

The compound-phrase divide and the lexicon: Insights from non-lexicalized adjective-noun combinations in German

Abstract

Compounds and phrases have been extensively contrasted on formal and functional grounds in the literature. Much less is known, however, about the cognitive differences between the two. The present article uses this observation as a point of departure and investigates whether non-lexicalized German adjective-noun compounds and phrases differ in how well they are memorized. Crucially, the contribution goes beyond previous research on this issue by (a) concentrating on the auditory presentation of compounds and phrases within a single language that uses both types as a naming device, (b) considering the role of prosodic prominence in the compound-phrase divide in German, and (c) looking at non-lexicalized constructions either without or with an explicitly given invented meaning. Two experiments are reported, in which subjects were asked to memorize auditorily presented compounds and phrases and participated in a response-time and response-accuracy experiment. While the constructions were not associated with a specific and explicitly given meaning in Experiment 1, they were in Experiment 2. The data show that compounds are memorized more efficiently than phrases, both without and with an explicitly given meaning, and independently from their prosodic prominence pattern. It is argued that the effect derives from their formal and functional characteristics.

Keywords

Compound, phrase, prosodic prominence, memorization, mental lexicon, German

1 Introduction

Knowing and using a language always implies that items of varying complexity are memorized. That is, speakers memorize, among other units, individual morphemes, monomorphemic words, complex words such as compounds, phrases, or even entire sentences. From this list, in turn, combinations such as compounds and phrases commonly function as expressions for complex lexical concepts that have to be memorized by language users. German, the language in the center of the present article, has both lexicalized compounds (see 1a) and lexicalized phrases (see 1b) in its inventory, which designate fixed lexical concepts and are stored in the mental lexicon of the average native speaker.

- (1) (a) *Rotfuchs*
red_fox
'red fox (specific kind of fox)'
- (b) *grüner Tee*
green tea
'green tea (specific kind of tea)'

Although both compounds and phrases are lexicalized, German is known for its affinity to prefer compounds in order to refer to complex lexical concepts (see, e.g., Ortner 1991; Motsch 2004: 379–383). This observation raises the question why this is so. A possible reason might be that compounds are more likely to suppress the descriptive meaning of their constituents, so that the kind interpretation remains in focus. The compound given in (1a), for instance, only refers to a specific biological kind (*Vulpes vulpes*) rather than to any fox of red color. That is, even if an arctic fox (*Vulpes lagopus*) is painted red, it does not become a *Vulpes vulpes* but remains a *Vulpes lagopus*. The compound does not have, in addition to the kind interpretation, a

supplementary descriptive meaning. Phrases that refer to a specific kind, in turn, always have a secondary descriptive meaning. The example in (1b) can refer to both the meaning given above and to any tea of green color, for instance, peppermint tea (see, e.g., Schäfer 2009: 281–282; Schlücker 2014: 147). Keeping in mind that the relation between form and meaning differs between compounds and phrases, the question then arises whether these different construction types are also memorized differently. The present contribution aims at examining this issue by focusing on non-lexicalized adjective-noun (AN) compounds and phrases in German.

Generally speaking, the current article intends to continue investigating the understanding of the formal, functional, and cognitive nature of compounds and phrases, as well as the interplay of these three levels, and to extend and go beyond previous research in the field (see also, e.g., Kotowski, Böer and Härtl 2014; Schlechtweg 2018a, 2018b; Schlechtweg and Härtl 2016). In order to do so, the paper is structured in the following way. In Section 2, the formal properties of German AN compounds and phrases are discussed. Section 3 analyzes the functional behavior of the two construction types and supports the idea that compounds are more apt than phrases to serve as names of fixed lexical concepts. In the next step, previous findings concerning the mental characteristics of complex constructions in general and of compounds and phrases in particular are considered in Section 4 and it is claimed that further research is necessary to deepen our understanding of how compounds and phrases are memorized. In Section 5, two new empirical studies are presented, which were designed to test whether the two aforementioned construction types differ with respect to how well they are memorized. The two reported studies significantly went beyond previous research in three ways. First, auditorily presented non-lexicalized German AN compounds and phrases were compared with respect to how well they are memorized for the first time. Second, the role of prosodic prominence in the

compound-phrase divide in German was analyzed. Third, compounds and phrases were memorized either without or with an invented and explicitly given meaning. This section also discusses the findings of the experiments against the background of a cognitive distinction between compounds and phrases. Section 6 finally concludes the present article.

2 Formal properties of compounds and phrases

The first question that arises if one intends to contrast two categories is how to recognize each of them. Following Zwicky (1986: 58), Donalies (2003), Booij (2009: 224), and many others, the two construction types are defined on a morpho-syntactic basis. Specifically, the presence and absence of inflectional agreement between the adjective and the noun permits to decide whether an item represents a phrase or a compound. That is, the example given in (2a) is a phrase because the adjectival suffix signals agreement between the adjective and the noun with respect to grammatical features, for instance, gender, number, or case. (2b), in turn, is a compound as no suffix is available and the two constituents do not agree in terms of the aforementioned features.

- (2) (a) *ein weicher Käse*
 ein weich-er Käse
 a soft-M.SG.NOM¹ cheese.M.SG.NOM
 ‘a soft cheese’
- (b) *ein Weichkäse*
 a soft_cheese
 ‘a soft cheese’

¹ Abbreviations: M = Masculine, SG = Singular, NOM = Nominative.

Inflectional agreement as a factor clearly distinguishes between compounds and phrases and unambiguously defines either construction type. Other aspects do not play a role for the definition and, therefore, the term “compound” can refer, for example, to both lexicalized and non-lexicalized constructions and to both descriptive and naming units (see Section 3 for a discussion on descriptive and naming units). The same holds for the term “phrase”.

Having defined the construction types, one can now investigate potential characteristics of the two. German AN compounds and phrases differ in their preferred prosodic prominence pattern. In the literature, which primarily focuses on the English language but is also relevant to German, one generally distinguishes between two prominence patterns, namely initial and non-initial prominence. In traditional accounts such as Chomsky and Halle (1968: 94), Liberman and Prince (1977: 257), and Giegerich (1992: 253–257), the two alternatives are regarded as a difference in stress. That is, initial prominence means here that primary stress is placed on the first constituent. Primary stress on the final constituent, in turn, is considered non-initial prominence. A modified concept of initial and non-initial prominence is discussed in Gussenhoven (2004: 19), who argues that both constituents of complex constructions, such as AN compounds and phrases, are stressed as they can function as free units. Crucially, however, the constructions can differ in their accentuation pattern (on the level of the entire complex construction). In this account, initial prominence refers to the presence of an accent only on the first constituent but non-initial prominence implies that both constituents are accented. The present contribution does not further compare the two aforementioned approaches and is in principle compatible with both. Specifically, it is assumed that initial prominence can either signify that the first element has primary stress or that only the first element is accented. Non-initial prominence, in turn, means that the first element is not the most

prominent one, either because the final constituent bears primary stress or because the two constituents are approximately equally prominent in terms of accentuation. After this terminological note, the two terms of initial and non-initial prominence can now be transferred and applied to German AN combinations. As has been repeatedly observed in the literature, German AN compounds are usually initially prominent; in contrast, phrases typically carry non-initial prominence (see, e.g., Fleischer 1969; Erben 1975; Motsch 2004). Exceptions exist but are rare. Apart from the compound *Schlechtwetter* (bad_weather, 'bad weather'), which prefers non-initial prominence (Schlücker 2014: 24), one does presumably not find any non-initially prominent compound in the literature. On the phrasal side, in turn, only *Hohepriester* ('high priest') and *Hohelied* ('canticle'), which are initially prominent, are known to me.² Finally, it has to be added that the prosodic prominence pattern of a construction is by no means entirely fixed and can vary across different speakers or varieties of a language, within the same speakers, due to information structure, or the syntactic context such as sentence type and position (for an overview, see, e.g., Schlechtweg 2019).

Apart from prosodic prominence, German AN compounds and phrases typically, but not necessarily, differ in terms of orthography and the types of adjectives that can occur in the constructions. Since these two aspects are not relevant to the empirical studies reported later, they are not discussed at this point. That is, first, the experiments focus on spoken, rather than written, language and we can therefore ignore orthographic aspects (for discussion, see, e.g., Fleischer 1969; Erben 1975; Simoska 1999; Motsch 2004; Altmann 2011; Schuster 2016). Second, the studies to be reported on concentrate on adjectives that are monomorphemic and monosyllabic in their basic form and can therefore naturally occur in both compounds and phrases. Adjectives that

² Note that the items are considered to be phrases due to the presence of inflectional agreement (for discussion, see Schlechtweg 2018a, 2018b).

are restricted to one of the two construction types are complex and are not examined here (for discussion, see, e.g., Barz 1996; Eisenberg 2006; Schlücker 2014).

In conclusion, AN compounds are defined as constructions without grammatical agreement between the constituents. AN phrases, in turn, are defined on the basis of the presence of agreement between the individual elements. Crucially, as mentioned earlier already, the two constructions are defined on the basis of this aspect only. Further characteristics can be more or less typical for the constructions, for instance, a specific prominence pattern, but they do not define the constructions. I argue that this represents a decisive step in order to avoid circularity. Hence, we are able to clearly distinguish a compound (without agreement) from a phrase (with agreement), independently of other aspects.³ The discussion above revealed that the two construction types differ in their prosodic preferences; however, variation is also attested to a certain extent. This variation is taken into consideration in the two experiments outlined in Section 5.

3 Functional properties of compounds and phrases

After the formal differentiation between German AN compounds and phrases in the previous section, the present part analyzes the functional characteristics of these constructions. Generally speaking, it has been claimed time and again that compounds express fixed complex lexical concepts, that is, they fulfill the naming function (see, e.g., Bauer 2003: 135;

³ Consider an alternative. If one assumes that both agreement and prosodic prominence are parts of the definition of compounds and phrases, one faces a serious problem. Arguing, for instance, that a construction is a compound if there is no agreement AND if it is initially-prominent, the question arises what an item like *Schlechtwetter*, which does not show agreement but is non-initially prominent, is. One has to state that it is neither a compound nor a phrase. Equally, imagine a construction without agreement and initial prominence changes its prominence pattern due to the information structure of a specific discourse. Would we then say that one and the same construction is a compound in the first/neutral scenario but not a compound if information structure modifies the prominence pattern? I believe that this would be an unattractive solution.

Schlücker and Hüning 2009; Hüning 2010: 197). Note that, in this context, naming means reference to kinds, which are specific categories of objects that have specific properties in common (see, e.g., Zimmer 1971: C15; Krifka, Pelletier, Carlson, ter Meulen, Link and Chierchia 1995). More precisely, compounds can represent objects or entities that designate a sub-concept of the concept expressed by the head noun (see, e.g., Gunkel and Zifonun 2009; Schlücker 2016). A *Schwarzstorch* (black_stork, 'black stork'), for instance, is a kind of stork, that is, a sub-kind of the kind expressed in the head. In opposition to compounds, phrases have been regarded as simple descriptive units. A *schwarzer Storch* (black stork, 'black stork') can in principle refer to any stork of black color, independently of the specific kind of stork. As has become clear earlier, this functional distinction between compounds and phrases is by no means absolute as the inventory of naming items of the German language contains many phrases (see 1b above; see also, e.g., Booij 2009: 220; Schlücker 2014). Likewise, compounds occasionally serve the descriptive function, as in *Heißwasser* (hot_water), which does not refer to a specific kind but, instead, simply to water that is hot. Nevertheless, although both compounds and phrases can serve the naming function and enter the mental lexicon, it has been suggested that compounds fulfill the naming function better than phrases. This proposal is examined in more detail below.

The assumption that compounds are preferably used to name complex lexical concepts or to refer to kinds is derived from the formal properties of these constructions. Lacking an adjectival suffix that signals grammatical agreement between the adjective and the noun, a compound's form clearly deviates from that of the respective phrase. The formal difference between the two seems to be opportune to trigger a functional contrast; that is, while phrasal items fulfill the descriptive function by default, compounds commonly represent and name fixed lexical concepts. Compounds' affinity to initiate naming is connected to their markedness (see, e.g., Barz 1996; Härtl 2015).

That is, the special, rather unusual, less frequent, or marked form of compounds – at least in comparison to the form of the respective phrases – is claimed to be responsible for the functional shift. Since phrases occupy the standard descriptive function, which is frequently applied in language use in items like *kleines Auto* (small car, 'small car'), *junges Mädchen* (young girl, 'young girl'), or *lange Straße* (long street, 'long street'), they are overall unmarked and usual. The lack of markedness seems to impede the acquisition of the naming function, which remains for the marked category, namely compounds, by default.

The question that now arises is whether support for a general functional difference between compounds and phrases exists. Several authors have argued, primarily on the basis of their individual judgments, that compounds are inherently more suited to function as kind-referring or naming units. These purely theoretical arguments are not recapitulated at this point (for discussion, see, e.g., Barz 1996; Bücking 2009; Van Goethem 2009; Hüning 2010; Schlücker 2013; Härtl 2015). Instead, the present section aims at looking at three empirical studies that looked at the question whether compounds and phrases differ on a functional basis. Schlücker and Plag (2011) examined in a production study whether participants favored German AN compounds or phrases if they were requested to construct a complex name for an invented lexical concept. They found that the creation of a compound was more likely if the number of known compounds with the given constituent(s) was higher than the number of phrases with the same constituent(s), or vice versa. Overall, the experiment seems to suggest that no principal functional difference between compounds and phrases exists; instead, the choice for one of the two construction types primarily depends on the nature of lexical memory. Unfortunately, it remains open how the authors, using the DWDS corpus of the German language, verified whether a constituent occurs in compounds only, in phrases only, in both, or in neither type. This kind of

information is, however, essential. Although there are tools, such as the word information function of the corpus (see Schlechtweg 2018a), to approach this issue to a certain extent, there does not seem to be a single and perfect strategy. For instance, the word information of the adjective *schwarz* ('black') does, strangely enough, not contain the common and frequent compound *Schwarzmarkt* (black_market, 'black market'); it does contain, however, compounds such as *Schwarzerle* (black_alder, 'black alder'), a very rare compound that is probably unknown to most native speakers of German. Also, the categorization of several of the examples given in Schlücker and Plag (2011) seems to be problematic. To mention just one example, the adjective *offen* ('open') is used as an example of an adjective that does not occur in compounds; however, searching for the adjective in the DWDS corpus, one detects the compound *Offenstall* (open_stable, 'open stable') in its entry.

On the other end of the spectrum, studies have found evidence for the idea that compounds serve the naming function more straightforwardly than phrases. Härtl (2017) examined German AN compounds and phrases in a pilot corpus study. The author found, first, that phrases were more often preceded by the modifier *sogenannt* ('so-called') than compounds. Further, in *sogenannt* contexts, phrases were more frequently highlighted with quotation marks than compounds. Härtl (2017) argues that phrases depend more than compounds on additional means, for instance, *sogenannt* or quotation marks, which indicate the naming function. Compounds, in turn, seem to fulfill this function more naturally and can occur more easily without these explicit markers. Controlling for several potentially confounding variables such as lexicalization and the semantic relationship between the constituents, Schlechtweg (2018a) recently investigated whether invented/non-lexicalized German AN compounds (e.g., *Kurzcouch*, short_couch) and phrases (e.g., *kurze Couch*, short couch) differ with respect to how well they are accepted as

kind terms for new and invented objects (e.g., It is a very specific couch that is 1.30 meters short because it is designed only for children up to this size). It was found that subjects, first, preferred compounds significantly more often than phrases as names for the new objects in the forced-choice study and, second, assessed compounds with significantly better values in a rating study, in which they were asked to state how well a given novel concept and a given construction, that is, either a non-lexicalized compound or a non-lexicalized phrase, fit together. Overall, Schlechtweg's (2018a) findings, which are based on the data of about two hundred native speakers of German and forty-eight examples, provide empirical evidence for the idea that compounds fulfill the naming function more satisfyingly than phrases.⁴

In sum, there are both purely theoretical arguments and empirical findings in favor of the idea that compounds and phrases differ in functional terms. Assuming that naming units have to be memorized by language users (see Booij 2010: 169) and that compounds are more apt to represent naming units, we will now investigate whether the formal and functional properties of compounds and phrases are also reflected cognitively. Put differently, it will be analyzed whether compounds are memorized more efficiently than phrases.

4 Cognitive properties of compounds and phrases

Before considering and analyzing existing evidence on the memorization of compounds and phrases, we should reflect upon the notion of memorization itself. Memorization is understood here as the integration of an item into an individual's mental lexicon (see, e.g., Schwarze and Wunderlich 1985: 16; Wunderlich 1986: 231). Note that the term "lexicalization" has been used in the same sense in some contributions (see, e.g., Blank 2001: 1599; Gaskell

⁴ Many parts of the test material from Schlechtweg (2018a) were also used in Experiments 1 and 2 reported in Section 5.

and Dumay 2003: 106; Mithun 2010: 53; Montermini 2010: 83). I prefer, however, to distinguish between memorization and lexicalization by considering the former to cover the integration of an item into one's mental lexicon and the latter to refer to the integration of an item into the shared or common lexicon of a speech community (see, e.g., Schlechtweg 2018b; see also Schwarze and Wunderlich 1985: 16; Lüdi 1986: 226; Wunderlich 1986: 231; Bakken 2006: 107; Fiedler 2007: 21).

If an item is memorized, or integrated in one's mental lexicon, it is stored in the mental lexicon. The storage of complex constructions in the mental lexicon, in turn, has been generally described by referring to three different kinds of models. The first category are so-called full-listing models, which assume that complex items such as inflected forms or derivatives are stored and accessed as whole units in the mental lexicon (see, e.g., Manelis and Tharp 1977; Butterworth 1983; see also, e.g., Bybee 1985; Rumelhart and McClelland 1986; Sereno and Jongman 1997). With respect to the items that the present article concentrates on, one would regard an entry of the entire AN compound or phrase as the central element to access the respective combination. As opposed to these approaches, the second kind of models relies on the decomposition of complex items into their constituents, that is, the individual parts such as stems or bases primarily serve to access a complex unit (see, e.g., Taft and Forster 1975; Pinker 1991; Pinker and Prince 1991; Clahsen and Almazan 2001; see also, e.g., Sandra 1990; Zwitserlood 1994). Focusing on AN constructions, a decomposition-inspired theory would assume that the adjectives and nouns play a key role in the access to these constructions. Apart from the two extreme positions, several intermediate alternatives have been developed as well (see, e.g., Caramazza, Miceli, Silveri and Laudanna 1985; Caramazza, Laudanna and Romani 1988; Baayen 1992; Frauenfelder and Schreuder 1992; Baayen and Schreuder 1999; Giraudo and Grainger 2000). In essence, these theories target a

combination of the two aforementioned extreme positions in order to minimize the weak aspects of either type. That is, for instance, on the one hand, full-listing models have difficulties in explaining how new complex items are treated since the individual elements are crucial in this case. On the other hand, it is clear that decomposition becomes unattractive in certain cases as well; for example, a single entry for a construction of high frequency decreases processing costs as it can be directly accessed instead of always being accessed on the basis of its constituents. Intermediate models therefore emphasize the strong points of the two extreme positions and assume, for instance, that complex items of low frequency rely on decomposition, while those of high frequency are preferably accessed via their full form.

Although many contributions have examined the mental access to and the storage of inflected forms, derivatives, and compounds, much less is known about the exact cognitive distinction between compounds and phrases. One model to approach this distinction is the so-called Full-Form-Storage Principle for Compounds and Phrases (Schlechtweg 2018b). According to this principle, both compounds and phrases can develop an entry of the entire form in the mental lexicon. The decisive difference between the two construction types is, however, the moment in time when this full-form entry is created. If a non-lexicalized compound and a non-lexicalized phrase start with a frequency of zero occurrences, come into existence, and gradually increase in frequency, it is assumed that the full-form entry of the compound is established earlier, that is, at a lower frequency, than that of the phrase. The principle is motivated on the basis of the formal and functional properties of compounds and phrases discussed in Sections 2 and 3. Since the compound is due to its formal nature more apt to function as a naming unit and to designate a fixed complex lexical concept and since fixed complex lexical concepts have to be stored (as they do not simply equal the sum of the constituent meanings), it is assumed that an entry in the lexicon is created

earlier for the compound than for the phrase. While for compounds, so the argument goes, the descriptive meaning does not interfere, it always pops up in the case of phrases; a potential fixed lexical meaning can develop only more difficultly with phrases, as does the entry of the phrase in the lexicon.

In the spirit of the aforementioned model, it is assumed that the difference in formal markedness between compounds and phrases is reflected cognitively. First support for this idea comes from studies that have shown that marked items are recognized better than unmarked ones (see, e.g., Schulman 1967; Glanzer and Adams 1985, 1990; Criss, Aue and Smith 2011; Lohnas and Kahana 2013). The question that now arises is, however, whether there is more direct empirical support for the model, that is, support from studies specifically looking at compounds and/or phrases. There are indeed some psycho- and neurolinguistic studies that have examined cognitive properties of AN combinations in languages other than German. A central shortcoming of some experiments, however, is the fact that the authors did not control for the potentially confounding variable lexicalization, that is, lexicalized and non-lexicalized constructions were actually compared (e.g., Mondini, Jarema, Luzzatti, Burani and Semenza 2002; McCauley, Hestvik and Vogel 2012). Since compound or phrasal status and degree of lexicalization are independent factors (see, e.g., Di Sciullo and Williams 1987: 3; Bauer 1998: 67–68; Sadock 1998: 164–166), it is necessary to separate these aspects and investigate constructions that are homogenous in terms of lexicalization.

One study that directly contrasted non-lexicalized German AN compounds and phrases in terms of memorization, and therefore controlled for the confounding variable of lexicalization, is Kotowski et al. (2014). In their experiment, subjects were tested on three days (day one, four, and eight) and, on each day, in two phases. In the first part, participants were requested to memorize a visually presented object, for example, a broom or a comb, in

combination with a non-lexicalized AN compound (e.g., *Tiefbesen*, deep_broom) or with a non-lexicalized AN phrase (e.g., *breiter Kamm*, broad comb). After memorization, all subjects were tested in a recall phase, in which they had to decide whether a given picture-item combination was correct or not. Kotowski et al. (2014) found that compounds were responded to more slowly and less accurately than phrases if both had not been memorized before. If they had been memorized before, however, participants performed equally well on compounds and phrases. According to the authors, the markedness of non-lexicalized compounds that subjects have never seen before creates a processing burden. Memorization can weaken these difficulties and compounds finally improve more than phrases during the memorization process. Although the study supports the idea that compounds and phrases are memorized differently, it has two shortcomings. First, the authors favored written language and visually presented items. As we know from the literature given in Section 2, compounds are typically written as one unit (e.g., *Tiefbesen*, deep_broom) but phrases as two (e.g., *breiter Kamm*, broad comb). Kotowski et al. (2014) only relied on these standard orthographic conventions and this might be another reason why subjects performed more poorly on compounds that they had never seen before. Due to the presence of the space, the individual constituents of phrases can be recognized more easily in comparison to those of compounds. Apparently, this played a role only if the constructions had not been memorized before. Once they had been memorized and once subjects were familiar with the respective adjectives, compounds and phrases were responded to in a comparable way. The effects of orthographic spaces are well attested in the literature and should therefore be taken into consideration in order to exclude the influence of this potentially confounding variable (see, e.g., Inhoff, Radach and Heller 2000; Libben, Gibson, Yoon and Sandra 2003; Juhasz, Inhoff and

Rayner 2005). Second, the aforementioned experiment was not more than a first pilot study that tested only six compounds and phrases.

In two other studies reported in Schlechtweg (2018b) and Schlechtweg and Härtl (2016), also, only non-lexicalized AN combinations were tested with respect to how well they were memorized and, therefore, the confounding variable of lexicalization was controlled for. Further, in these studies, only spoken language was investigated to control for the influence of orthography. Although these experiments approached a similar question as the present article, the studies to be reported in Section 5 in the current paper go beyond previous work. On the one hand, the experiments in Schlechtweg (2018b) and Schlechtweg and Härtl (2016) investigated initially and non-initially prominent items in English. In English, however, the compound-phrase distinction in the case of AN constructions is not as straightforward as in German as inflectional agreement is never expressed (via adjectival suffixes) in this language. Hence, it is necessary to consider languages in which the divide is clear-cut. On the other hand, the above-named contributions also considered the memorization of German compounds, but only in comparison to the memorization of phrases in French. There are now three reasons why the analyses should be extended and why the experiments presented below were in order. First, in Schlechtweg (2018b) and Schlechtweg and Härtl (2016), German compounds were not contrasted to German phrases in terms of memorization. In the experiments reported below, a direct comparison between German compounds and phrases, which can both function as naming units in this language, was conducted. This analysis will give new insights on how two different construction types that are available within a single language are memorized. Crucially, as opposed to Kotowski et al. (2014), all items were presented in the auditory mode only. Second, no previous work has examined the role prosodic prominence plays in the compound-phrase divide in German, that is, whether or not the memorization

of compounds and phrases is further dependent on their prosodic prominence. This aspect was targeted in the experiments reported in Section 5 as well. Third, and finally, previous work has only concentrated on the memorization of non-lexicalized constructions for which no invented meaning was explicitly given. In the present contribution, both memorization without (Experiment 1) and memorization with an explicitly given meaning were examined (Experiment 2).

5 Memorizing non-lexicalized AN compounds and phrases in German

5.1 Experiment 1

5.1.1 Kind, goal, and hypothesis

The present experiment, a memorization study conducted with the program E-Prime (Psychology Software Tools, Inc. 2010), aimed at testing whether non-lexicalized German AN compounds and phrases are memorized differently in the auditory mode. Specifically, the study tested the hypothesis that compounds are memorized more efficiently than phrases. It is generally assumed that shorter latencies and higher accuracy rates signal greater efficiency of processing / memorization (see, e.g., Menn and Duffield 2014: 283–284). The hypothesis is derived from the formal and functional properties of compounds and phrases outlined in Sections 2 and 3. Both theoretical and empirical aspects support the idea that compounds are due to their specific form more apt to function as naming units than phrases. Naming units, understood as kind-referring units in the present paper, in turn, have to be memorized by language users. Combining these points, the question arises whether the “better” naming units, that is, compounds, are also memorized more satisfyingly. If this is the case, it will lend some support for the Full-Form-Storage Principle for Compounds and Phrases discussed in Section 4.

In order to create an appropriate memorization scenario, subjects were exposed to the items several times on each of three days in the course of a week. The aforementioned objective of the study refers to compounds and phrases as defined earlier, that is, as constructions without or with inflectional agreement. Remember from Section 2, however, that compounds and phrases also differ in their prosodic preferences. Due to the fact that compounds generally prefer initial but phrases non-initial prominence, the prosodic prominence pattern would represent a potentially confounding variable if one focused on the prosodic preferences of either construction type only. That is, potential effects might not necessarily emerge from the compound-phrase distinction but rather from the prosodic difference. Therefore, in the present experiment, not only compounds and phrases with their favored prosodic prominence pattern but also the same constructions with their unusual pattern were tested.

5.1.2 Method

5.1.2.1 Subjects

Twenty-four monolingual native speakers of German, all of whom were university students in the language department, completed the entire study for course credit (eighteen females and six males, mean age: 22.8 years, standard deviation of age: 3.7 years, age range: 19–34 years). Two subjects started the experiment but did not finish it; their data was excluded from all analyses. No subject participated in Experiment 2 reported later.

5.1.2.2 Materials

Twenty-four German AN compounds and twenty-four German AN phrases represented the experimental stimuli. No compound and no phrase were lexicalized, that is, first, they did not occur in the Wortschatz ('vocabulary') corpus of the German language (<http://wortschatz.uni-leipzig.de/de>) and,

second, they were unknown to three educated native speakers of German.⁵ Both compounds and phrases were on average composed of eight phones (median compounds: 8; median phrases: 8). Compounds and phrases were trisyllabic, that is, the compounds were composed of a monosyllabic adjective and a disyllabic noun and the phrases were made up of the same adjective, the inflectional adjectival suffix, and a monosyllabic noun. From a semantic point of view, the two construction types were considered to be comparable. That means, first, the adjectives were identical and, second, all nouns referred to inanimate and physical/concrete objects, which were similar across the groups of compounds and phrases. If the head of a compound (e.g., *Bürste* 'brush' was the head of *Dünnbürste* 'thin_brush'), for instance, represented an object that can be used to clean something, the head of the respective phrase (e.g., *Schwamm* 'sponge' was the head of *dünner Schwamm* 'thin sponge') did so as well. A further example of a compound, the respective phrase, and the semantic aspects shared by the two head nouns are given in (3); the entire set is presented in Appendix A. Note that both the same adjectives

⁵ Note that the Wortschatz corpus is a huge collection of more than 26 million sentences and is based on news texts. Due to the size of the corpus and, in my opinion, the diversity of this type of texts, I chose this collection. A third advantage of the corpus is that it has individual entries for lexicalized phrases (e.g., *blauer Fleck*, blue spot, 'bruise') but not for non-lexicalized phrases (e.g., *blauer Stuhl*, blue chair, 'blue chair'). In this respect, it is superior to, for example, a Google search. Searching for some of the items used in my study on Google, you certainly get hits. However, this is rather unsurprising because phrases represent the standard descriptive construction type and are likely to occur. *blauer Stuhl*, for instance, can refer to any chair of blue color but is not a fixed naming unit. Even if phrases are, due to their inherent descriptive nature, never really new, they are not necessarily fixed terms. This is also why the adjectives "novel" or "new" are avoided. Crucially, phrases must not represent fixed lexical units and must not function as naming units, which is, in turn, difficult to decide by means of a Google search. Therefore, I relied, in the first step, on the verification in the Wortschatz corpus. Nevertheless, one might object that news texts, on which this corpus is based, are not optimal for checking the lexicalization status of the specific items under investigation. Therefore, it is important that I opted for a second verification of lexicalization, namely the judgment of the three educated native speakers of German. These raters were requested to indicate whether a construction represents a fixed and established term (in German: *Begriff*) in the German language. They were given examples beforehand, that is, for instance, while the phrase *grüner Tee* (green tea, 'green tea') was regarded as a fixed and established term (because it refers to a specific kind of tea and not only to any tea of green color), the phrase *grüner Tisch* (green table, 'green table') was not.

(e.g., *dünn*) and the same nouns (e.g., *Schwamm*) could not be used in the compounds and phrases because the number of syllables would then have been unequal between the two construction types (e.g., *Dünnschwamm* would have had two syllables but *dünner Schwamm* would have had three). Further, the reason why the nouns were not kept constant across the compounds and phrases was that it would have been impossible to control for the frequency of the adjectives in this case. That is, it would have been necessary to use monosyllabic (if uninflected) adjectives in the phrases and disyllabic adjectives in the compounds. Many of the monosyllabic adjectives used in the study are, however, frequent, and there are overall no comparable disyllabic ones.

- | | | |
|-----|--------------------------------------|---------------------------------------|
| (3) | (a) Compound: | <i>Schwersocke</i>
heavy_sock |
| | (b) Phrase: | <i>schwerer Strumpf</i>
heavy sock |
| | (c) Semantics of the two head nouns: | sock |

Furthermore, while the adjectives on average belonged to frequency class ten in the Wortschatz corpus, both the nouns of the compounds and those of the phrases on average belonged to frequency class thirteen. The frequency classes of this corpus categorize items according to their frequency relative to the most frequent German word, the masculine definite article (*der*), which belongs to frequency class zero. Hence, the higher the frequency class is, the lower the frequency of an item.

A note on a further aspect, namely the concept of analogy, is also in order here (see, e.g., Krott 2009). Ideally, the constituents of the present study, that is, the adjectives and nouns, should occur in the same number of lexicalized compounds and lexicalized phrases in order to entirely control for potential

analogical effects. Approaching this issue, however, one faces several problems and limitations. First of all, it is not clear how one can draw the line between lexicalized and non-lexicalized items. Although several possible correlates of lexicalization have been established in the literature, different correlates do not always coincide. Three examples of such correlates are frequency (the higher the frequency, the higher the degree of lexicalization), semantic non-compositionality (non-compositionality signals a higher degree of lexicalization than compositionality), and orthography (solid spelling indicates a higher degree of lexicalization than spaced spelling) (see, e.g., Plag 2006; Plag, Kunter and Lappe 2007; Siddiqi 2014). Take, for example, the German AN compound *Rotbuche* (red_beech, 'copper beech') and the AN phrase *kleines Auto* (small car, 'small car'). While the second and third correlates of lexicalization would suggest that the compound is lexicalized but the phrase is not (the compound, but not the phrase, is non-compositional as the tree is not really / entirely red; the compound, but not the phrase, is spelled out as a single unit), frequency would point in the other direction as the phrase seems to be much more common and frequent. Second, it is methodologically difficult to entirely control for analogical effects (see discussion of Schlücker and Plag 2011 in Section 3). Hence, it has to be admitted that analogical effects cannot be entirely controlled for and have to be kept in the back of the head when interpreting the data gathered in the experiments.⁶

The experimental items were categorized into the following four conditions: Compounds with initial prosodic prominence, compounds with non-initial prominence, phrases with initial prominence, and phrases with non-initial

⁶ Note that, initially and in Schlechtweg (2018a), I controlled for potential analogical effects using the word information function of the DWDS corpus. Although the strategy was an approximation, no procedure seems to be able to *entirely* circumvent the theoretical and methodological problems related to the concept of analogy discussed above as well as in Section 3. Therefore, I finally decided to treat the topic with greater caution here. At this point, I also wish to thank an anonymous reviewer for thoughtful comments on the subject.

prominence. Overall, there were ninety-six experimental sound files (twenty-four items x four conditions). A male native speaker of German, who was twenty-eight years old, spoke the items with the respective prosodic pattern and was recorded with Praat (Boersma and Weenink 2017). The mean duration of the final sound files in each of the four conditions was identical, that is, 933 milliseconds (ms). The prosodic prominence pattern of each sound file was verified by means of a listening judgment (see, e.g., Terken and Hermes 2000; Michael Wagner personal communication on June 14, 2017). That is, a phonetically and phonologically trained rater categorized all compounds and phrases according to their prominence pattern. In items with initial prominence, the first syllable, that is, the adjectival stem, was considered to be the most prominent one. In contrast, in constructions with non-initial prominence, this was not the case. Three other independent raters confirmed the categorization.

Apart from the experimental items, the same amount of fillers, distributed equally across the four conditions, was used. Filler items were only used in the test phases (and not in the memorization phases) (see Section 5.1.2.3 for further details). They were AN constructions with the same adjectives and nouns, only the precise combinations of the constituents differed. For instance, *Dickstiefel* (thick_boot) represented an experimental and *Dicktasse* (thick_mug) a filler item. Fillers were also controlled for the potentially confounding variables mentioned in the description of the experimental items.

5.1.2.3 Procedure

The twenty-four subjects participated in a memorization study on test days one, four, and eight. On each day, they were exposed to two blocks of phases, each block consisting of four phases (see Figure 1). Across all subjects, Block 1 preceded Block 2 as often as Block 2 preceded Block 1.

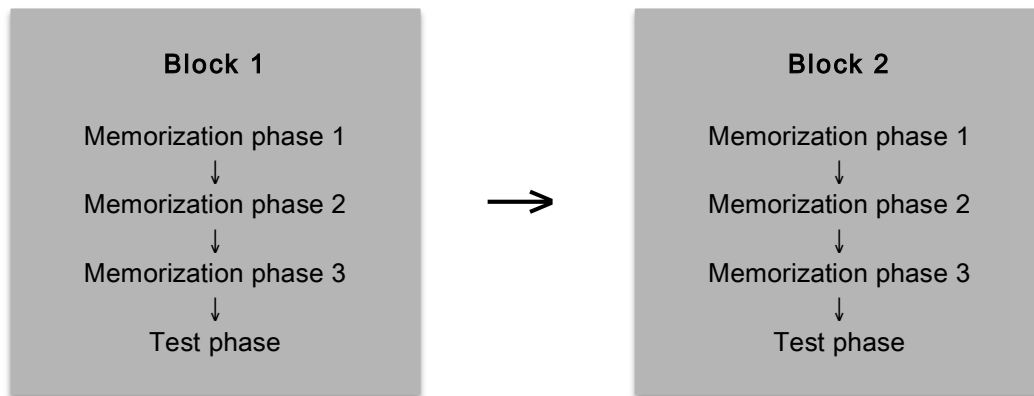


Figure 1 The individual phases on each test day

In each memorization phase, subjects had the task to memorize each item as well as they could and heard a total of twenty-four items, that is, six items in each of the four conditions. The items/sound files in the three memorization phases of Block 1 were identical and the items/sound files in the three memorization phases of Block 2 were identical. The two blocks differed in the following way. If, for instance, the compound *Dickstiefel* (thick_boot) and the phrase *schwerer Strumpf* (heavy sock) appeared in Block 1, the respective phrase *dicker Schuh* (thick shoe) and the respective compound *Schwersocke* (heavy_sock) appeared in Block 2. Note that each subject was exposed to each compound and phrase with only one prominence pattern in order to keep the total number of items that had to be memorized manageable. For instance, one subject was tested on *Dickstiefel* (thick_boot) only with initial, on *dicker Schuh* (thick shoe) only with non-initial, on *Schwersocke* (heavy_sock) only with non-initial, and on *schwerer Strumpf* (heavy sock) only with initial prominence. Items appeared in randomized order in all memorization phases. Further, each trial in these phases started with a fixation cross lasting for 1000 ms on the computer screen. Afterwards, participants heard, but did not see, an item and had 4000 ms, measured from the onset of the sound file, to memorize it.

In each of the test phases, subjects were exposed to a total of forty-eight items, twenty-four had been memorized in the three immediately preceding memorization phases and twenty-four had not. They were requested to press the “Yes”-button if they heard constructions that they had memorized in the three memorization phases that immediately preceded the test phase. In contrast, they were instructed to press “No” if they heard an item that had not been memorized before.⁷ The memorized (e.g., *Dickstiefel*, thick_boot) and the non-memorized items (e.g., *Dicktasse*, thick_mug) were made up of the same adjectives and nouns, which were combined differently. A memorized and a non-memorized item with the same adjective were matched with respect to both the construction type (compound versus phrase) and the prosodic prominence pattern (initial versus non-initial). In the test phases, a fixation cross appeared for 1000 ms on the screen before subjects heard a sound file, and were asked to make up their mind. Response time was measured from the onset of an item. In all test phases, items appeared in randomized order.

5.1.3 Statistical analyses and results

The statistical analyses of Experiments 1 and 2 were conducted with the software Minitab (Minitab Inc. 2013/2017). In the first step, the overall accuracy rate of all subjects and experimental items was calculated. Each of the twenty-four participants responded correctly in at least 75 percent of all cases. The data of the experimental items showed accuracy rates of at least 81 percent. Neither a subject nor an experimental item was excluded from further analyses. Second, all filler items were excluded from further analyses. The reason for discarding fillers was that they were not, in contrast to the experimental items, memorized (several times on each day and in the course

⁷ The following buttons of a keyboard were used: “Yes” = the eighth button from the left in the lowest row; “No” = the third button from the left in the lowest row. All subjects were right-handed.

of a week). Since the focus of the study laid on the memorization of compounds and phrases, these items were ignored. Their primary purpose was to make the procedure of the study possible, that is, while experimental items were supposed to trigger a “Yes”-response, fillers were supposed to trigger a “No”-response (as in a typical lexical-decision design). Third, in the analysis of the response-time data, all incorrect answers were discarded. Fourth, using a boxplot analysis described in Larson-Hall (2010: 245), statistical outliers were removed from the reaction-time data. In a boxplot, all values from the 25th to the 75th percentile are located within a box, the so-called interquartile range. A solid line within the box represents the median. So-called whiskers, that is, vertical lines extending out from the top of the box on the one side and the bottom of the box on the other side, reach the minimum and maximum values of a dataset. If, however, values are located at a point that is more than “one and a half times the length of the box” (Larson-Hall 2010: 245) away from the edge of the box, they are outliers. Outliers in the dataset with the raw values were detected in a boxplot and subsequently discarded. In sum, only values from 671 to 2069 ms were kept for the response-latency investigations. These values (without incorrect responses and outliers) represent 85 percent of the raw values of the experimental items.

Repeated-measures ANOVAs were used to investigate the two dependent variables `RESPONSE TIME` and `RESPONSE ACCURACY`. The model included the independent and fixed factors `CONSTRUCTION TYPE` (compound, phrase), `PROSODIC PROMINENCE` (initial, non-initial), `DAY` (1, 4, 8), all possible interactions between these factors, and the random factors `SUBJECT` (in F_1) and `ITEM` (in F_2). All fixed factors were of the type within-subject and within-item. One analysis by subject (F_1) and one analysis by item (F_2) were calculated.

The three main effects reached (high) significance in both the response-time and the response-accuracy analysis (`CONSTRUCTION TYPE`, `RESPONSE`

TIME: $F_1(1, 253) = 17.09, p < .001, F_2(1, 253) = 22.55, p < .001$; CONSTRUCTION TYPE, RESPONSE ACCURACY: $F_1(1, 253) = 4.67, p < .05, F_2(1, 253) = 4.14, p < .05$; PROSODIC PROMINENCE, RESPONSE TIME: $F_1(1, 253) = 30.49, p < .001, F_2(1, 253) = 36.15, p < .001$; PROSODIC PROMINENCE, RESPONSE ACCURACY: $F_1(1, 253) = 19.68, p < .001, F_2(1, 253) = 14.83, p < .001$; DAY, RESPONSE TIME: $F_1(2, 253) = 43.94, p < .001, F_2(2, 253) = 50.41, p < .001$; DAY, RESPONSE ACCURACY: $F_1(2, 253) = 9.46, p < .001, F_2(2, 253) = 6.80, p < .01$). That means specifically, compounds were reacted to more quickly (see Figure 2) and more accurately than phrases and items with non-initial prominence were responded to faster and more correctly than items with initial prominence. In the reaction-time data, a clear improvement, that is, a reduction of the latencies, over the different test days was detected (Day 4 versus Day 1: $t_1 = -4.51, p_1 < .001, t_2 = -5.25, p_2 < .001$; Day 8 versus Day 4: $t_1 = -4.86, p_1 < .001, t_2 = -4.78, p_2 < .001$; Day 8 versus Day 1: $t_1 = -9.37, p_1 < .001, t_2 = -10.04, p_2 < .001$).⁸ In the accuracy data, the improvement was confirmed in the comparisons of Day 4 and Day 1 ($t_1 = 4.18, p_1 < .001, t_2 = 3.58, p_2 < .01$) as well as Day 8 and Day 1 ($t_1 = 3.13, p_1 < .01, t_2 = 2.54, p_2 < .05$). The descriptive statistics of the three main effects are presented in Table 1.

⁸ Note that all p-values reported for the post-hoc comparisons in the present paper are corrected p-values.

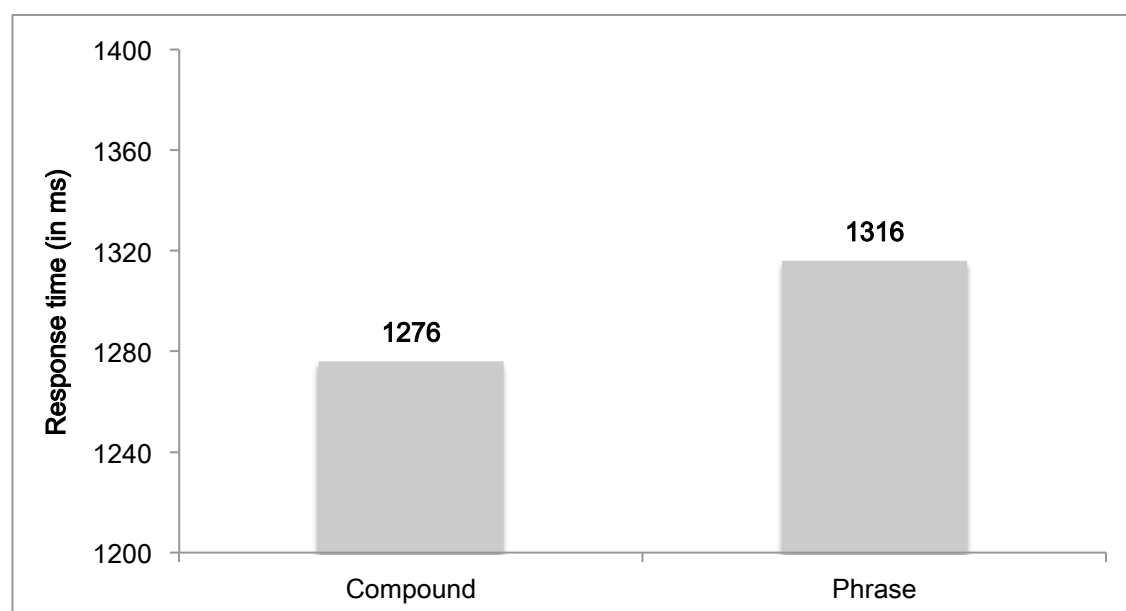
Table 1 Descriptive statistics of the three main effects

N – Number of observations, M – Mean, SD – Standard deviation

RT – Response time, RA – Response accuracy

Subscript 1 – Analysis by subject, Subscript 2 – Analysis by item

Condition	N ₁ (N ₂), RT	M ₁ (M ₂), RT in ms	SD ₁ (SD ₂), RT in ms
	N ₁ (N ₂), RA	M ₁ (M ₂), RA in %	SD ₁ (SD ₂), RA in %
1. Compound	144 (144)	1276 (1278)	160 (128)
	144 (144)	91 (91)	11 (10)
2. Phrase	144 (144)	1316 (1324)	167 (133)
	144 (144)	88 (88)	12 (12)
1. Initial prominence	144 (144)	1323 (1330)	161 (129)
	144 (144)	87 (87)	12 (12)
2. Non-initial prominence	144 (144)	1269 (1272)	164 (129)
	144 (144)	92 (92)	9 (10)
1. Day 1	96 (96)	1352 (1362)	146 (123)
	96 (96)	86 (87)	12 (13)
2. Day 4	96 (96)	1298 (1299)	156 (115)
	96 (96)	92 (92)	9 (10)
3. Day 8	96 (96)	1239 (1243)	172 (131)
	96 (96)	90 (90)	12 (10)

**Figure 2** Main effect of CONSTRUCTION TYPE (F_1)

Only the interaction of STRESS and SESSION reached significance, only in the analysis of response accuracy, and only in F_1 ($F_1(2, 253) = 4.05, p < .05$). This interaction is, however, ignored as it does not contribute to answer the questions raised in the current investigation. No other interaction reached significance. One of the objectives of the present study is to examine whether the prosodic prominence pattern of compounds and phrases has an influence on how they are memorized. Since there is no interaction between CONSTRUCTION TYPE and PROSODIC PROMINENCE, we can claim that compounds are generally memorized more efficiently than phrases. In Figure 3, we see that initially prominent compounds triggered shorter response latencies than initially prominent phrases. Moreover, non-initially prominent compounds were reacted to more quickly than non-initially prominent phrases. In other words, compounds were generally responded to faster, that is, both if they carried their normal and phrases their non-normal prominence pattern (initial prominence) and if they carried their non-normal and phrases their normal prominence pattern (non-initial prominence). Hence, it was not the case that the normal or the non-normal prominence pattern caused quicker response times; instead, compounds were always reacted to faster than phrases. Due to the absence of the interaction, post-hoc comparisons were not conducted. However, in order to evaluate the differences between the two construction types with the two prominence patterns, dependent t tests were conducted as a supplement.⁹ In the response-time analyses, these tests clearly indicated that initially prominent compounds ($N_1 = 72, M_1 = 1298, SD_1 = 146; N_2 = 72, M_2 = 1299, SD_2 = 120$) were reacted to significantly more quickly than initially prominent phrases ($N_1 = 72, M_1 = 1349, SD_1 = 173; N_2 = 72, M_2 = 1362, SD_2 = 132$) ($t_1 = -3.47, p_1 < .01; t_2 = -4.38, p_2 < .001$) and that non-initially prominent compounds ($N_1 = 72, M_1 = 1254, SD_1 = 171; N_2 = 72, M_2 = 1258, SD_2 = 133$)

⁹ Dependent, rather than independent, t tests were chosen because all subjects and all items were exposed to all conditions (within-subject and within-item design).

were responded to faster than non-initially prominent phrases ($N_1 = 72$, $M_1 = 1284$, $SD_1 = 156$; $N_2 = 72$, $M_2 = 1287$, $SD_2 = 123$) ($t_1 = -2.50$, $p_1 < .05$; $t_2 = -2.02$, $p_2 < .05$).^{10 11} The differences are visualized in Figure 3.

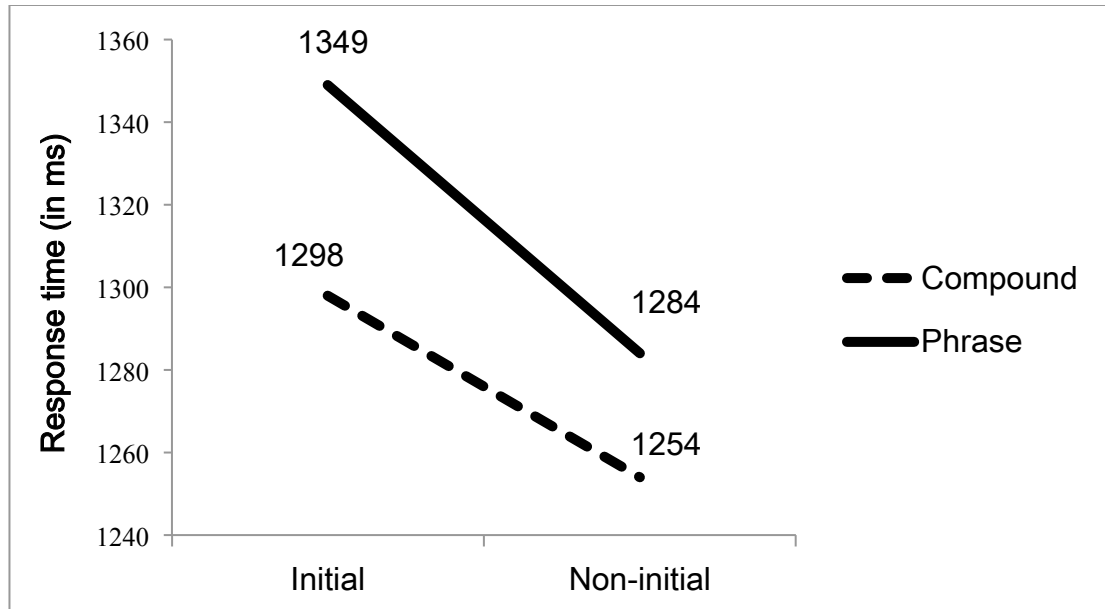


Figure 3 CONSTRUCTION TYPE and PROSODIC PROMINENCE together (t_1)

¹⁰ Further, initially prominent compounds were responded to more slowly than non-initially prominent compounds ($t_1 = 3.12$, $p_1 < .01$; $t_2 = 3.21$, $p_2 < .01$) and initially prominent phrases were reacted to more slowly than non-initially prominent phrases ($t_1 = 5.06$, $p_1 < .001$; $t_2 = 5.87$, $p_2 < .001$). The difference between non-initially prominent compounds and initially prominent phrases reached significance as well ($t_1 = -8.61$, $p_1 < .001$; $t_2 = -7.06$, $p_2 < .001$). The difference between initially prominent compounds and non-initially prominent phrases did not reach significance.

¹¹ In the analysis of RESPONSE ACCURACY, dependent t tests only revealed significant differences if non-initially prominent compounds ($N_1 = 72$, $M_1 = 94$, $SD_1 = 8$; $N_2 = 72$, $M_2 = 94$, $SD_2 = 8$) were involved, which had the highest accuracy rates. The values were as follows: Non-initially prominent compounds versus non-initially prominent phrases ($N_1 = 72$, $M_1 = 90$, $SD_1 = 10$; $N_2 = 72$, $M_2 = 90$, $SD_2 = 11$) ($t_1 = 2.65$, $p_1 < .05$; $t_2 = 2.32$, $p_2 < .05$); initially prominent compounds ($N_1 = 72$, $M_1 = 88$, $SD_1 = 12$; $N_2 = 72$, $M_2 = 88$, $SD_2 = 11$) versus non-initially prominent compounds ($t_1 = -4.39$, $p_1 < .001$; $t_2 = -4.32$, $p_2 < .001$), and non-initially prominent compounds versus initially prominent phrases ($N_1 = 72$, $M_1 = 87$, $SD_1 = 13$; $N_2 = 72$, $M_2 = 87$, $SD_2 = 13$) ($t_1 = 5.23$, $p_1 < .001$; $t_2 = 3.73$, $p_2 < .001$). Nonetheless, the main effect of CONSTRUCTION TYPE was here significant as well, there was no significant interaction between CONSTRUCTION TYPE and PROSODIC PROMINENCE and, therefore, compounds were generally reacted to more accurately than phrases.

5.1.4 Summary and discussion of Experiment 1

In the experiment reported here, I investigated whether compounds and phrases differ in terms of memorization. As outlined in the description of the material earlier, there are certainly issues that have to be taken into account when interpreting the data, such as the problem of analogy, which cannot be entirely controlled for. Nevertheless, keeping this in the back of the head, we observe that the study and specifically the main effect of CONSTRUCTION TYPE suggest that compounds are memorized differently, that is, more efficiently, than phrases. We saw earlier that the formal distinction between compounds, which do not carry an adjectival suffix expressing grammatical agreement, and phrases, in which a suffix attaches to the adjective and expresses agreement, has clear consequences on the function of the constructions since German AN compounds are more apt to occur with the naming function in comparison to the respective phrases. As the results of the present investigation suggest, the formal differentiation between compounds and phrases not only seems to have implications for the function but also for the memorization of the items. The main effect of CONSTRUCTION TYPE is overall meaningful and informative because further factors, such as the prosodic prominence pattern or the potentially confounding variables introduced earlier, were adequately controlled for (possibly with the exception of analogy). That is, for instance, since compounds and phrases were tested with both their preferred and non-preferred prosodic prominence pattern, it can be excluded that the effect merely derives from a prosodic difference (see also the discussion of the main effect of PROSODIC PROMINENCE below). Further, it was shown that not only compounds with their normal prominence pattern were memorized more efficiently than phrases with their non-normal pattern but also that compounds with their non-normal pattern were memorized more efficiently than phrases with their normal pattern. Put differently, compounds were generally memorized more efficiently. One might now object that the

responses to compounds and phrases did not differ from each other if the two construction types carried their normal prominence pattern, that is, if compounds were initially and phrases non-initially prominent. However, as the main effect of PROSODIC PROMINENCE shows, one prominence pattern was generally reacted to more quickly and accurately; this must be taken into consideration (see next paragraph for a potential explanation of this main effect). In other words, the absence of a difference between the responses to compounds and phrases with their normal prominence pattern suffers from the presence of the potentially confounding variable prosodic prominence. Since non-initial prominence triggered faster and more accurate reactions than initial prominence, the construction types compound and phrase cannot be adequately contrasted if both carry their normal prominence pattern.

Non-initially prominent items of either type triggered significantly quicker responses than the initially prominent items of the same type. For phrases, one might argue that this pattern derives from the fact that phrases carry non-initial prominence by default; however, we should then find the opposite trend for compounds as they typically bear initial prominence. This was not the case: Compounds with non-initial prominence were reacted to significantly more quickly than compounds with initial prominence. Therefore, although compounds are prominent on the initial constituent by default whereas phrases favor non-initial prominence, it is claimed that the prosodic prominence pattern contributes independently of the specific construction type to how an item is memorized. Specifically, the response differences are argued to be due to a general frequency advantage: Non-initial prominence is overall more frequent than initial prominence in German AN constructions because phrases, which carry non-initial prominence by default, are more frequent than compounds. That is, if one considers all compounds and phrases – both lexicalized and non-lexicalized constructions, both naming and descriptive items – non-initial prominence appears more often than initial

prominence. This claim is based, first, on the fact that German AN phrases can contain any attributive adjective, while compounds are subject to several restrictions (see, e.g., references given in Section 2). Hence, the number of possible and actual phrases is clearly higher than the number of possible and actual compounds. Second, from a rather intuitive perspective, non-lexicalized and descriptive AN phrases such as *kleines Auto* (small car, 'small car'), *rote Jacke* (red jacket, 'red jacket'), or *wärmer Tag* (warm day, 'warm day'), for instance, are used all the time and carry non-initial prominence. Initially prominent units, for example, specific AN compounds such as *Rotfuchs* (red_fox, 'red fox'), phrases with contrastive stress, and others, seem to occur, in comparison, much more rarely. Therefore, the advantage of non-initial prominence is overall considered a mere frequency effect, which was also confirmed in the main effect of PROSODIC PROMINENCE (see also Schlechtweg 2018b; Mirjam Ernestus personal communication on September 27, 2018; for the connection between the frequency of a prosodic prominence pattern and response latencies, see also Schiller, Fikkert and Levelt 2004: 237–238).

Overall, the central hypothesis of the present experiment, namely the claim that compounds are memorized more efficiently than phrases, is confirmed in the data, primarily in the main effect of CONSTRUCTION TYPE. The study represents a clear improvement in comparison to other studies that looked at similar issues. While Mondini et al. (2002) and McCauley et al. (2012) did not control for the potentially confounding variable of lexicalization, Kotowski et al. (2014) missed to control for orthography. Therefore, the effects of these studies have to be treated with caution, as lexicalized or orthographically solid constructions were contrasted with non-lexicalized or orthographically spaced ones. Although these issues were taken into consideration in other studies (Schlechtweg 2018b; Schlechtweg and Härtl 2016), some questions remained open. The present study was the first that compared the cognitive properties

of a well-controlled set of auditorily presented compounds and phrases within a single language that relies on both compounds and phrases to express complex lexical concepts. Also, it was the first study that looked at the interplay of construction type (compound versus phrase) and prosodic prominence (initial versus non-initial prominence) in German.

The data of the current investigation support the Full-Form-Storage Principle for Compounds and Phrases (Schlechtweg 2018b) because compounds were overall responded to more quickly and accurately than phrases. It is argued that this advantage is based on the interplay of the formal, functional, and cognitive characteristics of compounds. That is, the special formal appearance of compounds, the markedness referred to in Section 3, signals that the item functions as a naming unit, which, in turn, has to be stored in the lexicon. The formal and functional deviation has to be represented in the lexicon and seems to promote the early creation of a full-form entry, which can then be accessed quickly.

For phrases, two interpretations of the data seem to be possible. First, the creation of a full-form entry in the lexicon is delayed. Even though phrases can also serve as naming units, enter the mental storage space, and be represented in a full-form entry, their formal nature makes them less suited to do so (see also Barz 1996; Härtl 2015). Phrases, in comparison to compounds, represent the unmarked form and naturally fulfill a descriptive purpose. Memorization and storage, however, often imply the naming function because it is less likely to memorize descriptive units such as *small chair*, *blue car*, or *big house* by heart (see Booij 2010: 169; but see also, e.g., Tremblay, Derwing, Libben and Westbury 2011 on lexical bundles). That is, a conflict arises if phrases are supposed to be memorized. On the one hand, they trigger the descriptive function by default; on the other hand, memorization as such actually often entails the naming function. This conflict might be the reason why the creation of a full-form entry is postponed and why,

consequently, the slower access route, namely the decomposition or constituent access route, has to be taken. Second, an alternative interpretation of the results of the phrases is the idea that phrases are memorized in their descriptive sense only, that is, no additional naming function is assigned or acquired at all. If this was the case, these phrases would permanently rely on decomposition and no full-form entry would be created at all. In Experiment 1, the two aforementioned interpretations of the phrase results cannot be disentangled as no meaning was provided and associated with the compounds and phrases. That is, the less efficient memorization of the phrases might be due to the fact that the creation of a full-form entry was delayed because the descriptive and the naming function were in conflict or due to the fact that no full-form entry came into existence at all because only the descriptive function was used. In Experiment 2, which aimed at extending the first study, a meaning was explicitly provided for each construction. That is, the experiment was intended to reduce the probability that the second interpretation of the phrase results in Experiment 1 holds, to emphasize the naming function, to increase the probability that a full-form entry is created, not only for the compounds but also for the phrases, and to find out whether phrases are memorized equally well in this scenario.

5.2 Experiment 2

5.2.1 Kind, goal, and hypothesis

Experiment 2 was very similar to Experiment 1 with respect to the kind, goal, and hypothesis. The primary difference between the two studies was that in Experiment 2, but not in Experiment 1, an invented meaning was explicitly provided for each compound and phrase. Experiment 2 aimed at investigating whether this has an effect on how well the constructions are memorized. It was hypothesized that, even if a meaning is explicitly given, compounds are still memorized more efficiently than phrases as the descriptive meaning can

be suppressed only with difficulties in phrases and is assumed to be in conflict with the naming function. In compounds, in turn, the descriptive meaning does not interfere with the naming function.

5.2.2 Method

5.2.2.1 Subjects

Twenty-four monolingual native speakers of German, all of whom were university students in the language department, completed the entire study for course credit (nineteen females and five males, mean age: 22.5 years, standard deviation of age: 1.9 years, age range: 19–26 years). No subject had participated in Experiment 1. Six subjects started the experiment but did not finish it; their data was excluded from all analyses.

5.2.2.2 Materials

The same experimental and filler items as in Experiment 1 were used. In Experiment 2, however, all experimental items were associated with an explicitly given meaning (for details on how the meaning was presented, see Section 5.2.2.3). An example is shown in (4), all other meanings are listed in Appendix B.¹² The meanings of the initially prominent and those of the non-initially prominent compounds were exactly identical, as were the meanings of the initially prominent and those of the non-initially prominent phrases. The meanings of the compounds and those of the phrases were almost identical,

¹² I would like to add a general note on the meanings used in the present study. As an anonymous reviewer remarked, some of the meanings sound “odd and improbable”. However, the reason for using these (“odd”) meanings was the objective to control the material as well as possible. As illustrated further below, the meanings were constructed with two goals in mind. First, they should express a direct modification relation and, second, they should express semantic specialization. More details on these issues are given below. If the sentences had been created in a less strict, more variable, and less “odd” way, the two aforementioned aspects would not have been controlled for adequately. Further, it might lie in the nature of invented objects that they sometimes seem “improbable”. Again, using invented meanings had the advantage of controlling for potentially confounding variables, such as the semantic relation between the constituents in the compounds and phrases.

the primary difference being the noun. In some cases, there were minor differences, for instance, the precise numeric dimension in (5).

- (4) (a) Compounds: *Hartmütze* 'hard_cap'
 Meaning: *Eine Mütze, die deswegen so hart wie Ahornholz ist, damit sie vor starkem Hagel schützt.* 'A cap that is as hard as maple wood in order to protect against heavy hail.'
- (b) Phrases: *harter Schirm* 'hard umbrella'
 Meaning: *Ein Schirm, der deswegen so hart wie Ahornholz ist, damit er vor starkem Hagel schützt.* 'An umbrella that is as hard as maple wood in order to protect against heavy hail.'
- (5) (a) Compounds: *Flachroller* 'flat_scooter'
 Meaning: *Ein Roller, der deswegen flacher als 1 Meter ist, weil er unter sehr niedrigen Dächern geparkt werden soll.* 'A scooter that is flatter than 1 meter because it is supposed to be parked under very low roofs.'
- (b) Phrases: *flache Tram* 'flat tram'
 Meaning: *Eine Tram, die deswegen flacher als 2 Meter ist, weil sie unter sehr niedrigen Dächern geparkt werden soll.* 'A tram that is flatter than 2 meters because it is supposed to be parked under very low roofs.'

It is known that German AN compounds and phrases deviate from each other in semantic terms. That is, while semantic relations within phrases are subject to several restrictions, both direct and indirect modification relations are found in compounds (see, e.g., Ortner 1991). As a consequence, all experimental items in the present study, that is, both compounds and phrases, were associated with a meaning that represented a direct modification relation

between the adjective and the noun because both compounds and phrases naturally occur with this kind of semantic relation (see, e.g., Ortner 1991: 718; Motsch 2004: 387; Schlücker 2016). The way this was realized is exemplified in (4) and (5) above, and in all other cases in Appendix B. For each example, it was expressed that the whole construction x containing the head n was an n with the property expressed through the modifier a .

The meanings of the complex constructions were created relying on a further aspect. In each case, it should become obvious that the compound or phrase serves as a naming unit, that is, as a novel sub-concept of the concept represented in the head noun, rather than as a simple descriptive unit. In order to achieve this, a semantic specialization, for which AN constructions with a direct modification relation are known (see, e.g., Ortner 1991: 724; Schlücker 2014: 39–41), was also emphasized in the meanings. That is, each meaning specified, first, that the complex item x represents an n with the characteristics expressed in a (= direct modification) and, second, why (and how) exactly n has the property a (= semantic specialization). For example, *Hartmütze* (hard_cap) / *harter Schirm* (hard umbrella), the items in (4) above, do not simply designate all caps / umbrellas that are hard but a specific cap / umbrella that is hard for a particular reason and that has a specific degree of hardness, namely hardness comparable to that of maple wood.

5.2.2.3 Procedure

The procedure of Experiment 2 was similar to that of Experiment 1 in several respects (see Section 5.1.2.3). However, in Experiment 2, all subjects participated in only one block consisting of three memorization phases and one test phase on each of the three test days. They memorized the same twenty-four items on each day, and, on each day, they memorized these items three times, that is, once in each of the three memorization phases. While subjects only memorized items, but no meanings, in Experiment 1, they

memorized both items and meanings in Experiment 2. The additional memorization effort in Experiment 2 was balanced out by reducing the overall number of items that subjects memorized. That is, in Experiment 2, each participant memorized each of the twenty-four items in one condition, resulting in six items per condition per person. The second reason to reduce the number of items to be memorized was the idea that each meaning should be associated with only one construction. For instance, one subject memorized example (4a) but another subject memorized (4b). Subjects were instructed to memorize an invented meaning together with a novel construction that expressed this meaning as well as they could. In order to ensure that subjects understood that the items represent a new subclass of the nominal head, that is, a new naming unit rather than a simple descriptive unit, they were given examples. Using *grüner Tee* (green tea, 'green tea' = specific kind of tea) and *Rotfuchs* (red_fox, 'red fox' = specific kind of fox), for instance, it was explained that these constructions do not simply refer to any tea of green color / any fox of red color but, instead, to a specific (sub-)kind of tea / fox. It was then added that all items in the present experiment are of this type, that is, that there is always, apart from the meanings of the adjective and the noun, an additional aspect of meaning, namely the reason why the concept represented by the noun has the property expressed in the adjective / how exactly the concept represented by the noun has the property (e.g., "*Green tea*, for example, is not any tea that is green but a specific kind of tea whose leaves remain green due to the specific processing (in comparison to *black tea*, whose leaves become black due to their specific processing).").

Items appeared in randomized order in all memorization phases. Each trial in the memorization phases started with a fixation cross lasting for 1000 ms on the computer screen. Then, the meaning was presented on the screen for 12500 ms. Another fixation cross followed for 1000 ms. Finally, subjects

heard, but did not see, an item and had 4000 ms, measured from the onset of the sound file, to memorize it.

In each of the test phases, subjects were exposed to a total of forty-eight items, twenty-four had been memorized in the three preceding memorization phases and twenty-four had not. They were requested to press the “Yes”-button if they heard constructions that they had memorized in the three memorization phases. In contrast, they were instructed to press “No” if they heard an item that had not been memorized before. The memorized (e.g., *Dickstiefel*, thick_boot) and the non-memorized items (e.g., *Dicktasse*, thick_mug) were made up of the same adjectives and nouns, which were combined differently. A memorized and a non-memorized item with the same adjective were matched with respect to both the construction type (compound versus phrase) and the prosodic prominence pattern (initial versus non-initial). In the test phases, a fixation cross appeared for 1000 ms on the screen before subjects heard a sound file, and were asked to make up their mind. Response time was measured from the onset of an item. In all test phases, items appeared in randomized order. The meaning was not presented in the test phases, but only in the memorization phases.

5.2.3 Statistical analyses and results

First of all, the overall accuracy rate of all participants and experimental items was calculated. Each of the twenty-four subjects responded correctly in at least 83 percent of all cases. The experimental items showed accuracy rates of at least 83 percent. Thus, neither a subject nor an experimental item was excluded from further analyses. Second, all filler items were excluded from further analyses. Third, in the analysis of the response-time data, all incorrect answers were discarded. Fourth, using a boxplot analysis described in Section 5.1.3, statistical outliers were removed from the reaction-time data. In sum, only values from 737 to 2264 ms were kept for the response-latency

investigations. These values (without incorrect responses and outliers) represent 86 percent of the raw values of the experimental items.

Repeated-measures ANOVAs were used to investigate the two dependent variables RESPONSE TIME and RESPONSE ACCURACY. The model, factors, and analyses were the same as in Experiment 1. The three main effects reached (high) significance (CONSTRUCTION TYPE, RESPONSE TIME: $F_1(1, 253) = 20.85$, $p < .001$, $F_2(1, 253) = 18.30$, $p < .001$; CONSTRUCTION TYPE, RESPONSE ACCURACY: $F_1(1, 253) = 6.21$, $p < .05$, $F_2(1, 253) = 7.11$, $p < .01$; PROSODIC PROMINENCE, RESPONSE TIME: $F_1(1, 253) = 13.74$, $p < .001$, $F_2(1, 253) = 14.71$, $p < .001$; PROSODIC PROMINENCE, RESPONSE ACCURACY: n.s.; DAY, RESPONSE TIME: $F_1(2, 253) = 61.67$, $p < .001$, $F_2(2, 253) = 58.92$, $p < .001$; DAY, RESPONSE ACCURACY: $F_1(2, 253) = 7.13$, $p < .01$, $F_2(2, 253) = 8.16$, $p < .001$). That means specifically, compounds were reacted to more quickly (see Figure 4) and more accurately than phrases and items with non-initial prominence were responded to faster than items with initial prominence. A clear improvement, that is, a reduction of the latencies and an increase in the accuracy, from day one to days four and eight was also detected (RESPONSE TIME: Day 4 versus Day 1: $t_1 = -8.27$, $p_1 < .001$, $t_2 = -8.35$, $p_2 < .001$; Day 8 versus Day 1: $t_1 = -10.56$, $p_1 < .001$, $t_2 = -10.18$, $p_2 < .001$; RESPONSE ACCURACY: Day 4 and Day 1: $t_1 = 3.27$, $p_1 < .01$, $t_2 = 3.50$, $p_2 < .01$; Day 8 and Day 1: $t_1 = 3.27$, $p_1 < .01$, $t_2 = 3.50$, $p_2 < .01$). The descriptive statistics are given in Table 2 below.

Table 2 Descriptive statistics of the three main effects

Condition	N ₁ (N ₂), RT	M ₁ (M ₂), RT in ms	SD ₁ (SD ₂), RT in ms
	N ₁ (N ₂), RA	M ₁ (M ₂), RA in %	SD ₁ (SD ₂), RA in %
1. Compound	144 (144)	1323 (1323)	209 (169)
	144 (144)	95 (95)	10 (10)
2. Phrase	144 (144)	1399 (1388)	224 (187)
	144 (144)	91 (91)	13 (11)

1. Initial prominence	144 (144)	1392 (1384)	225 (183)
	144 (144)	92 (92)	13 (12)
2. Non-initial prominence	144 (144)	1331 (1326)	210 (174)
	144 (144)	94 (94)	11 (10)
1. Day 1	96 (96)	1489 (1470)	233 (168)
	96 (96)	90 (90)	14 (13)
2. Day 4	96 (96)	1321 (1315)	180 (153)
	96 (96)	95 (95)	10 (10)
3. Day 8	96 (96)	1274 (1281)	183 (163)
	96 (96)	95 (95)	11 (9)

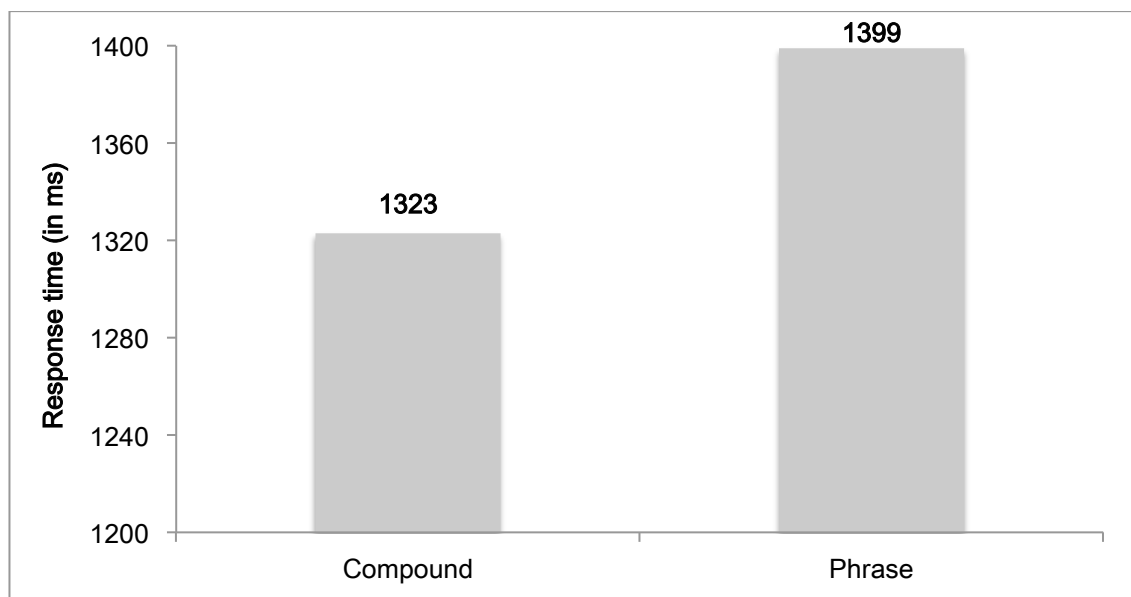


Figure 4 Main effect of CONSTRUCTION TYPE (F_1)

None of the interactions reached significance. Remember that one of the objectives of the present study is to examine whether the prosodic prominence pattern of compounds and phrases has an influence on how they are memorized. Since there is no interaction between CONSTRUCTION TYPE and PROSODIC PROMINENCE, we can claim again that compounds are generally memorized more efficiently than phrases. In Figure 5, we see that initially prominent compounds triggered shorter response latencies than initially prominent phrases. Moreover, non-initially prominent compounds were reacted to more quickly than non-initially prominent phrases. In other words,

compounds were generally responded to faster, that is, both if they carried their normal and phrases their non-normal prominence pattern (initial prominence) and if they carried their non-normal and phrases their normal prominence pattern (non-initial prominence). Therefore, again, it is not the case that the normal or the non-normal prominence pattern caused quicker response times; instead, compounds were always reacted to faster than phrases. Due to the absence of the interaction, post-hoc comparisons were not conducted. However, in order to evaluate the differences between the two construction types with the two prominence patterns, dependent t tests were conducted again. In the response-time analyses, these tests clearly indicated that initially prominent compounds ($N_1 = 72$, $M_1 = 1351$, $SD_1 = 226$; $N_2 = 72$, $M_2 = 1345$, $SD_2 = 177$) were reacted to significantly more quickly than initially prominent phrases ($N_1 = 72$, $M_1 = 1434$, $SD_1 = 219$; $N_2 = 72$, $M_2 = 1423$, $SD_2 = 182$) ($t_1 = -2.89$, $p_1 < .01$; $t_2 = -4.14$, $p_2 < .001$) and that non-initially prominent compounds ($N_1 = 72$, $M_1 = 1296$, $SD_1 = 189$; $N_2 = 72$, $M_2 = 1301$, $SD_2 = 158$) were responded to faster than non-initially prominent phrases ($N_1 = 72$, $M_1 = 1365$, $SD_1 = 225$; $N_2 = 72$, $M_2 = 1352$, $SD_2 = 186$) ($t_1 = -3.18$, $p_1 < .01$; $t_2 = -2.15$, $p_2 < .05$).^{13 14}

¹³ Further, initially prominent compounds were responded to more slowly than non-initially prominent compounds ($t_1 = 2.42$, $p_1 < .05$; $t_2 = 2.10$, $p_2 < .05$) and initially prominent phrases were reacted to more slowly than non-initially prominent phrases ($t_1 = 3.08$, $p_1 < .01$; $t_2 = 3.31$, $p_2 < .01$). The difference between non-initially prominent compounds and initially prominent phrases reached significance as well ($t_1 = -6.07$, $p_1 < .001$; $t_2 = -5.70$, $p_2 < .001$). The difference between initially prominent compounds and non-initially prominent phrases did not reach significance.

¹⁴ In the analysis of RESPONSE ACCURACY, only the comparison between non-initially prominent compounds ($N_1 = 72$, $M_1 = 96$, $SD_1 = 10$; $N_2 = 72$, $M_2 = 96$, $SD_2 = 10$) and initially prominent phrases ($N_1 = 72$, $M_1 = 90$, $SD_1 = 14$; $N_2 = 72$, $M_2 = 90$, $SD_2 = 12$) reached significance ($t_1 = 2.78$, $p_1 < .01$; $t_2 = 2.82$, $p_2 < .01$). The further descriptive values were as follows: Initially prominent compounds ($N_1 = 72$, $M_1 = 94$, $SD_1 = 11$; $N_2 = 72$, $M_2 = 94$, $SD_2 = 11$) and non-initially prominent phrases ($N_1 = 72$, $M_1 = 93$, $SD_1 = 12$; $N_2 = 72$, $M_2 = 93$, $SD_2 = 11$).

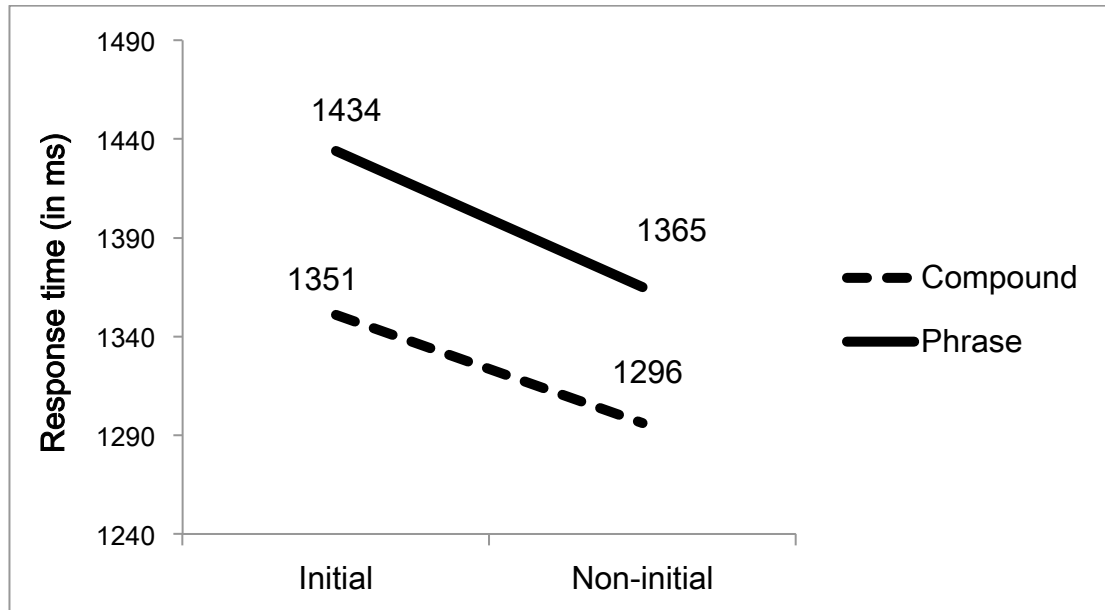


Figure 5 CONSTRUCTION TYPE and PROSODIC PROMINENCE together (t_1)

5.2.4 Summary and discussion of Experiment 2

As in Experiment 1, the analysis of Experiment 2 revealed three main effects. That is, first, a typical memorization effect occurred in that the memorization of the constructions generally improved in the course of the study. Second, constructions with non-initial prominence were memorized more efficiently than constructions with initial prominence. In Section 5.1.4, it was already argued that the effect derives from the different frequencies of the prominence patterns. Third, compounds were generally memorized more efficiently than phrases. Finally, again as in Experiment 1, separate comparisons in Experiment 2 showed that compounds with their normal prominence pattern were memorized more efficiently than phrases with their non-normal prominence pattern (initial prominence) and that compounds with their non-normal prominence pattern were memorized better than phrases with their normal prominence pattern (non-initial prominence). Hence, no effect of normality was detected; instead, compounds with a specific prominence pattern were generally memorized more efficiently than phrases with the same pattern.

Based on the results of Experiment 1, it was claimed that the formal and functional nature of compounds is responsible for their memorization advantage in comparison to phrases. The marked formal appearance of compounds leads by default to the immediate interpretation of the respective construction as a kind, which, in turn, needs to be stored in the mental lexicon. Although phrases can also serve the naming function, their unmarked form makes this more difficult as the descriptive meaning of phrases is in conflict with a potential new complex lexical concept. Memorization and full-form storage is thus delayed for phrases. An alternative explanation for the results of the phrases remains: Maybe the creation of a full-form entry in the lexicon was not simply delayed but was not executed at all; that is, maybe phrases were only interpreted in a descriptive sense and relied on decomposition altogether. Having conducted Experiment 1 without explicitly presenting a meaning associated with the compounds and phrases, I decided to provide a meaning in Experiment 2 in order to see whether phrases are memorized equally well if the naming function is emphasized more directly and if a meaning that is more likely to be stored is overtly given. Experiment 2 showed, however, that this was not the case: The memorization advantage of compounds persisted even if a meaning was directly provided. In other words, even if the naming function of phrases is emphasized to a certain extent, they are still memorized less efficiently than compounds. Apparently, the descriptive meaning of phrases cannot be blocked if the naming function operates and, therefore, remains in conflict with the latter. Since the provided meanings do not simply equal the sum of the adjectival and nominal semantics, they are likely to be stored in the mental lexicon. Hence, it is suggested here that the memorization disadvantage of the phrases should be interpreted as an indication that the creation of the full-form entry has been delayed. That is, the results of Experiment 2 are compatible with the Full-Form-Storage Principle for Compounds and Phrases (Schlechtweg 2018b),

which states, on the one hand, that both compounds and phrases can be stored as a full-form entry in the mental lexicon and, on the other hand, that a full-form entry of compounds is created earlier, that is, at a lower frequency, than that of phrases as only the former, but not the latter, adopt a naming function, which is not in conflict with the descriptive function, right away.

6 Conclusion

Keeping the problem of analogy in the back of the head, the current paper argues that compounds are memorized more efficiently than phrases and suggests that this advantage derives from the formal as well as functional nature of the two construction types. Two experiments that looked at non-lexicalized German AN combinations provide support for this claim and show that the effect holds across different prosodic prominence patterns and independently of whether a meaning is explicitly provided for the invented compounds and phrases or not.

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Appendix A Experimental items of Experiments 1 and 2

Compounds	Phrases	Meaning of head noun
1. <i>Flachroller</i> 'flat_scooter'	<i>flache Tram</i> 'flat tram'	means of transportation
2. <i>Pinktafel</i> 'pink_sign'	<i>pinkes Schild</i> 'pink sign'	traffic sign
3. <i>Hartmütze</i> 'hard_cap'	<i>harter Schirm</i> 'hard umbrella'	head protection
4. <i>Kurzsofa</i> 'short_couch'	<i>kurze Couch</i> 'short couch'	couch
5. <i>Heißtasse</i> 'hot_mug'	<i>heißer Krug</i> 'hot jug'	drinking vessel
6. <i>Dickstiefel</i> 'thick_boot'	<i>dicker Schuh</i> 'thick shoe'	clothing for the feet
7. <i>Leichtregal</i> 'light_shelf'	<i>leichter Schrank</i> 'light closet'	object to store other objects
8. <i>Kleintruhe</i> 'small_chest'	<i>kleiner Safe</i> 'small safe'	object to store other/valuable objects
9. <i>Kaltkette</i> 'cold_chain'	<i>kalter Ring</i> 'cold ring'	jewelry
10. <i>Lautkutter</i> 'loud_cutter'	<i>laute Jacht</i> 'loud yacht'	boat
11. <i>Schmalpaket</i> 'narrow_package'	<i>schmaler Brief</i> 'narrow letter'	mail
12. <i>Dünnbürste</i> 'thin_brush'	<i>dünnere Schwamm</i> 'thin sponge'	object to clean something
13. <i>Großtresen</i> 'big_counter'	<i>großes Pult</i> 'big console'	object someone can stand at/lean against
14. <i>Schwersocke</i> 'heavy_sock'	<i>schwerer Strumpf</i> 'heavy sock'	sock
15. <i>Breitkiste</i> 'broad_box'	<i>breite Box</i> 'broad box'	box
16. <i>Warmschüssel</i> 'warm_bowl'	<i>warmer Topf</i> 'warm pot'	object to store food
17. <i>Raureifen</i> 'rough_tire'	<i>raues Rad</i> 'rough wheel'	object that rolling means of transportation need
18. <i>Hochauto</i> 'high_car'	<i>hoher Bus</i> 'high bus'	means of transportation
19. <i>Langschlitten</i> 'long_slide'	<i>langes Board</i> 'long board'	object to slide on in the snow
20. <i>Jungmünze</i> 'young_coin'	<i>junger Schein</i> 'young banknote'	object used to pay something
21. <i>Weichscheibe</i> 'soft_pane'	<i>weiche Tür</i> 'soft door'	possible entrance of a room/house
22. <i>Tieftüte</i> 'deep_bag'	<i>tiefer Sack</i> 'deep bag'	bag
23. <i>Althose</i> 'old_trousers'	<i>alter Schal</i> 'old scarf'	clothing
24. <i>Rundsäge</i> 'round_saw'	<i>rundes Beil</i> 'round ax'	object to fell trees

Appendix B Meanings of the experimental items in Experiment 2

- (1) (a) Compounds: *Hartmütze* 'hard_cap'
 Meaning: *Eine Mütze, die deswegen so hart wie Ahornholz ist, damit sie vor starkem Hagel schützt.* 'A cap that is as hard as maple wood in order to protect against heavy hail.'
- (b) Phrases: *harter Schirm* 'hard umbrella'
 Meaning: *Ein Schirm, der deswegen so hart wie Ahornholz ist, damit er vor starkem Hagel schützt.* 'An umbrella that is as hard as maple wood in order to protect against heavy hail.'
- (2) (a) Compounds: *Flachroller* 'flat_scooter'
 Meaning: *Ein Roller, der deswegen flacher als 1 Meter ist, weil er unter sehr niedrigen Dächern geparkt werden soll.* 'A scooter that is flatter than 1 meter because it is supposed to be parked under very low roofs.'
- (b) Phrases: *flache Tram* 'flat tram'
 Meaning: *Eine Tram, die deswegen flacher als 2 Meter ist, weil sie unter sehr niedrigen Dächern geparkt werden soll.* 'A tram that is flatter than 2 meters because it is supposed to be parked under very low roofs.'
- (3) (a) Compounds: *Pinktafel* 'pink_sign'
 Meaning: *Eine Tafel im Straßenverkehr, die deswegen pink ist, damit sie von Verkehrsteilnehmern bei starkem Schneefall gut gesehen werden kann.* 'A traffic sign that is pink so that road users can see it well when it is snowing heavily.'
- (b) Phrases: *pinkes Schild* 'pink sign'
 Meaning: *Ein Schild im Straßenverkehr, das deswegen pink ist, damit es von Verkehrsteilnehmern bei starkem Schneefall gut gesehen werden kann.* 'A traffic sign that is pink so that road users can see it well when it is snowing heavily.'

- (4) (a) Compounds: *Kurzsofa* 'short_sofa'
Meaning: *Ein Sofa, das deswegen 1 Meter kurz ist, weil es nur für Kinder bis zu dieser Größe ausgelegt ist.* 'A couch that is short / has a length of 1 meter because it is designed for children up to this size only.'
- (b) Phrases: *kurze Couch* 'short couch'
Meaning: *Eine Couch, die deswegen 1 Meter kurz ist, weil sie nur für Kinder bis zu dieser Größe ausgelegt ist.* 'A couch that is short / has a length of 1 meter because it is designed for children up to this size only.'
- (5) (a) Compounds: *Heißtasse* 'hot_mug'
Meaning: *Eine Tasse, die aufgrund ihres besonderen Materials von Natur aus 60 Grad Celsius heiß ist und dazu dient, die Temperatur von Getränken zu halten.* 'A mug that is, due to its special material, by its nature hot / has a temperature of 60 degrees Celsius and serves to keep the temperature of drinks.'
- (b) Phrases: *heißer Krug* 'hot jug'
Meaning: *Ein Krug, der aufgrund seines besonderen Materials von Natur aus 60 Grad Celsius heiß ist und dazu dient, die Temperatur von Getränken zu halten.* 'A jug that is, due to its special material, by its nature hot / has a temperature of 60 degrees Celsius and serves to keep the temperature of drinks.'

- (6) (a) Compounds: *Dickstiefel* 'thick_boot'
Meaning: *Ein Stiefel, der deswegen 10 Zentimeter dick ist, damit er Fabrikarbeiter vor herunterfallenden Gegenständen schützt.*
'A boot that is thick / has a thickness of 10 centimeters so that it protects factory workers against falling objects.'
- (b) Phrases: *dicker Schuh* 'thick shoe'
Meaning: *Ein Schuh, der deswegen 10 Zentimeter dick ist, damit er Fabrikarbeiter vor herunterfallenden Gegenständen schützt.*
'A shoe that is thick / has a thickness of 10 centimeters so that it protects factory workers against falling objects.'
- (7) (a) Compounds: *Leichtregal* 'light_shelf'
Meaning: *Ein Regal, das 1 Kilogramm leicht ist, damit es von einer Person problemlos gehoben werden kann.* 'A shelf that is light / has a weight of 1 kilogram so that one person can lift it without problems.'
- (b) Phrases: *leichter Schrank* 'light closet'
Meaning: *Ein Schrank, der 1 Kilogramm leicht ist, damit er von einer Person problemlos gehoben werden kann.* 'A closet that is light / has a weight of 1 kilogram so that one person can lift it without problems.'

- (8) (a) Compounds: *Kleintruhe* 'small_chest'
Meaning: *Eine Truhe, die deswegen so klein wie eine Zigarettenschachtel ist, damit in ihr winzige und wertvolle Gegenstände platzsparend verstaut werden können.* 'A chest that is as small as a package of cigarettes so that tiny and valuable objects can be stored in it in a space-saving manner.'
- (b) Phrases: *kleiner Safe* 'small safe'
Meaning: *Ein Safe, der deswegen so klein wie eine Zigarettenschachtel ist, damit in ihm winzige und wertvolle Gegenstände platzsparend verstaut werden können.* 'A safe that is as small as a package of cigarettes so that tiny and valuable objects can be stored in it in a space-saving manner.'
- (9) (a) Compounds: *Kaltkette* 'cold_chain'
Meaning: *Eine Kette, die aufgrund ihres besonderen Materials von Natur aus 0 Grad Celsius kalt ist und dadurch während des Tragens Schwellungen am Körper lindert.* 'A chain that is, due to its special material, by its nature cold / has a temperature of 0 degrees Celsius and, hence, alleviates swelling while it is worn.'
- (b) Phrases: *kalter Ring* 'cold ring'
Meaning: *Ein Ring, der aufgrund seines besonderen Materials von Natur aus 0 Grad Celsius kalt ist und dadurch während des Tragens Schwellungen am Körper lindert.* 'A ring that is, due to its special material, by its nature cold / has a temperature of 0 degrees Celsius and, hence, alleviates swelling while it is worn.'

- (10) (a) Compounds: *Lautkutter* 'loud_cudder'
Meaning: *Ein Kutter, der mit Hilfe einer speziellen Technik so laut wie ein Flugzeug ist, um Haie schon auf hoher See davon abzuhalten, sich Stränden zu nähern.* 'A cutter that is, due to a specific technique, as loud as an airplane in order to prevent sharks from approaching beaches at high sea already.'
- (b) Phrases: *laute Jacht* 'loud yacht'
Meaning: *Eine Jacht, die mit Hilfe einer speziellen Technik so laut wie ein Flugzeug ist, um Haie schon auf hoher See davon abzuhalten, sich Stränden zu nähern.* 'A yacht that is, due to a specific technique, as loud as an airplane in order to prevent sharks from approaching beaches at high sea already.'
- (11) (a) Compounds: *Schmalpaket* 'narrow_package'
Meaning: *Ein Paket, das aus Kostengründen schmal ist, das heißt, nicht dicker als 5 Zentimeter sein darf.* 'A package that is narrow for financial reasons, that is, it is not allowed to be thicker than 5 centimeters.'
- (b) Phrases: *schmaler Brief* 'narrow letter'
Meaning: *Ein Brief, der aus Kostengründen schmal ist, das heißt, nicht dicker als 5 Millimeter sein darf.* 'A letter that is narrow for financial reasons, that is, it is not allowed to be thicker than 5 millimeters.'

- (12) (a) Compounds: *Dünnbürste* 'thin_brush'
Meaning: *Eine Bürste, die deswegen so dünn wie ein Blatt Papier ist, damit man mit ihr in sehr engen Ecken putzen kann.*
'A brush that is as thin as a sheet of paper so that one can clean with it in tight corners.'
- (b) Phrases: *dünner Schwamm* 'thin sponge'
Meaning: *Ein Schwamm, der deswegen so dünn wie ein Blatt Papier ist, damit man mit ihm in sehr engen Ecken putzen kann.*
'A sponge that is as thin as a sheet of paper so that one can clean with it in tight corners.'
- (13) (a) Compounds: *Großtresen* 'big_counter'
Meaning: *Ein Tresen, der deswegen 1,80 Meter groß ist, damit riesige Menschen bequem daran stehen können.* 'A counter that is big / has a height of 1.80 meters so that huge people can stand at it comfortably.'
- (b) Phrases: *großes Pult* 'big console'
Meaning: *Ein Pult, das deswegen 1,80 Meter groß ist, damit riesige Menschen bequem daran stehen können.* 'A console that is big / has a height of 1.80 meters so that huge people can stand at it comfortably.'

- (14) (a) Compounds: *Schwersocke* 'heavy_sock'
Meaning: *Eine Socke, die deswegen 100 Gramm schwer ist, weil sie Kindern beim Laufen lernen helfen soll.* 'A sock that is heavy / has a weight of 100 grams because it is supposed to help children while learning to walk.'
- (b) Phrases: *schwerer Strumpf* 'heavy sock'
Meaning: *Ein Strumpf, der deswegen 100 Gramm schwer ist, weil er Kindern beim Laufen lernen helfen soll.* 'A sock that is heavy / has a weight of 100 grams because it is supposed to help children while learning to walk.'
- (15) (a) Compounds: *Breitkiste* 'broad_box'
Meaning: *Eine Kiste, die deswegen 1 Meter breit ist, damit man mit ihr zwei Katzen gleichzeitig transportieren kann.* 'A box that is broad / has a breadth of 1 meter so that one can carry two cats in it at the same time.'
- (b) Phrases: *breite Box* 'broad box'
Meaning: *Eine Box, die deswegen 1 Meter breit ist, damit man mit ihr zwei Katzen gleichzeitig transportieren kann.* 'A box that is broad / has a breadth of 1 meter so that one can carry two cats in it at the same time.'

- (16) (a) Compounds: *Warmschüssel* 'warm_bowl'
Meaning: *Eine Schüssel, die aufgrund ihres besonderen Materials von Natur aus 50 Grad Celsius warm ist und dazu dient, die Temperatur von gekochten Speisen zu halten.* 'A bowl that is, due to its special material, by its nature warm / has a temperature of 50 degrees Celsius and serves to keep the temperature of cooked meals.'
- (b) Phrases: *warmer Topf* 'warm pot'
Meaning: *Ein Topf, der aufgrund seines besonderen Materials von Natur aus 50 Grad Celsius warm ist und dazu dient, die Temperatur von gekochten Speisen zu halten.* 'A pot that is, due to its special material, by its nature warm / has a temperature of 50 degrees Celsius and serves to keep the temperature of cooked meals.'
- (17) (a) Compounds: *Raureifen* 'rough_tire'
Meaning: *Ein Reifen, der deswegen so rau wie Schmirgelpapier ist, damit man auf vereisten Flächen sicher fahren kann.* 'A tire that is as rough as sandpaper so that one can drive safely on icy grounds.'
- (b) Phrases: *raues Rad* 'rough wheel'
Meaning: *Ein Rad, das deswegen so rau wie Schmirgelpapier ist, damit man auf vereisten Flächen sicher fahren kann.* 'A wheel that is as rough as sandpaper so that one can drive safely on icy grounds.'

- (18) (a) Compounds: *Hochauto* 'high_car'
Meaning: *Ein Auto, das deswegen doppelt so hoch wie ein normales ist, damit riesige Menschen bequem darin sitzen können.* 'A car that is twice as high as a normal one so that huge people can sit in it comfortably.'
- (b) Phrases: *hoher Bus* 'high bus'
Meaning: *Ein Bus, der deswegen doppelt so hoch wie ein normaler ist, damit riesige Menschen bequem darin stehen können.* 'A bus that is twice as high as a normal one so that huge people can stand in it comfortably.'
- (19) (a) Compounds: *Langschlitten* 'long_slide'
Meaning: *Ein Schlitten, der deswegen 3 Meter lang ist, damit sich das Gewicht des Fahrenden besser verteilt und sie/er nicht zu tief in den Schnee einsinkt.* 'A slide that is long / has a length of 3 meters so that the weight of its user is distributed more efficiently and so that one does not sink in the snow too deeply.'
- (b) Phrases: *langes Board* 'long board'
Meaning: *Ein Board, das deswegen 3 Meter lang ist, damit sich das Gewicht des Fahrenden besser verteilt und sie/er nicht zu tief in den Schnee einsinkt.* 'A board that is long / has a length of 3 meters so that the weight of its user is distributed more efficiently and so that one does not sink in the snow too deeply.'

- (20) (a) Compounds: *Jungmünze* 'young_coin'
Meaning: *Eine Münze, die aus Hygienegründen jung ist, das heißt, nicht länger als einen Monat im Umlauf sein darf.* 'A coin that is young for hygiene reasons, that is, it must not be used for more than one month.'
- (b) Phrases: *junger Schein* 'young banknote'
Meaning: *Ein Schein, der aus Hygienegründen jung ist, das heißt, nicht länger als einen Monat im Umlauf sein darf.* 'A banknote that is young for hygiene reasons, that is, it must not be used for more than one month.'
- (21) (a) Compounds: *Weichscheibe* 'soft_pane'
Meaning: *Eine Scheibe, die aufgrund ihres speziellen Materials von Natur aus so weich wie ein Teppich ist, damit sich Kinder beim Spielen nicht verletzen, wenn sie dagegen stoßen.* 'A pane that is, due to its special material, by its nature as soft as a carpet so that children do not get hurt if they bump against it while playing.'
- (b) Phrases: *weiche Tür* 'soft door'
Meaning: *Eine Tür, die aufgrund ihres speziellen Materials von Natur aus so weich wie ein Teppich ist, damit sich Kinder beim Spielen nicht verletzen, wenn sie dagegen stoßen.* 'A door that is, due to its special material, by its nature as soft as a carpet so that children do not get hurt if they bump against it while playing.'

- (22) (a) Compounds: *Althose* 'old_trousers'
Meaning: *Eine Hose, die deswegen bei ihrem Verkauf 20 Jahre alt ist, weil ihr besonderer Stoff erst dann schön kuschelig ist.*
'Trousers that are 20 years old when they are sold because their special material is only cuddly at this time.'
- (b) Phrases: *alter Schal* 'old scarf'
Meaning: *Ein Schal, der deswegen bei seinem Verkauf 20 Jahre alt ist, weil sein besonderer Stoff erst dann schön kuschelig ist.*
'A scarf that is 20 years old when it is sold because its special material is only cuddly at this time.'
- (23) (a) Compounds: *Tieftüte* 'deep_bag'
Meaning: *Eine Tüte, die deswegen 2 Meter tief ist, damit man in ihr Gegenstände bis zu dieser Größe verstauen kann.* 'A bag that is deep / has a depth of 2 meters so that one can store objects up to this size in it.'
- (b) Phrases: *tiefer Sack* 'deep sack'
Meaning: *Ein Sack, der deswegen 2 Meter tief ist, damit man in ihm Gegenstände bis zu dieser Größe verstauen kann.* 'A sack that is deep / has a depth of 2 meters so that one can store objects up to this size in it.'

- (24) (a) Compounds: *Rundsäge* 'round_saw'
Meaning: *Eine Säge, die deswegen rund ist, damit sie Bäume umkreisen und somit fällen kann.* 'A saw that is round so that it can circle around trees in order to fell them.'
- (b) Phrases: *rundes Beil* 'round ax'
Meaning: *Ein Beil, das deswegen rund ist, damit es Bäume umkreisen und somit fällen kann.* 'An ax that is round so that it can circle around trees in order to fell them.'