

# Syntactic templates and linking mechanisms: A new approach to grammatical function asymmetries

Ina D. Bornkessel<sup>1</sup>, Matthias Schlesewsky<sup>2</sup> and Robert D. Van Valin, Jr.<sup>3</sup>

<sup>1</sup>Max Planck Institute for Human Cognitive and Brain Sciences, Leipzig; <sup>2</sup>Junior Research Group Neurolinguistics, Philipps University Marburg; <sup>3</sup>Department of Linguistics, University at Buffalo  
bornke@cbs.mpg.de



MAX PLANCK INSTITUTE FOR HUMAN COGNITIVE AND BRAIN SCIENCES LEIPZIG | MÜNCHEN

## Introduction

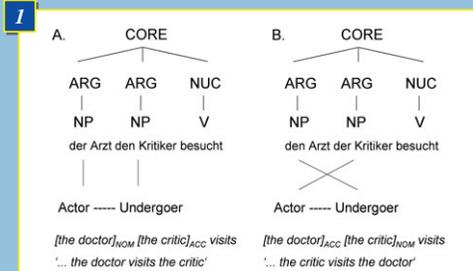
The comprehension of argument order variations has long posed an interesting challenge for psycholinguistic research. Typically, the processing of varying orders has been described in terms of reconstruction to a base order, i.e. in terms of a positional association between a particular argument and a specific (underlying) position in the phrase structure tree, which guarantees the correct interpretation of that argument. From this perspective, the well-known increases in processing cost for object-initial sentences are engendered by the fact that the object cannot be interpreted in the position in which it is encountered. These assumptions essentially rely on a classical generative perspective on argument interpretation (Chomsky, 1981, 1995, 2000), which posits that interpretation (i.e. thematic role assignment) is accomplished in a base position, while surface argument order is derived via movement. However, they hold even for grammatical theories without movement, e.g. HPSG (Pollard & Sag, 1994), in which interpretation of a fronted object also presupposes an association with a base position. Similar assumptions are also implicit in processing models such as that of Gibson (1998), in which the inverted order results in enhanced prediction and integration cost.

We present an alternative interpretation of argument order asymmetries based on the assumptions of Role and Reference Grammar (RRG), in which interpretation is accomplished without reference to a base position. We argue that this fundamentally different perspective on order variations can account for a number of findings in the psycho-linguistic literature, including a number of hitherto elusive results.

## Templates vs. linking in Role and Reference Grammar (RRG)

In RRG (Van Valin & LaPolla, 1997):

- Syntactic structures are represented as templates.
- Argument interpretation is accomplished via linking rules that associate an argument with a generalised semantic role (GSR; Actor/Undergoer).
- Argument interpretation is logically independent of syntactic position (though both may coincide, as in English).
- Languages differ in terms of template inventories (i.e. permissible phrase structures) and linking systems. Whereas English relies primarily on linear order for argument linking, case-marking languages such as German allow for a direct linking between morphological case and GSRs (cf. Schlesewsky & Bornkessel, in press, for psycholinguistic evidence).



Two examples from German showing the independence of templates and linking: a canonically ordered, nominative-initial (panel A) and a permuted, accusative-initial sentence (panel B). The syntactic structure of the two sentences does not differ, i.e. the same (transitive) template is drawn upon in each case. The correct interpretation is guaranteed by the linking algorithm, which maps the nominative-marked argument onto the Actor role and the accusative-marked argument onto the Undergoer role in each case.

## Templates vs. linking in sentence comprehension

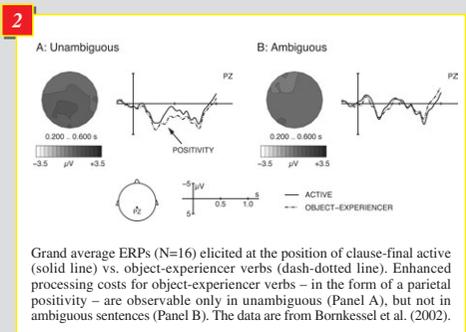
In the following, we present three findings which challenge the traditional view of position-based interpretation and which appear to be more easily accounted for under the assumption that phrase structure (templates) and interpretation (linking) are independent of one another.

### Incremental argument interpretation in German

From the perspective of reconstruction-based accounts, association with a particular structural position is a prerequisite for successful interpretation. Thus, it should never be the case that non-positional information should lead to a higher degree of incremental interpretation than positional information. However, a number of experimental findings have shown that incremental argument interpretation in German crucially depends on morphological case marking. Consider the following two examples:

- ... dass der Junge dem Mädchen gefällt.  
... that [the boy]<sub>NOM</sub> [the girl]<sub>DAT</sub> pleases  
... that the boy is appealing to the girl.
- ... dass Amanda Sängerinnen gefällt.  
... that Amanda<sub>NOM/ACC/DAT</sub> Singers<sub>NOM/ACC/DAT</sub> pleases  
... that Amanda is appealing to singers.

In both (1) and (2), the verb gefällt ('to be appealing to') projects an argument hierarchy with an Experiencer and a Stimulus argument. However, the lower-ranking Stimulus *der Junge/Amanda* ('the boy'/'Amanda') is realised as the (syntactically higher-ranking) subject. Thus, if mechanisms of incremental interpretation establish a canonical argument hierarchy – with the (nominative) subject outranking the (dative) object thematically – before the verb is encountered, a reanalysis of the thematic hierarchy will be required when a dative object-experiencer verb is encountered clause-finally. This is indeed the case for unambiguously case-marked sentences such as (1), while no additional processing costs arise at the point of the verb in sentences with ambiguous case marking such as (2) (Bornkessel et al., 2002, 2003; Figure 2). Nonetheless, the ambiguous first argument in (2) is analysed as the subject of the clause, as shown by the presence of a reanalysis effect when analogous sentences are disambiguated towards an object-initial order at the position of the clause-final verb (Schlesewsky & Bornkessel, in press).



The difference between (1) and (2) is difficult to reconcile with the assumption that incremental interpretation arises from an association with a particular structural position. If this were the case, the structurally-based preference to analyse the first argument in a sentence such as (2) as agreeing with the finite verb should also lead to an interpretation of this argument as Actor.

However, this second interpretive step only applies in the presence of unambiguous case marking (as in 1). In terms of a template and linking-based approach, by contrast, this finding is not surprising. From this perspective, argument interpretation may be accomplished directly by a linking from morphological case to a generalised semantic role hierarchy. No mediating influence of position is required.

### The role of Broca's area in syntactic processing

While Broca's area (the pars opercularis/triangularis of the inferior frontal gyrus, BA 44, 45) has often been associated with syntactic processing – and even been specifically linked to the processing of movement operations (Grodzinsky, 2000; Ben-Shachar et al., 2003) – cross-linguistic findings on the activation of this region during the processing of object-initial sentences remain difficult to explain. Increased activation in Broca's region obtains in English object relatives (e.g. Caplan et al., 2001). In German, however, it is only measurable in clause-medial argument order variations (Röder et al., 2002) but not in wh-questions or relative clauses (Fiebach et al., 2001). From a reconstruction-based perspective, these findings defy explanation because the successful interpretation of all of these permutation types crucially hinges on some sort of reconstruction.

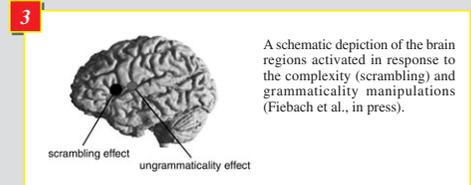
In terms of linking properties that are independent of phrase structure, by contrast, the cross-linguistic differences are naturally accounted for. English consistently links on the basis of linear order. Therefore, all object-initial structures require an "inverse linking" and thus engender additional processing (linking) costs. In German, by contrast, linking is accomplished via morphological case marking and construction-specific properties. While the clause-medial region in unmarked German sentences directly reflects the argument hierarchy in the semantic representation of the verb, the clause-initial region can host any single constituent (argument or adjunct). On-line linking processes are sensitive to this distinction and inverse linking is, therefore, only costly in clause-medial contexts.

### Syntactic complexity vs. grammaticality

Using functional magnetic resonance imaging (fMRI) to examine sentences such as (3), Fiebach et al. (in press) observed a double dissociation between syntactic complexity and grammaticality.

- Vielleicht hat der Gärtner dem Lehrer den Spaten geliehen.  
perhaps has [the gardener]<sub>NOM</sub> [the teacher]<sub>DAT</sub> [the spade]<sub>ACC</sub> lent  
'Perhaps the gardener lent the spade to the teacher.'
  - Vielleicht hat dem Gärtner der Lehrer den Spaten geliehen.  
perhaps has [the gardener]<sub>DAT</sub> [the teacher]<sub>NOM</sub> [the spade]<sub>ACC</sub> lent  
'Perhaps the teacher lent the spade to the gardener.'
  - Vielleicht hat dem Gärtner den Spaten der Lehrer geliehen.  
perhaps has [the gardener]<sub>DAT</sub> [the spade]<sub>ACC</sub> [the teacher]<sub>NOM</sub> lent  
'Perhaps the teacher lent the spade to the gardener.'
  - \* Vielleicht hat der Gärtner geliehen dem Lehrer den Spaten.  
perhaps has [the gardener]<sub>NOM</sub> lent [the teacher]<sub>DAT</sub> [the spade]<sub>ACC</sub>

The three grammatical sentences (3a)–(3c) encode a continuous increase in complexity: (3a) is a canonical German sentence with the ordering nominative-dative-accusative; in (3b) the dative has been scrambled to the left of the subject; (3c) involves two scrambling operations as both objects precede the subject. The structure in (3d), by contrast, is ungrammatical because the participle is infelicitously positioned between the subject and the indirect object. Both manipulations gave rise to distinct activation patterns using the fMRI method as shown in Figure 3.



As is apparent from Figure 3, the complexity manipulation was reflected in an activation increase in Broca's area in the left inferior frontal gyrus (BA 44), while the grammaticality manipulation engendered increased activation for ungrammatical sentences in the posterior deep frontal operculum. Importantly, note that the ungrammatical sentence condition did not elicit a higher level of activation in BA 44 than even the least complex (canonical) grammatical condition. The data therefore show a double dissociation between complexity and grammaticality, which is not straightforwardly derivable in models of grammar and language comprehension assuming that language is parsed from left to right on the basis of rule application. From such a perspective, both of the critical manipulations arise from the application of rules or the failure thereof, i.e. from qualitatively similar processes. Whereas the ungrammatical condition initiates a search process ending in a rule application failure – as there is no rule to derive the structure in (3d) – the complex (scrambled) grammatical conditions (3b,c) involve more rule applications than the canonical structure (3a). In each case, however, aspects of rule application are involved in generating the enhanced processing cost. Therefore, from a rule-based perspective, one should also expect to see an increased activation in BA 44 for the ungrammatical condition.

From a template-based perspective, however, the observed pattern of results falls out naturally. Structures such as (3d) require a syntactic template that does not exist in the template inventory of German. Thus, the activation in the posterior deep frontal operculum reflects template selection failure. By contrast, the complexity manipulation does not result from a template selection problem, since all of the structures in (3a) to (3c) may be straightforwardly associated with the same active ditransitive template. Rather, the three conditions differ with regard to the complexity of the linking mechanisms involved, from direct linking in (3a) to two crossed linking dependencies in (3c). The parametric increase in activation in Broca's area (BA 44) as a result of the complexity manipulation can therefore be interpreted as a response to the continually increasing complexity of linking requirements. In this way, the qualitative distinction between grammaticality and complexity apparent in these results may be straightforwardly derived in a grammatical framework assuming a distinction between syntactic templates and syntax-to-semantics linking via a generalised role hierarchy.

## Conclusion

The three sets of empirical findings discussed here indicate that the RRG perspective on phrase structure vs. interpretation – i.e. syntactic templates vs. linking mechanisms – constitutes a promising theoretical basis for language comprehension. Further research will now need to examine the theory's predictions for sentence processing more comprehensively.