAGEN}(e_1) \wedge \text{FORCE RECIPIENT}(e_1) = \text{FIGURE}(e_2) = \mathbf{den-nagel} \wedge \text{PATH}(e_2) = p \wedge \text{IN}(p, \mathbf{die-wand}) \wedge \text{FORCE EXERTER}(e_1) = \mathbf{maria}]$
 b. $\exists e_1 [\text{SCHLAGEN}(e_1) \wedge \text{FORCE RECIPIENT}(e_1) = \mathbf{den-nagel} \wedge \text{FORCE EXERTER}(e_1) = \mathbf{maria}]$
 c. $\exists e_1. \exists p [\text{PATH}(e_1) = p \wedge \text{SCHLAGEN}(e_1) \wedge \text{FORCE RECIPIENT}(e_1) = \mathbf{den-nagel} \wedge \text{FORCE EXERTER}(e_1) = \mathbf{maria} \wedge \text{INTR}(p, \text{FORCE RECIPIENT}(e_1))]$

The first step in (66-a) is identical to the final step of the derivation in (57-f). We have a complex event with two subevents, e_1 , the causing event, which SCHLAGEN predicates over; and e_2 , the caused event. In the step in (66-b), I make explicit the force relations in e_1 : it is an event of SCHLAGEN, the force recipient is the nail and the force exorter is Maria. The final step in (66-c) unpacks the path associated to e_1 , which in accordance with the definition of SCHLAGEN in (33) contains internally directed force vectors (the other meaning components of SCHLAGEN are omitted here for the sake of relevance and readability): INTR($p, \text{FORCE RECIPIENT}(e_1)$). It is precisely this meaning component, INTR($p, \text{FORCE RECIPIENT}$) that ensures that the entailment holds, because it is this meaning component that defines the (force) sense of AUF.

The entailment does not hold in reverse, because the resultative sentence in (64-b) also contains a second event, the caused event e_2 , with a different path (a spatial path, i.e. only zero force vectors without direction), which is not part of the event in the non-resultative sentence in (64-a). In (67), the different properties of e_2 are unpacked.

- (67) a. $\exists e. \exists e_1. \exists e_2. \exists p [e = e_1 + e_2 \wedge \text{CAUSE}(e_1, e_2) \wedge \text{SCHLAGEN}(e_1) \wedge \text{FORCE RECIPIENT}(e_1) = \text{FIGURE}(e_2) = \mathbf{den-nagel} \wedge \text{PATH}(e_2) = p \wedge \text{IN}(p, \mathbf{die-wand}) \wedge \text{FORCE EXERTER}(e_1) = \mathbf{maria}]$
 b. $\exists e_2. \exists p [\text{FIGURE}(e_2) = \mathbf{den-nagel} \wedge \text{PATH}(e_2) = p \wedge \text{IN}(p, \mathbf{die-wand})]$
 c. $\exists e_2. \exists p. \forall t [\text{FIGURE}(e_2) = \mathbf{den-nagel} \wedge \text{PATH}(e_2) = p \wedge |p(t)| = 0 \wedge p(t_0) \notin \text{INTERIOR}(\mathbf{die-wand}) \wedge p(t_1) \in \text{INTERIOR}(\mathbf{die-wand})]$

Again, the first step in (67-a) is identical to the last step in (57-f) above. The second step in (67-b) now makes explicit the movement components of the

caused event e_2 , where the nail serves as the Figure and the path of which is said to be $\text{IN}(\mathbf{die-wand})$. In the step in (67-c), the path associated to e_2 is unpacked to reveal the conditions attached to its force vectors, namely that they are all zero ($|p(t)| = 0$), that the first force vector is not located inside the wall ($p(t_0) \notin \text{INTERIOR}(\mathbf{die-wand})$) and that the last force vector is located inside the wall ($p(t_1) \in \text{INTERIOR}(\mathbf{die-wand})$). All of these are part of the definition for IN in (47). These conditions do not hold of the path expressed in the event in (64-a). The sentence in (64-b) is therefore not entailed by the sentence in (64-a).

6.7.2 Force Recipient

The role of the DP *den Nagel* (the nail) in the two sentences in (64) is another issue that was as yet unaccounted for. In (64-a) this is the argument of the preposition *auf* (on). But in (64-b), the same phrase is the force recipient role of the verb (the argument of the verb). The close relation between these two notions can also be modelled through the underlying force vector and path properties of the verbs and prepositions involved. The solution in this case lies in the definition of force recipient, cf. (14-a) in Section 6.3 above, repeated here as (68).

- (68) If $\text{PATH}(e)$ is a force path, then there is a participant $\text{FORCE EXERTER}(e)$ that is the exiter of the force and a participant $\text{FORCE RECIPIENT}(e)$ that is the recipient of the force. Every non-zero force vector of the path must be located on the boundary of the eigenspace of $\text{FORCE RECIPIENT}(e)$.

The definition in (68) states that if there is a force path associated to an event e , then there is a participant $\text{FORCE RECIPIENT}(e)$ that is the recipient of the force. And further: every non-zero force vector of the force path must be located on the boundary of the eigenspace of the force recipient.

Applying this to the phrase *den Nagel*, we can see that these conditions are met in both cases. The derivation for (64-b) makes explicit reference to the force recipient (see (65-b) above): $\text{FORCE RECIPIENT}(e_1) = \mathbf{den-nagel}$.

But even in the non-resultative sentence in (64-a), where *den Nagel* is the argument of *auf*, it can be identified as the force recipient. In order to see this, the meaning components of the preposition need to be unpacked. The definition for AUF in (43), repeated here as (69), also contains the meaning component INTR .

- (69) $\text{AUF} = \lambda x. \lambda p [\text{INTR}(p, x)]$

The meaning component INTR as defined in (22-a), repeated here as (70), states that the origins of the non-zero force vectors need to be located on the boundary of x , which in the derivation of the non-resultative sentence in (64-a) gets equated with the nail: $\text{AUF}(p, \mathbf{den-nagel})$. The nail is thus also in this case the

object on whose boundary the non-zero force vectors are located and therefore the force recipient.

$$(70) \quad \text{INTR}(p, x) \text{ iff } \exists t. \exists s [\text{ORIGIN}(p(t)) \in \text{BOUNDARY}(x) \wedge s > 0 \wedge \text{END}(sp(t)) \in \text{INTERIOR}(x)]$$

The nail is in both cases the force recipient, with the origins of the non-zero force vectors located on its boundary. The underlying semantics is the same, even though it surfaces in different constructions: as the argument of the verb in (64-b) and as the argument of the preposition in (64-a).

6.7.3 Preposition selection

The selectional restrictions some verbs display with respect to prepositions can now be explained as well. To recapitulate, a verb like *schlagen* (to hit) or *drücken* (to push/press) requires the preposition *auf* (on), whereas *ziehen* (to pull) requires the preposition *an* (on). These selectional restrictions can be explained through the need to match the direction of the force vectors of the path assigned to the event with those of the set of paths denoted by the PP to arrive at a non-empty set-intersection. This idea is already discussed by Zwarts (2010), but not as part of a formal semantic analysis.

To illustrate: the PP *auf den Nagel* (on the nail) is treated as a set of paths with internally directed force vectors applying to the nail (the force recipient), based on the specification in the definition for *auf* in (43), repeated in (69) above. The PP *an dem Nagel* (on the nail), on the other hand, is treated as a set of paths with externally directed force vectors, again applying to the force recipient, based on the definition for *an* in (45), repeated here as (71). These PPs thus have oppositely directed force vectors.

$$(71) \quad \text{AN} = \lambda x. \lambda p [\text{EXTR}(p, x)]$$

Since the PP+V combinations (after the PPs are shifted to sets of events, retaining their paths' properties) are interpreted as intersections, *auf den Nagel schlagen* leads to a non-empty intersection because *auf* and *schlagen* require the same directional properties, i.e. internally directed force vectors. This is illustrated in (72).

$$(72) \quad \begin{array}{l} \text{a. } \exists e. \exists p [\text{PATH}(e) = p \wedge \text{HART}(p) \wedge \text{AUF}(p, \mathbf{den-nagel}) \wedge \text{SCHLAGEN}(e) \wedge \text{FORCE EXERTER}(e) = \mathbf{maria}] \\ \text{b. } \exists e. \exists p [\text{PATH}(e) = p \wedge \text{HART}(p) \wedge \text{INTR}(p, \mathbf{den-nagel}) \wedge \text{INTR}(p, \text{FORCE RECIPIENT}(e)) \wedge \text{PUNCTUAL}(p) \wedge \text{FORCE EXERTER}(e) = \mathbf{maria}] \\ \text{c. } \exists e. \exists p [\text{PATH}(e) = p \wedge \text{HART}(p) \wedge \text{INTR}(p, \mathbf{den-nagel}) \wedge \text{PUNCTUAL}(p) \wedge \text{FORCE EXERTER}(e) = \mathbf{maria}] \end{array}$$

The step in (72-a) is the same as the final step of the derivation in (56) above. In step (72-b), the lexical definitions for *AUF* and *SCHLAGEN* are unpacked to reveal

the meaning components $\text{INTR}(p, x)$ for AUF and $\text{INTR}(p, \text{FORCE RECIPIENT}(e))$ and $\text{PUNCTUAL}(p)$ for SCHLAGEN (cf. the definition for SCHLAGEN in (33)). As I argued in Section 6.7.2, the nail can be identified as the force recipient in both the resultative sentence in (64-b) and the non-resultative sentence in (64-a). In the final step in (72-c), the meaning component $\text{INTR}(p, \text{FORCE RECIPIENT}(e))$ of SCHLAGEN, being the same as the meaning component of AUF, can therefore be omitted.

This is not so for the phrase *#an dem Nagel schlagen*, which leads to an empty set intersection, due to AN and SCHLAGEN having incompatible directional specifications. This is spelled out in (74).

- (73) # Maria schlägt an dem Nagel.
Maria hits on the nail
- (74) a. $\exists e. \exists p [\text{PATH}(e) = p \wedge \text{AN}(p, \mathbf{dem-nagel}) \wedge \text{SCHLAGEN}(e) \wedge \text{FORCE EXERTER}(e) = \mathbf{maria}]$
b. $\exists e. \exists p [\text{PATH}(e) = p \wedge \text{EXTR}(p, \mathbf{dem-nagel}) \wedge \text{INTR}(p, \text{FORCE RECIPIENT}(e)) \wedge \text{PUNCTUAL}(p) \wedge \text{FORCE EXERTER}(e) = \mathbf{maria}]$
c. $\exists e. \exists p [\text{PATH}(e) = p \wedge \text{EXTR}(p, \mathbf{dem-nagel}) \wedge \text{INTR}(p, \mathbf{dem-nagel}) \wedge \text{PUNCTUAL}(p) \wedge \text{FORCE EXERTER}(e) = \mathbf{maria}]$

The unpacking of the derivation in (74) shows that the final step in (74-c) contains both $\text{EXTR}(p, \mathbf{dem-nagel})$ and $\text{INTR}(p, \mathbf{dem-nagel})$, requiring oppositely directed force vectors to be exerted by the force exarter on the nail at the same time, illustrated in Figure 6.7. It is for this reason that the composition of (73) fails.

The reverse pattern holds for *an dem Nagel ziehen* and *#auf dem Nagel ziehen*, where the directional specifications for ZIEHEN match those of AN (both require externally directed force vectors), but not AUF.

6.7.4 Prepositional phrases

Under the standard event-based analysis it is unclear how to differentiate between the meaning contributions of the prepositional phrases *auf den Nagel* (on the nail) as in (64-a) above and *in die Wand* (into the wall) as in (64-b) above, since both are treated as predicates over events while they clearly have different functions in these sentences.

The contributions made by these PPs can be distinguished by the different types of paths assigned to them. *Auf den Nagel*, with the denotation $\lambda p [\text{INTR}(p, \mathbf{den-nagel})]$, specifies a force path (as in Figure 6.4a+b above). A force path includes non-zero force vectors. Remember from Section 6.3 above, that non-zero force vectors have an origin, a magnitude and a direction. The preposition *auf* is specified for a specific direction, namely internally directed force vectors ($\text{INTR}(p, x)$), i.e. force vectors directed towards the force recipient. The preposition *auf* as used here thus exclusively refers to the direction of the force. Accordingly, in the non-resultative sentence in (64-a), the PP *auf den*

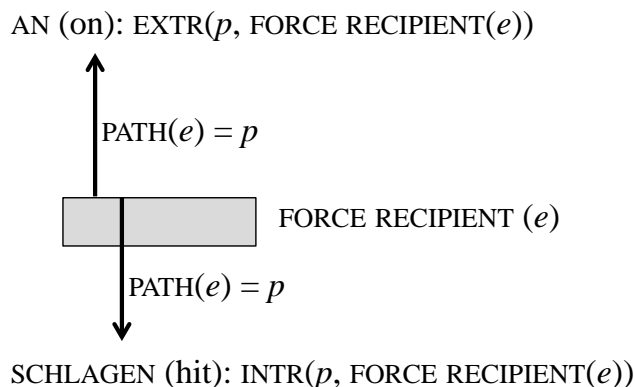


Figure 6.7: Illustration of the clash of the directional requirements of SCHLAGEN and AN, leading to an empty set intersection.

Nagel describes (the direction of) the force exertion.

In die Wand, however, has the denotation $\lambda p.\forall t [|p(t)| = 0 \wedge p(t_0) \notin \text{INTERIOR}(\mathbf{die-wand}) \wedge p(t_1) \in \text{INTERIOR}(\mathbf{die-wand})]$ and specifies a path of motion (as in Figure 6.4c above). A path of motion includes only zero force vectors ($|p(t)| = 0$). Zero force vectors have an origin (or location) but no magnitude or direction; they are points in space via which movement can be traced. The preposition *in* refers to specific conditions on the first and last zero-force vector (or point) of the path, such that there is a movement from outside the wall to inside the wall. *In* thus exclusively refers to motion (of the Figure) and says nothing about the force. In the resultative sentence in (64-b), the motion described by the PP *in die Wand* is analysed as a caused event, the motion resulting from the force exertion.

The PPs that denote force paths thus function as event modifiers (they modify the direction of the force), whereas PPs that denote paths of motion are resultative (they describe the motion resulting from the force exertion).

6.7.5 Intensity restrictions

The corpus and questionnaire studies reported in Chapter 5 showed that force verbs can be classified into three intensity classes, referring to their lexical specifications of the force magnitude. There are verbs like *schlagen* (to hit), which are not lexically specified for a specific force magnitude (though *schlagen* is standardly understood as involving a high force magnitude, cf. Chapter 3). And then there are verbs that are lexically specified for a specific (range on

the) force magnitude. Verbs like *pressen* (to press) always express a high force magnitude, whereas verbs like *berühren* (to touch) express a low force magnitude. This is correctly modelled in their lexical semantics in Section 6.5 above by making use of the meaning components INTENSIVE and NON-INTENSIVE.

These lexical specifications have an influence on the verbs' co-occurrence frequencies with the adverbs *leicht* (lightly) and *hart* (hard), such that intensive verbs co-occur more often with *hart* than *leicht*, and non-intensive verbs co-occur more often with *leicht* than *hart* (cf. the corpus results presented in Chapter 5). However, both combinations with *leicht* and with *hart* are felicitous for intensive force verbs, there was no significant difference in the rating for constructions with *leicht* and with *hart* in the questionnaire study presented in Chapter 5. This is different for non-intensive verbs: combinations with *hart* receive significantly lower ratings than combinations with *leicht*.

This behaviour of non-intensive verbs can be explained through the need to match the properties of force vectors, in this case their intensity or length properties. In (76), I show how the meaning components clash when the derivation of the sentence in (75) is unpacked.

- (75) # Maria berührt Joan hart.
Maria touches Joan hard
- (76) a. $\exists e. \exists p [\text{PATH}(e) = p \wedge \text{HART}(p) \wedge \text{BERÜHREN}(e) \wedge \text{FORCE RECIPIENT}(e) = \mathbf{joan} \wedge \text{FORCE EXERTER}(e) = \mathbf{maria}]$
b. $\exists e. \exists p [\text{PATH}(e) = p \wedge \text{INTENSIVE}(p) \wedge \text{NON-INTENSIVE}(p) \wedge \text{FORCE RECIPIENT}(e) = \mathbf{joan} \wedge \text{FORCE EXERTER}(e) = \mathbf{maria}]$

In the step in (76-b), the meaning components of HART and BERÜHREN are unpacked (the non-intensity related meaning components of BERÜHREN being omitted for readability's sake). As can be seen, the path is now defined to be both INTENSIVE and NON-INTENSIVE. That means that there needs to be at least on force vector above a certain average force magnitude for comparison, while at the same time all force vectors need to be below a certain average force magnitude for comparison (see also the definitions for INTENSIVE and NON-INTENSIVE in (27-a) and (27-b) in Section 6.4 respectively). These incompatible magnitude requirements lead to an empty set intersection once the adverb is shifted to a modifier of events, and the composition fails (because it requires a non-empty set intersection).

This explanation leads to a new puzzle, however. Intensive verbs like *pressen* can be modified by *leicht*, even though *leicht* is defined as non-intensive. The composition of the phrase *leicht pressen* should fail just as the composition of the phrase *hart berühren*. But it does not, as evidenced by the rating results from the questionnaire study presented in Chapter 5. It seems that intensive verbs can be coerced by adverbs to a smaller force intensity, making their lexical semantics compatible with a low force magnitude. I will leave the precise mechanism of this coercion for further research.

6.7.6 Force modification - force result incompatibility

The final issue concerns the unmodifiability of force verbs in a resultative construction, i.e. with a resultative particle or PP, through force-related adverbs such as *leicht* (lightly) and *hart* (hard). Remember that the questionnaire results as reported in Chapter 5 show that sentences with force verbs in a resultative construction and modified by a force-related adverb, cf. (77-b) below, are judged significantly less felicitous than sentences with force verbs in a non-resultative construction and modified by a force-related adverb (cf. (77-a) below).

- (77) a. Maria schlägt (hart) auf den Nagel.
 Maria hits (hard) on the nail
 ‘Maria hits the nail hard.’
- b. Maria schlägt den Nagel (*hart) in die Wand.
 Maria hits the nail (*hard) in the wall
 ‘Maria hits the nail (*hard) into the wall.’

The analysis given above suggests a possible explanation: In (16) in Section 6.3.6, I defined CAUSE and explained the underlying force interaction of this concept. This interaction requires an operation of vector addition of the force vector exerted by the force exiter on the force recipient at the moment of contact between the two, $\text{PATH}(e_1)(t_i)$, and the force recipient’s force tendencies, $\text{TENDENCY}(e_1)(t_i)$, resulting in a vector pointing in the direction of the resulting path of motion in e_2 : $\text{PATH}(e_2)$. I suggest that, once this computation has happened, the original force vectors of $\text{PATH}(e_1)$ become unavailable for modification by any adverb that requires a force vector with a magnitude bigger than zero. The only available force vectors are thus those of $\text{PATH}(e_2)$, which is a path of motion and therefore consists only of zero force vectors without a magnitude. This path is therefore not a suitable ‘attachment site’ for force-related adverbs. Note that this is in accordance with Gärdenfors’s (2014) analysis of adverbial modification, cf. Section 6.1.3.

As already discussed in Chapter 5, other types of modifiers are possible in resultative force constructions. Tested in the questionnaire were the adverbs *langsam* (slowly) and *schnell* (quickly). These adverbs modify the complex event ($e = e_1 + e_2$), i.e. the time that it takes until the result is reached. Adverbs such as *schief* (diagonally) and *gerade* (straight) modify the form of the resulting path of motion (Gärdenfors, 2014). And e.g. *vorsichtig* (carefully) and *hektisch* (hastily) modify the manner of the first event and are licensed by the force exiter, i.e. only an animate agent can do things in a hasty or careful manner (cf. the discussion on agent-oriented manner adverbs in Chapter 2 and the questionnaire results discussed in Chapter 3).

Note that explaining this problem in force-theoretic terms does not account for similar observations outside of the force domain, such as the general manner - result complementarity observed in a.o. Levin & Rappaport Hovav 2013. The force modification - force result incompatibility might thus be a force-related instantiation of a more general mechanism. Should this prove to be the case,

it would be interesting to find the principles underlying these observations in other domains, and see whether the force-dynamic explanation provided here matches up with those principles. The Single-Domain Thesis for Verbs presented by Gärdenfors (2014), summarised here in Section 6.1.3, might be a good candidate for such a general mechanism.

6.8 Summary and conclusion

In this chapter, I have presented an analysis of German force verbs in a force dynamic framework, making crucial use of notions presented in Talmy 2000; Wolff 2007; Gärdenfors 2014. To recapitulate, force verbs are verbs that can be used to describe the exertion of a force on an object, leaving open the possibility of, but not requiring, a change in the position or state of that object (cf. the definition of force verbs in Chapter 5).

A standard event-based analysis of these verbs as developed in Chapter 4, which makes use of a not further defined notion of the force component, presents a number of problems. These problems can be solved as soon as explicit reference is made to forces, formalised as vectors. In short: internal properties of events, such as their ability to be hard or to require a specific force magnitude, are accessed via paths that describe the way the force exertion (by the force exarter on the force recipient) develops over the course of the event: namely as a sequence of positions at which a force could be exerted.

It is those vectors and their properties that make it possible to account not only for the distinctions found in the domain of force verbs, such as differences in the aspectual, directional or compositional aspects. But also for issues such as the entailment of the non-resultative use of a force verb in its resultative use or the distinct meaning contributions of superficially similar prepositional phrases. The analysis thus allows for a compositional semantics of sentences/phrases with force verbs that does justice to relevant lexical factors.

Please note that the force implicatures triggered when agent-oriented adverbs such as *spielerisch* (playfully) or *freundlich* (friendly) are combined with force verbs (discussed in Chapters 2 to 4) can just as easily be modelled in this more detailed analysis as in the standard analysis as presented in Chapter 4. Instead of referring to the force magnitude of a not further analysed force component, the effect of the implicature can then also be more accurately presented via the length of the non-zero force vectors.

In order to address the problems arising with the standard analysis of force verbs in Section 6.7, I often had to unpack the words used in the derivations in Section 6.6 to show how their meaning components interact (or clash). In the next chapter, I will present an analysis of the same phenomena in a different framework, frame semantics, where the separate meaning components are modelled as nodes and arcs in a single frame structure. This allows one to immediately see the interaction of different components, and accurately model the effects in the whole network when one node is changed.

CHAPTER 7

A Frame Semantic analysis of verb-adverb modification¹

In the previous chapters, I have studied conceptual effects of verb-adverb modification. In Chapters 2-4, I have explored different types of adverbs and their modification of the class of verbs of contact by impact (Levin, 1993) in general and of *hit*-verbs in particular. Following that, in Chapters 5 and 6, I have presented a more thorough study of the verbal domain, established the domain of force verbs and given a detailed analysis of this domain in terms of force vectors and paths.

So far, I have analysed all of this in the framework of (Neo-Davidsonian) Event Semantics. This is the most commonly used framework for analysing verb semantics (cf. the overview in Chapter 4). In Chapter 6, I have illustrated how the necessary model-theoretic building blocks such as force vectors and paths can be put together to define meaning components that are added up in the lexical entries of force verbs to represent certain properties of these verbs (such as a continuous versus a momentary force exertion or the direction of the force transmission). In Section 6.7 in Chapter 6, I have shown how the analysis developed in that chapter can account for a number of phenomena observed with force verbs that were previously unaccounted for, such as the entailment of sentences containing a non-resultative force verb construction by a sentence containing its resultative counterpart, or the fact that once a force result is specified, the force component can no longer be modified. In order to do that, I had to unpack the lexical entries of the verbs into long lists of meaning

¹Parts of the frame analysis presented in this chapter has been published as Goldschmidt, Gamerschlag, Petersen, Gabrovska & Geuder 2017.

components to see how these interact or clash. In this chapter, I will show how these meaning components can be modelled as a single frame structure in Frame Semantics, where their interaction is immediately visible in a network of attributes.

An additional advantage of Frame Semantics is its close connection to conceptual semantics. Remember that this dissertation is about the conceptual effects of language composition. Frame Semantics as a tool to represent meaning takes seriously the underlying conceptual structure of words and makes it explicit.

In this chapter, I will therefore show how the findings of the previous chapters can be modelled in Frame Semantics. Section 7.1 is a short introduction into the theory of Frame Semantics. Section 7.2 contains summaries of the main findings presented in Chapters 2-6. In Section 7.3 I show how verb meanings can be represented in Frame Semantics and in Section 7.5 how those verb frames can be used to represent the conceptual effects of force implicatures discussed in Chapters 2-4 and the force result - force modification incompatibility presented in Chapters 5-6. Finally, Section 7.6 summarises.

7.1 Frame Semantics

Frame Semantics in linguistics is most well-known from the work of Fillmore on thematic role assignment with verbs and the FrameNet project in Berkeley (e.g. Fillmore 1970, 1982). A form of Frame Semantics or frames has also been used in artificial intelligence applications to model meaning, e.g. Abelson (1973); Minsky (1975) and their scripts and schemas respectively. However, while not incompatible, the notion of Frame Semantics that I am most interested in starts with Barsalou's (1992), and has since been further developed by a.o. Petersen & Werning (2007); Kallmeyer & Osswald (2013); Löbner (2014); Petersen (2015); Löbner (2017).

Frames represent word meaning by making explicit the underlying conceptual structure, i.e. the parts that make up the concept, and the relations between these parts. These are modelled as attributes and their values. Attributes are aspects of a concept, such as COLOUR, SIZE, SHAPE, etc., and values are the concrete instantiations of these attributes, e.g. **red** for COLOUR, **10cm** for SIZE and **elongated** for SHAPE.² A bottle of wine, for example, can be described by the attributes CONTENT (with the values of e.g. **red wine** or **white wine**), COLOUR (e.g. **green** or **brown**), FORM (**long neck, round body**) or FUNCTION (**holding wine**). Frames are recursive, that is, the values of attributes have their own attributes. Thus the value of the attribute CONTENT of a bottle of wine, e.g. **red wine**, can be further described by the attributes COLOUR (**red**), TASTE (e.g. **dry**) or PERCENTAGE OF ALCOHOL (e.g. **13.5 %**).

²I will follow the convention in Petersen (2015) and others by marking ATTRIBUTES in small caps and **values** in the text in bold-face (the bold-face is omitted in the actual frame structures).

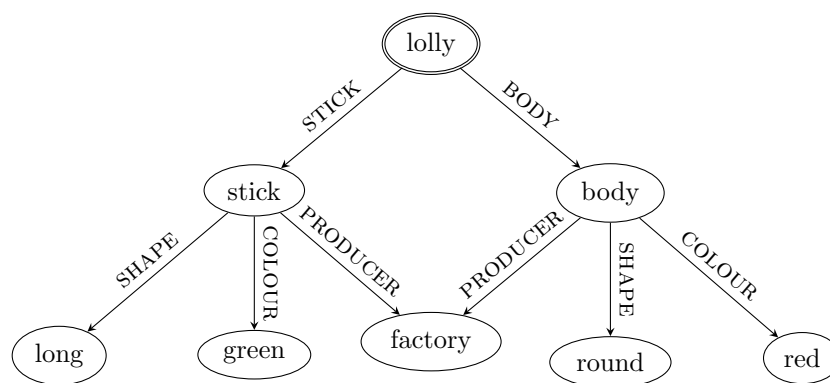


Figure 7.1: An example frame representing the word *lolly*, taken from Petersen (2015: 47).

Please note that I have now described a concrete bottle of wine. If the general concept of *bottle of wine* were to be described, one would need to give value ranges instead of concrete values. So instead of having e.g. **green** as the value for the attribute **COLOUR**, one would simply use **colour**, a short-hand for the set of all (admissible) colours, with admissible colours for wine bottles defined in a type signature (see below). These networks of attributes and their values can be formalised as labelled, directed graphs. Consider the representation of the concept *lolly* in Figure 7.1, taken from Petersen’s (2015: 47, Fig 2). As with the wine-bottle example, concrete values are given for the attributes, that is, the frame is taken to denote a specific subset of lollies.

The central node, the concept that is modelled by the frame, is **lolly**, marked by a double circle. A lolly consists of a body and a stick, represented by the outgoing arcs from the lolly-node. They lead to the **body**- and **stick**-nodes, which represent the values of the **BODY**- and **STICK**-attributes. The fact that the attributes **BODY** and **STICK** have values of the same label is similar to the above case with colour. Barsalou (1992) defines an attribute as “a concept that describes an aspect of at least some category members” (Barsalou 1992: 30); colour, for instance, can be an attribute of e.g. lollies, it describes an aspect of at least some category members. But colour can also be an independent concept, as in a situation when someone thinks of their favourite colour in isolation, which is specified with respect to a specific hue, brightness and saturation.

Petersen (2015) describes the attribute-use of **COLOUR** as a relational interpretation, i.e. the function assigning to each object its unique colour. The other use of **colour**, i.e. what Barsalou called an independent concept, is the denotational interpretation: the set of all colours or, for instance, the green subset. Please note that the denotational interpretation holds in the case of **colour** being used as a type or as a value of an attribute (e.g. **COLOUR**). It is

the denotational interpretation that is required for the bold-faced **body**- and **stick**-nodes, they represent the fact that lollies have a body and a stick (the BODY- and STICK-attributes are relational, i.e. functions assigning bodies and sticks to each object denoted by **lolly**, Petersen 2015: 47).

In Figure 7.1, both **body** and **stick** are further characterised by their shape, colour and producer, cf. the respective outgoing arcs. Please note that the fact that the PRODUCER-attributes from both the **body**- and **stick**-nodes point to the same **factory**-node specifies that the lollies' body and stick have been produced in the same factory (Petersen 2015: 47). Whether that is the case for prototypical lollies, or just the specific lollies that Petersen had in mind when creating the representation is another matter.

Depending on the context, one can further specify or add attributes. If the noun *lolly* were to be modified by the adjective *sweet* to create the concept *sweet lolly*, for example, the attribute TASTE would have to be added to the node **lolly**, and take as a value **sweet**. And if one were to modify *lolly* with the PP *from Utrecht*, the node **factory** would get another attribute LOCATION, which then takes the value **Utrecht**. Modification in frames is thus modelled through adding or changing attributes or their values. Which attributes and values can be added to a concept is specified in a type signature (see below).

In the following, I will explain the formalisation of some basic notions within Frame Semantics, and then outline the advantages of Frame Semantics as a tool to model meaning.

7.1.1 Constraints in frames

As stated above, the type of Frame Semantics that I am interested in goes back to Barsalou (1992), who introduces frame structures as a model of conceptual knowledge representation that is superior to the flat feature lists commonly used in psychological research in the 1970ies and 1980ies (for references see Barsalou 1992). Barsalou cites experimental evidence that people store knowledge in structures that go beyond pure co-occurrence lists (Barsalou 1992: 27). For example, even though both *feather* and *robin* co-occur with *bird*, there are clear differences between the relations they have to the concept of bird: a feather is a *part* of a bird, while a robin is a *type* of bird. Barsalou provides evidence that people are sensitive to these types of relations.

Barsalou models relations like these in frames via two basic notions. One of these notions are structural invariants, “relations that generally hold across most exemplars of a concept” (Barsalou 1992: 35). Examples are e.g. spatial relations such as that between *seat* and *back* in the frame for *chair*, which form a specific angle or set of angles, or causal relations like that between *fertilisation* and *birth* in the frame for *reproduction* such that fertilisation causes birth.

The other basic notion are constraints. Constraints capture systematic variance of values, i.e. they model how values influence each other in a systematic, predictable fashion. There are two types of constraints. Attribute constraints are global constraints, e.g. the relation between speed and duration of travel

over a constant distance, where a decrease of one usually results in an increase of the other. Value constraints are local constraints: in the frame for *vacation*, for instance, a particular value for LOCATION, say **beach**, constrains values for ACTIVITY to things like **surfing** or **swimming** and excludes e.g. **skiing**.

Please note that constraints do not necessarily represent logical truth; they can also be used to model statistical patterns, prototypicality or even personal preferences (Barsalou 1992: 37).

7.1.2 Frames as typed feature structures

Petersen (2015), which is a reprint of Petersen (2007), and others have further formalised Barsalou's original idea, making crucial use of Carpenter's (1992) feature structures. Given a set of types `TYPES`³ and a finite set of attributes `ATTR`, a frame is a tuple consisting of a finite set of nodes Q , a central node $\bar{q} \in Q$ and a partial transition function δ , which ensures that attributes do not simultaneously assign distinct values to the same node: $\delta : \text{ATTR} \times Q \rightarrow Q$. Finally, a frame has a node typing function $\theta : Q \rightarrow \text{TYPE}$. This typing function basically serves to label the nodes in a frame. In order to yield conceptually well-formed frames, it makes crucial use of a type signature.

Before describing a type signature, let me illustrate the above with an example. In the frame in Figure 7.1, the finite set of nodes Q contains the nodes **lolly**, **stick**, **body**, **long**, **green**, **factory**, **round** and **red**. The central node \bar{q} is **lolly**, which, as explained above, is marked in the frame with a double circle. It is a bit more difficult to explain the partial transition function, which takes a pair consisting of an attribute (say `STICK` in Figure 7.1) and a node (say **lolly**) and maps that to another node (**stick** in this case). This becomes important when two frames are unified (frame unification is one of the compositional mechanisms available in Frame Semantics, see Section 7.5.1), where it serves the purpose of determining whether two frames with the same attribute can be unified: yes, if the attribute assigns the same value; no, if it does not. The example given in Petersen & Gamerschlag 2014: 215 is the frame unification of the frames for the two utterances *The chocolate egg is old* and *The chocolate egg is new*. The frames for these utterances cannot be unified, because the value for the attribute `AGE` in one case is **old** and in the other **new** (and thus we know that the utterance *The chocolate egg is old and the chocolate egg is new* is semantically not well-formed). Lastly, as said above, the node typing function provides the labels in the frame, making use of the type signature.

A type signature has roughly the form of the well-known taxonomic hierarchies (except for having more diverse types) and is used to represent world-knowledge. It defines and orders a set of types and specifies the domain and range of attributes via appropriateness conditions. For example, objects have a taste, a colour, a shape, etc. Every subtype of the type **object** inherits these

³Above, I mostly spoke of values, not types. Roughly speaking, it can be said that values are points while types are regions in a conceptual space.

attributes, i.e. both apples and cars have a taste, a colour and a shape.⁴ However, it is not ‘appropriate’, i.e. not conceptually well-formed, to talk about the mother of an object (except for maybe in fictional contexts with animate objects). Objects are thus not in the domain of the attribute MOTHER-OF (and some living beings might not be either). Similarly, not all types are appropriate for all attributes. **Green** and **red** are in the range of, i.e. are appropriate for the attribute COLOUR, and **long** and **round** are appropriate for the attribute SHAPE. But **long** is not an admissible type for COLOUR, it is not part of the range of that attribute. The interested reader is referred to Petersen (2015: 48ff) for more formalisations of constraints necessary to produce well-typed frames.

When typing the frame for *lolly* in Figure 7.1, the type signature is thus needed to determine which types are appropriate for which attribute, so that **green** and **red** are typed for the attribute COLOUR and not SHAPE, and vice versa for **long** and **round**.

Links to first-order logic and the syntax-semantics interface

Frames can transparently be translated into first-order predicate logic, where feature-structures are treated as set-theoretic models. In a nutshell: types correspond to one-place predicates, attributes correspond to two-place predicates (for an illustration see e.g. Petersen & Osswald 2014; Vosgerau et al. 2015).

Frames can also be integrated into the syntax-semantics interface, for example by combining them with elementary trees in Lexicalised Tree Adjoining Grammar (LTAG), for details see e.g. Kallmeyer & Osswald (2013). However, the details of the connection between Frame Semantics and the syntax-semantics interface are beyond the scope of this dissertation.

7.1.3 Advantages of Frame Semantics

I have already mentioned some advantages of Frame Semantics above, the most important one being that it shows at one glance all the meaning components that are part of the concept underlying a word or phrase, and their connections to each other. In Chapter 6, when I wanted to illustrate properties of force verbs and how they interact, I needed to unpack the lexical entries for the verbs to make the machinery visible, cf. Section 6.7 in Chapter 6, where I unpack e.g. SCHLAGEN (the representation of the German verb *schlagen* (to hit)) into a long list of meaning components.

In Frame Semantics, the machinery is immediately visible. Frame Semantics was developed to model the conceptual structure of a word, all its meaning components and the network of relations between them, and to explicitly represent them in the frame structures. Remember from above that Frame Semantics as used here goes back to Barsalou (1992), who is a psychologist and developed

⁴To talk of the taste of a car might seem weird, but if one were to lick a car, there would be a taste. It is therefore represented in the type signature, even though taste is largely irrelevant for uses of the concept *car*.

Frame Semantics as a more accurate representation of word meaning than the flat feature lists that were popular at that time. Frame Semantics is based on experimental research into human language representation (Barsalou, 1992), and as such has the ambition not only to model word meaning in a logical system, but to model word meaning as it is represented in the human mind.

As such, Frame Semantics meets the demands of Grounded Cognition. Vosgerau et al. (2015) show how frames for action-related concepts can integrate motor-values, and are thus grounded in the motor processes of the human brain. Frames also seem neurologically realistic. Petersen & Werning (2007) cite evidence that certain neural activities might correspond to conceptual structure as modelled in frames.

Frame Semantics thus in a sense goes beyond other semantic theories such as Event Semantics in that it not only represents meaning in a logical formalism, but tries to establish the link to general human cognition.

7.2 Summary of previous chapters

Before I proceed to analyse in Frame Semantics the findings on verb meaning and adverbial modification presented in the previous chapters, I will first briefly summarise the main points from those chapters. This should enable readers to better understand the Frame Semantic analysis.

7.2.1 Adverbial modification and force-implicatures

In Chapters 2-4, I have explored the interaction between *hit*-verbs and different types of adverbs in verb-adverb modification. Broadly speaking, there are some adverbs that are agent-oriented, i.e. they add or modify some aspect of the agent of an event. Examples are e.g. the German adverbs *spielerisch* (playfully), *fröhlich* (cheerfully) or *freundlich* (friendly). The adverbs *spielerisch* and *freundlich* are agent-oriented manner adverbs (in a position following the direct object) according to the tests developed in Schäfer (2005, 2013); they require “the highest ranked argument of the sentence [...] [to] always contain some sort of agency properties” (Schäfer 2005: 47/48). These adverbs specify *how* an agent acts in an event. *Fröhlich*, on the other hand, is a subject depictive (in a position following the direct object), it directly predicates the property of cheerfulness over the subject of the event, not over how the agent acts in the event.

These adverbs are contrasted with pure manner adverbs such as *hart* (hard) or *leicht* (lightly), which directly modify an aspect of the event, force in this case (cf. the evidence presented in Chapter 2). When agent-oriented adverbs are used to modify *hit*-verbs a Neo-Gricean I-implicature (Levinson, 2000) or R-implicature in the sense of Horn (1984) is triggered on the force component of the verb. In a sentence such as (1-a), an implicature of low force magnitude arises, i.e. the default understanding is that the hitting was carried out with a

low amount of force. This is shown by the sentence in (1-b), where *spielerisch* is contrasted with *hart* (hard) in a so-called denial-of-expectation construction with the conjunction *but* (Lakoff, 1971).

- (1) a. Joan schlägt Mary spielerisch.
 Joan hits Mary playfully
 b. Joan schlägt Mary spielerisch, aber doch recht hart.
 Joan hits Mary playfully, but still rather hard

The sentence in (1-b) serves two purposes. Firstly, it shows that the modification of the verb by *spielerisch* results in a low force reading. This is evidenced by the fact that *spielerisch* can be contrasted with *hart*, an adverb that lexically specifies a high amount of force. And secondly, the sentence shows that this low force reading is cancellable and therefore an implicature (cf. the discussion in Chapter 3). Otherwise *spielerisch* could not felicitously be combined with *hart*.

In Chapter 3, I provided evidence for the existence of this type of force implicature for a broader range of verb-adverb combinations in German (via a questionnaire study) and Dutch (via a self-paced reading experiment). Participants constantly gave high ratings to sentences of the type of (1-b), and one can detect a significant reading time delay in sentences similar to that in (1-b), which cancel the force implicature, compared to sentences that don't cancel the implicature.

I gave a preliminary analysis of this phenomenon in (Neo-)Davidsonian Event Semantics in Chapter 4. In a nutshell: I assume that *hit*-verbs have a force component of unspecified magnitude. When a verb like *schlagen* (to hit) is used without modification, a high force magnitude is inferred, but it is not lexically specified (cf. the evidence from the questionnaire study presented in Chapter 3). If such a verb is combined with a pure force adverb such as *leicht*, the magnitude of the force is provided via the lexical semantics of the adverb. But if it is combined with an agent-oriented adverb such as *spielerisch*, the magnitude remains unspecified and needs to be computed via an implicature. This inference process can be formalised as in (2).

$$(2) \quad \forall e. \forall f [\text{playful}(\text{AGENT}(e)) \wedge \text{FORCE}(e) = f \stackrel{\text{def}}{\rightarrow} \text{MAGNITUDE}(f) < \text{average}_C]$$

The definition in (2) states that for all events and all forces, if the agent of the event is playful and the event has a force component, then the magnitude of that force will be below a certain average for comparison.

7.2.2 Verb semantics and forces

Chapters 5 and 6 contain a more detailed analysis of the force component in verbs and establish the domain of force verbs. Based on the findings from a corpus study and another questionnaire presented in Chapter 5, I extend

the semantics given in Chapter 4 with a more insightful notion of the force component based on a vector model.

In a nutshell: All (force-related) components of the events denoted by force verbs are accessed via paths which are constituted by a sequence of force vectors representing the force that the force exiter or agent of an event exerts on the force recipient or patient at each point of time during the event. This includes zero force vectors, i.e. vectors that have no magnitude and correspond to points in space. Consider the case of *schlagen* (to hit), which is characterised by a movement that leads to contact (and then maybe movement again), in (3).

- (3) Maria schlägt mit einem Hammer auf den Nagel.
 Maria hits with a hammer on the nail
 ‘Maria hits the nail with a hammer.’

There is a whole sequence of zero force vectors or points representing the movement of the hammer (Maria’s instrument/force exiter). This is followed by a non-zero force vector representing the forceful contact between the hammer and the nail (the force recipient). The length of that vector represents the magnitude of the force exerted through that contact.

The force vectors are thus doing double duty in a sense. As force vectors, they are used to represent the force that a force exiter exerts on a force recipient. But they are also used to represent the movement of the force exiter via the spatial origins of the force vectors.

Implementing this vector model into a (Neo-)Davidsonian Event Semantic analysis allows me not only to represent all the different properties of force verbs such as their aspectual and directional properties (cf. the distinctions between *drücken* (to push/press), which is directed towards the force recipient, and *ziehen* (to pull), which is directed away from the force recipient; or *drücken*, which is continuous, and *schlagen*, which is punctual). It also allows me to account for entailment relations between resultative and non-resultative uses of force verbs, make explicit the relation between verbs and prepositions and, crucially, model the force result and force modification incompatibility observable in sentences like (4).

- (4) ?? Maria schlägt den Nagel hart in die Wand.
 ?? Maria hits the nail hard into the wall
 ‘Maria hits the nail hard into the wall.’

The questionnaire results presented in Chapter 5 showed that sentences that specify a result of the force, e.g. the nail being in the wall, are rated significantly lower when they are modified by the force adverbs *hart* (hard) or *leicht* (lightly) than sentences that don’t specify a result (such as (3) above).

7.3 Verb frames

In order to represent all the different aspects of the verb semantics developed in Chapter 6 in one connected frame structure that makes explicit all their relations (as opposed to unpacking lexical entries into long lists), the frames for force verbs need to be much more complex than the example frame presented in Figure 7.1 above.⁵ So in order to keep the presentation manageable, I will present the different components of the frame separately below. Once the general frame for force verbs is in place, in Section 7.4, I will show how the main findings from Chapters 5 and 6 can be modelled within Frame Semantics.

First, to give an impression, the overall frame for force verbs is presented in Figure 7.2, allowing an immediate view on the network of relations between the different meaning components. This frame will be built up gradually in Figures 7.3-7.6 below. Please note that Figure 7.2 is the most general blueprint of a frame for a force verb. Some components might need to be excluded or to be modelled in greater detail in the representation of specific force verbs. Some empty nodes in this frame are not filled due to the concrete values of individual force verbs differing from each other. These differences will be discussed and illustrated in Section 7.4. Other empty nodes in this frame are not filled, because the information is contributed by other words in a sentence, such as the concrete agent.

I will now briefly illustrate some important aspects of the frame in Figure 7.2, before explaining them in more detail in the step-by-step approach in Sections 7.3.1-7.3.3.

The label **force verb** of the central node (marked by a double circle) refers to the set of all events described by force verbs. These are characterised in the frame in Figure 7.2 by a movement and a force transmission component, modelled as separate attributes of a force verb and taking as values the sets of all movement and force transmission events respectively.⁶ In line with the analysis presented in Chapter 6, the force component is represented in the frame via the FORCE TRANSMISSION attribute, i.e. the force that is modelled here is the force that the force exiter exerts on the force recipient. This notion excludes the ‘built-up’ force or impetus, i.e. the force that the force exiter needs to generate in order to move (e.g. Geuder & Weisgerber 2008).⁷ The movement attribute models the movement of the force exiter leading up to the force transmission, i.e. the movement that brings the force exiter in contact with the force recipient so that the force transmission can take place (expressed in a sentence such as *Maria hit the nail*). It is *not* the movement that might result from the force transmission (expressed in a phrase such as *into the wall*). If

⁵Please note, though, that while the frame structures presented here are similar to the analysis presented in Chapter 6, they are not a direct, mechanical translation of the analysis presented there.

⁶This is a bit different from the analysis in 6, where force and movement are integrated in one path. The two components will be connected further down in the frame structure.

⁷For a proposal of an analysis that includes this type of force, see e.g. Geuder (2016).

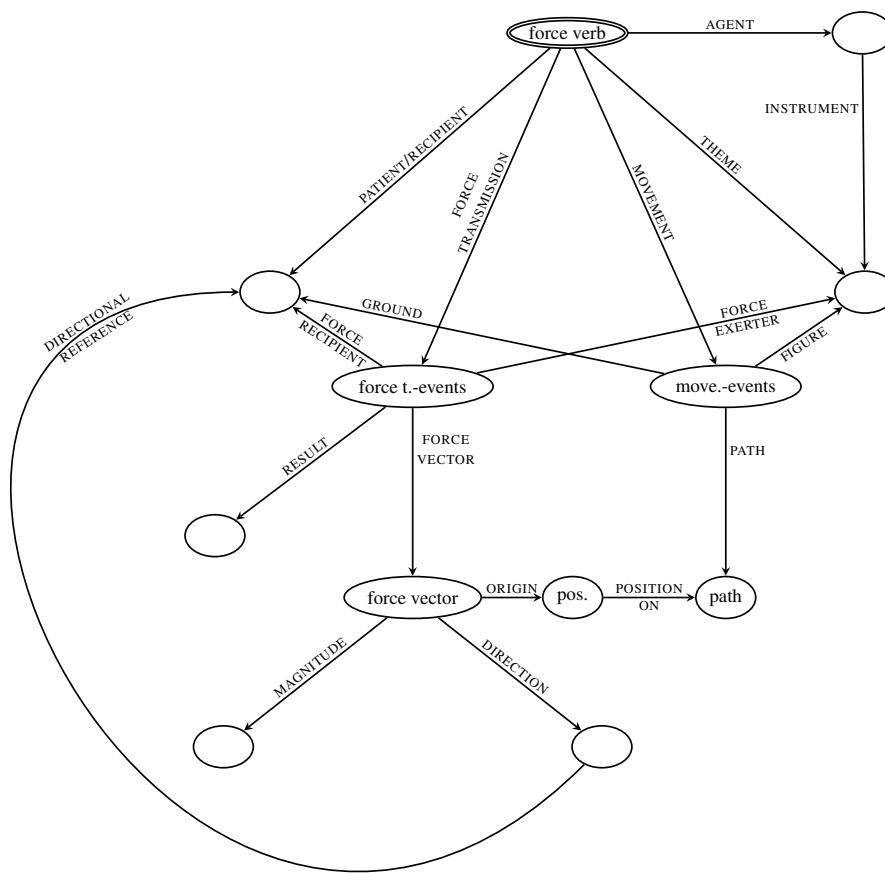


Figure 7.2: The general frame for force verbs. The abbreviation *force t.-events* stands for *force transmission events*, *move.-events* stands for *movement events* and *pos.* stands for *position*.

applicable, this will be modelled in a separate frame (see Section 7.5.1).

Both the force and movement components assign their own specific argument roles, as defined in Chapter 6. Imagine again a situation in which Maria is hitting on a nail. Maria exerts a force on the nail, Maria is therefore the force exarter, and the nail is the force recipient, the object to which the force is applied. But before Maria can exert a force on the nail, she must be in contact with it, i.e. she must make a movement towards the nail. As explained in Chapter 6, the entities involved in movement are called the Figure and the Ground (the terminology comes from literature on spatial language, cf. Talmy 1983). Maria is the object that is moving, the Figure, the nail is the object with respect to which the movement is described, the Ground. The different argument roles are modelled in the frame in Figure 7.2 by having multiple outgoing arcs from the **force transmission events** and **movement events** nodes. Both Maria and the nail thus fulfill several roles, the force exarter and the Figure (Maria) and the force recipient and the Ground (the nail). This can be seen in the frame by the multiple incoming arcs pointing towards their nodes.

The frame also shows how the force transmission and movement components are analysed in terms of force vectors and paths respectively, and how they come together through the double duty of the force vectors (explained in Section 7.2.2 above), the origins of which are positions on a path.

Finally, the frame has traditional argument roles such as agent, which become important when determining whether modification by agent-oriented adverbs is admissible, and when representing the implicature that arises when agent-oriented adverbs modify force verbs (cf. Section 7.2.1).

Please note that the distinction between individuals, sets of events and more abstract entities like the magnitude of a force vector are not visibly distinguished in the frame in Figure 7.2. In this, I follow the conventions in Barsalou 1992; Löbner 2014; Petersen 2015 and others.

In the next sections, I will walk through the frame structure in Figure 7.2 step-by-step. First, I will elaborate on the traditional argument roles. Then I will explain their relation to the notions of force exarter and force recipient on the one hand, and Figure and Ground on the other. Finally, I will explain in detail how the two components force transmission and movement relate to force vectors and paths.

7.3.1 The argument roles

The verb's argument roles agent, patient/recipient and theme are given as attributes in the frame fragment in Figure 7.3. These argument roles are used to represent the verb's argument structure as visible in the syntax. The concrete values will be contributed by noun phrase arguments in the sentence.

Notice that the agent and the theme are represented separately, yet are joined via the agent's instrument, representing that what moves in a force event is at the same time the instrument used by the agent, if there is an agent. The motivation behind this separation is that in order to explicitly model uses of

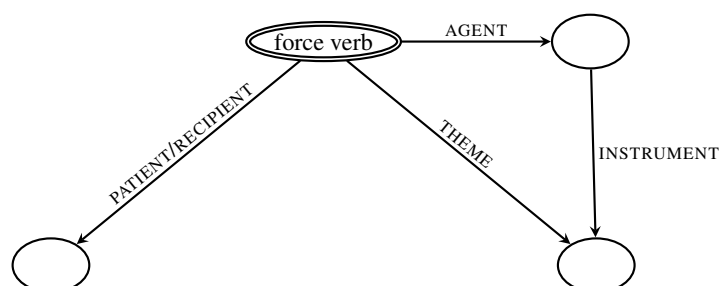


Figure 7.3: The verb's argument roles.

force verbs with an inanimate subject (cf. the discussion on animacy conditions in Chapter 3), the attributes AGENT and INSTRUMENT need to be dropped, leaving only THEME. To illustrate: If Maria hits something with a guitar, then Maria is the agent, and the guitar is both the instrument and the theme. But in a sentence such as *Die Gitarre schlägt gegen den Tisch* (The guitar hits against the table), the attributes AGENT and INSTRUMENT need to be dropped. The guitar is still the theme, but there is no agent and no instrument.

The doubly-labelled argument PATIENT/RECIPIENT serves a similar purpose. Both animate and inanimate entities can appear in the object position of sentences containing a force verb as main verb. The label patient is traditionally used for animate entities, while recipient or undergoer are chosen for inanimate entities (cf. Dowty 1991).

Finally, please note that the attributes AGENT, THEME and PATIENT / RECIPIENT in Figure 7.3 are used in their relational interpretations (cf. the introduction to Frame Semantics in Section 7.1 above). That is, these arguments are two-place predicates just as in Event Semantics, where $\text{THEME}(e, x)$ assigns a theme x to the event e .

7.3.2 The argument roles and the conceptual components

The attributes FORCE TRANSMISSION and MOVEMENT each assign their own roles. A force transmission event requires a role force exorter (which or who exerts a force) and a role force recipient (on whom or which the force is exerted). Movement events require a role Figure (that which is moving) and can additionally assign a role Ground, with respect to which the movement is located. This is illustrated in Figure 7.4.

The argument roles assigned by the two components force transmission and movement are connected to the argument roles AGENT, THEME and PATIENT/RECIPIENT as presented in the frame fragment in Figure 7.5. That is, the attributes FORCE EXERTER and FIGURE lead to the same node as THEME and INSTRUMENT (of the AGENT), and the attributes FORCE RECIPIENT and

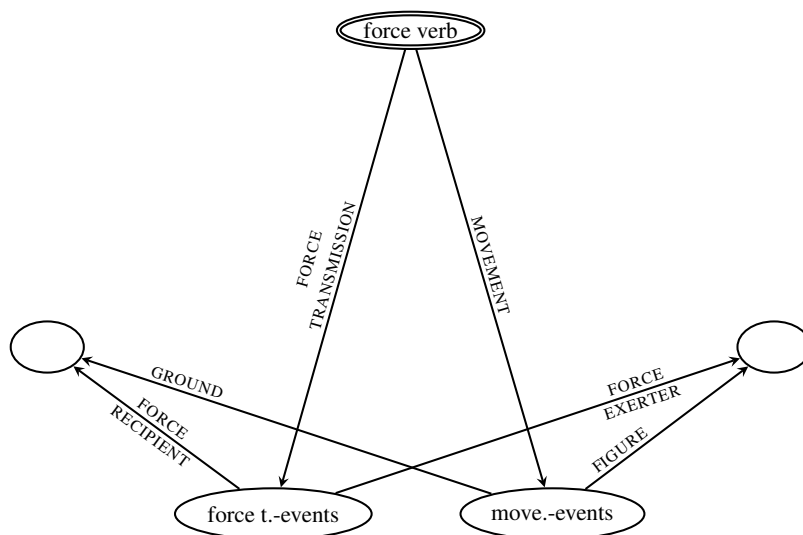


Figure 7.4: The frame fragment representing the force transmission and movement components and their argument roles. The abbreviation *force t.-events* stands for *force transmission events*, *move.-events* stands for *movement events*.

GROUND lead to the same node as PATIENT/RECIPIENT. The verb's arguments thus get several labels, which express the different perspectives of force transmission and movement, the fact that an argument is at the same time the Figure (a notion defined spatially) and the force exorter (a notion from the force-dynamic domain).

Events of force transmission require a force exorter and a force recipient. The force exorter can be the agent and their instrument/the theme, in the case of an animate force exorter as in (5-a) and (5-b) below. If there is an inanimate force exorter (as in (5-c) and (5-d) below), this is expressed by the fact that the roles AGENT and INSTRUMENT are dropped, and instead the force exorter is the THEME. The force recipient is either the patient (animate, as in (5-b) or (5-d)) or the recipient (inanimate, as in (5-a) or (5-c)).

Similarly, events of movement require a Figure and a Ground. The Figure is the theme (the hammer in (5-a) and the guitar in (5-c)), and in the case of an animate agent also the instrument (again, the hammer in (5-a)). The Ground is the patient (Joan or a part of her/her leg in (5-b) and (5-c)) or recipient (the nail in (5-a) and the table in (5-c)).

- (5) a. Maria schlägt mit einem Hammer auf den Nagel.
 Maria hits with a hammer on the nail
 'Maria hits the nail with a hammer.'

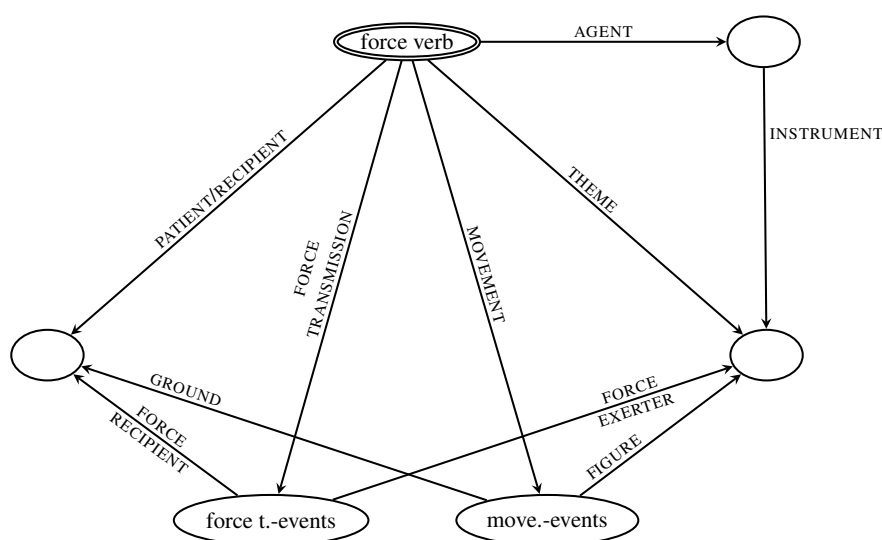


Figure 7.5: The frame fragment representing the connection between the different argument roles. The abbreviation *force t.-events* stands for *force transmission events*, *move.-events* stands for *movement events*.

- b. Maria schlägt Joan.
Maria hits Joan
- c. Die Gitarre schlägt gegen den Tisch.
the guitar hits against the table
'The guitar hits the table.'
- d. Die Gitarre schlägt gegen Joans Bein.
the guitar hits against Joan's leg
The guitar hits Joan's leg.

The frame representation thus makes explicit the relation between the verb's arguments and its conceptual structure relating to force transmission and movement.

7.3.3 The conceptual components

The attributes `FORCE TRANSMISSION` and `MOVEMENT` take as values the sets of all force transmission events and all movement events respectively. They assign their argument roles as described above, but the force transmission and movement events are also further decomposed into force vectors and paths, the backbones of the analysis presented in Chapter 6 (cf. the summary presented in Section 7.2.2 above). This is shown in the frame fragment in Figure 7.6.

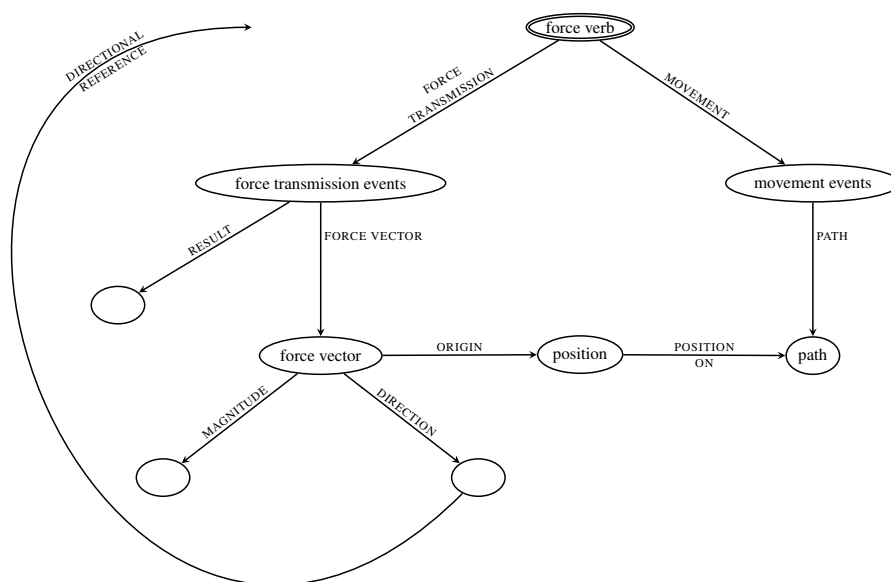


Figure 7.6: The frame fragment representing the structure of the force transmission and movement components.

The attribute **FORCE VECTOR** leads to the node **force vector**, **PATH** leads to **path**. As with the **BODY/body** and **STICK/stick** attributes and values in the lolly example in Figure 7.1 above, the nodes **force vector** and **path** represent the set of all force vectors and the set of all paths. The frame fragment in Figure 7.6 also shows how the three properties of force vectors established in Chapter 6, origin, magnitude and direction, are modelled as attributes of **force vector**. Note that once specific values are added for these attributes, they restrict the set of force vectors expressed in the node **force vector** to the subset with this specific origin, magnitude and direction.

Concerning the attribute **DIRECTION**: Remember that the possible directions (internally and externally) are all defined with the force recipient as a reference object (cf. Chapter 6). Therefore, there is an outgoing arc towards the force recipient, labelled **DIRECTIONAL REFERENCE**, making this explicit.

The attribute **ORIGIN** of **force vector** points to a node from which there is an outgoing arc towards **path**, labelled **POSITION ON**. The value of the attribute **ORIGIN**, **position**, is a spatial position on the path of the event. The double-duty of a force vector as on the one hand representing the force exerted by the force exarter on the force recipient, and on the other hand the position of the Figure (= force exarter) on a spatial trajectory is achieved by identifying the origin of the force vector with a position on a spatial path. Imagine again the

movement of Maria's hammer towards a nail. At every moment during that event, the hammer could exert a force, represented by a force vector: zero force vectors before the contact with the nail, when no force is exerted, and non-zero force vectors during the contact with the nail, when a force is exerted. Every force vector representing the force exerted by the hammer, zero and non-zero, has an origin. This origin serves to localise the hammer in space, and the sequence of the origins of all the force vectors form a path. That is, the origin of every force vector occupies a position on the path of movement of the hammer. That is what is modelled via the attributes `ORIGIN` and `POSITION ON`, connecting **force vector** to **position** to **path**.

The values for the attributes `MAGNITUDE`, `DIRECTION` and `ORIGIN` may vary for each force vector that is exerted over the run time of the event. In the example above, the hammer is moving constantly towards the nail, so each force vector representing the force exerted through the hammer will originate in a different position on the path (and might vary from other force vectors in its magnitude and direction). This time-dependent variance can be represented in Frame Semantics by a time function that keeps track of the changing values in a frame (see also Section 7.4 below).

Finally, please note that in order to model the resultative uses of force verbs, the attribute `RESULT` is added to **force transmission events**. The value of this attribute will be a second event (expressed by a resultative particle or preposition), which is modelled in a second frame. This will only be relevant, however, if the force exerted by the force exarter overcomes the force recipient's tendency (cf. the discussion on causation in Chapter 6). I will provide more details on force results in the next section.

7.4 Modelling force verbs in frame semantics

With the general verb frame as presented in Figure 7.2 in place, I can now proceed to model the main distinctions between force verbs as discussed in Chapter 5: directional, intensity and aspectual distinctions. I will first discuss these distinctions and show frame fragments that represent them in a force verb frame. Then I will present the fully specified verb frames for a couple of examples.

7.4.1 Directional and intensity distinctions

Firstly, there are directional distinctions between verbs such as e.g. *ziehen* (to pull) and *drücken* (to push/press). These can be modelled in frames by adjusting the value for the attribute `DIRECTION` of **force vector**, shown in the frame fragment in Figure 7.7. As mapped out in Chapter 6, *ziehen* (to pull) requires externally directed force vectors with respect to the force recipient, *ziehen* is away from the force recipient; *drücken* (to push/press), on the other hand, requires internally directed force vectors with respect to the force re-

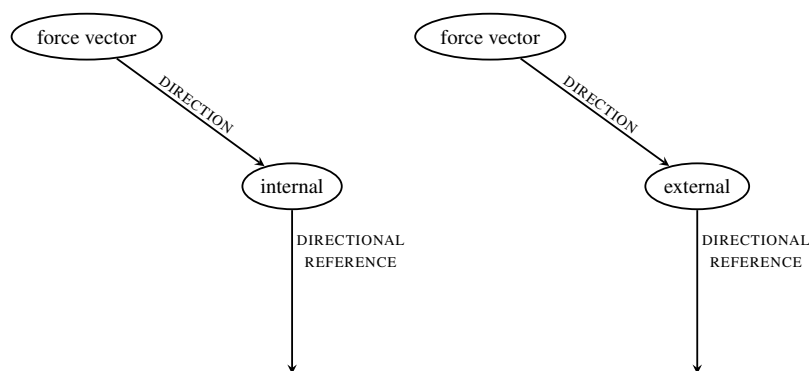


Figure 7.7: The frame fragment representing the directional distinctions between force verbs: internally directed and externally directed.

recipient, *drücken* is thus towards the force recipient. The notation *internal* and *external* can be entered into the frame as values of the attribute **DIRECTION**. As said above, the arc going from the node that contains the value of **DIRECTION** to the force recipient represents the fact that directionality is determined with respect to the force recipient (the node containing the force recipient is not shown in the frame fragment in Figure 7.7).

Secondly, force verbs differ with respect to intensity, i.e. the magnitude of the non-zero force vectors. Some verbs, like e.g. *berühren* (to touch), are lexically specified for a low amount of force, while others such as e.g. *zerren* (to drag/tug) are lexically specified for a high amount of force. And some verbs are unspecified with respect to the magnitude of the force, e.g. *schlagen* (to hit), though *schlagen* is typically understood as involving a high amount of force, cf. the questionnaire results in Chapter 3. The unspecified verbs can be modelled in frames by leaving the value of the attribute **MAGNITUDE** of **force vector** unspecified in the verb frame, shown in the frame fragment in Figure 7.8. If a concrete sentence is represented where the verb is modified by adverbs such as *leicht* (lightly) or *hart* (hard), i.e. adverbs that provide a value for the force magnitude, the value will be specified accordingly. Otherwise it will be specified for the typical interpretation (hard) by inserting default values (more on mechanisms for inserting inferred default values into frames in Section 7.5.2). Intensive verbs, on the other hand, need a force magnitude higher than a certain average for comparison, and non-intensive verbs need a force magnitude lower than a certain average for comparison (cf. the discussions on intensity in Chapter 6). The average for comparison is mostly not overtly expressed, there are thus no outgoing arcs from the node representing the value of **MAGNITUDE**. Rather, this is expressed by a subscript c for context in the notation.

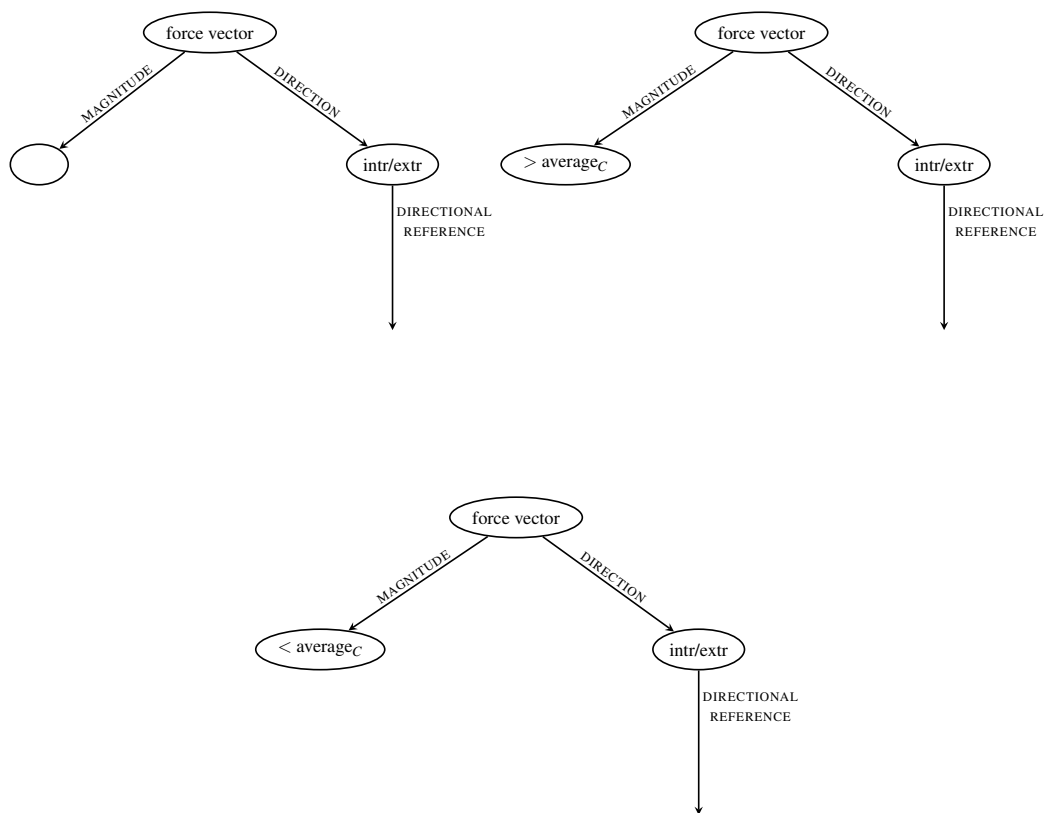


Figure 7.8: The frame fragment representing the intensity distinctions between force verbs: unspecified force magnitude, higher than some average and lower than some average.

7.4.2 Aspectual distinctions and a time function

Finally, force verbs exhibit differences with respect to their aspectual properties. There are punctual verbs such as e.g. *schlagen* (to hit), which require only one force vector to have a magnitude bigger than zero. And there are continuous verbs like *drücken* (to push/press), which require all force vectors to have a magnitude bigger than zero. The difference between punctual and continuous verbs is thus the quantity of non-zero force vectors.

Remember from Chapter 6 that events are assigned a run time, the interval $\text{TIME}(e)$, and that force vectors are modelled as $p(t)$, the force vector f representing the force exerted by the force exarter on the force recipient at time t from $\text{TIME}(e)$. At every moment of the event, there is thus a new force vector with potentially distinct origin, direction and magnitude. The aspectual distinctions are modelled such that for continuous verbs, at all moments during the run time of the event, the force vector of that moment needs to have a magnitude bigger than zero. For punctual verbs, there needs to be exactly one moment of the run time of the event (or maybe a small interval, see the discussion in Chapter 6) during which the force vector has a magnitude bigger than zero.

This is a bit more complicated to model in frames than directional or intensity distinctions, because it requires a time function to be built into frames. A complete proposal of how to incorporate a time function into event frames that model force verbs is beyond the scope of this work. But note that e.g. Naumann 2013; Gamerschlag et al. 2014; Löbner 2017 contain good proposals of how a time function can be built into frames. In essence, there needs to be a function that keeps track of changes in the values during the run time of the event. This can be done by making use of subevents, as in Gamerschlag et al. 2014; or by modelling dynamic aspects of a frame that change during time separately from static aspects of a frame that don't change over time, as in Naumann 2013. In order to simplify things, I will in the following treat the specific verb frames as snapshots, i.e. pick one moment of time and represent the values of the force vector of that specific moment of time.

7.4.3 Fully specified verb frames

I will now give a couple of examples of fully specified verb frames, modelling force verbs as they appear in the sentences given in (6). In order to provide the argument roles as specified in the verb frame with the concrete values given in the sentences in (6), a compositional mechanism is needed. There are several ways to do this in Frame Semantics. In the case of the sentences in (6), the values get added to the empty slots specified in the verb frame in Figure 7.2. Two other compositional mechanisms in Frame Semantics, frame unification and frame modification, will be introduced in Section 7.5.1 and 7.5.2 respectively, where I make use of them to model force results and force modification.

- (6) a. Joan schlägt Maria mit der flachen Hand.
Joan hits Maria with the flat hand
'Joan slaps Maria.'
- b. Der Hund zerrt mit den Zähnen an der Geschenkverpackung.
the dog tugs with the teeth on the present.wrappings
'The dog tugs with his teeth on the wrappings of the present.'
- c. Maria berührt den Hund mit der Hand.
Maria touches the dog with the hand
'Maria touches the dog with her hand.'

Remember that *schlagen* (to hit), as in (6-a), is a punctual force verb, unspecified with respect to the magnitude of the force (but typically interpreted as involving a high amount of force), and internally directed, i.e. the force is directed towards the force recipient. The verb *zerren* (to drag/tug), as in (6-b), is a continuous, intensive verb, i.e. lexically specified for a force magnitude higher than some average, and it is externally directed (force directed away from the force recipient). Finally, *berühren* (to touch), as in (6-c), is unspecified with respect to aspect, internally directed like *schlagen*, and non-intensive, i.e. lexically specified for a force magnitude lower than some average.

As said above, in the following I will present the verb frames as snapshots of one moment of the event denoted by the force verb. I do this because building a time function into frames to represent the aspectual distinctions is rather complicated and beyond the scope of this work. For all three force verbs, whether continuous or punctual, I choose to represent a moment in which the force magnitude is above zero. I do this so that I can illustrate the intensity distinctions: The distinction between a force magnitude above a certain average and a force magnitude below a certain average is only relevant with force magnitudes above zero. The frames for the three force verbs in the sentences in (6) are presented in Figures 7.9, 7.10 and 7.11.

A couple of points need to be mentioned. Firstly, as already stated above, the values **force t.-events** (short for force transmission events) and **move.-events** (short for movement events) stand for sets of force transmission and movement subevents. The central nodes **schlagen**, **zerren** and **berühren** refer to the respective sets of *schlagen*, *zerren* and *berühren* events. Secondly, the values for AGENT, INSTRUMENT / THEME and PATIENT/RECIPIENT are individuals. Remember from Section 7.3 above that the distinction between individuals and sets of events (and more abstract entities like the magnitude of a force vector) is not visibly distinguished in frames.

Thirdly, since the verbs *schlagen*, *zerren* and *berühren* differ with respect to their aspectual, directional and intensity components, so do the frames. As said above, the frames are snapshots of one moment of time during the events they represent, therefore the aspectual distinctions are not illustrated. The directional distinctions, as explained above, are represented as values of the attribute DIRECTION: **internal** for *schlagen* and *berühren*, and **external** for *zerren*. The intensity distinctions are represented by different values for the

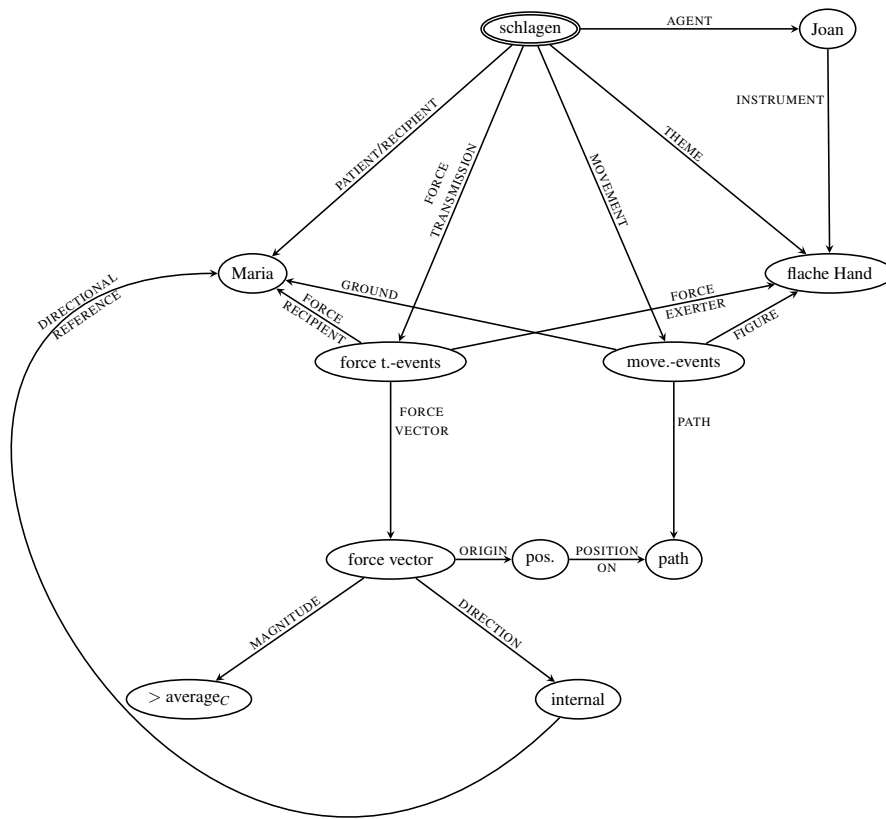


Figure 7.9: The frame representation of *Joan schlägt Maria mit der flachen Hand* (Joan slaps Maria).

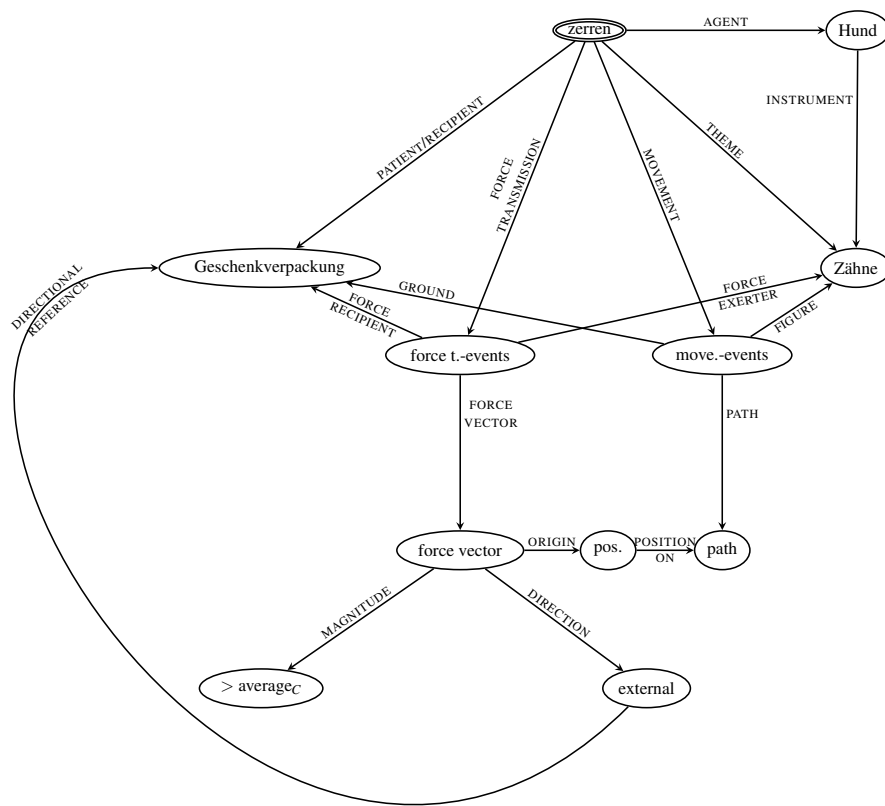


Figure 7.10: The frame representation of *Der Hund zerrt mit den Zähnen an der Geschenkverpackung* (The dog tugs with his teeth at the wrappings of the present).

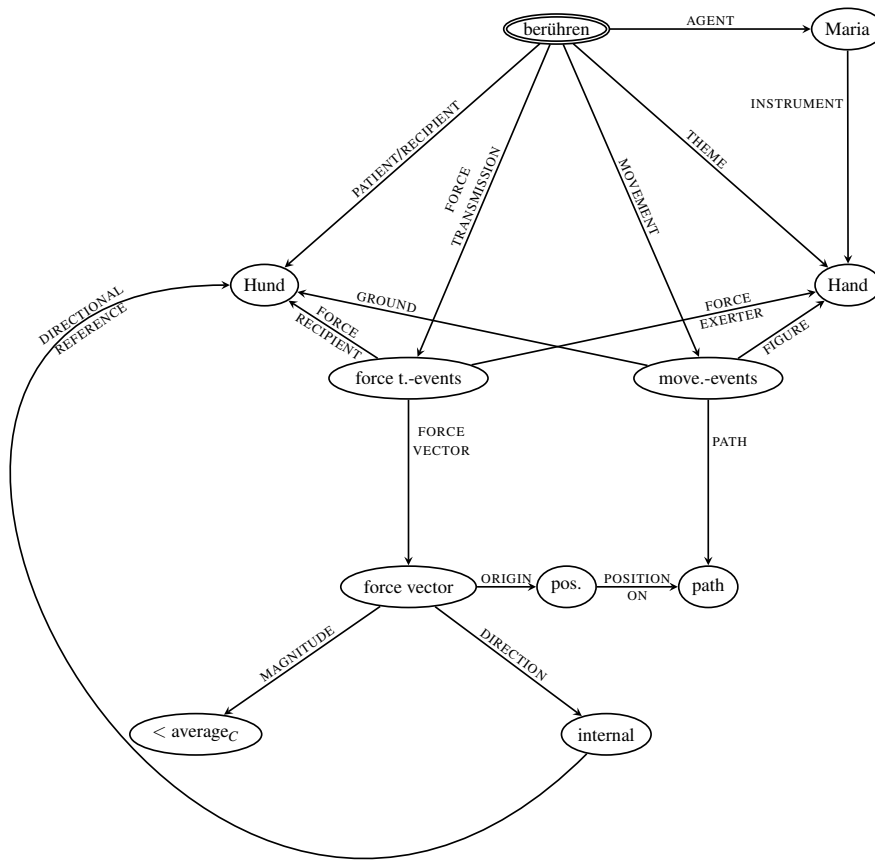


Figure 7.11: The frame representation of *Maria berührt den Hund mit der Hand* (Maria touches the dog with her hand).

attribute MAGNITUDE: **higher than average_C** for *schlagen* and *zerren* and **lower than average_C** for *berühren*. Please note though that the value for *schlagen*, other than that for *zerren* and *berühren*, is inserted due to a default process of interpretation rather than due to a lexical specification of the verb (*schlagen* is lexically unspecified with respect to a force magnitude). In Section 7.5.2, I will explain more about this and similar inferential processes, which are modelled as constraints in frames. For simplicity's sake I will not overtly mark this distinction here.

Finally, the value **pos.** (for position) in the fully specified verb frames is a placeholder for the specific spatial coordinate that is the origin of the force vector at the moment in the run time of the event that is represented in the frame (remember, the frames are snapshots of one moment of the run time of the event). Working out the precise coordinate is beyond the scope of this work.

7.4.4 Interim summary

I have presented a proposal on how to model force verbs in Frame Semantics. Force verbs have two components, a force or force transmission component and a movement component, which are modelled separately in Frame Semantics (cf. the general verb frame in Figure 7.2). Both components assign their own argument roles, the force exiter and force recipient of the force transmission component being equated with the Figure and Ground of the movement component respectively. The force recipient/Ground is then identified with the traditional argument role patient or recipient, while the force exiter/Figure is identified with the theme or the instrument of the agent.

The components force transmission and movement are brought together through the double duty of force vectors as a) modelling the force the force exiter exerts on the force recipient, and b) originating in a position of a spatial path used to track the movement of the Figure/force exiter. The value of the argument ORIGIN of **force vector** is a spatial position, which in turn has an argument POSITION ON which takes as a value **path**. The other properties of force vectors, magnitude and direction, are also modelled as attributes of **force vector**. The value of the attribute DIRECTION has an extra link to the force recipient, with respect to which the direction is determined.

The directional and intensity distinctions force verbs exhibit are modelled by adjusting the values of the attribute DIRECTION and MAGNITUDE respectively. In order to model the aspectual distinctions, one would have to build a time function into the frame representation. There are several approaches available to do this. However, in order to simplify matters, I have decided to present the verb frames as snapshots of one moment of time during the event.

The frame structure developed in this and the preceding section now shows how all the meaning components of force verbs 'hang together', i.e. the relations between the different meaning components of force verbs are made fully explicit in the frame structure. This can also be achieved in Neo-Davidsonian Event

Semantics, as I have demonstrated in Chapter 6, but the meaning components and their relations remain much more implicit in Event Semantics.

7.5 Force modification and force results in frames

In this section, I will show how modification of force verbs and resultative constructions with force verbs can be modelled in Frame Semantics on the basis of the general verb frame developed in the previous sections. I will first show how force results can be integrated into frames, cf. the sentence in (7) below. Then I will model modification of the force component, both directly through e.g. the adverbs *leicht* (lightly) and *hart* (hard), cf. the sentence in (8) below, and indirectly via an implicature triggered by adverbs such as *spielerisch* (playfully), cf. (9).

- (7) Maria schlägt den Nagel in die Wand.
'Maria hits the nail into the wall.'
- (8) Maria schlägt hart auf den Nagel.
'Maria hits the nail hard.'
- (9) Joan schlägt Mary spielerisch.
'Joan hits Mary playfully.'

7.5.1 Modelling force results

Force verbs in resultative constructions involve a second event: the movement that is the result of the force exertion. Remember from Chapter 6 that I chose to model even pure spatial paths or paths of motion on the basis of force vectors, namely zero force vectors that correspond to points in space and allow one to trace the movement of an object. Spatial prepositions such as *in* (into) are thus also modelled via force vectors (which require a force transmission component, even if that only serves to make explicit the absence of a force transmission). The frame for *in die Wand* (into the wall) is given in Figure 7.12. Please note that in this representation, the preposition *in* is treated semantically in the same way as a verb, cf. as a set of events. In Chapter 6, I have modelled prepositions as set of paths (the prepositional phrases are then shifted to sets of events). The frame in Figure 7.12 represents the preposition *in* as after the shift has been applied.

Since *in* is used as a spatial preposition in (7), there is no force that is exerted through contact and therefore no force transmission (only zero force vectors). This means that the force transmission component does not assign the argument roles force exorter and force recipient. There is movement, however, so there need to be a Figure and a Ground. The Ground is the wall, the Figure is not mentioned in the phrase that is represented: *in die Wand* (into the wall). The node that FIGURE points to needs to be identified with the object that goes into the wall when the PP is combined with other elements to compose

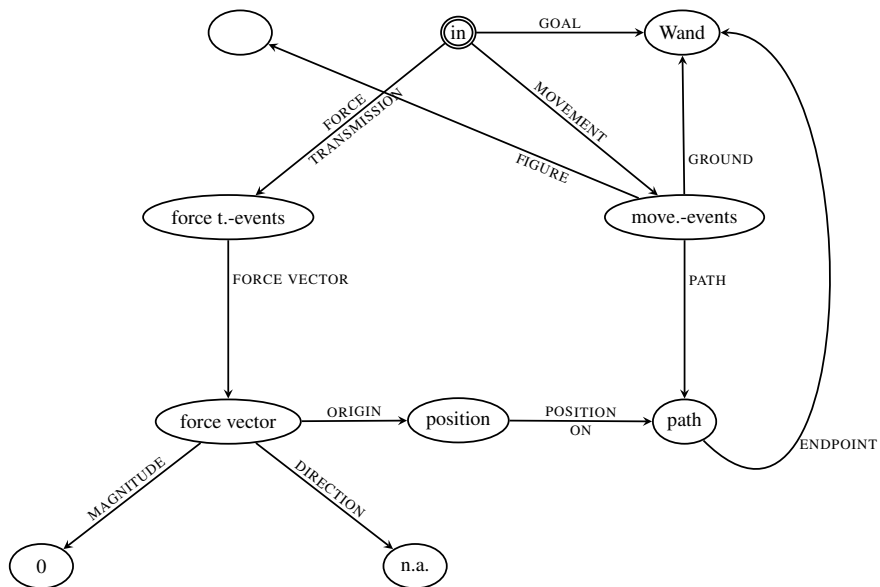


Figure 7.12: The frame representing the structure of the PP *in die Wand* (into the wall). The abbreviation *force t.-events* stands for *force transmission events*, *move.-events* stands for *movement events*.

a sentence. In the sentence in (7), it is the nail that goes into the wall. Please note that the Ground is at the same time represented as the goal argument of the preposition, the object inside of which the nail will be. In order to create a spatial path built up of zero force vectors, the attributes FORCE VECTOR and PATH also need to be present. But due to the zero magnitude of the force vector, the attribute DIRECTION does not apply.

The frame in Figure 7.12 needs to be unified with the frame for *schlagen* (to hit) (cf. Figure 7.9) in order to represent the sentence in (7). Frame unification is a compositional process, whereby two frames are integrated into one frame. Frame unification requires that the frames have “compatible information” (Schulzek 2014: 234), more specifically, that they do not have the same attribute assigning a different value (cf. the illustration of the partial transition function in Section 7.1.2 above).

When the frame in Figure 7.12 is unified with the frame for *schlagen*, the attribute RESULT as presented in Figure 7.2 above will be added to the node **force t.-events**. Its value will be the central node in the frame for *in die Wand: in*. *In die Wand* is the result of the force transmission. The empty node of the FIGURE-attribute in the frame in 7.12 will be identified with the node representing the patient/recipient in the verb frame: the nail. The unified frame is given in Figure 7.13.

Remember from Chapter 6 that *in die Wand* is modelled as an event caused by the event denoted by *schlagen*. The causation is due to the force exiter overcoming the force tendencies of the force recipient (the other forces working on the force recipient). This was modelled in Chapter 6 via vector addition, such that the force vector that represents Maria’s (the force exiter’s) force needs to be longer (have a bigger magnitude) than the force vector representing the nail’s (the force recipient’s) tendency.

The vector addition as explained in Chapter 6 is introduced as a constraint in the sense of Barsalou 1992 (see Section 7.1 above), such that the magnitude of the causing force vector is higher than the tendency of the nail. The constraint is represented as a dashed line in the frame. The intention of the constraint is to ensure that there is only a resulting movement event if the force exiter hit hard enough, roughly speaking. Ideally, this would be represented by an node *interaction*, that takes the force vector and checks whether its magnitude exceeds that of the force vectors representing the other forces working on the force recipient. If yes, then there should be an outgoing attribute from that node to the frame representing the resulting movement *in die Wand* (into the wall). But modelling such a node is beyond the scope of this dissertation.

Finally, in order to represent the sentence in (7), *Maria schlägt den Nagel in die Wand* (Maria hits the nail into the wall), the values for AGENT and RECIPIENT will be **Maria** and **Nagel** (nail) respectively.

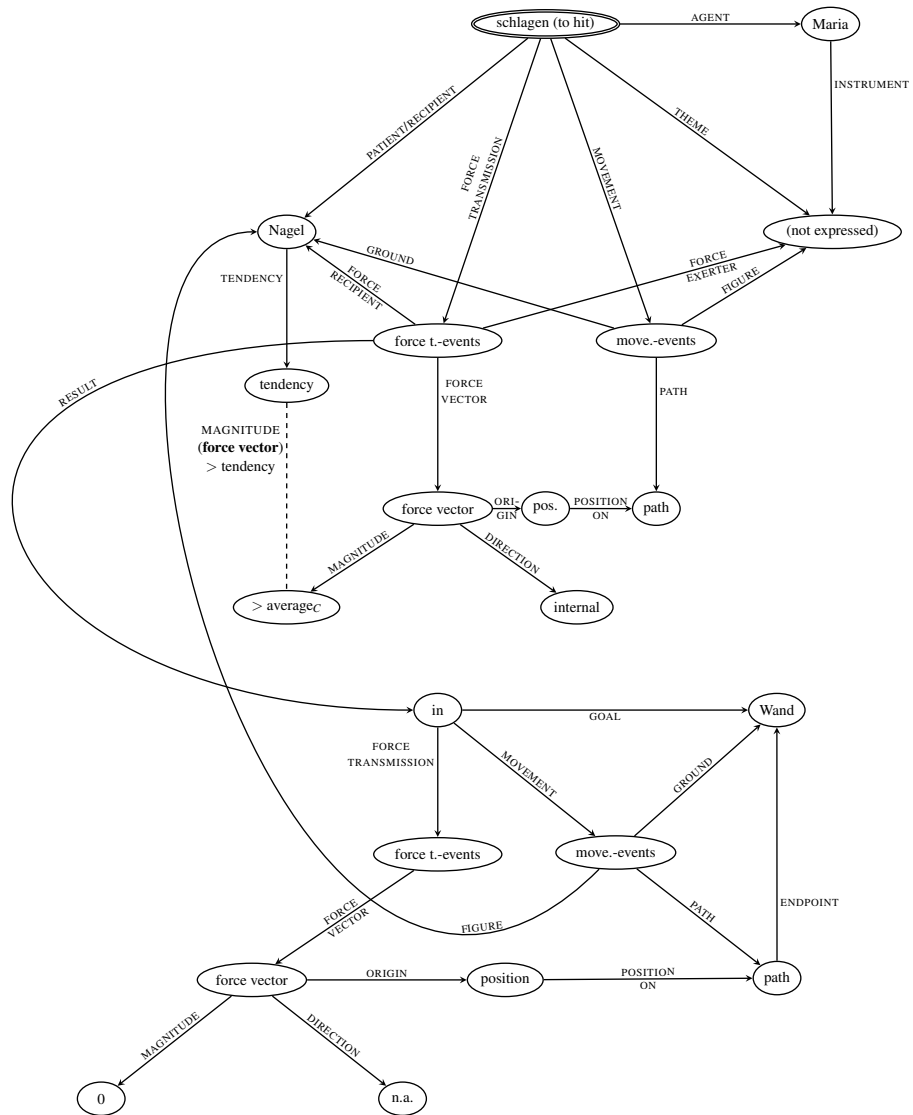


Figure 7.13: The unified frame construction for *Maria schlägt den Nagel in die Wand* (Maria hits the nail into the wall). Please note that attribute DIRECTIONAL REFERENCE of the direction of the force vector in the frame for *schlagen* has been omitted for readability's sake.

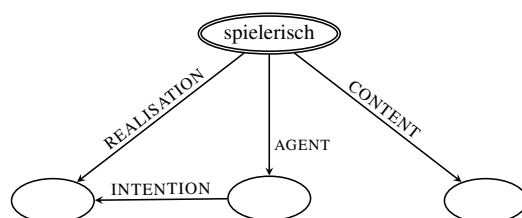


Figure 7.14: The frame representing the meaning of *spielerisch* (playfully).

7.5.2 Modification in frames

There are two options to model modification in frames, depending on the modifier (Geuder, 2006; Petersen & Gamerschlag, 2014). Either a modifier restricts the admissible values for an attribute already present in the to-be-modified frame, or the modifier adds new attributes to the frame. Both these types of modification can be found with force verbs. Modification of force verbs through the adverbs *hart* (hard) and *leicht* (lightly) is of the former type, i.e. these adverbs restrict the admissible values of the attribute MAGNITUDE in the verb frame. In the case of *hart*, the values will be restricted to the range above a certain average for comparison. And in the case of *leicht*, the values will be restricted to the range below a certain average for comparison (and above zero).

Modification by adverbs such as *spielerisch* (playfully) is of the latter type, i.e. the adverb adds attributes to the verb frame. This is achieved by first modelling a separate frame for the modifier, and then unifying that with the frame of the to-be-modified force verb. In the case of *spielerisch* modifying *schlagen* (to hit), as described in Chapter 4, I assume that the adverb serves to communicate a real, aggressive hit as a fictional possibility only, as a *Spiel* (play). *Spielerisch* in the context of *schlagen* thus refers to the intention of the agent to not hit aggressively (even though they could). Its semantics involves the simulation of an aggressive hit as a play or joke, i.e. the potentially aggressive hit is realised rather as a playful hit. I model the meaning of *spielerisch* as presented in Figure 7.14.

When the frame for *spielerisch* is unified with the frame for *schlagen* to represent the meaning of the sentence in (9), *Joan schlägt Mary spielerisch* (Joan hits Mary playfully), the empty nodes in the adverb frame will be identified with nodes from the verb frame. The attribute AGENT in the frame for *spielerisch* will be identified with the attribute AGENT in the frame for *schlagen*, i.e. both attributes will have the same value (in this case: Joan).

The CONTENT-attribute of *spielerisch* represents the activity that the agent intends as a play, in this case the full-fledged, aggressive hit. In the frame representation in Figure 7.15, the value of the CONTENT-attribute is simply **full hit**. This is a short cut which I use for reasons of space. What I intend to represent there is a frame just like the frame for *schlagen* in Figure 7.9 above,

with a magnitude higher than some average for comparison, which is the default for *schlagen*.

The attribute REALISATION leads to the central node of the frame, **schlagen**, indicating that the actual hitting is a playful realisation of a fully aggressive hit. Please note that this is the intention of the agent, to hit playfully, and not to hit aggressively. The attribute INTENTION therefore takes as a value the actual, playful realisation of the hit, not the fully aggressive hit. This has repercussions on the value of the attribute MAGNITUDE of the force transmission component of *schlagen*. Remember that *spielerisch* triggers an implicature of low force when combined with a force verb such as *schlagen* (cf. the results from the questionnaire and self-paced reading experiment presented in Chapter 3). Therefore, when the frames are unified, the value **lower than average_C** will be entered for the attribute MAGNITUDE, i.e. a value lower than some average for comparison (cf. Figure 7.15).

The cancellable nature of the implicature can be made explicit in frames by using a constraint in the sense of Barsalou 1992. Remember from Section 7.1.1 that constraints can be used to represent logical truth, but also statistical co-occurrence patterns or prototypicality. The constraint that is needed to model the implicature from *spielerisch schlagen* (to hit playfully) to *leicht schlagen* (to hit lightly) represents an inference to the stereotypical (cf. the discussion in Chapter 3). Please note that there is outwardly no difference between this constraint, which models a cancellable implicature, and the constraint used to represent the vector addition above. I use the dashed line representing the constraint in Figure 7.15 to make explicit that the value for the attribute MAGNITUDE is inferred.

The low force implicature triggered when *spielerisch* modifies *schlagen* can be cancelled as in (10).

- (10) Joan schlägt Mary *spielerisch*, aber doch recht *hart*.
 ‘Joan hits Mary playfully, but still rather hard.’

In order to model the sentence in (10), the constraint needs to be overridden, and the admissible values for MAGNITUDE need to be modified by *hart* (hard) to a range higher than some average for comparison: **higher than average_C**. This is shown in the frame in Figure 7.16. Please note that Figure 7.16 is only a suggestion on how to analyse the overriding of constraints in Frame Semantics. It is not yet entirely clear how constraints or their cancellation can be represented in Frame Semantics.

7.6 Summary and conclusion

In this chapter I have presented a Frame Semantic analysis of the main findings presented in Chapters 2 - 6. Frame Semantics goes back to Barsalou (1992), who introduces frames as recursive attribute-value structures, a representation of word meaning that focuses on the different types of relations and interactions

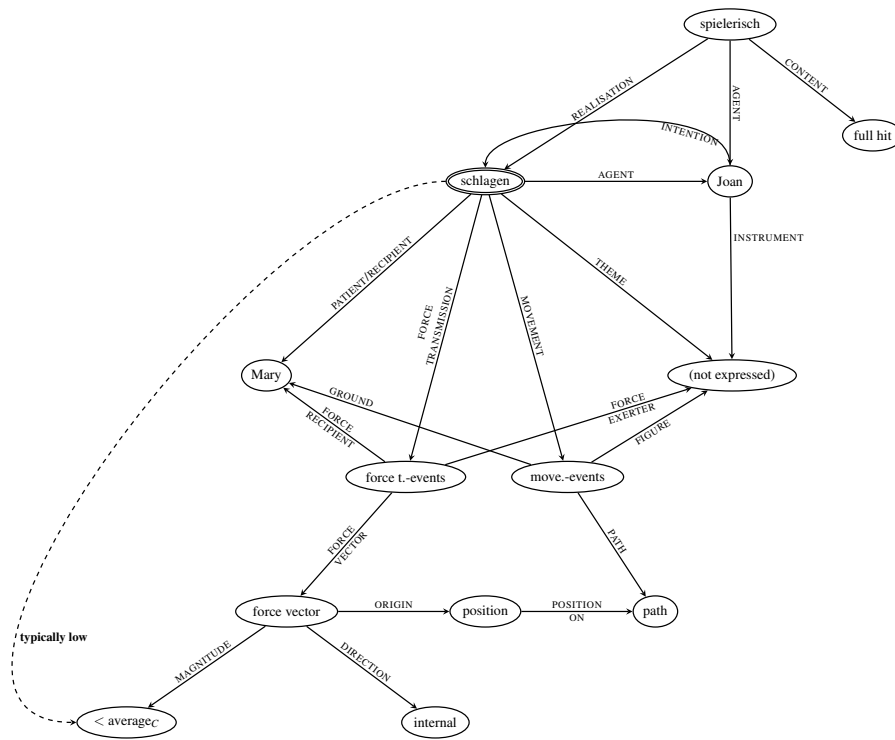


Figure 7.15: The frame construction representing the meaning of *Joan schlägt Mary spielerisch* (Joan hits Mary playfully).

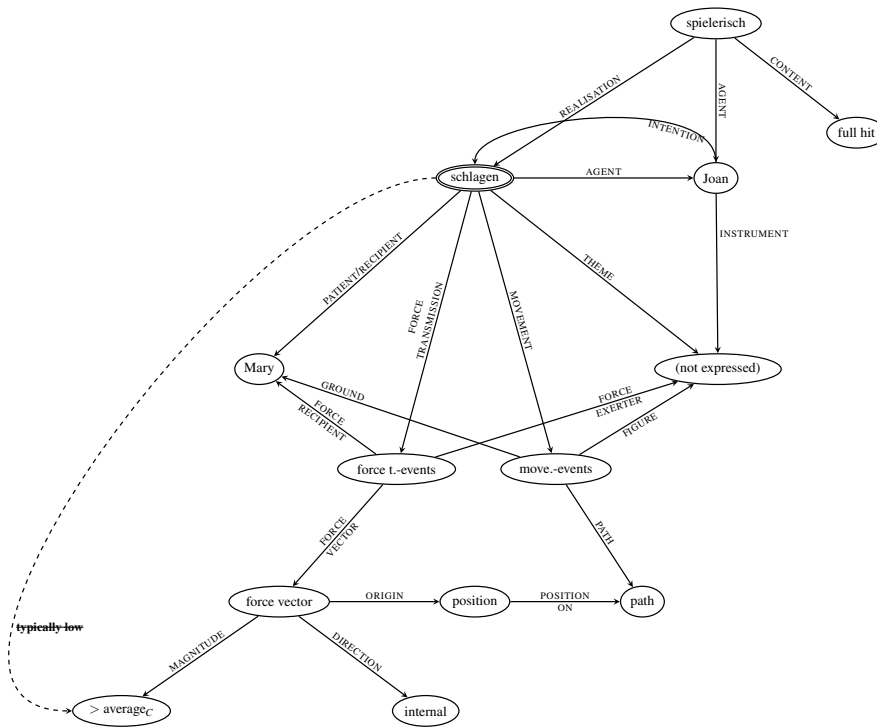


Figure 7.16: The frame construction representing the meaning of *Joan schlägt Mary spielerisch, aber doch recht hart* (Joan hits Mary playfully, but still rather hard).

between components of a concept. By virtue of frames being recursive, one can add more attributes and values to a given representation as necessary, which makes frames an attractive tool to model meaning in different contexts. Frame Semantics has been formalised by among others Petersen (2015), who defines frames as typed feature structures and provides links to first-order logic, thus allowing a translation of frame structures into frameworks such as e.g. (Neo-) Davidsonian Event Semantics.

The elaborate structure of frames allowed me to show the relations between different meaning components of force verbs in a single construction, as opposed to unpacking lexical entries into long lists of meaning components as was done in Chapter 6. Force transmission and movement are the two essential components of force verbs, united via the double-duty of force vectors as modelling the magnitude and direction of the force as well as the spatial position of a moving object.

In Section 7.3, I have shown how the different components of the verb frame are built up: the traditional argument roles agent and patient/recipient and their links to the argument roles force exiter/force recipient and Figure/Ground assigned by the conceptual components force transmission and movement respectively. I have also shown the internal built-up of these components. Crucially, the three aspects of force vectors discussed in Chapter 6, origin, direction and magnitude, are all modelled as attributes of the force vector.

The directional and intensity distinctions that are found in the domain of force verbs, cf. the results from the corpus study presented in Chapter 5, can be modelled by assigning different values to the attributes MAGNITUDE and DIRECTION. In order to model the aspectual distinctions, however, a time function would need to be built into the frame representation (which I have not done here, because this far exceeds the scope of this work).

Finally, in order to model force results and force modification, separate frames for resultative PPs and adverbs need to be assumed. These can then be unified with the verb frame to model whole sentences. Prepositional frames attach to the attribute RESULT of the force transmission node in the verb frame, and are mediated via a constraint on the force vectors' magnitude, corresponding to Wolff's (2007) idea. Adverbs can either modify the frame by restricting the range of admissible values for certain attributes, as e.g. *hart* (hard) and *leicht* (lightly) do with the attribute MAGNITUDE (of the force vector). Or they add extra attributes, as in the case of e.g. *spielerisch* (playfully), which takes the verb frame as its REALISATION value, modelling the fact that a playful hit is a playful realisation of a fully aggressive hit.

Frame Semantics thus allows me to model my findings in a way that makes transparent the links between the different meaning components. Doing this has allowed me to embed work on verb-adverb modification in the growing model of Frame Semantics, contributing towards representational power of this framework.

The explicit representation of the conceptual well-formedness conditions in

verb-adverb modification that has been developed in this chapter closes off this dissertation. In the next chapter, I will summarise the main findings and conclude.

CHAPTER 8

Conclusion

With this dissertation, I have contributed to uncovering some of the mechanisms underlying semantic well-formedness in verb-adverb modification. Crucially, I argue that in order to understand what determines semantic well-formedness of phrases or sentences, one needs to consider the conceptual structure of the words involved. But other than in the domain of adjective-noun modification, conceptual restrictions on verb-adverb modification are not very well researched. This dissertation is therefore intended as a contribution to the study of verb-adverb modification. The following sections include a summary of the main results as well as an outlook on future research.

8.1 Summary of the main results

As the domain of study I chose the modification of verbs with a force component. The choice for the domain of force was motivated by three main reasons.

Firstly, one can perceive force (an object feels differently when it hits one lightly compared to when it hits one hard). Since our perception and knowledge of the world play an important role in what we express in language, cf. the discussion in the introduction, this makes force an important entry point into the study of conceptual restrictions on verb-adverb modification.

Secondly, the use of force can be controlled. In a sentence with a volitional agent and a force verb, one can thus assume that the force magnitude is controlled by the agent. This is at the basis of the implicature triggered by agent-oriented adverbs modifying verbs with a force component, discussed in Chapters 2, 3 and 4.

Thirdly, force interactions have been analysed as the basic component of causal interactions in the theory of Force Dynamics (Talmy, 1988, 2000; Wolff, 2007). Building on this theory, I have developed an analysis of the force component where forces are modelled as vectors, and which allows me to accurately model the occurrences of force verbs in resultative as well as non-resultative constructions, discussed in Chapters 5 and 6.

In the following, I will summarise my approach for uncovering the mechanisms determining semantic well-formedness in verb-adverb combinations, as well as the main results of the research presented in Chapters 2 to 7.

8.1.1 Force implicatures

In order to determine the conceptual structure of verbs with a force component, I conducted a corpus study, searching for adverbs co-occurring with a selection of verbs (the selection of verbs was based on Levin's (1993) book on verb classes). The rationale behind this corpus study was that if an adverb co-occurs with a verb, the verb has a meaning component corresponding to the meaning of the adverb.

The results of the study are reported in Chapter 2. In summary: the three English verbs *slap*, *punch* and *hit*, as well as their German counterpart *schlagen* (translated mostly as *hit*, but also covering instances of *slap* and *punch*), all have a force component. This is evidenced by the frequent co-occurrences of the adverbs *lightly* and *hard* with these verbs. All of these verbs also co-occur with adverbs that express something about the agent of the event, such as *playfully* or *angrily*. It is usually claimed that adverbs like *playfully* and *angrily* can alternate between an agent-oriented reading and a manner reading depending on their position in the sentence (a low position in the sentence is associated with the manner reading, while a high position is associated with the agent-oriented reading). But based on insights by Schäfer (2005, 2013) for German and Ernst (2002) for English, I have been able to show that these adverbs are always agent-oriented; in a low position in a sentence they are classified as agent-oriented manner adverbs. That means that these adverbs always specify something about the agent of the event, whether the agent's manner of doing something or the agent's state of mind. This is in contrast to adverbs such as *lightly* or *hard*, which are pure manner adverbs and only modify the event itself (the force component of the event in the case of *lightly* and *hard*).

When agent-oriented adverbs are used to modify verbs with a force component, an interesting effect can be observed. While they don't specify anything about force, a sentence such as (1-a), which contains the verb-adverb combination *hit playfully*, gives rise to a defeasible inference, namely that the force of the hit was low (the inference is indicated by the \rightarrow in the example sentence). The sentence in (1-b) provides evidence for this force inference: *playfully* can be contrasted with *hard*, the opposite of *lightly* with respect to force (cf. the discussion in Chapter 2). This contrast indicates that the phrase *hit playfully* gives rise to a meaning component similar to *hit lightly*; it is this meaning com-

ponent which is contrasted with *hard*. The sentence in (1-b) also shows that this low force inference is defeasible, i.e. that it can be cancelled: the use of *hard* indicates that the force magnitude of the hitting event was high.

- (1) a. Joan hit Mary playfully. →
 Joan hit Mary lightly.
 b. Joan hit Mary playfully but still rather hard.

In order to determine the type of the inference, Chapter 3 contains a classification of the inference as an I-implicature (Levinson, 2000) or R-implicature (Horn, 2004). Crucially, these types of implicature are described as ‘stereotypical enrichment’, that is, the phrase *hit playfully* is interpreted as describing a stereotypical playful hitting, which is light. That means that in order for the implicature to arise, world knowledge about hitting events and certain states of mind of the agent are required (a detailed analysis identifying the world knowledge responsible for the force implicature in (1) is provided in Chapter 4, a short version of the analysis is given in the summary of that chapter below). In this respect, force implicatures are similar to the *brown apple* case discussed in the introduction. Remember that the adjective *brown*, when modifying the noun *apple*, not only modifies the colour of the apple, but also its taste and texture. Yet *brown* by itself specifies nothing about taste or texture. The additional meaning components are due to world knowledge about the decaying process of fruit. It can thus be said that verb-adverb modification resembles adjective-noun modification in that world-knowledge gives rise to additional meaning effects that cannot be traced to either the modifier or the ‘modiffee’ in isolation.

Chapter 3 also contains the results of a questionnaire study and a self-paced reading experiment. In Chapter 2, the force implicature has only been observed with the verb-adverb combination *hit playfully*. So in order to test whether the implicature is triggered by a wider array of verb-adverb combinations, I conducted a questionnaire study in German. The results of the questionnaire study show that force implicatures like those in (1) commonly arise when agent-oriented adverbs are used to modify verbs with a force component. The questionnaire results show further that the force magnitude of verbs of contact by impact is unspecified with respect to a precise value or range of values. When the verb *schlagen* is used in a sentence without a modifier, the force magnitude is inferred to be high, an inference similar to the one arising when the verb is modified by an agent-oriented adverb.

The self-paced reading experiment was conducted in order to test the strength of the implicature. The experiment was designed to test whether the cancellation of the implicature results in a reading time delay, indicating additional processing cost due to the cancellation. The results show that sentences in which the implicature is cancelled are read slower than sentences where the implicature is not cancelled.

Given the wide distribution of this force implicature with verb-adverb pairs,

it should be modelled in Event Semantics, the standard framework for verb-adverb modification. Event Semantics is not commonly used to model pragmatic phenomena such as implicature. However, the force implicatures described here are a product of the compositional process of verb-adverb modification. As explained in Chapters 2 and 3, neither the adverb nor the verb does by itself give rise to the observed force implicature. The implicature should therefore be modelled in a compositional framework for verb-adverb modification such as Event Semantics.

Chapter 4 contains an analysis of force implicatures in Event Semantics. In order to account for the implicature in (1), one needs to consider the meaning of the adverb *playfully*. In a nutshell: If an agent is playful, this indicates that they are not serious. If an agent then hits in a playful manner, the inference arises that they do not hit seriously, i.e. not with a high amount of force. This process is spelled out in the generalisation that agent-oriented adverbs and verbs with a force component give rise to low force implicatures.

8.1.2 Force results

Throughout Chapters 2 - 4, I have used a variety of adverbs, but only a relatively small selection of verbs taken from Levin's (1993) book on verb classes. In order to find a wider array of verbs with a force component, I therefore conducted a second corpus study. This time, I searched for verbs co-occurring with the adverbs *leicht* (lightly) and *hart* (hard). In Chapter 2, I have argued that these adverbs modify the force component of verbs. Therefore, verbs co-occurring with these adverbs should have a force component.

The results of the corpus study are presented in Chapter 5. In summary: A variety of verbs co-occur with the adverbs *leicht* and *hart*. These verbs differ along certain force-related parameters. For instance, a verb such as *schlagen* (to hit), expresses a momentary exertion of force. By contrast, a verb such as *drücken* (to push/press) expresses a continuous exertion of force. Both *schlagen* and *drücken* require the force to be directed towards the patient or recipient. This is in contrast with *ziehen* (to pull), which requires the force to be directed away from the patient or recipient. And while *schlagen*, *drücken* and *ziehen* are lexically unspecified with respect to a precise force magnitude (remember, the questionnaire results presented in Chapter 3 showed that the high force interpretation of *schlagen* is due to an inferential process), other verbs are lexically specified for a specific force magnitude. The verb *pressen* (to press), for instance, always expresses a high force magnitude, and the verb *berühren* (to touch) expresses a low force magnitude.

Interestingly, there are a couple of resultative particle verbs in the corpus that co-occur with the adverb *leicht*, such as *ausdrücken* (to squeeze out). The adverb in this case does not modify the force component, but rather expresses a quantity (see Chapter 5 for details). This observation led me to hypothesise that once a force result is specified, the force itself can no longer be modified. In order to test this hypothesis, I conducted a questionnaire study, testing a

variety of resultative force constructions with particle verbs or combinations of verbs and prepositional phrases. An example sentence is given in (2) below. The results show that, indeed, once a force result is specified via a resultative particle or PP, the modifiers *leicht* and *hart* are significantly less acceptable.

- (2) Maria schlägt den Nagel (*hart) in die Wand.
 Maria hits the nail (*hard) into the wall.

The questionnaire further provides evidence that verbs that are lexically specified for a low force magnitude, such as *berühren*, cannot be modified by an adverb expressing a high force magnitude, such as *hart*. Interestingly, though, the reverse was not the case: verbs specified for a high force magnitude, such as *pressen*, can very well be modified by *leicht*.

The notion of the force component as used in Chapter 4, where it is not further analysed and integrated as a primitive notion into the model, is not enough to adequately analyse the distinctions between force verbs as found in the corpus study. Nor will it allow me to account for the force result - force modification incompatibility observed in the questionnaire study. In Chapter 6, I therefore presented a more refined notion of the force component. In that chapter, I model the force exerted by an agent or force exerter as vectors, based on Wolff's (2007) idea and the vector model developed in Zwarts & Winter 2000. In a nutshell: At every moment during the event, the agent or force exerter either exerts a force or they don't. If a force is exerted, this is modelled via a non-zero force vector, that is, a force vector that has an origin, a magnitude and a direction. If no force is exerted, this is modelled via a zero-force vector, i.e. a force vector with an origin, but no magnitude or direction; a point, essentially. The sequence of unique (zero or non-zero) force vectors that represent the force exerted at each moment during the event forms a path. This path is associated to the event denoted by the verb. Modelling the force component in this vector-based approach allows me to capture all of the distinctions between force verbs observed in the corpus data.

To illustrate: The verb *schlagen* expresses a momentary exertion of force. The phase during which the agent or force exerter moves towards the patient or force recipient is modelled via zero force vectors, no force is yet exerted. The moment or interval of impact, when the force exerter exerts a force on the force recipient, is modelled by a non-zero force vector. Verbs such as *drücken*, which express a continuous exertion of force are analysed as denoting an event with a path of only non-zero force vectors, i.e. a force is exerted at every moment during the event. When a force is exerted, the directional and intensity distinctions observed in the corpus data can be modelled via the direction and magnitude of the force vectors respectively. Verbs that express a force directed towards the force recipient, such as *schlagen* or *drücken*, require force vectors that are internally directed, whereas verbs that express a force directed away from the force recipient, such as *ziehen*, require force vectors that are externally directed (for more details see Chapter 6). And verbs that are lexically specified for a

certain force magnitude require force vectors with a magnitude above or below a certain average for comparison.

In order to model force results, I make use of vector addition as used by Wolff (2007) to capture the insight by Talmy (2000) that in order to cause movement of an object, one needs to overcome the intrinsic force tendencies of that object. In the example sentence in (2) above, Maria needs to overcome the other forces working on the nail, such as e.g. gravity, in order to hit the nail into the wall. These other forces working on the nail are also modelled as force vectors. The force exerted by Maria needs to be higher than the other forces working on the nail. This is modelled via vector addition, where the length of a force vector represents its magnitude. The length of the force vector representing the force exerted by Maria thus needs to be greater than the length of the force vector representing the other forces working on the nail. I argue that once this vector addition has proceeded, the magnitude of the force vector representing Maria's force is no longer available for modification. The adverbs *leicht* and *hart*, which decrease and increase the force magnitude respectively, are thus not acceptable as modifiers.

This model also accounts for the unacceptability of verb-adverb combinations such as *hart berühren* (to touch hard) or verb-PP combinations such as *auf etwas ziehen* (to pull on something) or *an etwas drücken* (to push on something). By analysing adverbs and PPs as denoting sets of paths with force dynamic properties as described above, the unacceptability of these verb-modifier combinations can be explained by incompatible force magnitude and force direction requirements which lead to empty set intersections in a Neo-Davidsonian Event Semantics model. The analysis developed in Chapter 6 thus not only accurately accounts for all the lexical distinctions between force verbs, it also gives an account of how the conceptual structure of both verbs and modifiers (adverbs and PPs) restricts semantic well-formedness of verb-adverb and verb-PP combinations.

8.1.3 Conceptual structure

In order to make this conceptual structure of verbs and modifiers explicit, Event Semantics as used in Chapter 6 is not the most elegant tool. One can model all the necessary meaning components in Event Semantics as lists in the lexical entries of verbs and modifiers, as I have done in Chapter 6. But in Frame Semantics, one can not only make visible all the meaning components at one glance, but also explicitly model their connections. In Chapter 7, I therefore provide an analysis of modification of force verbs in the framework of Frame Semantics.

In Frame Semantics, word meaning is modelled via attributes and their values. For example, the force component is modelled as an attribute of force verbs, which takes *force vector* as its value. The origin, magnitude and direction of force vectors are then modelled as attributes of *force vector* and take as values concrete origins, magnitudes and directions. The resulting frame structure is

modelled as a network of arcs that represent the attributes and connect the nodes, which represent the attributes' values.

Meaning effects that are based on world-knowledge, such as the force implicatures described in Section 8.1.1 above, can be modelled as constraints. Constraints in Frame Semantics are not only used to model logical truth, but also statistical co-occurrence or stereotypes. Thus the stereotypical enrichment that e.g. a playful hit is a light hit can be nicely captured by this system.

Frame Semantics thus allows me to make explicit the conceptual structure which determines semantic well-formedness in verb-adverb modification.

8.2 Outlook and concluding remarks

In this dissertation, I have uncovered several of the mechanisms that determine semantic well-formedness in verb-adverb modification in the domain of force. These mechanisms might relate to more general mechanisms determining semantic well-formedness. For example, Rappaport Hovav & Levin (2010) and Levin & Rappaport Hovav (2013) discuss a general manner-result complementarity. While this is about meaning components of verbs (and not verb-adverb modification), it is possible that the observed force result - force modification incompatibility as discussed in Chapters 5 and 6 might be a specific instance of this general observation. If so, similar incompatibilities might be observed in other domains as well, such as the domain of speed or sound-volume.

Similarly, as explained in the introduction and mentioned briefly in Section 8.1.1 above, Smith et al. (1988) make observations about world-knowledge and meaning effects of adjective-noun modification in the domain of natural objects and colour, which are very similar to the meaning effects of the force implicatures discussed in Chapters 2 - 4. This might indicate that force implicatures, too, are a specific instance of a more general mechanism. Both Wolff (2007) and Talmy (2000) discuss causation in the psychological and social domain as based on forces. This indicates that the mechanisms observed in this dissertation might apply in those domains as well. Both the psychological and the social domain are less perception-based than the force domain, and it might be that world-knowledge about, for instance, social situations, plays a bigger role here.

With this dissertation I have shown that the conceptual structure of words influences compositional processes. Compositional semantic theories should thus not only take into account word meaning in the narrow sense of reference, but also consider the broader world knowledge connecting words, including perception and stereotypical enrichment.

APPENDIX A

Full data from the corpus study on adverbs

A.1 Data from the British National Corpus

The full list of adverbs from the British National Corpus (BNC) used to modify the English verbs of contact by impact *slap*, *punch* and *hit* can be found in Table A.1. The total number of occurrences of each verb with an adverb in the BNC is: *slap* = 82, *punch* = 40, *hit* = 250. The percentages given below are calculated based on that number.

slap		punch		hit	
adverb	frequency	adverb	frequency	adverb	frequency
hard	37.8%	hard	35%	hard	52%
lightly	7.3%	lightly	15%	badly	8%
suddenly	7.3%	playfully	12.5%	harder	8%
gently	6.1%	gently	5%	suddenly	4%
promptly	4.9%	sharply	5%	worst	3.2%
sharply	4.9%	strongly	5%	violently	2.4%
harder	3.65%	aggressively	2.5%	angrily	1.6%
angrily	2.4%	angrily	2.5%	fast	1.6%
firmly	2.4%	harder	2.5%	immediately	1.2%
playfully	2.4%	painfully	2.5%	properly	1.2%
softly	2.4%	savagely	2.5%	quickly	1.2%
brutally	1.2%	viciously	2.5%	ferociously	0.8%
fiercely	1.2%	vigorously	2.5%	firmly	0.8%
hastily	1.2%	violently	2.5%	painfully	0.8%
instantly	1.2%	wildly	2.5%	quick	0.8%
loosely	1.2%			severely	0.8%
loudly	1.2%			sharply	0.8%
mildly	1.2%			strongly	0.8%
painfully	1.2%			sweetly	0.8%
quickly	1.2%			wildly	0.8%
smartly	1.2%			accidentally	0.4%
soundly	1.2%			briefly	0.4%
swiftly	1.2%			fatally	0.4%
viciously	1.2%			fiercely	0.4%
violently	1.2%			forcibly	0.4%
wildly	1.2%			gently	0.4%
				glancingly	0.4%
				hardest	0.4%
				heavily	0.4%
				lightly	0.4%
				mercilessly	0.4%
				playfully	0.4%
				promptly	0.4%
				rapidly	0.4%
				savagely	0.4%
				seriously	0.4%
				solidly	0.4%
				soundly	0.4%
				weakly	0.4%

Table A.1: The full list of adverbs used to modify the verbs *slap*, *punch* and *hit*.

A.2 Data from the Digitales Wörterbuch der Deutschen Sprache

The full list of adverbs from the Digitales Wörterbuch der Deutschen Sprache (digital dictionary of the German language, DWDS) used to modify the German verb *schlagen* (most faithfully translated as *hit*, but also covering instances of *slap* and *punch*) can be found in Table A.2. The total number of occurrences of the verb *schlagen* with an adverb in the DWDS is 256. The percentages given below are calculated based on that number.

adverb	translation	frequency
plötzlich	suddenly	5.1%
leicht	lightly	3.5%
hart	hard	3.1%
heftig	severely	3.1%
dumpf	dully	2.7%
kräftig	strongly	2.7%
lachend	laughingly	2.7%
wütend	angrily	2.7%
dröhnend	booming	1.9%
wild	wildly	1.9%
klatschend	slapping	1.6%
krachend	crashing	1.6%
langsam	slowly	1.6%
laut	loudly	1.6%
entsetzt	horrified	1.2%
hell	light	1.2%
knallend	banging	1.2%
lieblich	lovely	1.2%
schwer	heavily	1.2%
silbern	silver	1.2%
tüchtig	vigorously	1.2%
unbarmherzig	mercilessly	1.2%
begeistert	enthusiastically	0.8%
dicht	close	0.8%
fern	remotely	0.8%
fest	tightly	0.8%
gellend	shrilly	0.8%
grausam	cruelly	0.8%
jäh	suddenly	0.8%
lärmend	noisily	0.8%
leise	quietly	0.8%
nah	closely	0.8%
rasch	swiftly	0.8%

schnell	quickly	0.8%
voll	fully	0.8%
wuchtig	massively	0.8%
zornig	furiously	0.8%
ärgerlich	annoyed	0.4%
aufmunternd	encouragingly	0.4%
aufschluchzend	sobbing	0.4%
bedeutungsvoll	meaningfully	0.4%
beiläufig	casually	0.4%
belustigt	amused	0.4%
beteuernd	assuringly	0.4%
bewundernd	admiringly	0.4%
blind	blindly	0.4%
blitzschnell	very fast	0.4%
brutal	brutally	0.4%
derb	roughly	0.4%
deutlich	distinctly	0.4%
eilig	hastily	0.3%
einfach	simply	0.4%
erschüttert	shaken	0.4%
fangend	catching	0.4%
feierlich	solemnly	0.4%
freundlich	friendly	0.4%
fröhlich	cheerfully	0.4%
fröstelnd	shivery	0.4%
früh	early	0.4%
gedankenvoll	thoughtfully	0.4%
gelangweilt	bored	0.4%
gepeinigt	anguished	0.4%
gewalttätig	violently	0.4%
gewichtig	gravely	0.4%
giftig	poisonously	0.4%
gleichmäßig	evenly	0.4%
glitzernd	glittering	0.4%
grell	glaringly	0.4%
grimmig	grimly	0.4%
gut	good/well	0.4%
härter	harder	0.4%
heimlich	secretly	0.4%
hemmungslos	unrestrained	0.4%
herb	harshly	0.4%
heulend	howling	0.4%
hörbar	audibly	0.4%
hysterisch	hysterically	0.4%
jauchzend	whooping	0.4%

kalt	coldly	0.4%
klagend	plaintively	0.4%
klappernd	clattering	0.4%
klirrend	clanging	0.4%
kurz	shortly	0.4%
lustlos	listlessly	0.4%
mächtig	mightily	0.4%
massenhaft	plentifully	0.4%
meisterlich	masterfully	0.4%
mörderisch	murderously	0.4%
müheless	effortlessly	0.4%
munter	spiritedly	0.4%
mutig	bravely	0.4%
nervös	nervously	0.4%
platt	flat	0.4%
platzend	bursting	0.4%
plump	plumply	0.4%
polternd	rumbling	0.4%
qualblind	mercilessly	0.4%
reißend	torrential	0.4%
rücksichtslos	ruthlessly	0.4%
schallend	resoundingly	0.4%
scherzhaft	jokingly	0.4%
schimpfend	scolding	0.4%
schläfrig	sleepily	0.4%
schmerzend	smarting	0.4%
schmerzhaft	painfully	0.4%
schnalzend	chirruping	0.4%
schräg	skewed	0.4%
schreiend	yelling	0.4%
schweigend	silent	0.4%
schwerfällig	cumbersome	0.4%
sicher	securely	0.4%
sinnend	musingly	0.4%
sinnlos	pointlessly	0.4%
sorgfältig	thoroughly	0.4%
spöttisch	mockingly	0.4%
stöhnend	groaning	0.4%
stumm	mutely	0.4%
täglich	daily	0.4%
taktmäßig	in time to	0.4%
tapfer	brave	0.4%
tief	deep	0.4%
todesmutig	very bravely	0.4%
todeswütig	very angry	0.4%

tönend	ringing	0.4%
umständlich	labouriously	0.4%
unablässig	ceaselessly	0.4%
unaufhörlich	relentlessly	0.4%
ungeregelt	irregularly	0.4%
unglücklich	unhappily	0.4%
unmotiviert	unmotivated	0.4%
ununterbrochen	incessantly	0.4%
unvermittelt	abruptly	0.4%
unwillkürlich	involuntarily	0.4%
verächtlich	scornfully	0.4%
verrückt	crazily	0.4%
verzweifelnd	despairing	0.4%
verzweifelt	despairingly	0.4%
wahllos	randomly	0.4%
willenlos	weak-willed	0.4%
wohlwollend	benevolently	0.4%
wutblind	furiously	0.4%
wütig	raging	0.4%
zeternd	clamouring	0.4%
zierlich	delicately	0.4%
zitternd	shakily	0.4%
zuckend	jerkily	0.4%
zuversichtlich	confidently	0.4%

Table A.2: The full list of adverbs used to modify the verb *schlagen* (~ to hit).

APPENDIX B

Materials from the adverb questionnaire

The stimuli testing predictions from the Verb Force Hypothesis can be found in Table B.1.

The Verb Force Hypothesis	
basic construction animate	Sophia schlägt Simon hart. (Sophia hits Simon hard.) Chris schlägt Alex leicht. (Chris hits Alex lightly.)
basic construction inanimate	Die Gitarre schlägt hart gegen die Tischkante. (The guitar hits the edge of the table hard.) Der Zweig schlägt hart gegen die Hauswand. (The branch hits the wall of the house hard .) Die Wellen schlagen hart gegen den Deich. (The waves hit the dyke hard.) Die Gitarre schlägt leicht gegen die Tischkante. (The guitar hits the edge of the table lightly.) Der Zweig schlägt leicht gegen die Hauswand. (The branch hits the wall of the house lightly.) Die Wellen schlagen leicht gegen den Deich. (The waves hit the dyke lightly.)
denial-of-expectation construction animate	Julia schlägt Tobias, aber hart. (Julia hits Tobias, but hard.) Tobias schlägt Maike, aber leicht. (Tobias hits Maike, but lightly.)
denial-of	Die Gitarre schlägt gegen die Tischkante, aber hart.

expectation	(The guitar hits the edge of the table, but hard.)
construction	Der Zweig schlägt gegen die Hauswand, aber hart.
inanimate	(The branch hits the wall of the house, but hard.) Die Wellen schlagen gegen den Deich, aber hart. (The waves hit the dyke, but hard.) Die Gitarre schlägt gegen die Tischkante, aber leicht. (The guitar hits the edge of the table, but lightly.) Der Zweig schlägt gegen die Hauswand, aber leicht. (The branch hits the wall of the house, but lightly.) Die Wellen schlagen gegen den Deich, aber leicht. (The waves hit the dyke, but lightly.)

Table B.1: The stimuli testing the predictions from the Verb Force Hypothesis.

The stimuli testing predictions from the Agentivity Hypothesis can be found in Table B.2.

The Agentivity Hypothesis	
agent-oriented	Chris schlägt Alex kühn auf den Arm. (Chris hits Alex boldly on the arm.)
manner animate	Andrea schlägt Jan spielerisch on the arm. (Andrea hits Jan playfully on the arm.)
agent-oriented	Die Gitarre schlägt kühn gegen die Tischkante. (The guitar boldly hits the edge of the table.)
manner inanimate	Der Zweig schlägt kühn gegen die Hauswand. (The branch boldly hits the wall of the house.) Die Wellen schlagen kühn gegen den Deich. (The waves boldly hit the dyke.) Die Gitarre schlägt spielerisch gegen die Tischkante. (The guitar playfully hits the edge of the table.) Der Zweig schlägt spielerisch gegen die Hauswand. (The branch playfully hits the wall of the house.) Die Wellen schlagen spielerisch gegen den Deich. (The waves playfully hit the dyke.)
subject depictives animate	Jan schlägt Stephan verzweifelt auf den Arm. (Jan hits Stephan despairingly on the arm.) Stephan schlägt Sandra belustigt auf den Arm. (Amused, Stephan hits Sandra on the arm.)
subject depictives inanimate	Die Gitarre schlägt verzweifelt gegen die Tischkante. (Despairingly, the guitar hits the edge of the table.) Der Zweig schlägt verzweifelt gegen die Hauswand. (Despairingly, the branch hits the wall of the house.) Die Wellen schlagen verzweifelt gegen den Deich. (Despairingly, the waves hit the dyke.)

	Die Gitarre schlägt belustigt gegen die Tischkante. (Amused, the guitar hits the edge of the table.) Der Zweig schlägt belustigt gegen die Hauswand. (Amused, the branch hits the wall of the house.) Die Wellen schlagen belustigt gegen den Deich. (Amused, the waves hit the dyke.)
mental attitude adverbs animate	Stephan schlägt Florian wütend auf den Arm. (Stepahn hits Florian angrily on the arm.) Maike schlägt Tobias ängstlich auf den Arm. (Frightened, Maike hits Tobias on the arm.)
mental attitude adverbs inanimate	Die Gitarre schlägt wütend gegen die Tischkante. (The guitar angrily hits the edge of the table.) Der Zweig schlägt wütend gegen die Hauswand. (The branch angrily hits the wall of the house.) Die Wellen schlagen wütend gegen den Deich. (The waves angrily hit the dyke.) Die Gitarre schlägt ängstlich gegen die Tischkante. (Frightened, the guitar hits the edge of the table.) Der Zweig schlägt ängstlich gegen die Hauswand. (Frightened, the branch hits the wall of the house.) Die Wellen schlagen ängstlich gegen den Deich. (Frightened, the waves hit the dyke.)
pure manner adverbs animate	Sophia schlägt Simon hart auf den Arm. (Sophia hits Simon hard on the arm.) Stephan schlägt Julia fest auf den Arm. (Stephan hits Julia tightly on the arm.) Sandra schlägt Tobias kräftig auf den Arm. (Sandra hits Tobias strongly on the arm.) Chris schlägt Alex leicht auf den Arm. (Chris hits Alex lightly on the arm.) Sandra schlägt Julia sanft auf den Arm. (Sandra hits Julia gently on the arm.)
pure manner adverbs inanimate	Die Gitarre schlägt hart gegen die Tischkante. (The guitar hits the edge of the table hard.) Der Zweig schlägt hart gegen die Hauswand. (The branch hits the wall of the house hard.) Die Wellen schlagen hart gegen den Deich. (The waves hit the dyke hard.) Die Gitarre schlägt kräftig gegen die Tischkante. (The guitar hits the edge of the table strongly.) Der Zweig schlägt kräftig gegen die Hauswand. (The branch hits the wall of the house strongly.) Die Wellen schlagen kräftig gegen den Deich. (The walls hit the dyke strongly.)

Die Gitarre schlägt fest gegen die Tischkante.
 The guitar hits the edge of the table tightly.
 Der Zweig schlägt fest gegen die Hauswand.
 (The branch hits the wall of the house tightly.)
 Die Wellen schlagen fest gegen den Deich.
 (The waves hit the dyke tightly.)
 Die Gitarre schlägt leicht gegen die Tischkante.
 (The guitar hits the edge of the table lightly.)
 Der Zweig schlägt leicht gegen die Hauswand.
 (The branch hits the wall of the house lightly.)
 Die Wellen schlagen leicht gegen den Deich.
 (The waves hit the dyke lightly.)
 Die Gitarre schlägt sanft gegen die Tischkante.
 (The guitar hits the edge of the table gently.)
 Der Zweig schlägt sanft gegen die Hauswand.
 (The branch hits the wall of the house gently.)
 Die Wellen schlagen sanft gegen den Deich.
 (The waves hit the dyke gently.)

Table B.2: The stimuli testing the predictions from the Agentivity Hypothesis.

The stimuli testing predictions from the Force Implicature Hypothesis can be found in Table B.3.

The Force Implicature Hypothesis	
force decrease implicatures	Andrea schlägt Jan spielerisch, (Andrea hits Jan playfully, aber doch recht hart/leicht, auf den Arm. but still rather hard/lightly, on the arm)
	Stephan schlägt Sandra belustigt, (Stephan hits Sandra amused, aber doch recht hart/leicht, auf den Arm. but still rather hard/lightly, on the arm)
	Maike schlägt Tobias ängstlich, (Maike hits Tobias frightened, aber doch recht hart/leicht, auf den Arm. but still rather hard/lightly, on the arm)
force increase implicatures	Chris schlägt Alex kühn, (Chris hits Alex boldly, aber doch recht leicht/hart, auf den Arm. but still rather lightly/hard, on the arm)
	Jan schlägt Stephan verzweifelt, (Jan hits Stephan despairingly, aber doch recht leicht/hart, auf den Arm.

	but still rather lightly/hard, on the arm)
	Stephan schlägt Florian wütend, (Stephan hits Florian angrily, aber doch recht leicht/hart, auf den Arm. but still rather lightly/hard, on the arm)
contradiction baseline	Sophia schlägt Simon hart, (Sophia hits Simon hard, aber doch recht leicht, auf den Arm. but still rather lightly, on the arm)
	Stephan schlägt Julia fest, (Stephan hits Julia tightly, aber doch recht leicht, auf den Arm. but still rather lightly, on the arm)
	Sandra schlägt Tobias kräftig, (Sandra hits Tobias strongly, aber doch recht leicht, auf den Arm. but still rather lightly, on the arm)
	Chris schlägt Alex leicht, (Chris hits Alex lightly, aber doch recht hart, auf den Arm. but still rather hard, on the arm)
	Sandra schlägt Julia sanft, (Sandra hits Julia gently, aber doch recht hart, auf den Arm. but still rather hard, on the arm)

Table B.3: The stimuli testing the predictions from the Force Implicature Hypothesis.

APPENDIX C

Materials from the self-paced reading experiment

The stimuli used in the experiment can be found in Table C.1, sorted by condition (force decrease sentences versus force increase sentences).

Condition	Test Sentences
force decrease	Jet sloeg Harry vrolijk/kwaad, (Jet hit Harry cheerfully/viciously, en tegelijk vrij machtig, op zijn schouder. and simultaneously rather powerfully, on his shoulder.)
	Jan kuste Nina lieflijk/woest, (Jan kissed Nina sweetly/savagely, en tegelijk vrij stevig, op haar voorhoofd. and simultaneously rather strongly, on her forehead.)
	Kim stootte Ben vriendelijk/kwaad, (Kim hit Ben friendly/viciously, en tegelijk vrij hevig, tegen zijn schenen. and simultaneously rather fiercely, against his shins.)
	Jet plaatste het kopje lachend/boos, (Jet placed the cup laughingly/angrily, en tegelijk vrij machtig, op de tafel. and simultaneously rather powerfully, on the table.)
	Ben duwde Jan speels/gemeen, (Ben pushed Jan playfully/viciously, en tegelijk vrij hard, tegen de muur. and simultaneously rather hard, against the wall.)
	Ans gooide de bal vrolijk/serieus,

	(Ans threw the ball cheerfully/seriously, en tegelijk vrij krachtig, over de schutting. and simultaneously rather strongly, over the fence.)
	Kim kneep Lisa speels/woest, (Kim pinched Lisa playfully/savagely, en tegelijk vrij grof, in haar neus. and simultaneously rather roughly, into her nose.)
	Linde hamerde de spijker vrolijk/boos, (Line hammered the nail cheerfully/angrily, en tegelijk vrij grof, de muur in. and simultaneously rather roughly, into the wall.)
	Bob prikte Kees vriendelijk/wild, (Bob poked Kees friendly/wildly, en tegelijk vrij hevig, in zijn borst. and simultaneously rather fiercely, into his chest.)
	Ans trok Bob speels/pijnlijk, (Ans pulled Bob playfully/painfully, en tegelijk vrij stevig, naar haar toe. and simultaneously rather strongly, towards her.)
	Jet greep Rick speels/serieus, (Jet grabbed Rick playfully/seriously, en tegelijk vrij stevig, bij de arm. and simultaneously rather strongly, on his arm.)
	Els stompte Harry vriendelijk/pijnlijk, (Els punched Harry friendly/painfully, en tegelijk vrij krachtig, op zijn arm. and simultaneously rather strongly, on his arm.)
force	Jet sloeg Harry pijnlijk/lieflijk, (Jet hit Harry painfully/sweetly, en tegelijk vrij zwakjes, op zijn schouder. and simultaneously rather weakly, on his shoulder.)
increase	Jet sloeg Harry boos/speels, (Jet hit Harry angrily/playfully, en tegelijk vrij zachtjes, op zijn schouder. and simultaneously rather softly, on his shoulder.)
	Jan kuste Nina kwaad/speels, (Jan kissed Nina viciously/playfully, en tegelijk vrij licht, op haar voorhoofd. and simultaneously rather lightly, on her forehead.)
	Jan kuste Nina boos/vrolijk, (Jan kissed Nina angrily/cheerfully, en tegelijk vrij zacht, op haar voorhoofd. and simultaneously rather softly, on her forehead.)
	Kim stootte Ben serieus/speels,

(Kim hit Ben seriously/playfully,
 en tegelijk vrij licht, tegen zijn schenen.
 and simultaneously rather lightly, against his shins.)

Jet plaatste het kopje kwaad/lieflijk,
 (Jet placed the cup viciously/sweetly,
 en tegelijk vrij zwak, op de tafel.
 and simultaneously rather weakly, on the table.)

Jet plaatste het kopje serieus/vrolijk,
 (Jet placed the cup seriously/cheerfully,
 en tegelijk vrij licht, op de tafel.
 and simultaneously rather lightly, on the table.)

Ben duwde Jan woest/lieflijk,
 (Ben pushed Jan savagely/sweetly,
 en tegelijk vrij zwak, tegen de muur.
 and simultaneously rather weakly, against the wall.)

Ans gooide de bal boos/vrolijk,
 (Ans threw the ball angrily/cheerfully,
 en tegelijk vrij zwakjes, over de schutting.
 and simultaneously rather weakly, over the fence.)

Kim kneep Lisa serieus/vriendelijk,
 (Kim pinched Lisa seriously/friendly,
 en tegelijk vrij zacht, in haar neus.
 and simultaneously rather softly, into her nose.)

Kim kneep Lisa boos/lachend,
 (Kim pinched Lisa angrily/laughingly,
 en tegelijk vrij zwak, in haar neus.
 and simultaneously rather weakly, into her nose.)

Linde hamerde de spijker kwaad/lachend,
 (Linde hammered the nail viciously/laughingly,
 en tegelijk vrij zwak, de muur in.
 and simultaneously rather weakly, into the wall.)

Linde hamerde de spijker serieus/speels,
 (Linde hammered the nail seriously/playfully,
 en tegelijk vrij zwakjes, de muur in.
 and simultaneously rather weakly, into the wall.)

Bob prikte Kees kwaad/vrolijk,
 (Bob poked Kees viciously/cheerfully,
 en tegelijk vrij licht, in zijn borst.
 and simultaneously rather lightly, into his chest.)

Ans trok Bob woest/lachend,
 (Ans pulled Bob savagely/laughingly,
 en tegelijk vrij zacht, naar haar toe.
 and simultaneously rather softly, towards her.)

Els stompte Harry serieus/speels,
 (Els punched Harry seriously/playfully,

en tegelijk vrij zwak, op zijn arm.
and simultaneously rather weakly, on his arm.)

Kees wreef Bob boos/speels,
(Kees rubbed Bob angrily/playfully,
en tegelijk vrij zwakjes, over zijn hoofd.
and simultaneously rather weakly, over his head.)

Table C.1: The stimuli from the self-paced reading experiment,
sorted by condition.

APPENDIX D

Full data from the corpus study on verbs

The full list of verbs from the Digitales Wörterbuch der Deutschen Sprache (digital dictionary of the German language, DWDS) that can be modified by the German adverbs *leicht* (lightly) and *hart* (hard) can be found in Table D.1. The total number of occurrences of each adverb with a verb in the DWDS is: *leicht* = 157, *hart* = 81. The percentages given below are calculated based on that number.

leicht			hart		
adverb	translation	freq.	adverb	translation	freq.
liegen	lie	14.01 %	schlagen	hit	17.28 %
stoßen	thrust	12.74 %	stoßen	thrust	13.58 %
schlagen	hit	10.19 %	klopfen	knock	7.4 %
legen	lay	8.28 %	anfaßen	handle	6.17 %
berühren	touch	7.64 %	aufschlagen	hit (on)	6.17 %
schütteln	shake	7.01 %	packen	seize	6.17 %
klopfen	knock	5.73 %	pressen	press	6.17 %
streichen	stroke	5.73 %	drücken	push/press	4.94 %
stützen	support	5.09 %	fallen	fall	4.94 %
faßen	grip	4.46 %	setzen	set	4.94 %
drücken	push	3.82 %	stellen	put	2.47 %
andrücken	press on	2.55 %	tippen	tap	2.47 %
ausdrücken	squeeze out	2.55 %	treten	kick	2.47 %
tippen	tap	2.55 %	anprallen	crash into	1.23 %
eindrücken	dent	1.91 %	berühren	touch	1.23 %
kneifen	pinch	1.27 %	einschlagen	smash	1.23 %
schieben	push/shunt	1.27 %	greifen	grasp	1.23 %
werfen	throw	1.27 %	hämmern	hammer	1.23 %
halten	hold	0.64 %	klappen	clap	1.23 %
reiben	rub	0.64 %	klatschen	clap	1.23 %
streicheln	stroke/caress	0.64 %	legen	lay	1.23 %
			schieben	push/shunt	1.23 %
			stampfen	stamp	1.23 %
			umklammern	clutch	1.23 %
			werfen	throw	1.23 %

Table D.1: The full list of verbs that can be modified by *leicht* and *hart*, sorted by frequency (with respect to other verbs occurring with these adverbs).

APPENDIX E

Materials from the verb questionnaire

The stimuli testing the hypotheses from the verb questionnaire described in Chapter 5 can be found in Table E.1.

condition	stimuli
without result	
non-intensive	Florian berührt Andrea hart am Arm. (Florian touches Andrea's arm hard.) Florian berührt Andrea leicht am Arm. (Florian touches Andrea's arm lightly.) Florian berührt Andrea schnell am Arm. (Florian touches Andrea's arm quickly.) Florian berührt Andrea langsam am Arm. (Florian touches Andrea's arm slowly.) Simon streicht hart über die Tischplatte. (Simon strokes hard over the table's surface.) Simon streicht leicht über die Tischplatte. (Simon strokes lightly over the table's surface.) Simon streicht schnell über die Tischplatte. (Simon strokes quickly over the table's surface.) Simon streicht langsam über die Tischplatte. (Simon strokes slowly over the table's surface.)
neutral	Julia drückt hart gegen die Tür. (Julia pushes hard against the door.) Julia drückt leicht gegen die Tür.

(Julia pushes lightly against the door.)
Julia drückt schnell gegen die Tür.
(Julia pushes quickly against the door.)
Julia drückt langsam gegen die Tür.
(Julia pushes slowly against the door.)
Chris drückt Alex hart gegen die Wand.
(Chris pushes Alex hard against the wall.)
Chris drückt Alex leicht gegen die Wand.
(Chris pushes Alex lightly against the wall.)
Chris drückt Alex schnell gegen die Wand.
(Chris pushes Alex quickly against the wall.)
Chris drückt Alex langsam gegen die Wand.
(Chris pushes Alex slowly against the wall.)
Maike drückt die Pappe nach dem Kleben hart an.
(Maike presses the cardboard hard together.)
Maike drückt die Pappe nach dem Kleben leicht an.
(Maike presses the cardboard lightly together.)
Maike drückt die Pappe nach dem Kleben schnell an.
(Maike presses the cardboard quickly together.)
Maike drückt die Pappe nach dem Kleben langsam an.
(Maike presses the cardboard slowly together.)
Sophia reibt hart über die Tischplatte.
(Sophia rubs hard over the table's surface.)
Sophia reibt leicht über die Tischplatte.
(Sophia rubs lightly over the table's surface.)
Sophia reibt schnell über die Tischplatte.
(Sophia rubs quickly over the table's surface.)
Sophia reibt langsam über die Tischplatte.
(Sophia rubs quickly over the table's surface.)
Alex schlägt hart auf den Nagel.
(Alex hits the nail hard.)
Alex schlägt leicht auf den Nagel.
(Alex hits the nail lightly.)
Alex schlägt schnell auf den Nagel.
(Alex hits the nail quickly.)
Alex schlägt langsam auf den Nagel.
(Alex hits the nail slowly.)
Alex schlägt den Nagel hart auf den Kopf.
(Alex hits the nail hard on the head.)
Alex schlägt den Nagel leicht auf den Kopf.
(Alex hits the nail lightly on the head.)
Alex schlägt den Nagel schnell auf den Kopf.
(Alex hits the nail quickly on the head.)
Alex schlägt den Nagel langsam auf den Kopf.
(Alex hits the nail slowly on the head.)

	<p>Tobias zieht hart an der Tür. (Tobias pulls hard on the door.) Tobias zieht leicht an der Tür. (Tobias pulls lightly on the door.) Tobias zieht schnell an der Tür. (Tobias pulls quickly on the door.) Tobias zieht langsam an der Tür. (Tobias pulls slowly on the door.) Andrea zieht hart an Florians Arm. (Andrea pulls hard on Florian's arm.) Andrea zieht leicht an Florians Arm. (Andrea pulls lightly on Florian's arm.) Andrea zieht schnell an Florians Arm. (Andrea pulls quickly on Florian's arm.) Andrea zieht langsam an Florians Arm. (Andrea pulls slowly on Florian's arm.)</p>
intensive	<p>Jan hämmert hart gegen die Tür. (Jan hammers hard against the door.) Jan hämmert leicht gegen die Tür. (Jan hammers lightly against the door.) Jan hämmert schnell gegen die Tür. (Jan hammers quickly against the door.) Jan hämmert langsam gegen die Tür. (Jan hammers slowly against the door.) Jan hämmert hart gegen die Tür. Alex presst Chris hart gegen die Wand. (Alex presses Chris hard against the wall.) Alex presst Chris leicht gegen die Wand. (Alex presses Chris lightly against the wall.) Alex presst Chris schnell gegen die Wand. (Alex presses Chris quickly against the wall.) Alex presst Chris langsam gegen die Wand. (Alex presses Chris slowly against the wall.) Florian zerrt hart an der Verpackung des Geschenks. (Florian tugs hard on the present's wrappings.) Florian zerrt leicht an der Verpackung des Geschenks. (Florian tugs lightly on the present's wrappings.) Florian zerrt schnell an der Verpackung des Geschenks. (Florian tugs quickly on the present's wrappings.) Florian zerrt langsam an der Verpackung des Geschenks. (Florian tugs slowly on the present's wrappings.)</p>
with result	
	Tobias drückt die Zahnpastatube hart aus.

(Tobias squeezes the toothpaste package hard.)
Tobias drückt die Zahnpastatube leicht aus.
(Tobias squeezes the toothpaste package lightly.)
Tobias drückt die Zahnpastatube schnell aus.
(Tobias squeezes the toothpaste package quickly.)
Tobias drückt die Zahnpastatube langsam aus.
(Tobias squeezes the toothpaste package slowly.)
Sandra drückt die Seite vom Karton hart ein.
(Sandra dents the sides of the box hard.)
Sandra drückt die Seite vom Karton leicht ein.
(Sandra dents the sides of the box lightly.)
Sandra drückt die Seite vom Karton schnell ein.
(Sandra dents the sides of the box quickly.)
Sandra drückt die Seite vom Karton langsam ein.
(Sandra dents the sides of the box slowly.)
Chris drückt die Tür hart zu.
(Chris closes the door hard (while pushing it).)
Chris drückt die Tür leicht zu.
(Chris closes the door lightly (while pushing it).)
Chris drückt die Tür schnell zu.
(Chris closes the door quickly (while pushing it).)
Chris drückt die Tür langsam zu.
(Chris closes the door slowly (while pushing it).)
Andrea hämmert den Nagel hart in die Wand.
(Andrea hammers the nail hard into the wall.)
Andrea hämmert den Nagel leicht in die Wand.
(Andrea hammers the nail lightly into the wall.)
Andrea hämmert den Nagel schnell in die Wand.
(Andrea hammers the nail quickly into the wall.)
Andrea hämmert den Nagel langsam in die Wand.
(Andrea hammers the nail slowly into the wall.)
Tobias schlägt das Fenster hart ein.
(Tobias breaks the window hard.)
Tobias schlägt das Fenster leicht ein.
(Tobias breaks the window lightly.)
Tobias schlägt das Fenster schnell ein.
(Tobias breaks the window quickly.)
Tobias schlägt das Fenster langsam ein.
(Tobias breaks the window slowly.)
Alex schlägt den Nagel hart in die Wand.
(Alex hits the nail hard into the wall.)
Alex schlägt den Nagel leicht in die Wand.
(Alex hits the nail lightly into the wall.)
Alex schlägt den Nagel schnell in die Wand.
(Alex hits the nail quickly into the wall.)

<p>Alex schlägt den Nagel langsam in die Wand. (Alex hits the nail slowly into the wall.) Maike zieht die Wurzeln hart aus der Erde. (Maike pulls the roots hard out of the earth.) Maike zieht die Wurzeln leicht aus der Erde. (Maike pulls the roots lightly out of the earth.) Maike zieht die Wurzeln schnell aus der Erde. (Maike pulls the roots quickly out of the earth.) Maike zieht die Wurzeln langsam aus der Erde. (Maike pulls the roots slowly out of the earth.) Jan zieht die Tür hart zu. (Jan closes the door hard (while pulling it).) Jan zieht die Tür leicht zu. (Jan closes the door lightly (while pulling it).) Jan zieht die Tür schnell zu. (Jan closes the door quickly (while pulling it).) Jan zieht die Tür langsam zu. (Jan closes the door slowly (while pulling it).)</p>
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Table E.1: The stimuli sentences testing the hypotheses from the verb questionnaire.

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Samenvatting in het Nederlands

Dit proefschrift gaat over de modificatie van contactwerkwoorden door bijwoorden. Om de effecten van modificatie goed te kunnen begrijpen, moet gekeken worden naar de conceptuele structuur van woorden, dat wil zeggen naar de manier waarop onze kennis en waarneming van de wereld onze interpretatie van talige uitingen beïnvloedt.

Contactwerkwoorden beschrijven het uitoefenen van kracht door contact. Door te kiezen voor contactwerkwoorden wordt het mogelijk om te kijken hoe taal en onze waarneming en ervaring van de wereld samen de betekenis van een zin bepalen. Hier is een voorbeeld uit het onderzoek: als een object met veel kracht met ons in contact komt nemen we dit anders waar dan wanneer dit met weinig kracht gebeurt. Dit verschil kunnen we uitdrukken door de bijwoorden *hard* of *zacht* te gebruiken, te zien in (1) hieronder.

- (1) a. De tak sloeg hard tegen mijn arm.
b. De tak sloeg zacht tegen mijn arm.

Een deel van de betekenis van het werkwoord *slaan* is de hoeveelheid kracht die door het contact uitgeoefend wordt. De bijwoorden *hard* en *zacht* modificeren de kracht-component van de betekenis van het werkwoord *slaan*. Maar er zijn ook andere soorten bijwoorden die naar de hoeveelheid gebruikte kracht kunnen verwijzen, zoals *speels* in (2) hieronder.

- (2) Lisa sloeg Jan speels op zijn schouder.

De interpretatie van deze zin is dat Lisa Jan niet hard heeft geslagen. Dit is opmerkelijk, want anders dan bijvoorbeeld *zacht* verwijst het bijwoord *speels* niet rechtstreeks naar de hoeveelheid gebruikte kracht.

In hoofdstuk 2 worden de verschillen tussen bijwoorden in kaart gebracht. Hiervoor wordt data uit twee corpora gebruikt, één in het Duits, één in het Engels. Bijwoorden zijn grof gezien in twee klassen in te delen. De eerste klasse bestaat uit zogenaamde “pure manner adverbs”, bijwoorden die uitsluitend

verwijzen naar de wijze waarop een activiteit wordt uitgevoerd. Een voorbeeld hiervan is *zacht*, dat in de zin in (1-b) uitsluitend betrekking heeft op de hoeveelheid kracht waarmee wordt geslagen. De tweede klasse bestaat uit zogenaamde “agent-oriented adverbs”, bijwoorden die ook iets over de agens zeggen, de persoon die de handeling uitvoert (in (2) is dat Lisa). Een voorbeeld van deze klasse is *speels*, dat in (2) aangeeft dat Lisa in een speelse stemming is of dat ze iets speels doet.

In hoofdstuk 3 worden de resultaten gerapporteerd van een enquête in het Duits en een leestijd-experiment in het Nederlands. Hieruit blijkt dat bijwoorden uit de tweede klasse geregeld naar de hoeveelheid gebruikte kracht verwijzen als ze een contactwerkwoord modificeren. Dit wordt duidelijk in zin (3).

(3) Lisa sloeg Jan speels, maar toch vrij hard, op zijn schouder.

Het voegwoord *maar* signaleert een contrast tussen de bijwoorden *speels* en *hard*. Zowel in het Duits als ook in het Nederlands worden zinnen zoals (3) door moedertaal-sprekers geaccepteerd. Het feit dat we geen moeite hebben om het contrast tussen *speels* en *hard* te herkennen betekent dat *speels* vergelijkbaar is met *zacht*.

Voorbeeld (3) maakt echter ook duidelijk dat de kracht-lezing van *speels* genegeerd kan worden. Het bijwoord *hard* betekent het tegenovergestelde van *zacht* met betrekking tot de uitoefening van kracht. De zin in (4) hieronder is dan ook een contradictie: het is onmogelijk om iemand tegelijkertijd hard en zacht te slaan.

(4) Lisa sloeg Jan zacht, maar toch vrij hard, op zijn schouder.

Dat is niet het geval met *speels*: de zin in (3) is geen contradictie. Dit toont aan dat de kracht-lezing van *speels* een implicatuur is, een interpretatie van de zin die over het algemeen zo begrepen wordt, maar die opgeheven kan worden. Normaal gesproken gebruikt iemand die speels slaat weinig kracht, maar het is ook mogelijk om iemand tegelijkertijd speels en hard te slaan.

Steun voor deze hypothese komt ook van het leestijd-experiment. De resultaten tonen aan dat een zin als (3) langzamer wordt gelezen dan een vergelijkbare zin waarin de implicatuur niet wordt opgeheven. Een zin waarin *speels* met *hard* samen gaat is dus onverwacht, maar geen contradictie.

Hoe kan het dat een bijwoord zoals *speels*, dat eigenlijk iets over de agens zegt, ook naar de hoeveelheid kracht kan verwijzen? In hoofdstuk 4 wordt geredeneerd dat wereldkennis hier van belang is. Als iemand speels slaat, is het niet de bedoeling om serieus pijn te doen en wordt dus maar een kleine hoeveelheid kracht gebruikt. Een soortgelijke redenering kan hetzelfde effect bij andere bijwoorden verklaren, zoals *vriendelijk* of *vrolijk*. In hoofdstuk 4 wordt deze wereldkennis in de formeel semantische theorie van Event Semantics ingebouwd, een theorie die meestal gebruikt wordt voor het analyseren van modificatie van werkwoorden door bijwoorden. Door expliciet te verwijzen naar kracht als een betekenis-component van contactwerkwoorden kan de kracht-

lezing van een bijwoord als *speels* verklaard worden.

In hoofdstuk 5 worden verschillende typen contactwerkwoorden in kaart gebracht en nader geanalyseerd. Op basis van Duitse corpus data worden contactwerkwoorden onderverdeeld in de manier waarop ze naar de uitgeoefende kracht verwijzen. Zo zijn er werkwoorden als *trekken*, die uitdrukken dat er gedurende een langer tijdsvak contact bestaat tussen twee personen of een persoon en een object, terwijl werkwoorden als *slaan* naar een kort contact verwijzen.

Net als bijwoorden verschillen ook werkwoorden in het uitdrukken van de hoeveelheid kracht die door contact wordt uitgeoefend: vergelijk *aaien* (weinig kracht) met *drukken* (veel kracht). Dit verschil heeft invloed op de frequentie van combinaties van deze werkwoorden met de bijwoorden *hard* en *zacht*. De corpus data laten zien dat een werkwoord als *drukken* vaker samen gaat met het bijwoord *hard* dan *zacht*, terwijl dit voor een werkwoord als *aaien* andersom is. Een enquête in het Duits toont aan dat moedertaal-sprekers een combinatie als *zacht drukken* wel accepteren, maar een combinatie als *hard aaien* niet. Die twee werkwoord-bijwoord combinaties resulteren dus in een verschil in semantische acceptabiliteit.

De Duitse corpus data laten ook zien dat de bijwoorden *hard* en *zacht* niet niet meer gebruikt kunnen worden om een werkwoord te modificeren wanneer een resultaat gespecificeerd wordt. Dit wordt bevestigd door een enquête: een zin als (5) is in het Duits niet grammaticaal.

- (5) Lisa schlug das Fenster hart ein.
'Lisa sloeg het raam hard in.'

Deze observaties worden in hoofdstuk 6 geanalyseerd. Om dit te doen, moet de theorie uit hoofdstuk 4 worden uitgebreid. Om de verschillen tussen werkwoorden te kunnen analyseren, is een gedetailleerde analyse van kracht als betekeniscomponent nodig. Zo wordt een model voorgesteld dat gebaseerd is op vectoren. De hoeveelheid kracht die iemand uitoefent, wordt in dit model door een vector weer gegeven. Naarmate de hoeveelheid kracht verandert, wordt de lengte van de vector aangepast. Dit model is gebaseerd op inzichten uit de psychologie over de menselijke waarneming van krachten en de weergave daarvan in talige uitingen. Door een tijd-component in te voeren, kan ook het verschil tussen *trekken* en *slaan* worden verklaard.

In hoofdstuk 7 wordt een analyse in Frame Semantics ontwikkeld die aangeeft hoe het vectorenmodel uit hoofdstuk 6 en andere componenten van betekenis met onze wereldkennis in een netwerk samenhangen. Dit netwerk laat zien hoe de verschillende componenten elkaar beïnvloeden en uiteindelijk tot onze rijke interpretatie van zinnen met contactwerkwoorden en bijwoorden leiden.

Dit onderzoek draagt bij aan het ontdekken van de complexe relaties tussen taal aan de ene kant en wereldkennis en waarneming aan de andere kant. Vervolgonderzoek zou kunnen aantonen in hoeverre de hier voorgestelde analyse kan worden generaliseerd en toegepast op andere vakken zoals werkwoorden

die emoties uitdrukken of betrekking hebben op sociale relaties.

Curriculum Vitae

Anja Goldschmidt was born on the 22nd of April 1986 in Aachen, Germany. She holds a Bachelor of Science degree in Linguistics and English Language, Literature and Culture from Potsdam University and graduated in 2012 cum laude from the Research Master programme at Utrecht University. In 2012 she obtained a grant for her PhD project entitled *Pinching Loudly Doesn't Hurt: Adverb Modification and the Conceptual Structure of Events in Language and Cognition* from the NWO programme Promoties in de Geesteswetenschappen and started her research at Utrecht University. In 2014, she was invited to join the Collaborative Research Center SFB 991 at Heinrich-Heine-Universität Düsseldorf on an 8-month fellowship for international graduate students. This dissertation is the result of her PhD research carried out in Utrecht and Düsseldorf. During her time as a PhD student, Anja Goldschmidt was part of the organisation committee of among others the 17th Szklarska Poreba workshop and the Leiden Utrecht Semantic Happenings. She currently works as a lecturer at the department of Language, Literature and Communication (TLC) at Utrecht University, where she teaches courses in German linguistics as well as semantics and pragmatics at Bachelor and (Research) Master level.