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Compound or Phrase? Analogy in Naming

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Abstract

In German (and other Germanic languages) both phrases and compounds are used as names for concepts (e.g. *Rotwein* 'red wine', *grüner Daumen* 'green thumb/green fingers'). This study examines such kind-referring German A+N compounds and phrases. Whereas it is a widely accepted fact that compounds are inherently suitable for kind reference (or "naming"), due to their status as word formation entities, phrases used for kind reference are regarded as isolated, idiosyncratic cases. This paper presents the results of a production experiment which show that both A+N phrases and A+N compounds should be regarded as a productive means of coining names. The choice between the two constructions is largely dependent on the availability of similar constructions in the mental lexicon of the speakers. The larger the number of lexicalized compounds with the same adjective or noun, the higher the probability of the subjects choosing a compound. The larger the number of lexicalized phrases with the same adjective or noun, the higher the probability of the subjects choosing a phrase. This effect is stronger for adjectives than for nouns. These results cannot be accounted for in a rule-based approach to grammar and lexicon. Instead they support a constructionist approach in which differences in productivity directly relate to the (number of) existing instantiations of the respective constructions in the mental lexicon.

Keywords

analogy; phrase; compound; naming; construction morphology; German

1. Introduction

This study compares German adjective + noun (A+N) compounds and phrases that are used as naming devices, such as *Altpapier* 'recovered paper', *Heißluft* 'hot air', or *Rotwein* 'red wine' as opposed to (lexicalized) A+N phrases like *grüne Bohnen* 'green beans', *bunter Abend* 'evening of music and entertainment', lit. 'colourful evening', or *wilde Ehe* 'cohabitation', lit. 'wild marriage'. It has often been observed that compounds (being word formation entities) are used as a naming device whereas phrases have descriptive force (cf. Bauer, 1988). However, it

is equally clear that there is no one-to-one relationship between compounds and naming on the one hand, and phrases and descriptions on the other. As shown by the above examples, phrases may function as names for established concepts just as compounds do. The main question addressed in this paper is which principles govern the choice between these two forms when new names are coined. This will be investigated with the help of a production experiment that tests the hypothesis that the choice is governed by analogy.

The study unites a constructionist with an analogical approach. Both theories deal with the properties and the structure of the lexicon, although from different perspectives, and can be fruitfully combined.

A+N compounds and phrases are analyzed as constructions that compete with each other with regard to the naming function. The constructionist perspective allows to treat compounds and phrases alike, because it abandons the strict distinction between grammar and the lexicon. Compounds and phrases are regarded as pieces of linguistic structure, labelled "constructions", that differ from each other, among other things, with regard to the degree of productivity.

The analogical approach, on the other hand, deals with complex and simplex lexemes and the way they are connected to each other in the mental lexicon. It is argued that the formation of new complex lexemes is based on the paradigms of similar existing complex lexemes and their formal properties rather than on abstract rules. Paradigmatic analogical relations are therefore assumed to play a major role for the choice between compounds and phrases. That is, the form of new complex naming entities relies heavily on the formal properties of the constituent words the new combinations share with other complex lexemes these constituents form part of.

This analysis is supported by experimental data. In a production study, participants were asked to coin novel names for novel concepts, using adjectives and nouns that form part of existing compounds and phrases with the naming function but have not been combined before. The experimental results show that analogical relations are in fact a strong predictor for the choice between compounds and phrases.

The paper is structured as follows. In the next section we discuss the nature of A+N constructions in German and lay out the theoretical framework for our study. In section 3, we present the methodology of our experiment, which is followed by the results in section 4. Section 5 summarizes the results and discusses the theoretical implications.

2. A+N combinations as analogical constructions

2.1 Formal properties of A+N combinations

In German, A+N compounds can be clearly distinguished from phrases on the basis of the stress pattern and the inflection of the adjective: in a compound, the adjective receives main stress and it is not inflected whereas in a phrase, the nominal head receives main stress and the adjective is inflected for number and case. This distinction is also reflected by orthography, as compounds are consistently written as one word, and phrases as two words.

Regarding the formal properties of the adjectives and nouns involved in German A+N compounds and phrases, there are no restrictions on the noun in either the compound or the phrase. The adjective, on the other hand, must not be morphologically complex in a compound, with the exception of adjectives suffixed by *-al*, *-ar*, *-är*, *-iv* or *-ig* (cf. *Temporalsatz* 'clause of time', *Polareis* 'polar ice', *Suggestivfrage* 'leading question', *Niedrigwasser* 'low water'). There are also few exceptional cases of past and present participles, as, for example, *Gebrauchtwagen* 'used car' or *Lebendgewicht* 'live weight'. Furthermore, the bulk of the adjectives in A+N compounds is monosyllabic, although di- and trisyllabic adjectives also occur (as in *Kapitalverbrechen* 'capital crime', *Geheimwaffe* 'secret weapon', *Trockenübung* 'dry run', see, for example, Motsch (2004), Schlücker et al. (2009)).

Hence, the choice between compounds and phrases as naming units can be explained only to a small extent on morphosyntactic grounds. What we can say is that if the adjective is morphologically complex – with the above mentioned exceptions –, the intended name must be realized as a phrase. A compound like **Springendpunkt* instead of the phrase *springender Punkt* 'crucial point', lit. 'jumping point', would be excluded due to the morphological complexity of the present participle form *springend*. Crucially, the said restriction has no say in the much more numerous cases where simplex adjectives are involved.

Furthermore, as there are no morphosyntactic restrictions whatsoever on the formation of an A+N phrase, the more elaborate question then is how to distinguish "regular" phrases from lexicalized ones. It has often been claimed that compounds differ from corresponding phrases in that compounds receive a non-compositional interpretation whereas phrases are always interpreted compositionally. This is obviously not true for the phrases under investigation – only some of them have a compositional meaning which is one of the reasons why they have to be learned and stored. Importantly, all of these phrases are ambiguous, as they can also receive a literal, compositional meaning. So, for example, the (non-compositional) meaning of the

lexicalized phrase *grüne Bohne* is identical to that of phaseolus vulgaris, whereas in its literal, non-lexicalized reading, the phrase *grüne Bohne* can be predicated of any item having the colour green and being a bean at the same time.

The status of the phrases under investigation as lexical item and their naming function has been discussed in detail in Booij (2009b) for Dutch and in Schlücker (2011) for German. For the present purpose, it will suffice to consider three of those properties, illustrating the difference between the lexical and the "regular" phrases. First, the existence of an A+N phrase blocks the formation of the corresponding compound, as the examples in (1) and (2) show. As syntax normally does not block word formation, the blocking ability of these phrases indicates their lexical status.

(1) trockener Wein → *Trockenwein 'dry wine'
(2) grüner Daumen → *Gründaumen 'green thumb/green fingers'

Second, the adjective and the noun of lexicalized phrases cannot be separated (or else the literal meaning will be available only):

(3) grüner Daumen 'green thumb/green fingers' → #grüner dicker Daumen 'green thick thumb'
(4) gelbes Trikot 'yellow jersey' → #gelbes schmutziges Trikot 'yellow dirty jersey'

And third, in lexicalized phrases the adjective normally cannot be modified, or, again, the literal meaning will be available only. (The non-literal meanings are 'noticeboard' and 'the Tour de France leader's jersey'):

(5) #ein sehr schwarzes Brett lit. a very black board
(6) #ein sehr gelbes Trikot lit. a very yellow jersey

2.2 A+N compounds and phrases as constructions

In the light of the view that the basic function of syntactic entities is description, not naming, A+N phrases with the naming function could be regarded as isolated idiosyncratic lexicalized items. The experimental results presented in section 4 show, however, that forming A+N

phrases is a productive, regular means of coining names. If those phrases are characterized by formal syntactic properties but, at the same time, are competing with word formation entities, they are obviously to be localized at the interface between morphology and syntax.

Conceiving of these phrases as the result of a productive syntactic pattern that is localized within the lexicon, however, forms an unsolvable task for a strictly generative, rule-based, modularized account of grammar. Assuming, in contrast, a template or schema within the lexicon can account for the productivity of these phrases as lexical items and – via inheritance relations – also for their formal agreement with regular syntactic phrases. Such an analysis as constructional schema has been proposed by Booij (2002, 2009a, 2009b).

The theory of constructions has been elaborated in several constructionist or constructionist-like frameworks (among others, Goldberg, 1995, 2006; Jackendoff, 2002, 2008; Langacker, 1987). These theories reject the idea of a sharp boundary between syntax and the lexicon. Instead, syntax and lexicon are situated on a continuum and in fact linguistic entities of differing complexity, single words as well as complex syntactic structures, are described as constructions, i.e. as fixed pairings of form and meaning.

Constructional schemas are organized in varying levels of abstractions, linked together by inheritance relations. General schemas at the top level dominate more specific schemas at lower levels and fully specified constructions at the bottom level. Properties are inherited from the higher-level constructions, as long as they are not overridden by construction-specific properties. In word-formation schemas, individual complex words form the bottom level. At the same time, the words involved in a specific construction are linked to the words listed in the lexicon (as minimal constructions). Evidence for such links between compounds and their constituent words in the mental lexicon has been provided in several psycholinguistic studies (e.g. Libben, 1998; Libben et al., 2003; Sandra, 1990; Zwitserlood, 1994). Thus, a fully specified construction is an instantiation of a general constructional schema. At the same time, it is linked to the constituent words (i.e. constructions) which also form part of other constructions, cf. Booij (2005, 2009a).

The constructional schemas for A+N compounds and phrases with the naming function have to encode their phonological, syntactic, and semantic properties. Most of those properties (e.g., word order, structural properties of the adjective and the noun involved etc.) are inherited from the general schemas for A+N compounds and phrases (which in turn are dominated by general schemas for phrasal modification and nominal compounding). In addition, the schemas are specified by the information that the instantiations of the schema are names. To be sure, a linguistic expression is a name if it is conventionally linked to an established concept. It is this

relation with conceptual structure that makes an expression a name. However, the naming status may come along with consequences for the syntactic and semantic behaviour of the linguistic expression, such as the property of non-separability and the restriction that the adjective may not be modified. Specifying those constructions as names therefore means that such information does not have to be added separately.

To sum up, a constructionist analysis of compounds and phrases with the naming function can capture the fact that both are productive lexical patterns that are used to coin conventional names and that display formal agreement with compounds and phrases that are not names. They are competing schemas with regard to the naming function (cf. Taylor, 2002), as can be seen from their blocking behaviour, but they are also related via the constructions (i.e. the lexemes) they are built up from. For instance, the adjective *blau* 'blue' forms part of both the phrase *blauer Brief* 'pink slip', lit. 'blue letter', and the compound *Blaumeise* 'blue tit'. Similarly, the noun *Karte* 'card' can be found in the phrase *rote Karte* 'red card' as well as in the compound *Freikarte* 'free ticket'.

The next section explores these paradigmatic relations, i.e. the relations between the lexemes that form part of constructions.

2.3 Analogical relations

A prerequisite for analogical relations between words and complex constructions is a mental lexicon that allows redundancy: complex words and syntactic constructions may be stored even if they do not display idiosyncratic properties. Family size effects (Schreuder et al., 1997; Bertram et al., 2000; De Jong et al., 2000), frequency effects (Baayen et al., 1997; Baayen et al., 2002, among others) as well as research on the semantic transparency of compounds (cf. Libben, 2006) provide independent psycholinguistic evidence for such a "redundant" mental lexicon. Analogy then, in general terms, can be described as

> a general cognitive process that transfers specific information or knowledge from one instance or domain (the analogue, base, or source) to another (the target). Sets of percepts, whether visual images, auditory signals, experiences, or dreams, are compared, and higher-order generalizations are extracted and carried over to new sets. [Blevins and Blevins, 2009:2]

A common notion conceives of analogy as the exceptional case as opposed to rule, as expressed in the Neogrammarian view. Booij (2010) expresses a similar understanding of the role analogy may play for compounding. Analogical compounding is based on an individual compound with an idiosyncratic meaning as model word that must be known for new compounds formed by analogy from the model compound to be understood. Importantly, in Booij's view there is no absolute boundary between 'analogy' and 'schema' but a gradual one, as abstraction from a specific model word may result in an abstract word formation schema.

The idea pursued here, however, is that analogy does not necessarily involve individual idiosyncratic model words but rather whole paradigms that function as models. Therefore, a notion of analogy that seems to be better suited is that of 'paradigmatic analogy' as defined in Krott et al. (2007:27-28):

> In this type of analogy, the selection is based on the similarity of the target compound to a set (i.e., paradigm) of compounds, opposed to its similarity to a single exemplar, i.e., a single compound.

Krott and her collaborators examine analogical relations between compounds in terms of similarity between constituent sets. That is, analogical relations link compounds that share either the modifier or the head constituent. These sets of compounds sharing the modifier or the head constituent are referred to as modifier family and head family respectively. In a series of related studies (Krott et al., 2001, 2002a, 2002b, 2004, 2007) analogical relations between constituent families have been shown to play a central role in the processing of noun-noun compounds. In particular, they have been proven as by far the most important predictor for the choice of Dutch and German linking elements. Speakers rely on the occurrence of linking elements in both the modifier and the head family when choosing a linking element for a new compound, i.e., the constituent families sharing the same structural position in the compound constitute the basis for the analogical relation.

Similarly, studies on the stress assignment in English noun-noun compounds by Plag (2006), Plag et al. (2007), Plag (2010), and Arndt-Lappe (2011) show that analogy is a strong predictor that may overrule other factors such as argument structure or semantics. Constituent

families have also been demonstrated to play an important role for compound interpretation (Gagné and Shoben, 1997; Gagné, 2001) in that the interpretation of lexicalized compounds (or, more precisely, the interpretation of the semantic relations associated with a particular constituent) heavily influences the interpretation of new compounds sharing that constituent.

However, the first and the second constituent do not necessarily exert influence on the selection to the same degree. In German and Dutch the modifier family seems to be much more influential than the head family. This is particularly true for the choice of linking elements but presumably also for other phenomena (cf. Krott, 2009). A predominant influence of the modifier constituent has also been found for English for novel compound interpretation by Gagné and Shoben (1997) and Gagné (2001) and for assigning compound stress (Plag, 2010).

Regarding A+N compounds and phrases with the naming function, the analysis introduced above proposes that both patterns are productive (although not necessarily to the same degree), instantiating lexical items that are specified as names. The schemas for A+N compounds and phrases with the naming function can therefore be regarded as competing schemas: a speaker who wishes to coin a name on the basis of a given adjective and noun has to select one of these two schemas. With the exception of the morphosyntactic constraints on compounding described above, there are no other formal factors that guide the decision. Therefore, in the majority of cases the speaker seems to be free to choose one form or the other. The idea pursued in the present study is that speakers make their choice on the basis of similar constructions in their mental lexicon. 'Similar' is understood here as containing the same adjective or noun in an A+N construction. That is, a constituent family may have a bias towards either a compound or a phrase, and the choice between compound and phrase will be influenced (to a large extent) by the family biases of the constituents that form part of the new construction.

It is, however, not entirely clear what the relevant domain is the analogical relations are based on. Krott (2009), after stating that constituent families play an important role in very different domains of language processing, discusses whether the analogical effects are based on a single lexical system or on two (or more) structurally similar domain-specific subsystems, such as the level of morphophonological representation and the level of conceptual representation. In a constructionist approach, different levels of representations are combined in one constructional schema. Still, the question arises whether analogical relations are based on the meaning of the constituents or rather on their form.

If analogy applies to the meaning of the constituents one could expect the selection of the form to be influenced primarily by the head family rather than by the modifier family. The

head constituent denotes the name of the superordinate concept whereas the modifier serves to identify subconcepts. A bigger effect of the head constituent may be expected because the human conceptual system seems more likely to bundle head subconcepts (e.g., subconcepts of beer or buildings) than modifier subconcepts (e.g., subconcepts of being blue or strong). The group of subconcepts belonging to the same superordinate concept would then be formally marked through a consistent form (i.e. compound or phrase). Support for such groups of subconcepts with a consistent form comes from examples like (7) and (8):

(7) dicker Zeh, großer Zeh, kleiner Zeh
'big toe', 'big toe', 'small toe', lit.'fat toe', 'big toe', 'small toe'

(8) Trockenmilch, Sauermilch, Dickmilch, Magermilch, Vollmilch, Frischmilch, Rohmilch
'dried milk', 'curdled milk', 'soured milk', 'skimmed milk', 'whole milk', 'fresh milk', 'raw milk'
lit. 'dry milk', 'sour milk', 'thick milk', 'meagre milk', 'whole milk', 'fresh milk', 'raw milk'

Accordingly, a novel name containing *Zeh* would be expected to be realized as a phrase and every new name containing *Milch* as a compound.

However, the different semantic contributions of the head and the modifier to the meaning of the combined concept can also be used to argue just the other way round. This is the line followed in Gagné and Spalding (2006) (on N+N compounds). In previous studies on the interpretation of novel compounds the (semantic relation associated with the) modifier constituent has been found to be much more important than the head. According to Gagné and Spalding this must be explained by the fact that the modifier provides the relevant contrast set and that it indicates that the concept provided by the head must be altered (cf. Markman, 1989). This also fits nicely with the stress pattern of German compounds. According to Eisenberg (2002:353), the stress on the modifier constituent can be interpreted as morphologized contrastive stress, that is the stress on the modifier is used to refer to alternative subconcepts.

If, on the other hand, the morphophonological form is the relevant domain for the analogical process to apply to, this would also explain a predominance of the modifier constituent over the head constituent, for the simple reason that the modifier is the left constituent and processed first.

3. Methodology

We devised an experiment in which participants were asked to produce new names for new concepts from a given adjective and a noun. The resulting name thus consisted of a sequence of an adjective and a noun, and participants could produce this sequence either in the form of a compound, or in the form of a phrase. The particular combinations of the adjective and noun in the experiment were novel in two ways. First, they were combinations that are unattested in the DWDS-corpus. (*Das Digitale Wörterbuch der Deutschen Sprache des 20. Jahrhunderts*, www.dwds.de). This is a 100 million token online corpus which contains German texts from each decade of the 20th century. The corpus is balanced chronologically and by text genre. Second, the combinations were novel in the sense that they were unknown to everybody involved in preparing the study. For each adjective-noun pair, a new concept was invented by the researchers and presented to the participants. Participants were asked to coin a name for these new concepts by using the adjective and noun presented to them.

3.1. Participants and stimuli

29 native speakers of German (21 female, 8 male) participated in the experiment, the majority being students at the *Freie Universität Berlin*, others working as administrative clerks at the same university. The age ranged from 19 to 62 years, with a mean of 26.2 years. Participants were paid for their participation. The data from two participants had to be discarded because they apparently had not understood the task. Unlike all other participants, these two participants produced exclusively phrases and not a single compound.

The stimulus material consisted of 76 nouns and 42 adjectives, sampled from the DWDS-corpus. Adjectives and nouns were selected from this corpus on the basis of their occurrence in either compounds or phrases, resulting in four nominal sets and three adjectival sets. The noun set N1 contained nouns which, in the reference corpus, occur exclusively in compounds. Set N2 contained nouns that occur both in compounds and phrases. Set N3 contained nouns that occur exclusively in phrases, and N4 contained nouns that occur neither in a compound nor in a phrase.

Similarly for the adjectives, set A1 contained adjectives that occur exclusively in compounds. Set A2 contained adjectives that occur both in compounds and phrases and set A3

contained adjectives that occur exclusively in phrases. The adjectives involved fulfilled the structural conditions to occur both in compounds and phrases. The reason why we only have three adjectival sets is that there are no pertinent adjectives in the corpus that occur neither in a compound nor in a phrase. An overview of the sets and sample items is given in table 1. As shown in the fourth column, not all sets were of the same size, as for some categories it proved difficult to find pertinent items. Sampling stopped at a maximum of 20 items per set, but, due to an initial coding error, one noun had to be reclassified, to the effect that set N2 has 21 items.

Table 1: Stimuli sets

Set	**Set description**	**Sample items**	**Number of items**
A1	adjectives occurring exclusively in compounds	*extrem, jung, billig*	20
A2	adjectives occurring both in compounds and phrases	*frisch, groß, hart*	18
A3	adjectives occurring exclusively in phrases	*offen, sicher, blutig*	4
N1	nouns occurring exclusively in compounds	*Leder, Milch, Mond*	20
N2	nouns occurring both in compounds and phrases	*Kohle, Regen, See*	21
N3	nouns occurring exclusively in phrases	*Ausrede, Draht, Sahne*	18
N4	nouns occurring neither in compounds nor phrases	*Ast, Damm, Dose*	17

Combining the noun sets N1-N4 with the adjective sets A1-A3 in a cross-classification scheme yields 4 x 3 = 12 different sets. For every set, 20 stimuli were created, except for the ones containing A3, for which only eight stimuli each were created. The resulting 192 stimuli were completed by 64 fillers which made a total of 256 experimental stimuli. All participants saw the same set of stimuli.

3.2. Procedure

The experiment was conducted in a quiet room. Participants sat in front of a computer screen. The stimuli were presented on ppt-slides; the trial presentation was self-paced. The responses were put down by the experimenter; additionally, each experiment session was recorded acoustically.

In order to facilitate the acceptance of new concepts, a parallel universe called “Gimini” was invented. 192 new concepts were created, each described in 15-25 words and presented visually to the participants. An example of a description of a concept and the corresponding target items is given in (9).

(9) (a) In der Nationaloper von Gimini wird künstlich eine besonders sauerstoffarme Luft erzeugt, durch die der Klang der Trompeten und Posaunen besonders strahlend wird.
(In the national opera of Gimini there is an artificial sort of very low-oxygen air which makes the sound of the trumpets and the trombone extra brilliant)

(b) Diese Luft heißt darum …
(Therefore, this air is called …)

(c) LUFT (AIR
MAGER MEAGER)

The stimuli were presented on a computer screen. Each trial consisted of three slides (corresponding to (a)-(c) in the above example). On the first slide the concept description was presented. On the second one there was the beginning of a sentence triggering the naming procedure, i.e. the participants had to complete the sentence by producing the name. The third slide contained the target items. The items were written in capital letters, each framed separately. Importantly, the adjective was positioned below the noun, in order both to ensure that the items had to be used actively for the naming process (as the noun is the second constituent both in the compound and the phrase) and to avoid that reading the items in a sequence could prime one of the forms.

Due to the size of the experiment, the procedure was split in two sessions. Before the experiment began, participants were read the instructions, and the experimenter answered questions about the procedure. Participants were told that they were allowed to inflect the items, but not to produce derivations or use words other than those presented. The concept of naming was explained very carefully. They were told that there was no correct answer and they were asked to produce the name as quickly as possible after reading the items. After a short introduction into the parallel universe called "Gimini", participants were given two practice trials with existing combinations (*Altpapier*, *saurer Regen*). Participants were given a short break after the practice trials and they were encouraged to ask the experimenter about parts of the procedure that they did not understand. Subsequently, participants received the first half of the 256 experimental trials and the second half in a later session.

3.3. Hypotheses and statistical analysis

For the analysis of the data we used generalized mixed effects regression, with subject and item as random effects (e.g. Baayen 2008, Baayen et al. 2008). For all our analyses, we tested the necessity of these random effects with log-likelihood tests, which always showed that the inclusion of the random effects was justified. One important additional advantage of generalized mixed effects models is that they are able to work with unbalanced data sets, as in the present study.

We devised two different kinds of analyses. In the first analysis, we predict the choice of compound or phrase, encoded in the variable RESPONSE, on the basis of the sets the adjectives and nouns belong to. This analysis tests the hypotheses formulated in (10).

(10) Hypothesis 1:

The choice of the construction (compound or phrase) depends on the existence of related constructions in the lexicon.

H1a: Adjectives that occur exclusively in compounds will tend to be used in compounds by the participants

H1b: Nouns that occur exclusively in compounds will tend to be used in compounds by the participants

H1c: Adjectives that occur exclusively in phrases will tend to be used in phrases by the participants

H1d: Nouns that occur exclusively in phrases will tend to be used in phrases by the participants

H1e: Adjectives that occur in both compounds and phrases will show no particular tendency concerning the choice

H1f: Nouns that occur in both compounds and phrases, or in none of the two constructions, will show no particular tendency concerning the choice

In addition, we wanted to know whether the effect of related constructions can be further quantified. That is, we wanted to know whether the number of existing pertinent constructions correlates with the strength of the analogical effect to be observed. In order to do so we counted the number of different constructs with that item as evidenced in the corpus. This measure is known as the constituent family size. In our study, the compound constituent family size of an adjective of set A2 would consist of all compounds that have this adjective as their

left constituent. Each adjective in set A2 would also have a phrasal constituent family size, which is the number of different phrases in which the adjective is attested. An adjective of set A3 would have a phrasal family consisting of all the different phrases in which this adjective occurs, and a compound family of size zero. An adjective of set A1 would have a phrasal family of size zero. Analogous computations were carried out for the nouns. Finally the token frequencies of each family were computed. As a result, for each adjective or noun we have the number of different compounds it occurs in ('compound family'), the number of different phrases it occurs in ('phrasal family') and the corresponding token frequencies. The coding of these family sizes allows us to test a set of stronger and more specific hypotheses. These hypotheses are spelled out in (11):

(11) Hypothesis 2:

The choice of the construction (compound or phrase) for a given item depends on the size of the construction families in the lexicon.

H2a: The larger the compound family of an item, the more likely it is that participants choose the compound.

H2b: The larger the phrasal family of an item, the more likely it is that participants choose the phrase.

To test the hypotheses in (11) we again used mixed effects regression models, this time with the family measures as independent variables.

The hypotheses in (10) and (11) are psycholinguistically grounded. Studies of the structural behaviour, the semantic interpretation and the processing of compounds have shown that constituent families have a strong effect in these areas (cf. section 2.3), and any effect we could find in the present study would nicely tie in with these previous findings. Notably, in our study we extend the notion of family across the traditional morphology-syntax boundary and include phrasal families. We will see whether the notion of phrasal family can receive empirical support.

4. Results

4.1. Categorical predictors

In order to test hypothesis 1 we devised a mixed effects model with CATEGORY OF ADJECTIVE and CATEGORY OF NOUN as predictors and RESPONSE as dependent variable. The values for the variable CATEGORY OF ADJECTIVE encoded whether the adjective occurred exclusively in compounds (‘`compound-only-adjective`’), exclusively in phrases (‘`phrase-only-adjective`’), or in both phrases and compounds (‘`neutral-adjective`’). Similarly, the variable CATEGORY OF NOUN encoded whether the noun occurred exclusively in compounds (‘`compound-only-noun`), exclusively in phrases (‘`phrase-only-noun`), in both phrases and compounds (‘`neutral-noun`’), or neither in phrases nor in compounds (‘`control-noun`’). The dependent variable could take the value `compound` or `phrase`. The initial data set contained 5022 observations, of which 98 had to be discarded because of errors. The remaining data set contained 4924 observations.

The distribution of `compound` and `phrase` responses is given in figure 1, which clarly shows that both phrase and compound are productive naming devices.

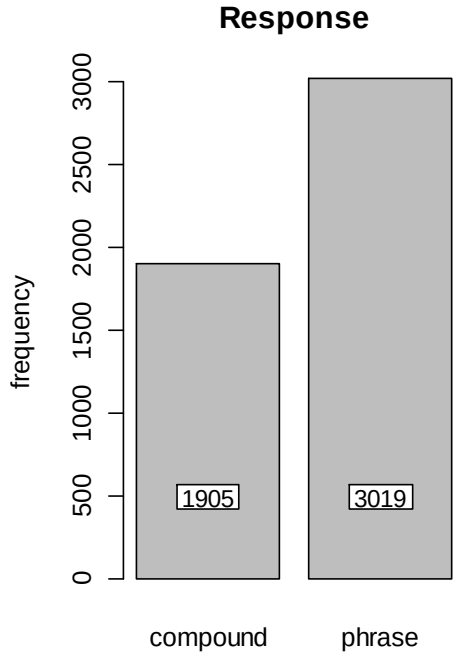

Figure 1: Distribution of responses

Individual subjects varied a great deal, as did individual test items. We therefore also included SUBJECT and ITEM as random effects. Log-likelihood tests showed that both random effects were justified. We also tested random contrasts for SUBJECT and CATEGORY OF NOUN, and random slopes for SUBJECT and CATEGORY OF ADJECTIVE. The inclusion of random contrasts for CATEGORY OF ADJECTIVE proved to be justified, which means that subjects varied with regard to the strength of this effect. When computing the estimates, our models takes this variation into account. The model shows a significant main effect for CATEGORY OF ADJECTIVE, and a significant main effect for CATEGORY OF NOUN, with no interaction. Table 1 documents the final model. The baseline is a compound-only adjective combined with a compound-only noun.

Table 2: Mixed effects model, categorical analysis

Random effects

Groups	Name	Variance	Std.Dev.	Corr	
ITEM	(Intercept)	1.44813	1.20338		
SUBJECT	(Intercept)	0.92962	0.96417		
	CATEGORY OF A neutral-A	0.17434	0.41755	-0.348	
	CATEGORY OF A phrase-only-A	0.67636	0.82241	-0.495	0.804

Fixed effects

	Estimate	Std. Error	z value	Pr(>|z|)
(Intercept)	-0.7261	0.2879	-2.522	0.011663
CATEGORY OF A neutral-A	0.7406	0.2271	3.262	0.001108
CATEGORY OF A phrase-only-A	2.2805	0.3170	7.193	6.32e-13
CATEGORY OF N neutral-N	0.8236	0.2633	3.128	0.001761
CATEGORY OF N phrase-only-N	1.0289	0.2782	3.699	0.000217
CATEGORY OF N control-N	1.1061	0.2739	4.038	5.39e-05

C	**AIC**	**BIC**	**logLik**	**deviance**
0.8629	5118	5202	-2546	5092

The table shows that responses to constituents which only occur in compounds (the baseline) differ significantly from the responses to the neutral constituents, and from responses to the phrasal-only constituents. The predictive power of the model is highly satisfactory (C=0.86).

The partial effects of the two predictors are illustrated in figure 2. The y-axes show the probability of the response `phrase`, the x-axis gives the respective categories of adjectives and nouns. As can be easily seen, the probability of choosing a phrase is lowest for compound-only adjectives and compound-only nouns. In contrast, phrase-only constituents go together with a high-probability of phrasal responses, with this effect being especially pronounced for adjectives and less so for nouns. That the adjectival category has a larger effect can also be seen with the coefficients in the model in table 2 (2.2805 for phrase-only adjectives, vs. 1.0289 for phrase-only nouns) and with the ranges of the lines in figure 2 (0.50 for adjectives, as against 0.27 for nouns).

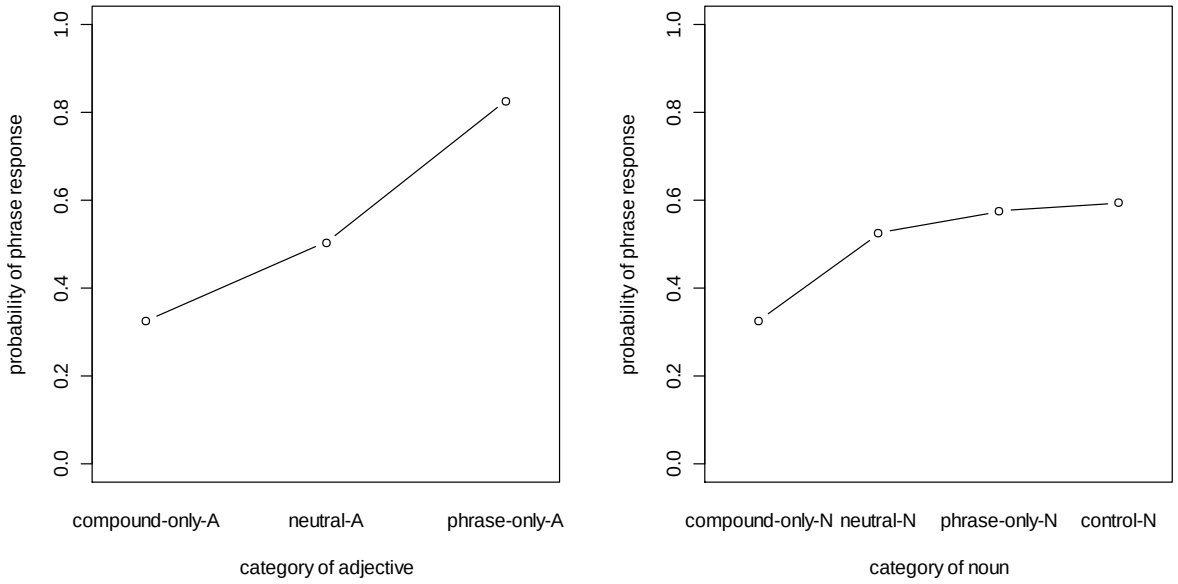

Figure 2: Partial effects of regression model (see table 2)

The significant random slope for the adjective category shows that subjects vary significantly in how far their responses are influenced by that factor. For the noun category, we find a generally much weaker effect and differences between subjects are not as pronounced.

To summarize, we have found substantial evidence supporting hypothesis 1. Adjectives that occur exclusively in compounds tend to be used in compounds by the participants, and nouns that occur exclusively in compounds tend to be used in compounds by the participants.

In contrast, adjectives that occur exclusively in phrases tend to be used in phrases by the participants, and nouns that occur exclusively in phrases will tend to be used in phrases by the participants. With regard to adjectives and nouns that occur in both types of construction, we see a mixed picture. While neutral adjectives indeed seem to trigger intermediate response probabilities, neutral nouns behave more or less like phrase-only nouns or control nouns. It will therefore be interesting to devise an analysis in which a gradient measure is used to predict subject responses. This is the topic of the next section.

4.2. Family sizes

In this analysis we used a gradient measure to predict subject responses. We counted the number of different constructions (i.e. types) in which each of our nouns and adjectives occur in the corpus. From these type counts, we computed a family bias for each noun and each adjective, with the number of compound types divided by the number of phrase types. For illustration, consider the adjective *sauer* 'sour', which we find attested in the corpus in 8 compounds and in 10 lexicalized phrases. This yields a bias of 8/10, i.e. 0.8, in favour of compounds for this adjective. For the noun *Tier*, 'animal', for example, we analogously compute a bias towards compounds of 7/3, i.e. of 2.33. Overall, we can say that the larger the computed bias, the more there is a preponderance of compounds in the respective family.

There is, however, the complication, that many compound families and phrase families are empty, they have zero members. This creates mathematical problems if we want to compute a quotient of the two family sizes. We therefore transformed all frequency measures into mathematically more convenient numbers by adding 1 to all frequencies. Note that such a procedure inevitably works against the hypothesis to be tested, since it will decrease the proportional difference between the two conflicting family size measures. In other words, this transformation will, if anything, weaken the effects that we are looking for. Following standard procedures with word frequency data, we also log-transformed the bias to alleviate potential problems with outliers.

We also included the token frequencies of each type in our analysis, but the token frequencies turned out to have no significant effects, a result that is in line with the results of other studies of family size effects (e.g. Schreuder & Baayen , 1997; De Jong et al., 2000, Bertram et al., 2000). These studies all found that family size effects are essentially type effects, independent of token frequencies.

We document the final model in table 3, and figure 3 shows the partial effects of the two biases. We find basically the same effects as in the previous analysis. Increasing the family bias towards compounds leads to a higher probability of a compound response. The effect is stronger for adjectives than for nouns, and subjects vary significantly in the strength of this effect.

Table 3: Mixed effects model, gradient family bias, full data set (N=4924)

Random effects				
Groups	Name	Variance	Std.Dev.	Corr
ITEM	(Intercept)	1.393125	1.18031	
SUBJECT	(Intercept)	0.760281	0.87194	
	LOGBIASA	0.032525	0.18035	-0.136
Fixed effects				
	Estimate	Std. Error	z value	Pr(>|z|)
(Intercept)	1.62942	0.21582	7.550	4.36e-14
LOGBIASA	-0.50418	0.06643	-7.589	3.21e-14
LOGBIASN	-0.35521	0.08033	-4.422	9.78e-06
C	**AIC**	**BIC**	**logLik**	**deviance**
0.8614815	5102	5148	-2544	5088

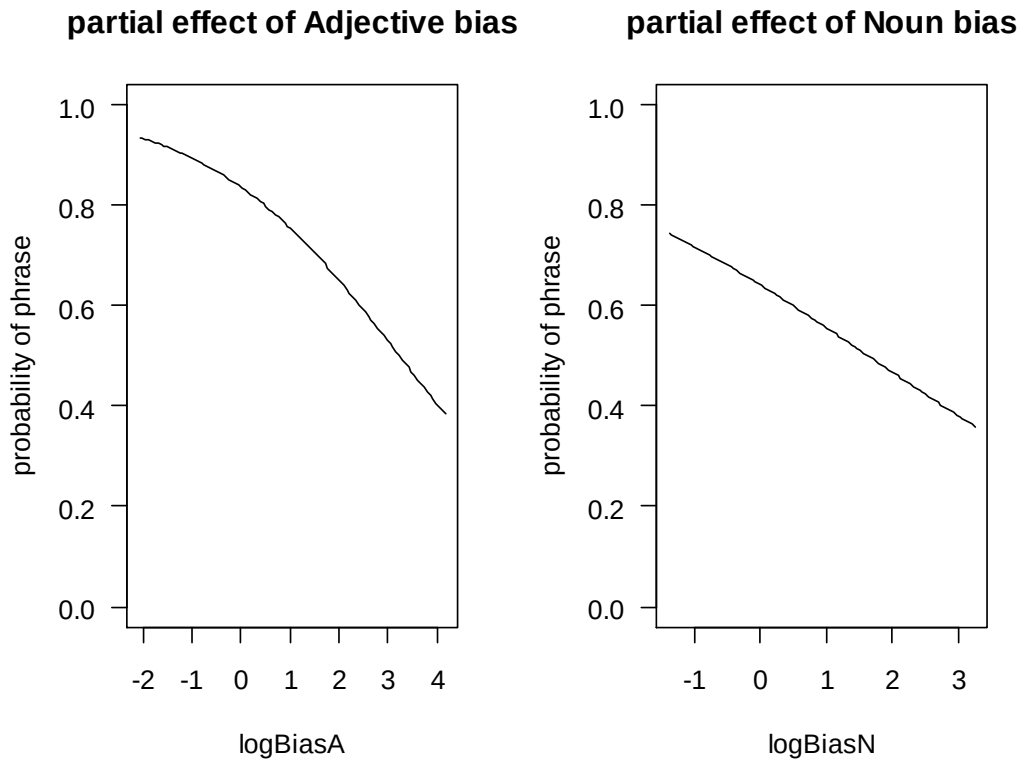

Figure 3: Partial effects of mixed effect regression model, full data set

The reader may wonder whether these clear results are perhaps an artefact of the distribution of the family sizes. Thus, it is conceivable that the many items with only one family (either compound or phrase) had a disproportionate influence on the results. In order to test this, we devised an additional analysis in which we only included items that (before adding 1 to all measures) had constituents with non-zero compound family size and non-zero phrase family size for both adjectives and nouns. In other words, we looked at all items that have both a neutral adjective and a neutral noun as constituents. This restriction leads to a considerable reduction of the number of observations (N=530). The biases for this set were computed without adding 1 to each measurement, since there were no zero family sizes. Due to the reduction in the number of observations and due to the fact that we restricted the data set to neutral adjectives and nouns, we can expect that it will be much harder with this data set to detect any significant analogical effect in regression.

Among the responses to these stimuli we find 167 compounds and 363 phrase responses. A mixed effects regression model with item and subject as random effects and the two biases (A and N biases) as predictors showed only a main effect of adjective bias and no interaction.

The additional inclusion of random slopes was not supported by log-likelihood tests. The final model is documented in table 4 and figure 4.

Table 4: Mixed effects model, gradient family bias, data set with only neutral constituents (N=530)

Random effects				
Groups	Name	Variance	Std.Dev.	
ITEM	(Intercept)	0.73684	0.85840	
SUBJECT	(Intercept)	0.86687	0.93106	
Fixed effects				
	Estimate	Std. Error	z value	Pr(>|z|)
(Intercept)	1.7209	0.4030	4.270	1.95e-05
LOGBIASA	-0.4426	0.1828	-2.422	0.0154
C	**AIC**	**BIC**	**logLik**	**deviance**
0. 8468023	589.8	606.9	-290.9	581.8

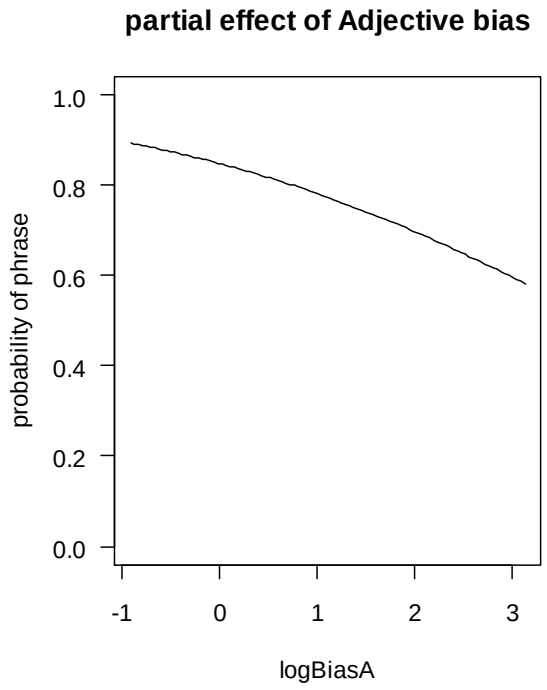

Figure 4: Effect of adjective bias on choice of construct, gradient family bias, data set with only neutral constituents (N=530)

The effect size (as indicated by the range of the minimum and maximum probability in the graph) is smaller than in the analysis of the full data set, but this was to be expected in view of the fact that all strongly biased items have been taken out of this data set before the analysis, and we are thus dealing with, in terms of the biases, middle range data. That the effect of adjective bias survives for this limited data set is further support for hypothesis 2.

4.3. Summary

All analyses have shown that in naming new concepts, speakers do not choose randomly between the two possible constructs. Instead, their choice is determined by the existence and number of related similar constructions in their mental lexicon. This effect is stronger for adjectives than for nouns and holds no matter whether we choose a categorical or a gradient approach. This is strong evidence for family bias effects, and supports both hypotheses under investigation.

5. General discussion

The present study confirms several findings known from previous studies on the processing of compounds. First, the constituent families of the individual constituents of the compounds and phrases under investigation turned out as the relevant entities for predicting the realization of novel forms, i.e. they determine the choice between compound and phrase. A similar influence of the constituent family has also been found for the choice of linking elements in Krott et al. (2001, 2002b, 2007) and for assigning compound stress in English (cf. Plag, 2006; Plag et al., 2007; Plag, 2010; Arndt-Lappe, 2011) as well as for the interpretation of English N+N compounds (cf. Gagné & Shoben, 1997, Gagné, 2001).

Second, the strength of the family bias (compound / phrase bias) is associated with the type frequency, i.e. with the family size, which is also in accordance with the above-mentioned studies. Increasing the number of (compound constituent or phrasal constituent) family members of a particular adjective or noun leads to an increased family bias (towards compounds or phrases) and increasing the family bias leads to a higher probability of a

compound or phrase responses respectively. The token frequencies, on the other hand, turned out to have no significant effects.

Third, the present results show that the modifier constituent has a larger influence than the head constituent in that the choice whether a novel name will be realized as a compound or a phrase depends on the family bias of the given adjective rather than on the bias of the noun.

The study also provides evidence for the existence of phrasal families. Extending the notion of family across the traditional morphology-syntax boundary allows us to put morphological and the phrasal families on a par and it supports the view that there is no sharp boundary between syntax and the lexicon. Rather, these morphological and phrasal entities are to be analysed as constructions, i.e. as form-meaning-pairings of different morphosyntactic complexity.

On the one hand, constructions are linked together via inheritance relations, with more abstract schemas at higher levels dominating more specific schemas at lower levels. On the other hand, the constituent words of the individual, fully specified constructions are linked to the words listed in the lexicon as minimal constructions. In this way, the constituent family can be described as the set of links between the individual word listed in the lexicon and the specific constructions this word is part of. If, for example, a constituent word (i.e. an adjective or a noun) is exclusively linked to compound constructions but not to phrasal constructions (with regard to the subset of constructions we are interested in, i.e. A+N constructions), this constituent word has a compound bias. The larger the set of links is, the stronger the compound bias will be. If, on the contrary, the number of links between the constituent word and the compound constructions and the number of links between the constituent word and the phrasal constructions is roughly the same, this constituent cannot be assigned a (clear) compound or phrasal bias (and would therefore belong to the group referred to as ‘neutral’, cf. section 4).

Thus, the set of related constructions and the links between them form the basis for the analogical relations. There are – with the exception of the morphosyntactic constraints on compounding described in section 2.3 – no rules that can explain the distribution of compounds and phrases. Instead, the results of the experimental study show that analogical relations are a strong predictor for the realization of naming entities as either compounds and phrases. The existence of related constructions determines the choice between compounds and phrases, both in a categorical and a gradient approach, which confirms our hypotheses.

Finally, the study provides evidence for the idea that lexical phrases with the naming function should not be considered as isolated idiosyncratic lexicalized items. Rather, it suggests that A+N phrases are a productive naming device in German, just as compounds.

Note, however, that there are many more adjectives and nouns with a compound bias than with a phrase bias; especially adjectives with a phrase bias a very rare. Moreover, the compound constituent families tend to be larger than the phrasal constituent families which leads to a stronger bias for compound than for phrases. Therefore, in reality, the probability of coining a compound seems higher than in this experimental setting. Hence, A+N compounds and phrases can be regarded as competing naming devices, although with different degrees of productivity. Contrary to a rule-based approach, the analogical approach allows to relate this difference in productivity directly to the (number of) existing instantiations of the respective constructions.

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