Morphological decomposability of concatenative and non-concatenative word forms
Evidence from slip experiments

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This paper deals with morphological exchanges in concatenative and non-concatenative polymorphemic words in Spoken German. Exchanges were elicited in a repeat-reverse paradigm. Concatenative morphemes were expected to be separated more easily than non-concatenative morphemes. In addition, it was assumed that morphological information (abstract vs. phonologically specified information) is processed on different levels. It turned out that both hypotheses can be verified.

1. Introduction

Recently, morphology has attracted a lot of research interest. Theoretical as well as psycholinguistic studies focus on morphological representation and morphological processing, respectively. In particular, theoretical models have been developed such as Distributed Morphology (henceforth DM, Halle & Marantz 1993), and Minimalist Morphology (Wunderlich & Fabri 1995). One of the recurrent issues in theoretical and psycholinguistic research concerns the decomposability of regular and irregular word forms. The controversy between single and dual-mechanism models is intended to be resolved by investigating the inflectional system of language. In dual-mechanism models two different representations of inflected word forms are assumed. (i) full form representations of inflected forms, and (ii) decomposed representations consisting of stems and affixes (Pinker & Prince 1994). In contrast, single mechanism models hypothesize that all inflected forms are stored in the lexicon as full forms, therefore decomposition processes are irrelevant.

Psycholinguistic approaches aim at finding evidence for various morphological processes by means of investigating spontaneous speech errors or carrying out several kinds of experiments, e.g. priming experiments or elicitation of slips of the tongue. Sonnenstuhl, Eisenbeiss, and Clahsen (1999) investigated regular and irregular forms of German participles and noun plurals by means of priming experiments. They obtained full priming for regular forms

but only partial priming for irregular forms. They concluded that regular forms are decomposable on-line whereas irregular stems and their respective inflected forms have separate representations, i.e. they are not decomposable. These findings were considered a confirmation for the dual-mechanism model.

Lately, some attempts have been taken to form a relationship between psycholinguistic and theoretical concepts. One of these efforts has been undertaken by Pfau (2000). He questions "how a particular formal grammar such as DM can be mapped onto a processing model". This analysis was based on an extensive set of speech error data. In particular morphological slips of the tongue can be explained in a straightforward manner by referring to DM.

In this paper, we want to combine psycholinguistic and theoretical approaches as well in order to explain parts of the inflectional system of Spoken German. We focus on morphological exchanges in concatenative and non-concatenative polymorphemic words. We will discuss our findings in the framework of DM which provides a reliable theoretical explanation for morphological decomposition processes.

2. *Preliminary remarks*

The results presented in this article have been obtained in the scope of a research project funded by the German Research Foundation (Deutsche Forschungsgemeinschaft, DFG).[1] In the first place, our research was concerned with a comparison of German sign language (DGS) and Spoken German by means of investigating slips of the hand and slips of the tongue, respectively. Sign languages are processed in the visuo-gestural modality, spoken languages in the aural-oral modality. One of our essential objectives was to study the impact of modality on language production. To this end, we compiled and analyzed two extensive corpora of slips of the tongue and hand. We devised an elicitation task to hearing speakers as well as deaf signers. Subjects had to tell picture stories under various cognitive stress conditions while being audio- and/or videotaped. As a result, we obtained spontaneous, naturalistic spoken and signed utterances. The video and audio tapes were analyzed according to various psycholinguistic criteria such as slip category (e.g. anticipation, perseveration, exchange, substitution, blend, fusion), affected unit (e.g. phonological feature, segment, morpheme, word, phrase), and locus of repair (if the utterance was interrupted). For detailed information see Hohenberger et al. (2002), Leuninger et al. (to appear).

One of the most stunning –and unexpected- results was the almost complete absence of exchanges of any kind (word, morpheme, or segment). The lack of morphological exchanges, in particular, was deplorable as the most striking difference between Spoken and Sign languages concerns their morphological typology. According to Brentari (2002), sign languages are characterized by

[1] The precise title of the project was: 'Language production errors and their repairs in dependence on the modality. German sign language vs. Spoken German' (LE 596/61-3).

'vertical processing', i.e. linguistic information is predominantly organized in a fusional/simultaneous way with few big chunks carrying a lot of information. In contrast, spoken languages are characterized by 'horizontal processing', i.e. linguistic information is organized predominantly in a serial way with many small chunks carrying few information. Therefore we designed an experiment focusing on morphological exchanges in concatenative and non-concatenative polymorphemic signs and words in DGS and Spoken German. Morpheme errors can provide crucial evidence for morphological processing, in particular decomposition. In this article, however, we will focus on the experimental results of Spoken German. The findings can be considered independently from the results of German sign language providing interesting insights in morphological processes of Spoken German.

3. Morpheme errors in Spoken German

We base the analysis of our corpus on a strictly serial-modular model of language production in the sense of Levelt (1989, 1999, Levelt, Roelofs & Meyer 1999) which is based on the seminal work of Garrett (1975, 1980). In this model, linguistic information is processed top down on various levels each of which has its own representational form and computational vocabulary. Language production operates in a feed-forward fashion only, without any local feedback from the level of phonological encoding to the level of grammatical encoding. The production process starts out with the preverbal message, which has to be translated into articulated speech (or sign). This translation process passes through levels of lexical, morphological, and phonological planning. The processing of words and segments is definitely assigned to independent levels (lemma and form retrieval respectively). The level of morphological processing, however, is not yet completely determined. Only recently it has been attributed a level of its own, between the level of lexical and phonological processing (Levelt et al. 1999, Zwitserlood, Boelte & Dohmes 2000, 2002). To completely reveal the problem of morphological processing remains to be investigated.

The psychological reality of morphemes during language processing is evidenced by morphological speech errors. In order to occur as an error unit, morphemes must be accessible to the processor. Morphological errors show that morphological information can be accessed during processing and single morphemes can be detached and manipulated independently. Considering morphological error types in concatenative languages such as German it becomes obvious that in most cases morpheme boundaries coincide with points of fracture. Therefore, concatenatively ordered morphemes are likely to be separated more easily than non-concatenatively organized morphemes.

Specifically, structures involving sequences of lexical roots and derivational or inflectional affixes are separated frequently. In morphological "stranding" errors, for example, only lexical roots are exchanged, as in (1) and (2). This error type occurs at a point in production when lexical roots are inserted in a

previously established morpho-syntactic planning frame (Garrett 1980). The lexical roots of two derived or inflected polymorphemic words are exchanged leaving behind the grammatical affixes (which are features of the morpho-syntactic frame).

(1) Ich pflanz-e die Topf-en um ← Ich topf-e die Pflanz-en um
I plant$_{[1SG]}$ the pot-s re
'I repot the plants.'
(Frankfurt slip corpus)[2]

(2) I thought the park was truck-ed ← the truck was parked.
(Garrett 1980, pp. 188)

Garrett (1980) distinguishes two types of stranding errors, those which are grammatically well-formed, i.e. accommodated as in (3) and those resulting in an ungrammatical string as in (4). In order to explain this variation Garrett assumes an additional level which is responsible for the grammatical accommodation process. Relating these types of morphological errors in (3) and (4) to DM appears to be a rather economical explanation (Pfau 2000). Instead of adding a further level, this difference can be explained by assuming that the errors take place on different levels.

(3) da war der Bruch ge-bannt-t ← der Bann ge-broch-en
there was the break spell-PART ← the spell break-PART
'the ice had broken at last.'
(Pfau 2000, pp. 185)

(4) der Mann hat mich Straf-en ge-lüg-t ← Lüg-en ge-straf-t
the man has me punish-PL lie-PART
'the man has given the lie to me.'
(Pfau 2000, pp. 185)

In example (3) two morphemes [brech] and [bann] are exchanged. Note that the exchanged elements are correctly accommodated to their new syntactic environment. The processor has properly adjusted the past stem *–broch* 'broke' to the nominal stem *Bruch* and selected the correct participle suffix –t for the resulting participle *ge-bann-t*. In contrast, in (4) the exchanged elements are not accommodated. The participle *ge-lüg-t* is morphologically ill-formed, it should be *ge-log-en*.

In DM, morphological information is not stored in a lexicon in the traditional sense but rather distributed over three lists. List 1, the lexicon, contains only abstract features relevant for syntactic processes, list 2, the vocabulary, contains the word forms, i.e. the phonological information, list 3,

[2] This error stems from Helen Leuninger's Frankfurt slip corpus which is a collection of spontaneous German slips of the tongue at the University of Frankfurt. It comprises ca. 6,000 slips.

the encyclopedia, comprises the idiomatic meaning of the lexical entries. The error in (3) must have occurred while accessing list 1. The selected roots are inserted in the wrong position. After being selected from list 1 and after syntactic operations such as movement and merger have been applied on the level of the computational system, items pass through the level of morphological structure (MS) where morphological operations such as merger, fusion, adjunction of agreement nodes, and readjustment rules take place. It is exactly on the level of MS where accommodation happens. Whereas Garrett interprets accommodation as a second step after the error as a first step, accommodation in DM is an operation "implemented" on the level of MS applying freely to errors as well as to any other morphological item. Note that at MS the processor is not able to distinguish between correctly or incorrectly selected roots. The error in (4) must have occurred while retrieving items from list 2 and being processed on the level of Phonological Form (PF). Understanding DM as a processing model operating strictly top down one can conclude that MS precedes PF. Therefore, no accommodation process can take place on PF any more so that the utterance results in an ungrammatical string.

In the DFG-corpus for Spoken German, morphemes are affected in 174 cases (18%). Morphological errors rank behind lexical errors (35%) and phonological errors (30%) in frequency. Affected morphemes comprise root (content) morphemes, and functional/grammatical morphemes, i.e. derivational and inflection such as tense marking, agreement of subject and verb. As opposed to the homogeneous set of word and phonological errors, the set of morphological errors is heterogeneous. There are three classes of syntagmatic morphological errors that can be distinguished, namely lexical content morphemes (5), abstract grammatical morphemes (6), and morpho-phonological morphemes (7) (see also Hohenberger & Waleschkowski to appear).

(5) Lexical morpheme error (anticipation)

Sonnen-stühle//	Liege-stühle	und	einen	Sonnen-schirm
sun-chairs//	deck-chairs	and	a	sun-shade

In (5), the affected morpheme *Sonnen-* is a content morpheme within the compound noun *Sonnen-stühle* 'sun-chairs'. Although *Sonnen-stühle* is a single concept, two lemmas, the specifier *Sonnen* and the head *-stühle*, are components of the compound. During lexical access, the concept activates both lemma nodes. In this process, the content morpheme *Sonnen* was anticipated and substituted for the correct morpheme *Liege*.

(6) Abstract grammatical morpheme error (perseveration)

die	Gäste-PL	für	die	Partie-s-PL
the	guest-s-PL	for	the	partie-s-PL

In (6), the plural morpheme of *Gäst-e* 'guest-s' was perseverated and affixed onto the following noun *Party* 'party', resulting in the slip *Partie-s* 'partie-s'. In this case, it must have been the abstract plural morpheme that was

perseverated because *Gäste* and *Party* have different plural allomorphs, namely *–e* and *–s*, respectively.[3] According to DM, this perseveration must have been taken place at a fairly early level of processing where only abstract features are computed but not yet their concrete morpho-phonological form.

(7) Morpho-phonological error (anticipation)
ein Bild-er-PL, zwei Bild-er ← ein Bild-SG
one picture-s-PL, two picture-s ← one picture-SG

In (3), it is also a plural morpheme that is affected. The concrete *–er* suffix of *zwei Bilder* 'two pictures' was anticipated, resulting in an ungrammatical string. Note that there is no correct number agreement in the DP *ein Bilder* 'one picture-s' between the quantifier *ein* (Sg) and the noun *Bild-er* (Pl). Therefore, we assume that this error has taken place later in processing, when the morpho-phonological form is retrieved. At this point in time the processor is no longer able to match both features as this would require backtracking to an earlier level of processing.

The different patterns of morphological errors show that the retrieval of morphological information is distributed over time. Errors as in (6) indicate that there is a point in time when abstract feature bundles are computed, which are not yet phonologically specified. On the level of phonological encoding the anticipated abstract plural feature is spelled out in its correct plural form. In contrast, errors as in (7) show that also fully specified morphemes can be manipulated, often resulting in an ungrammatical string. As soon as the morpho-phonological form is retrieved, the abstract grammatical information is not accessible any more. Hence, the grammatical form cannot be accommodated any more. Particularly, these types of errors provide strong evidence for a strict top-down processor. On the basis of the different types of morphological errors it seems reasonable to suppose that it is a matter of timing when a certain kind of morphological information is available. To sum up: morphological retrieval is a two-staged process. Abstract grammatical features are computed earlier than their morpho-phonological form. While the former can only be manipulated during the first retrieval step when the phonological form is not at issue, phonologically specified morphemes can be manipulated during the second retrieval step when the processor plans the morpho-phonological form of the word.

The structure of morphological errors mirrors the morphological design of Spoken German. The processor is forced to operate in the confines imposed by the format of the grammar. The different types of morpheme errors show that abstract and phonologically specified morphological information is processed on independent levels. The accessibility of morphemes is determined by the morphological type of the respective language to a high degree. Languages of a concatenative morphological type such as Spoken German tend to show a

[3] In German, there are up to nine plural allomorphs. For further information the reader is referred to Wegener (1994, 1995).

higher rate of morphological errors than languages of a fusional-simultaneous type such as German sign language. As opposed to Spoken German, in DGS morphemes are clearly less affected (18% vs. 6%). These findings are attributed to the typological differences between Spoken German and DGS. Thus, simultaneity appears to inhibit decomposition during language processing whereas concatenative structures are more susceptible to separation (at least in the second step).

4. Experiment

In the present study, we focus on morphological exchanges in concatenative and non-concatenative polymorphemic words in Spoken German. As already mentioned, we did not find any "stranding" error in Spoken German. In many cross-linguistic paper-and-pencil corpora, however, this error type is well documented (Poulisse 1999). These divergent results may be attributed to the different fashion in which the corpora are compiled. Compared to traditional corpora, which contain a huge set of spontaneous data collected by multiple contributors and produced by multiple subjects, our data set is elicited by means of a more restricted experimental method (see section 4.1). It cannot be excluded that the frequency distribution of errors in spontaneous corpora is rather a result of observer or collecting biases than a reliable representation of the actual occurrence of slip categories (Cutler 1982).

As morphological exchanges do occur in German - though to a lower degree as assumed so far, we devised an experiment in order to elicit this particular slip category. Especially by means of elicitation techniques, specific hypotheses can be tested. The experimental design restricts the possible reactions (dependent variable) of the subjects by way of controlling the conditions (independent variables). We assume that typological differences account for the occurrence of morphological exchanges once a suited experimental technique has been found that can elicit them. As already pointed out, languages with a concatenative typology such as Spoken German tend to show more morpheme errors than non-concatenative languages such as DGS. Morphological root exchanges are characteristic of languages in which morphemes are arranged in a linear fashion. At this point, the question arises to what extent non-concatenative morphemes are decomposable in on-line processing.

Though Spoken German is concatenative to a high degree it displays some non-concatenative properties regarding grammatical information, i.e. some grammatical features are expressed simultaneously. There is a subgroup of non-linear morphemes occurring in irregular word forms with umlauts and ablauts (vowel gradation), e.g. in noun plurals as in *Vater-V*[æ]*ter* (father-fathers), which can be used to test our hypotheses.

The hypotheses are as follows.

H1: Morpheme types
Concatenative morphemes should detach more easily than non-concatenative ones, and therefore produce more root exchanges.
H2: Levels of processing
Morphological information can be processed on different levels. On the first level, abstract morphological information is processed; on the second level the morphological form. Non-concatenative morphemes can only be manipulated on the former level, concatenative morphemes on both.

4.1 Method

We devised an experimental task in order to investigate morphological processing in Spoken German. Subjects were required to exchange polymorphemic spoken words. The morphological exchanges in concatenative and non-concatenative polymorphemic words were elicited in a repeat-reverse paradigm (Baars 1992, Humphreys 2002). Two short phrases, which had to be learnt by heart, were followed by a list of two pairs of phrases priming root exchanges and one distractor pair. After being exposed to the priming list the subjects were asked to reverse or to repeat the critical polymorphemic items from the target pair. (Participants were instructed to shadow the list silently.) In the repeat condition (control condition) the target pair simply had to be repeated. The ordering reverse/repeat condition was presented at random.

The experiment was organized as a semi-self-paced procedure. The 28 target pairs were presented on a SONY Vaio PCG-SR1K notebook in form of audio sequences. The subjects were allowed to listen to the target pairs as often as they needed to memorize them. The priming list, however, was directly followed by the request to repeat/reverse the critical items. At this point, subjects could not control the course of the experiment but had to answer immediately. The duration of the experiments amounted to 60 minutes on average. The subjects were 26 undergraduate students of the University of Frankfurt. All of them were native speakers of German.

The experimental setting is sketched in the following.

Target pair:

das Auto$_{[SG]}$ reparieren;	die Lok-s$_{[PL]}$ reinigen
to repair the car-SG;	to clean the locomotive-s-PL

distractor phrase:
die Geschwister versorgen
to look after siblings

Priming list:

die Oma-SG fragen;	die Opas-PL einladen
to ask the grandmother-SG;	to invite the grandfathers-PL

das Dia-SG zeigen; die Fotos-PL entwickeln
to show the slide-SG; to develop the photo-s-PL

distractor phrase:
die Milch kochen
to boil the milk

Critical Condition: Swap
Was reparieren? to repair what?
Answer of the subject:_____
Was reinigen? to clean what?
Answer of the subject:_____

Apart from root exchanges in which we were primarily interested there are several other possible outputs such as whole word and affix exchanges. Note that the priming phrases were structurally equivalent to the target phrases. It is crucial that the ordering of affixes remains the same as in the target input pair in order to enhance the probability of root exchanges.

The German regular *–s* plural exemplifies a concatenative morpheme in Spoken German for the reverse condition. All possible outputs are listed below.

target phrase
das Auto-SG reparieren; die Lok-s-PL reinigen
to repair the car-SG to clean the locomotive-s-PL

output: root exchange
die Lok-SG reparieren; die Auto-s-PL reinigen
to repair the locomotive-SG to clean the car-s-PL

output: word exchange
die Lok-s-PL reparieren; das Auto-SG reinigen
to repair the locomotive-s-PL to clean the car-SG

output: affix exchange
die Auto-s -PL reparieren; die Lok-SG reinigen
to repair the car-s-PL to clean the locomotive-SG

The experimental material comprises different morphological types such as inflection (e.g. tense, number), derivation (e.g. diminutive, nominalization, aspect), and compounds in order to obtain an overall insight into decomposition processes. We had no specific hypotheses as to the different susceptibility of the various morphological processes (derivation, inflection, compounding) to decomposition.

4.2 Results

The results confirm the appropriateness of the reverse/repeat paradigm for the elicitation of morphological errors.

In the reverse condition, most of the errors are word exchanges (67.2%). As expected the reverse condition elicits more root exchanges than affix exchanges since the priming sentences were designed to elicit more root exchanges. In all, we obtained 119 root exchanges, which are 10 % of all cases and 31 affix exchanges, which are 2.6% of all cases. In 113 cases the condition was not met.[4]

In the repeat condition, most cases are word repetitions - as expected. Interestingly, this condition caused more affix exchanges than root exchanges. We obtained 32 root exchanges and more than twice as many affix exchanges (n=76). Adding up the root and affix exchanges for both conditions, the mean percentage value amounts to 9% for the repeat condition and to 13% for the reverse condition.

Condition	Reverse		Repeat	
Type	n	%	n	%
word repetition	113	9.4	981	82
word exchange	804	67.2	26	2.2
root exchange	**119**	**10**	**32**	**2.7**
affix exchange	**31**	**2.6**	**76**	**6.4**
Other	87	7.3	66	5.5
Omission	42	3.5	15	1.2
Sum	1196	100	1196	100

Table 1.: Distribution of error types under the repeat-reverse condition

Table 2 shows an overview of the ranking of morpheme types in Spoken German that are decomposable during morphological processing. As hypothesized most cases show root exchanges in serial morphemes. The ranking is headed by the diminutive *Bäumchen/Blümchen* (19 cases), followed by the nominal derivation (12 cases) and the regular *–s* plural inflection (11 cases). In the middle field, there are 4 serial morpheme types, which occur eight times in each case. These types cannot be assigned to one particular morpheme type, as they comprise semi-regular plural inflection, adjective derivation, nominal composition, and regular participle inflection. Likewise, the non-concatenative target pairs such as the irregular tense inflection and the irregular plural inflection can be separated though less often than the concatenative morphemes. Strikingly, there is only a small difference between the exchange occurrence between the concatenative regular tense inflection (6) and the non-concatenative irregular tense inflection (5).

[4] In such cases, subjects repeated the target pair instead of exchanging the critical elements.

Morphological type/process	Example	n
concatenative diminutive, derivation	Bäum-chen/Blüm-chen tree-DIM/flower-DIM	19
concatenative nominal derivation	Kompens-ierung/Neutralisa-tion Compensation/neutralization	12
concatenative regular plural inflection	das Auto-ø/die Lok-s the car-ø /the locomotive-s	11
concatenative semi-regular plural inflection	die Bluse- ø/die Hose-n the blouse-ø/trousers	8
concatenative adjective derivation	Unüberwind-bar/unverletz-lich Insuperable/unviolable	8
concatenative nominal composition	Koch-topf/Suppen-löffel sauce-pan/soup-spoon	8
concatenative regular participle inflection	mal-end/ge-zeich-net painting/drawn	8
concatenative regular tense inflection	er lach-t/sie brüll-te he laugh-s/he shout-ed	6
non-concatenative irregular tense inflection	Er läuf-t/sie sprang He walk-s/she sprang	5
non-concatenative irregular plural inflection	Vater/Mütter father/mother-s	5

Table 2: Decomposition during processing: ranking of morpheme types

4.3 Evaluation of hypotheses

Our results verify that concatenative morphemes are separated most frequently. With the experimental technique applied, we are able to get direct insights into decomposition processes. By doing so we can show that even non-concatenative morphemes can be separated.

The second hypothesis, which predicts that abstract and phonologically specified information are processed on different levels, can also be verified. The results have shown that irregular non-concatenative forms are processed on a separate level, prior to the retrieval of the phonological form. In German, irregular, non-concatenative forms are phonologically characterized by umlauts or ablauts. Root exchanges requiring a vowel gradation must have been processed on a level where abstract morphological information rather than phonological information is processed. Otherwise an exchange such as

den Vater-SG ehren, die Mütter-PL lieben (target pair)
to honour the father, to love the mothers

die Mutter-SG ehren, die Väter-PL lieben (output: root exchange)
to honour the mother, to love the fathers

could not have taken place. The change of the phonological form necessitates an exchange of the abstract roots not yet being phonologically specified. In this case, the abstract root of *Mutter*, but not the phonologically specified form *Mütter* must have been exchanged.

On which processing level regular roots are exchanges cannot be completely determined. On the basis of our experimental results it is not possible to ascertain on which level the respective exchange has occurred. (An answer to this question could only be given in a priming experiment by manipulating the SOAs (stimulus onset asynchronies) of the morphological distractors.)

5. Discussion

The main goal of this study was to investigate the decomposability of concatenative and non-concatenative polymorphemic word forms in Spoken German. In German, most irregular forms are non-concatenative, whereas regular forms tend to be concatenative.[5] The experiment revealed that both forms can be separated though to different extents. As expected, non-concatenative irregular forms turned out to be detached less frequently than concatenative regular forms. These results verify our first hypothesis, namely that concatenative morphemes are separated more easily than non-concatenative ones. The fact that simultaneous forms can be manipulated refers to our second hypothesis, namely that abstract and phonologically specified morphological information is processed on different levels.

First, let us discuss the frequency distribution of the different morphological types being affected during the reverse condition (see table 2). The ranking is headed by the diminutive (19 cases). This frequent occurrence calls for some explanation. The reason for this result may be attributed to the phonological and semantic similarity of the target pair *Blümchen* 'flower'/*Bäumchen* 'tree'. Additionally, the derivation suffixes *–chen* and *–lein* do not differ in their meaning. Since it is likely that the memorizing of the target pairs is based on the meaning of the single expressions, the subjects may not be able to remember the precise difference between *Blümchen* and *Bäumchen* when they are asked to exchange the critical elements. As a consequence, *Blüm* and *Bäum* interact more frequently. Another prominent target pair is the nominal derivation *Kompens-ierung* and *Neutralisa-tion* (12 cases). Apart from phonological similarity, this target pair is comparable to the diminutive with respect to the semantic relationship. The suffixes *–ierung* and *–tion* also do not considerably differ in their meaning. Therefore, a root exchange does not change the meaning of the target pair expressions in a significant way. On the basis of these observations one can conclude that decomposability is not only a matter of concatenativity but also a matter of the meaning of the roots and

[5] Tense information in irregular forms is expressed in terms of stem alternation, e.g. the past tense form of 'lauf-' (walk) is 'lief-' ('walked' first and third person singular).

affixes. Affixes not differing in their meaning are more likely to remain in their original position, leading to more root exchanges. Affixes differing in their meaning are supposed to be strongly connected to their root morpheme leading to more word exchanges.[6]

The stimulus pairs also differed in their degree of imaginability. Thus, subjects frequently reported that they had pictures of the target pairs in their mind (note that this was a memory task). In this case, morphological decomposing was not an issue at all: pictorial representations will not be decomposed morphologically. This might have fostered the degree of whole-word exchanges instead of partial exchanges.

Furthermore, there is a surprising discrepancy between affixes being affected in the repeat condition and the reverse condition, respectively. As for the repeat condition, affixes are affected more than twice as often than roots. As for the reverse condition, affixes turned out to be affected to a considerably less degree. Maybe the two conditions – to repeat and to swap – differently highlight the content and form, respectively. It could be that under the repeat condition subjects might be more likely to focus on the "same word" in the sense of "same meaning" (thus concentrating on the content morpheme while possibly mixing up the affixes). However, in the swap condition, subjects might be focussed more on "different word" in the sense of "different form" (thus equally paying attention to the roots and the affixes. In this case, root exchanges will always be fostered, as roots are the more mobile parts that are inserted into a pre-established fixed morphological frame).

Now let us consider cases of tense and plural inflection. These morphological types are relevant for a comparison of the decomposability of concatenative and non-concatenative forms. It came as a surprise that there is no significant difference between regular (concatenative) and irregular (non-concatenative) tense inflection (6 vs. 5). According to our hypotheses, the regular tense inflection was expected to yield more root exchanges than the irregular inflection. On the basis of the results so far, it is not possible to explain the slight difference between these inflection types. In order to draw reliable conclusions it is necessary to devise a further repeat/reverse experiment that focuses on regular and irregular tense inflection more extensively.

The results obtained from regular and irregular plural inflection on the other hand provide stronger evidence for differing decomposition processes. The regular plural inflection is affected twice as often than the irregular plural inflection (11 vs. 5). In German, the regular –s plural is considered the default plural form.[7] As a consequence, this plural form is expected to be affected more frequently than other plural forms.

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[6] The difference of the affixes concerning meaning can be illustrated by means of the following example: 'Was für ein herr-licher König' ('what a wonderful king')/ 'was für ein kind-isches Wesen' ('what a childish character'). The critical items are 'herr-lich' and 'kind-isch'. A root exchange results in 'was für ein kindlicher König' ('what a childlike king') and 'was für ein herrisches Wesen' ('what a domineering character').

[7] Despite its low frequency, the –s plural is very productive in German. Marcus et al. (1995) have shown that the application of this form is hardly restricted. The –s plural is attached to neolo-

As far as the rate of occurrence is concerned, frequency should not be the only evaluative factor. A prime issue in our findings is that irregular forms can be separated, indeed. One of the advantages of the reverse-repeat paradigm is that one can elicit data that allows for conclusions on the processing of regular and irregular forms. Whereas longer reaction times obtained in priming experiments only indirectly bear on the issue of decomposability of irregular forms, our method directly requires decomposition.

The decomposition revealed in the repeat/reverse experiment can provide instructive information on morphological processing in general. In DM, as outlined in section 3, abstract information and phonologically specified information are processed on independent levels. Our results indicate that irregular forms, e.g. tense, are processed in the computational system or on the level of morphological structure where only abstract information is available. Only if this is the case the correct phonological string can be inserted by means of readjustment rules on a later level. Otherwise irregular/non-concatenative forms as illustrated in the target pair *sie läuft* 'she walks', *er sprang* 'he sprang' could not turn into *sie springt* 'she springs', *er lief* 'he walked'. It is still an open question, however, on which level regular forms are processed. The results do not provide any information if regular forms are processed in the computational system, on the level of morphological form, or on the level phonological form. In particular, the decomposition of irregular forms provides strong indication for the processing of abstract roots (instead of their lexical form) which is one of the basic assumptions of DM.

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