

WORD COUNT: 3.602 words

**Word category conversion causes processing costs: evidence from adjectival passives**

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## ***Abstract***

*Constructing syntactic representations in language comprehension begins with the identification of word categories. The category of a word is stored in the mental lexicon, but it can be changed if necessary. There are productive grammatical processes like nominalization and adjectivization which are able to convert a word of category A into one of category B. Whether this change of category causes processing costs is still an open question. In a self-paced reading study, we investigated category conversion, a grammatical process which converts the category of a word without a visible morphological change. We looked at the processing of adjectival passives in German. It is widely assumed that in adjectival passives the participle is converted into an adjective resulting in a copula-adjective construction (Kratzer, 2000). No such conversion is necessary for eventive passives. Our experiment revealed significantly longer reading times for the participle in adjectival passives compared to eventive passives. These results demonstrate that adjectival conversion is a costly process. In addition, they shed new light on an on-going debate about how words are stored and processed in the mental lexicon.*

*Keywords:* category conversion, mental lexicon, sentence processing

## **Introduction**

Identifying the word category of an incoming word in sentence processing is assumed to be the first step in understanding a sentence. It is assumed that building the hierarchical syntactic structure begins with labeling each lexical element. To identify a word as a noun, verb or adjective enables the human parser (the syntactic processing mechanism) to project noun phrases, verb phrases and adjective phrases (Frazier, 1987; Frazier & Clifton, 1996). Typically the word category can be assigned unambiguously on the basis of phonological and morphological information. But in some cases, the parser has to deal with category ambiguities (e.g., *subject* as verb or noun). Moreover, there are grammatical processes like nominalization and adjectivization which convert a word of category A into one of category B without a visible morphological change. If you look at the famous locally ambiguous sentence in (1) (Chomsky, 1965), this kind of process has clear consequences for sentence interpretation.

- (1) Flying planes can be dangerous.
- (2a) If you walk too near the runway, landing planes ...
- (2b) If you've been trained as a pilot, landing planes ...

(Tyler & Marslen-Wilson, 1977) looked at the processing of sentence fragments like (2) and found that context determines the interpretation of *landing* as either an adjective in (2a) or a gerund in (2b): Naming latencies to a visually presented probe word (a verb) were longer for an inappropriate continuation (*is* for (2a) and *are* for (2b)) than for an appropriate one (*are* for (2a) and *is* for (2b)). But it is still an open question whether the category conversion itself (from verb to adjective in (2a) and to a nominal in (2b)) causes processing costs. To answer this question, we investigated the processing of adjectival passives in German.

Many languages display two kinds of passives: an eventive, or verbal, passive and a so-called “stative”, or “adjectival”, passive (see the overview in Emonds, 2006). English does not mark this difference overtly: Both verbal and adjectival passives are expressed by a verbal participle and a form of *to be* as illustrated in (3). In languages like German, however, verbal and adjectival passives are expressed differently: Whereas the verbal passive is built with the auxiliary *werden* (‘become’), the adjectival passive uses *sein* (‘be’) as illustrated in (4) vs. (5). That is, while the English sentence in (3) is ambiguous between an eventive and a stative reading and can be disambiguated only by the linguistic or extralinguistic context (cf. (3a) vs. (3b)), its German counterparts in (4) and (5) are unambiguous.

- (3) The door was closed. adjectival or verbal passive
  - a. The door was slowly closed by the housekeeper. verbal passive
  - b. When he came back the door was still closed. adjectival passive
  
- (4) Die Tür wurde geschlossen. verbal passive  
*The door became closed* participle + passive aux: werden  
 ‘The door was closed.’
  - a. Die Tür wurde langsam von der Haushälterin geschlossen.  
*The door became slowly by the housekeeper closed*  
 ‘The door was slowly closed by the housekeeper.’
  - b. \*Als er zurückkam, wurde die Tür immer noch geschlossen.  
*When he came back became the door still closed*

- (5) Die Tür war geschlossen. *adjectival passive*  
*The door was closed* **adjectivized participle + copula: sein**  
 ‘The door was closed.’
- a. \*Die Tür war langsam von der Haushälterin geschlossen.  
*The door was slowly by the housekeeper closed*
- b. Als er zurückkam, war die Tür immer noch geschlossen.  
*When he came back was the door still closed*  
 ‘When he came back the door was still closed.’

Whereas the eventive passive in (4) is analyzed as the combination of the participle and the passive auxiliary *werden*, it is widely assumed that the participle in (5) is converted into an adjective resulting in a copula-adjective construction comparable to the copula adjective-construction with genuine adjectives like the one in (6)<sup>1</sup>.

- (6) Die Tür ist offen. adjective + copula: *sein*  
*The door is open*

In the following self-paced reading study, we investigated whether the adjectivization of the participle in sentences like (5) causes processing costs. If processing costs do appear, this would be first psycholinguistic evidence for the existence of adjectival conversion in processing adjectival passives. Furthermore, this result also would have methodological consequences. If category conversion is a costly process, one should be aware that this process might be confounded with other processes investigated in psycholinguistic studies.

## The Experiment

With a self-paced reading study, we tested whether syntactic category conversion increases processing costs during sentence comprehension.

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<sup>1</sup> Although nowadays most authors agree on the adjectival analysis, there are still proponents of a verbal analysis of the adjectival passive who assume that the German stative passive is built by a verbal participle plus a passive auxiliary *sein* (‘to be’) (Helbig, 1983, 1987); (Leiss, 1992; Zifonun, Hoffmann, & Strecker, 1997). Arguments against a verbal analysis can be found in Rapp, (1998), Kratzer (2000) and Maienborn (2007). Gese, Stolterfoht, & Maienborn (to appear) and Gese, Maienborn, & Stolterfoht (submitted) present corpus evidence as well as psycholinguistic evidence in favor of an adjectival analysis.

### *Predictions*

- For the processing of sentences like (7) we predict longer reading times for the participle *verschüttet* ('spilled') after *sein* than after the passive auxiliary *werden*, because the adjectival conversion process is only necessary for the adjectival passive in (7a), whereas the verbal passive in (7b) does not require a conversion process to take place.
- To control for effects of different lexical material preceding the critical word (the participle) we also tested sentences with *sein* and *werden* plus a genuine adjective, for which no additional process is predicted. Thus we shouldn't find any reading time difference on the adjective in sentences (8a) and (8b).

Furthermore, the sentences with adjectives were used to prevent participants from predicting and preparing a conversion process when confronted with an occurrence of *sein*, which would have been possible if every form of *sein* had been followed by a participle. Conversely, an occurrence of *werden* could not be used to predict a verbal continuation of the sentence.

- (7) a. (SeinPart) Die Milch **war** verschüttet und Frau Meier schimpfte.  
... b. (WerdPart) Die Milch **wurde** verschüttet und Frau Meier schimpfte.  
*The milk was spilled and Mrs. Meier cursed*
- (8) a. (SeinAdj) Die Milch **war** sauer und Frau Meier schimpfte.  
*The milk was sour and Mrs. Meier cursed*  
b. (WerdAdj) Die Milch **wurde** sauer und Frau Meier schimpfte.  
*The milk became sour and Mrs. Meier cursed*

To avoid wrap-up effects, the sentences continued with a sentence coordination after the critical word.

Participants were asked to read the sentences in a self-paced manner.

### **Method**

#### *Participants*

48 undergraduate students of the University of Tübingen who were paid for their participation (7 €). All were native speakers of German.

### Materials

Materials consisted of the 24 experimental sentences and 72 filler sentences. Each experimental item was prepared in four versions which differed with respect to the two parts of the predicate: *sein* vs. *werden* and *participle* vs. *adjective* (see examples in (7) and (8)). For 25% of the sentences simple comprehension questions were constructed. Half of these required a ‘yes’-response and the other half a ‘no’-response.

### Design and procedure

Four presentation lists were constructed in which the 24 experimental items were randomly mixed with the 72 filler items. The four lists were counterbalanced across items and conditions: Each list included only one version of each experimental sentence. Half of the sentences had *sein*, the other half had *werden*, and half of each of these included a participle, the other half an adjective. Thus, we employed a 2 (*sein/werd*) by 2 (*part/adj*)-design with both factors being manipulated within participants and within items.

The experiment was run on a PC using E-Prime software (Psychology Software Tools, Inc.). The sentences were presented in 6 regions in a self-paced mode with a moving window technique. Participants pressed the space bar of the keyboard to begin the trial, at which time a row of dashes appeared on the screen preceded by an asterisk. A dash represented each character of the sentence. Then, participants pressed the space bar to present each region of the sentence (see illustration in (9))

(9)

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--- ----- --- ----- --- ----- .  
Die Milch --- ----- --- ----- .  
--- ----- war ----- --- ----- .  
--- ----- --- verschüttet --- ----- .  
--- ----- --- ----- und ----- .  
--- ----- --- ----- Frau Meier ----- .  
--- ----- --- ----- schimpfte.
```

In 25 % of the trials, a comprehension question appeared on the screen by pressing the space bar, preceded by a question mark to signal the new task. To answer the question, participants chose ‘YES’ or ‘NO’ by pressing one of two keys. They were told to read through the sentences at a natural pace and to read closely enough to answer the questions. Each experimental session lasted approximately 30 minutes.

### *Data Analysis*

We analyzed participants' reading times for the six regions. For outlier elimination we employed a two-step procedure: We first excluded reading times that were shorter than 100 ms or longer than 5000 ms. In a second step, reading times that were more than 2 SD away from the mean per participant and condition were excluded from the analysis. This led to 1.02 % loss of data. The remaining reading times were submitted to two separate ANOVAs for each region, one with an error term that was based on participant variability (F1) and one with an error term that was based on item variability (F2). The ANOVAs we conducted were 2(*sein/werd*) x 2(*part/adj*) x 4(*list*) ANOVAs with repeated measurement on the first two factors in both the participant- and the items-analysis. The counterbalancing factor 'list' was included in the analyses to reduce error variance. Because of lacking theoretical relevance, we will not report the results of this factor in what follows.

### *Results*

Participants gave 99 % correct responses to the comprehension questions.

The mean reading times in the six regions are displayed in Figure 1. As expected the largest differences between the four conditions were observed in Region 3, the participle or the adjective.

For Regions 1, 2, 5 and 6, we did not observe any significant effects but only tendencies towards a main effect of the factor *part/adj* in Region 2, and towards an interaction between *part/adj* and *sein/werd* in Region 2, the latter confined to the analysis by participants (all other  $F_s < 2.4$ ; all other  $p_s > .14$ ). In contrast, in Regions 3 and 4, we did observe significant effects. In Region 3, the analyses revealed a marginal significant main effect of *part/adj* in the analysis by subjects ( $F_1(1,44) = 3.73, p_1 = .06$ ;  $F_2(1,20) = 2.32, p_2 = .14$ ). No main effect of *sein/werd* was found ( $p_s > .10$ ). As predicted, there was a significant interaction of the two factors ( $F_1(1,44) = 5.95, p_1 < .05$ ;  $F_2(1,20) = 4.08, p = .057$ ). In order to obtain more information about this interaction, planned comparisons were conducted. As predicted, we found significantly longer reading times for participles following *sein* than for those following *werden* (657 ms vs. 591 ms:  $t_1(47)=2.22, p_1 < .05$ ;  $t_2(23) = 1.98, p_2 < .05$ , one-tailed). No such corresponding difference was found for sentences with adjectives (585 ms vs. 597 ms: both  $t$ 's  $< 1$ ). Correspondingly, for the conditions with *sein*, reading times were significantly longer for participles than for adjectives ( $t_1(47)=2.22, p_1 = .01$ ;  $t_2(23) = 1.98, p_2 < .05$ , one-tailed), whereas for conditions with *werden*, no such difference was observed (both  $t$ 's  $< 1$ ).

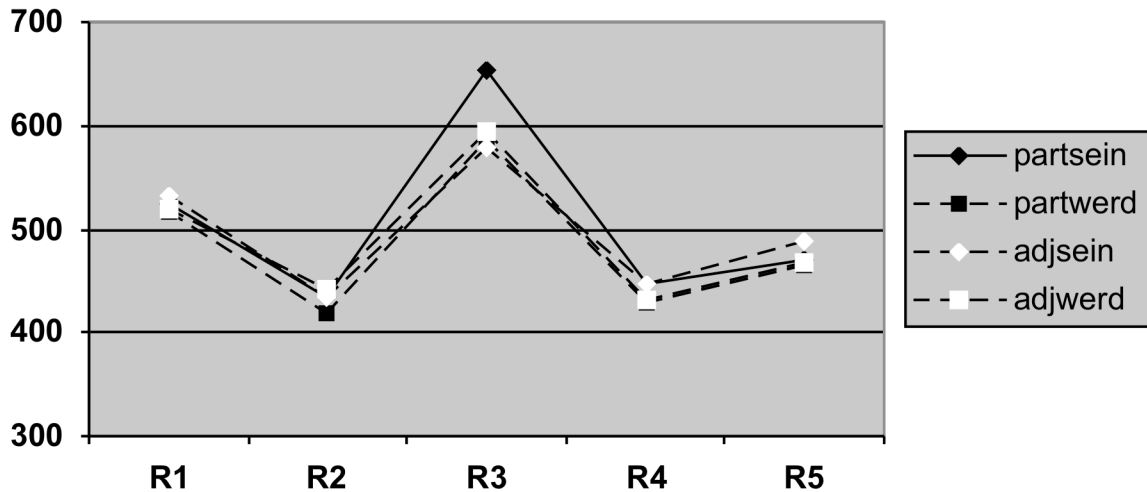


Figure 1. Reading times in ms for the four different conditions in Regions 1 through 5

In Region 4 (i.e., the conjunction following the critical word), the reading times showed a main effect of *sein/werd*, with longer readings times for the conjunction after *sein* than after *werden* (447 ms vs. 431 ms:  $F_1(1,44) = 5.1, p_1 < .05$ ;  $F_2(1,20) = 6.1, p_2 < .05$ ). There was no significant main effect of *part/adj* and no significant interaction of the two factors (all  $F_s < 1$ ).

## Discussion

The results for reading Region 3 revealed a significant interaction of *part/adj* and *sein/werd*. We found significantly longer reading times for the participle following *sein* than following *werden*. By contrast, we found no significant difference for the sentences with adjectives. This pattern of results was predicted by the hypothesis that an adjectival conversion process has to take place on the participle in the adjectival passive sentences with *sein*, but not in the eventive passive sentences with *werden*. The adjectival conversion process is only present in copula-adjective constructions, not in verbal passives. For sentences with genuine adjectives, for which no additional process was predicted, we found no reading time difference.

These results confirm our hypotheses and show that there is additional processing on the participle in adjectival passives.

Region 4, the conjunction following the critical Region 3 was read more slowly in sentences with *sein* than with *werden*. This might reflect the semantic difference between events or change-of-states and states. Whereas the sentences with *werden* express an event or change-of-state, the sentences with *sein* refer to a state. The most important implicature of



conjunctions like *and* is the successive one which means that *and* is interpreted as *and then*. This temporal interpretation is highly compatible with events and change-of-states, but is not that easily compatible with states. Therefore, the temporal implicature has to be cancelled in sentences with *sein* which would explain longer reading times on the conjunction in these sentences (see e.g. Katsos, 2003, for increased processing costs in connection with implicature cancelling).

All in all, our results show that participles in adjectival passives require additional processing which we interpret as category conversion. These results are first evidence that category conversion during sentence comprehension is indeed a costly process. But let us examine whether there could be an alternative explanation of these results. One might argue that adjectival passives are more difficult to process because they are less frequent than eventive passives in German. Whether frequency information influences the ease of processing in the resolution of syntactic ambiguities is still a matter of debate, but it has been shown in some studies that the frequency of occurrence of a specific syntactic structure in a language influences the ease of processing. The more frequent a structure is, the easier is the processing of this structure (e.g., Mitchell, Cuetos, Corley, and Brysbaert, 1995). To see whether this might be a feasible explanation for longer reading times on the participle in copula-adjective constructions, we conducted a corpus search in the morphosyntactically annotated German corpus TIGER 1.0 consisting of 700,000 tokens (40,000 sentences) of German newspaper text (<http://www.ims.stuttgart.de/projekte/TIGER>). We extracted all occurrences of *sein* + participle, *werden* + participle, *sein* + adjective and *werden* + adjective. The results are given in Table 1<sup>2</sup>.

	participle	adjective
<i>sein</i>	1261	2478
<i>werden</i>	5595	413

Table 1. Frequencies of occurrence of participles and adjectives with *sein* and *werden*.

As predicted by the frequency-based hypothesis, there are clearly more occurrences of participles with *werden* than with *sein* (proportion 1 : 4.4). This frequency difference could explain longer reading times on the participle after *sein* than after *werden*. But we also found an even clearer frequency difference for adjectives with more occurrences of an adjective with

<sup>2</sup> Present perfect tense occurrences of the eventive passive with *sein* + participle + *worden* were excluded from the *sein* + part count and were counted as *werden* + participle.

*sein* than with *werden* (proportion 6 : 1). Under a frequency account, we should therefore find longer reading times on the adjective after *werden* than after *sein*. But this is not what we found. The results revealed no significant difference in the reading times on the adjective.

On the basis of our corpus data, an explanation of the reading time difference on the participles in terms of frequency seems to be highly implausible. Instead, we conclude that longer reading times on the participle in copula-adjective constructions reflect an additional processing effort due to adjectival conversion.

### **Conclusions and Outlook**

All in all, our results show that word category conversion is in fact a costly process. We found evidence for an additional process on the participle in adjectival passives, which we interpret as evidence for a lexical conversion process. This result contributes to the long-lasting debate on the grammatical status of adjectival passives and clearly favors the adjectival analysis of this construction. Furthermore, it gives rise to an additional methodological point. Since category conversion is a costly process, one should be very cautious with regard to the design of sentence material for language processing studies: costly conversion processes might be confounded with the processes under investigation.

Our results are also relevant to the on-going debate on how lexical elements are stored in the mental lexicon. The standard approach which can be called the “lexicalist” approach (see e.g. Bierwisch 1997) assumes that a lexical item is stored with its syntactic category in the lexicon and in constructions like adjectival passives, the stored category has to be converted into another one. In contrast, advocates of Distributed Morphology (which we will call the “syntactic” account in the following, see e.g. Borer, 1994, 1997; Marantz, 1995, 1997) have proposed that lexical elements (*roots*) are stored without information about their syntactic category. These roots get categorized only in the course of syntactic derivation. Thus, for adjectival passives, the lexicalist approach assumes that there is word category conversion from verb to adjective which takes place in the lexicon (Kratzer, 2000; Maienborn, 2007; Rapp, 1998). By contrast, proponents of a syntactic approach predict that no such conversion is needed, because lexical roots are not categorized until syntactic derivation (see e.g., Embick, 2004). The results of our study can be interpreted as evidence for lexicalist approaches which assume that category information is located within the mental lexicon. In order to substantiate this conclusion, further research will be necessary to find out whether evidence for lexical conversion processes can be found not only for conversion between verbs

and adjectives but also with other types of morphologically unmarked category changes, for instance between verbs and nouns.

## References

- Bierwisch, M. (1997). Lexical Information from a Minimalist Point of View. In Wilder, Ch., H.-M. Gärtner & M. Bierwisch (eds.), *The Role of Economy Principles in Linguistic Theory*. Berlin: Akademie-Verlag, 227-266.
- Chomsky, N. (1965). *Aspects of the theory of syntax*. Cambridge, Mass.: MIT Press.
- Embick, D. (2004). On the structure of resultative participles in English. *Linguistic Inquiry*, 35(3), 355-392.
- Emonds, J. (2006). Adjectival passives: The construction in the iron mask. In M. Everaert, H. Van Riemsdijk, B. Hollebrandse & R. Goedemans (Eds.), *The Blackwell Companion to Syntax* (Vol. 1). Malden, Mass.: Blackwell.
- Frazier, L. (1987). Sentence processing: A tutorial review. In M. Coltheart (Ed.), *Attention and performance XII: The psychology of reading* (pp. 559-586). Hillsdale, NJ: Erlbaum.
- Frazier, L., & Clifton, C. (1996). *Construal*. Cambridge, MA: MIT Press.
- Gese, H., Maienborn, C., & Stolterfoht, B. (submitted). Adjectival resultatives: unaccusatives meet the adjectival passive.
- Gese, H., Stolterfoht, B., & Maienborn, C. (in press). Adjectival resultative formation in context. In: Featherston, S. & Winkler, S. (eds.) *The Fruits of Empirical Linguistics. Volume 1: Product*. Berlin: de Gruyter
- Helbig, G. (1983). Zustandspassiv, sein-Passiv oder Stativ? In G. Helbig (Ed.), *Studien zur deutschen Syntax* (Vol. 1, pp. 47-57). Leipzig.
- Helbig, G. (1987). *Zur Klassifizierung der Konstruktion mit sein+Partizip II (Was ist ein Zustandspassiv?)*. Paper presented at the Das Passiv im Deutschen. Akten des Colloquiums über das Passiv im Deutschen, Nizza 1986.
- Katsos, N. (2003). *An Experimental Study on Pragmatic Inferences: Processing Implicatures and Presuppositions*. Unpublished manuscript, University of Cambridge.
- Kratzer, A. (2000). *Building statives*. Unpublished manuscript, Berkley.
- Leiss, E. (1992). *Die Verbalkategorien des Deutschen. Ein Beitrag zur Theorie der sprachlichen Kategorisierung*. Berlin, New York: De Gruyter.
- Maienborn, C. (2007). Das Zustandspassiv: Grammatische Einordnung – Bildungsbeschränkung – Interpretationsspielraum. *Zeitschrift für Germanistische Linguistik*, 35(1), 83-114.
- Mitchell, D. C., Cuetos, F., Corley, M. M. B., & Brysbaert, M (1995). Exposure-based models of human parsing: Evidence for the use of coarse-grained (nonlexical) statistical records. *Journal of Psycholinguistic Research* 24, 469-488.
- Rapp, I. (1998). Zustand? Passiv? - Überlegungen zum sogenannten "Zustandspassiv". *Zeitschrift für Sprachwissenschaft* 15, 231-265.
- Tyler, L. K., & Marslen-Wilson, W. (1977). The on-line effects of semantic context on syntactic processing. *Journal of Verbal Learning & Verbal Behavior* 16, 683-692.
- Zifonun, G., Hoffmann, L., & Strecker, B. e. a. (1997). *Grammatik der deutschen Sprache*. Berlin, New York: de Gruyter.