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Multi-dimensional contributions to garden path strength: Dissociating phrase structure from case marking☆

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Abstract

Psycholinguistic investigations of reanalysis phenomena have typically focused on revisions of phrase structure. Here, we identify a further subcomponent of syntactic reanalysis, namely the revision of case marking. This aspect of reanalysis was isolated by examining German subject–object ambiguities that require a revision towards a dative-initial order. Since dative-initial orders are potentially unmarked, no phrase structure corrections are required, but the original, preference-based nominative assignment must be revised. Experiment 1, an ERP study, revealed an N400 component for reanalysis of case marking, which contrasted with a P600 component for phrase structure revisions. The 'reanalysis N400' was replicated in Experiment 2, which also showed that direct lexical support for a dative-initial order leads to a reduction of the effect. Finally, in Experiment 3, direct time course measures provided by the speed-accuracy trade-off (SAT) procedure supported the case reanalysis account by showing that conditions hypothesized to involve case reanalysis (dative-initial structures) require longer computation times than their nominative-initial counterparts. Lexeme-specific support for the dative-initial reading, however, does not lead to a faster computation of the target structure, but rather increases the likelihood that the correct interpretation will be computed. We interpret these findings as evidence for the general availability of an unmarked dative–nominative word order in German, the accessibility of which may be increased by lexical information. Moreover, the data show that syntactic reanalysis is not a homogeneous process, but may rather be subdivided along several dimensions that interact in determining overall garden path strength.

Keywords: Reanalysis; Subject–object ambiguity; ERPs; SAT; N400; P600; LAN; Case; Thematic relations

Readers and listeners often make incorrect initial commitments to ambiguous input, which eventually need to be revised. The study of these types of revisions, or 'reanalyses,' has played a significant role in the investigation of sentence comprehension mechanisms (see Fodor & Ferreira, 1998, for an overview). Reanalysis

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phenomena can shed light on different aspects of the comprehension architecture, including, for example, how the analysis of the linguistic input has proceeded up to the point of the conflict, and which features of the input are taken into account during conflict resolution. In this way, reanalysis-based research has provided many insights into the organization of the human language processing system.

Most investigations of syntactic reanalysis have focused on the revision of phrase structure and, hence, on the role of differing phrase structure configurations in determining garden path strength. However, recovery from a misanalysis involves more than the revision of syntactic phrase markers, and several potentially heterogeneous mechanisms may need to act in concert for recovery to proceed successfully. As an illustration, consider the well-known garden path sentence in (1).

(1) While Mary was mending the sock fell off her lap.

In an initial analysis of (1), readers have a high probability of treating the noun phrase (NP) *the sock* as a syntactic complement of the verb *mending* by attaching it to the verb's sister position in the phrase structure tree (Frazier, 1978). When *fell* is encountered, however, this structural configuration must be revised and *the sock* assigned to the subject position of the matrix clause. Additionally, however, the reanalysis of (1) entails that, in terms of relational properties, *the sock* must be reanalyzed from the *direct object* of the adjunct clause**,** bearing accusative or objective case, to the *subject* of the matrix clause, bearing nominative case. Furthermore, the reanalysis of (1) must also involve a revision of interpretive properties, since, in the original analysis, mechanisms of incremental interpretation will already have assembled a semantic representation in which Mary is mending a sock, before the reanalysis makes clear that Mary may have been mending something else entirely (regarding interpretive revisions cf. Christianson, Hollingworth, Halliwell, & Ferreira, 2001; Ferreira, Christianson, & Hollingworth, 2001).

Isolating different facets of the reanalysis process is difficult in languages like English as the phrase structure position of an NP determines its grammatical function (case) and, accordingly, at least certain aspects of its interpretation. By contrast, there are languages—German being one—in which cases assignment is not determined by specific positions in the phrase marker. For example, there does not appear to be a designated "subject position" responsible for the assignment of the nominative ("subject") case in German (Haider, 1993). The decoupling of phrase structure and case in languages like German enables researchers to examine whether revisions of the two types of properties draw upon distinct mechanisms.

In this paper, we examine case ambiguities in German to determine whether revisions of phrase structure and revisions of case marking indeed differ qualitatively from one another. Experiments 1 and 2 report event-related brain potential (ERP) studies, which demonstrate that the reanalysis of structures that we argue involve case-based revisions only engender an N400 component. In contrast, structures that require the revision of phrase structure engender the more often observed P600 component. The qualitatively different ERP components implicate different reanalysis mechanisms. In Experiment 3, measures of the full time course of processing derived from a variant of the response-signal speed accuracy tradeoff (SAT) procedure (e.g., McElree, 1993) demonstrate that this N400 component is associated with substantial delays in processing, as predicted by an account assuming that revision of case properties alone requires a costly reanalysis.

Dissociating reanalysis mechanisms in German

In this section, we outline the difference between two types of non-nominative-initial word orders in German, base orders and permuted orders, which we argue provides a basis on which to experimentally contrast revisions of phrase structure and revisions of case marking. We first discuss the linguistic motivations for assuming the distinction between the two types of structures, before turning to implications for parsing and reanalysis.

Theoretical motivations for base and permuted orders

In contrast to English, German displays a high degree of variability in possible argument serializations. In addition to nominative-initial orders (as are mandatory in most constructions in English), German allows serializations in which an argument marked with an object (accusative or dative) case precedes the nominative argument. Importantly for present purposes, two types of non-nominative-initial orders can be distinguished in German: unmarked (base) and marked (permuted) orders. An undisputed example of an unmarked non-nominative-initial ordering is shown in (2).

(2) Amanda sagt, ...
Amanda says ...
a. ... dass dem Jungen das Fahrrad gefällt.
... that [the boy]$_{DAT}$ [the bicycle]$_{NOM}$ pleases
'... that the bicycle appeals to the boy'
b. # ... dass das Fahrrad dem Jungen gefällt.
... that [the bicycle]$_{NOM}$ [the boy]$_{DAT}$ pleases

Example (2) illustrates the unmarked dative–nominative word order in German. A word order is argued to be unmarked, as in (2a), if the sentence can be felicitously uttered in the absence of any constraining context, the typical test case being a presumably neutral context such as 'What happened?' (cf. Siwierska, 1988). Marked orders such (2b), which are denoted by the '#' symbol, occur only in a constraining context, e.g., when the nominative argument *das Fahrrad* ('the bicycle') is contextually given (e.g., Lenerz, 1977).

In addition to non-nominative-initial base orders, German also permits permuted orders, as illustrated in (3).

(3) a. # ... dass den Jungen das Fahrrad bedrückt.
... that [the boy]$_{\text{ACC}}$ [the bicycle]$_{\text{NOM}}$ depresses
'... that the bicycle depresses the boy'
b. ... dass das Fahrrad den Jungen bedrückt.
... that [the bicycle]$_{\text{NOM}}$ [the boy]$_{\text{ACC}}$ depresses

In example (3), the accusative-initial order (3a) is marked in the sense introduced above, while the nominative-initial order is not (3b). A typical way of modeling the distinction between unmarked and marked orders in generative syntactic approaches is to associate the former with base generation and the latter with some type of syntactic derivation (movement). Thus, while the accusative-initial permuted order in (3a) is typically derived via movement of the accusative NP, the dative-initial base order in (2a) is analyzed as not involving a movement operation (cf. Haider & Rosengren, 2003; see below for an illustration).

It is widely held in the syntactic literature on German that unmarked argument orders are direct reflections of the argument hierarchy encoded in the lexical entry of a verb (e.g., Bierwisch, 1988; Fanselow, 2000; Haider & Rosengren, 2003; Wunderlich, 1997, 2003; cf. also Grimshaw, 1990). Consider, for example, a verb calling for an Agent and a Patient as arguments, e.g., *hit*. A verb of this type is thought to project an unmarked syntactic structure in which the Agent argument outranks the Patient. This base order may, then, serve as the basis for further syntactic operations, including argument permutation. Typically, the higher-ranking argument in the base order (the Agent, in this example) is marked with nominative case, while the second NP bears either accusative or dative case. Notably, however, there are also verbs with which a dative-marked Experiencer is argued to outrank a nominative-marked Theme (e.g., *gefallen*, 'to be appealing to,' in example 2), and these verbs are thought to project a dative-initial base order. Similar arguments have been advanced for passive constructions with ditransitive verbs as in (4), in which the dative Recipient outranks the nominative Theme (Fanselow, 2000; Wunderlich, 1997).

(4) a. ... dass dem Jungen das Fahrrad gestohlen wurde.
... that [the boy]$_{\text{DAT}}$ [the bicycle]$_{\text{NOM}}$ stolen was
'... that (someone) stole the bicycle from the boy.'
b. # ... dass das Fahrrad dem Jungen gestohlen wurde.
... that [the bicycle]$_{\text{NOM}}$ [the boy]$_{\text{DAT}}$ stolen was

Although, as illustrated above, dative-initial base orders are possible in several constructions, the consensus is that there are no accusative-initial base orders in German (Fanselow, 2000; Wunderlich, 2003), as accusatives generally cannot outrank nominatives in the argument hierarchy.[1] Additionally, psycholinguistic studies have provided evidence that even accusative object-experiencer verbs do not force a reading in which the accusative thematically outranks the nominative (Bornkessel, 2002; Scheepers, Hemforth, & Konieczny, 2000), whereas dative object-experiencer verbs do (Bornkessel, Schlesewsky, & Friederici, 2002a, 2003; Schlesewsky & Bornkessel, 2004).

Existing experimental findings are consistent with the assumption of an unmarked dative-initial order for dative object-experiencer verbs. In a speeded acceptability judgment study, Schlesewsky and Bornkessel (2003) examined sentences like (5) and (6), including dative active and dative object-experiencer verbs, respectively.

(5) a. ... dass Maria Sängerinnen folgt.
... that Maria$_{\text{NOM/ACC/DAT.SG}}$ singers$_{\text{NOM/ACC/DAT.PL}}$ follows $_{\text{SG}}$
'... that Maria follows singers.'
b. ... dass Maria Sängerinnen folgen.
... that Maria$_{\text{NOM/ACC/DAT.SG}}$ singers$_{\text{NOM/ACC/DAT.PL}}$ follow $_{\text{PL}}$
'... that singers follow Maria.'

(6) a. ... dass Maria Sängerinnen gefällt.
... that Maria$_{\text{NOM/ACC/DAT.SG}}$ singers$_{\text{NOM/ACC/DAT.PL}}$ appeals-to$_{\text{SG}}$
'... that Maria is appealing to singers.'

[1] Even though accusative object-experiencer verbs (e.g., *ängstigen*, 'to frighten') are sometimes cited as projecting an accusative (Experiencer) > nominative (Theme) hierarchy, evidence against this view stems from the observation that, in contrast to dative object-experiencer verbs, verbs such as *ängstigen* may undergo passivization and nominalization. These processes are only possible with a 'canonical' mapping between syntactic and thematic structure (cf. Grimshaw, 1990; Jackendoff, 1972). The need for a canonical hierarchy in accusative object-experiencer verbs appears to stem from the fact that this verb class allows for a causative reading in which the nominative Causer outranks the accusative Experiencer.

b. ... dass Maria Sängerinnen gefallen.
... that Maria$_{\text{NOM/ACC/DAT.SG}}$ singers$_{\text{NOM/ACC/DAT.PL}}$ appeal-to$_{\text{PL}}$
'... that singers are appealing to Maria.'

Participants rated dative–nominative structures like (5b) as less acceptable than nominative–dative structures like (5a). For the object-experiencer verbs (6), by contrast, the dative-initial structure (6b) was not judged to be less acceptable than its nominative-initial counterpart (6a), but rather (marginally) more acceptable. These findings are consistent with the idea that dative object-experiencer verbs are associated with a dative–nominative base order. One might think that dative-initial structures in (6b) should be judged dramatically more acceptable than (6a), comparable to the differences between (5a) and (5b), if (6b) is indeed consistent with a base order. However, the structures in (6), like those in (5), are fully case ambiguous before the verb is encountered. As such, they are likely to require reanalysis from an original nominative-initial analysis (see below), and judgments of their acceptability will be influenced by the fact that reanalysis is required.

Implications for parsing and reanalysis

The different types of non-nominative-initial orders in German are of particular interest for research on syntactic reanalysis because, despite the various possible argument serializations, German speakers exhibit a strong preference to adopt a nominative-initial analysis of a clause with ambiguous grammatical roles (e.g., Bader & Meng, 1999; beim Graben, Saddy, Schlesewsky, & Kurths, 2000; Hemforth, 1993; Mecklinger, Schriefers, Steinhauer, & Friederici, 1995; Schlesewsky, Fanselow, Kliegl, & Krems, 2000; Schriefers, Friederici, & Kühn, 1995). This strategy may be viewed as resulting from the processing system's endeavor to construct minimal well-formed structures, i.e., structures consisting of a finite verb and an NP agreeing with it (de Vincenzi, 1991; Gibson, 1998; Schlesewsky & Friederici, 2003). As agreement is restricted to nominative-marked arguments in German, a preference for nominative-first naturally follows. However, for current purposes, it is not the source of this nominative-initial strategy that is at issue, but rather how comprehenders recover from misanalyses. When a nominative-initial analysis is subsequently disconfirmed, we predict that the computational steps required for a successful reanalysis differ when the target analysis requires a non-nominative base or a non-nominative permuted order. We illustrate the differences with annotated phrase structure trees in Fig. 1.

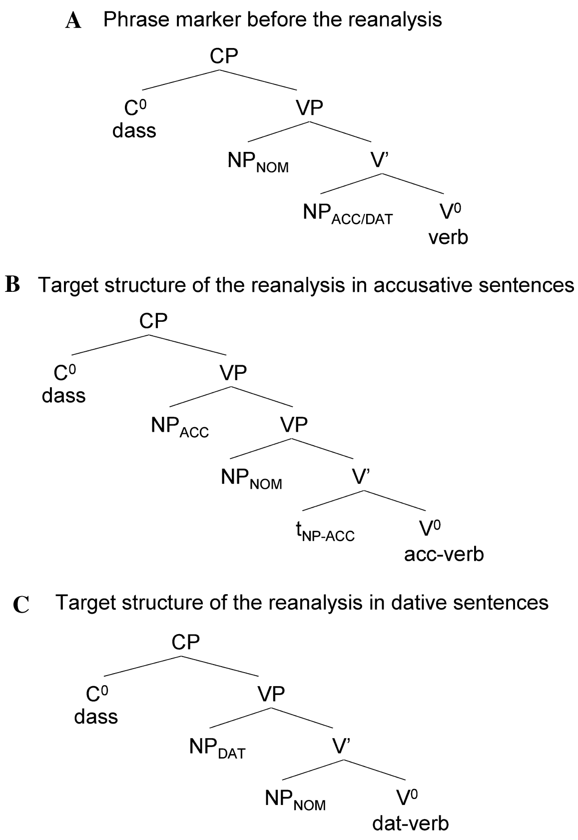

Fig. 1. Phrase structure representations for the preference-based structure constructed during an initial analysis of a case ambiguous sentence (A) and the target structures for the reanalysis in accusative-initial (B) and dative-initial (C) sentences, respectively. The following abbreviations are used: CP, complementizer phrase; VP, verb phrase; and NP, noun phrase.

Fig. 1A shows the phrase structure that is established before the verb is encountered.[2] Consistent with prior research, readers are expected to follow a strategy in which nominative case is assigned to the first argument. Which case is assigned to the second argument is more controversial: whereas a preference for accusative over dative case has been reported in some constructions (e.g., Hopf, Bayer, Bader, & Meng, 1998), accusative/dative-ambiguities adjacent to the clause-final verb (as in Fig. 1A) have hitherto failed to yield garden-path effects (Scheepers, Hemforth, & Konieczny, 1998). For our account, it is not critical which object case is assigned to the second argument prior to processing the verb, so we have labeled NP2 as ACC/DAT in Fig. 1A.

[2] We follow Haider (1993) in analyzing German clauses as consisting only of a complementizer phrase (CP) and a verb phrase (VP) without an intervening inflectional phrase (IP).

The target structures for the reanalyses in permuted (accusative-initial) and non-nominative base (dative-initial) structures are shown in Figs. 1B and C, respectively. When reanalysis is triggered by an accusative verb, the phrase marker must be restructured towards a mental representation that is functionally similar to the permuted structure in Fig. 1B, in which the accusative argument is displaced from its base position to a position adjoined to the verb phrase (VP). However, Fig. 1C illustrates that no such phrase structure revision may be required in dative sentences. This prediction follows from the assumption that dative–nominative is a possible base order in German. Crucially, all that is required for a successful reanalysis in these sentences is a reassignment of dative and nominative case to the two arguments (and, thereby, a reassignment of agreement properties). Note that, although we illustrate the difference between accusative- and dative-initial orders in terms of movement operations, our hypotheses do not crucially rely on the assumption that the accusative-initial structures are derived via movement. Fanselow (2003), for example, shows that correlates of marked and unmarked order can be derived without movement.

The above account predicts that there should be measurable differences between the reanalysis towards permuted (accusative-initial) and base (dative-initial) non-nominative-initial orders. This hypothesis is consistent with previous experimental findings, which suggest that revisions with dative verbs may be easier than revisions with accusative verbs: In Schlesewsky and Bornkessel (2003), dative-initial structures with active verbs were rated acceptable 85% of the time, while Meng and Bader (2000) found that verb-final accusative-initial sentences were rated far less acceptable, only 49% of the time. Although less than optimal, this cross-experiment contrast suggests that reanalysis towards a dative-initial order may be less costly than reanalysis towards an accusative-initial order, as would be expected if the former only involves a reassignment of cases rather than a full phrase structure revision.

Detecting qualitative distinctions in reanalysis

Processes of reanalysis are typically examined with behavioral methods such as self-paced reading and measurements of eye movements during reading. These methods are appropriate for assessing the degrees of difficulty associated with different types of reanalysis, but, as unidimensional measures, they cannot provide clear and unambiguous evidence to support a qualitative rather than quantitative difference in processing. Although different values on a unidimensional scale may be consistent with a qualitative distinction between the underlying processes, they may also reflect quantitative variations, such as, for example, differences in the proportion of trials eliciting a reanalysis or differences in the likelihood of successfully reanalyzing different structures. Multidimensional measures such as event-related brain potentials (ERPs), by contrast, can provide evidence for qualitatively different processes, since they allow for a classification of observed effects on the basis of a number of parameters such as latency (onset/peak of an observed effect relative to critical stimulus onset), topography (electrode sites at which an effect is observable), and polarity (negativity or positivity of an observed effect relative to a control condition).

Indeed, since Kutas and Hillyard's (1980) seminal application of the ERP methodology to language processing, several language-related ERP components have been identified. Kutas and Hillyard (1980) first reported a centro-parietal negativity with a maximum at approximately 400 ms post critical word onset (N400), which came to be regarded as a general marker of increased effort in lexical–semantic processing (cf. Kutas & Federmeier, 2000, for a review). Syntactic processing difficulty, on the other hand, has typically been associated with a parietal positivity with a maximum at approximately 600 ms (P600 or 'syntactic positive shift,' SPS; e.g., Hagoort, Brown, & Groothusen, 1993; Osterhout & Holcomb, 1992) and left-anterior negativities of varying latency (the ELAN, e.g., Hahne & Friederici, 1999; Neville, Nicol, Barss, Forster, & Garrett, 1991; and the LAN, e.g., Coulson, King, & Kutas, 1998; Gunter, Stowe, & Mulder, 1997; Osterhout & Mobley, 1995). We capitalized upon the ability of ERP measures to detect qualitatively different underlying processes to examine potential differences between reanalyses towards accusative- and dative-initial orders.

Several ERP studies have examined the reanalysis of accusative constructions in German. Sentences like (7), for example, elicit P600 effects at the position of the underlined clause-final auxiliary, which disambiguates the sentence towards an accusative-initial reading (Friederici & Mecklinger, 1996; Friederici, Mecklinger, Spencer, Steinhauer, & Donchin, 2001).

(7) Klaus weiß, dass die Studentin die Freundinnen besucht haben.
Klaus knows that [the student]$_{\text{NOM/ACC.SG}}$ [the friends]$_{\text{NOM/ACC.PL}}$ visited have$_{\text{PL}}$
'Klaus knows that the friends visited the student.'

Here, the first NP (*die Studentin*) is initially associated with nominative case. However, this initial assignment must be revised when the auxiliary is reached, since this constituent does not agree in number with the supposed nominative argument. As described above, this revision cannot simply consist of a case reassignment, but rather must involve revisions of aspects of the phrase structure representation. The observed P600 was argued to be engendered by these reanalysis operations.

An earlier positivity peaking at approximately 350 ms (P345) has also been reported and argued to reflect the reanalysis of nominative–accusative ambiguities in German relative clauses such as (8) (Friederici, Steinhauer, Mecklinger, & Meyer, 1998; Mecklinger et al., 1995; Steinhauer, Mecklinger, Friederici, & Meyer, 1997).

(8) Das ist die Studentin, die die Professorinnen besucht haben.
this is the student who$_{\text{NOM/ACC.SG}}$
[the professors]$_{\text{NOM/ACC.PL}}$ visited have$_{\text{PL}}$
'This is the student who the professors visited.'

Again, a number agreement mismatch—here between the auxiliary and the relative pronoun—signaled that the initial nominative assignment must be revised. One possible explanation for the latency difference between this positivity and the one observed in structures like (7) is that relative pronouns always occupy the same structural position in German, independently of their case marking. Thus, the positioning of the ambiguous argument itself is not affected by the reanalysis in (8), thereby leading to an easier reanalysis. Note, however, that phrase structure revisions are still necessary in this case, since the gap site must be relocated (cf. Friederici & Mecklinger, 1996; Friederici et al., 2001).

Studies like these suggest that the latency of the ERP component may index the ease or difficulty of the revision process. How pronounced a component is may also reflect the magnitude of the processing cost (cf. Rugg & Coles, 1995). Different occurrences of a component that differ only with regard to amplitude or latency are consistent with quantitative variations in the underlying process, though they do not unequivocally call for a quantitative explanation as there is a many-to-one mapping between cognitive subdomains and individual ERP components (e.g., Roehm, Schlesewsky, Bornkessel, Frisch, & Haider, 2004). Hence, previous ERP findings on the reanalysis of case ambiguities in German accusative sentences clearly established that different structures induce different degrees of processing cost. However, they do not provide evidence for qualitatively different reanalysis operations. Variations in the polarity and/or the topography of the ERP component provide more compelling evidence for qualitatively different underlying mechanisms.

Experiment 1

Experiment 1 examined whether there are principled differences between the reanalysis of case ambiguities in constructions with accusative and dative verbs. There are two reasons to expect differences between the constructions. First, as discussed above, experimental evidence suggests that reanalysis to a dative-initial order is easier than reanalysis to an accusative-initial order, independent of verb class (Schlesewsky & Bornkessel, 2003). Second, theoretical considerations suggest that a dative-initial structure is a possible base order in German while accusative-initial structures necessarily reflect a permuted order. The relevance of this distinction for processing is that the system may be able to forego phrase structure reanalysis when faced with a dative-initial structure. Unlike reanalysis to an accusative-initial structure, which may require computing a structural representation analogous to Fig. 1B from a representation analogous to Fig. 1A, the dative-initial structure in Fig. 1C can be computed from Fig. 1A by simply reassigning case relations.

To test the strongest version of this hypothesis, we compared reanalysis towards an accusative-initial order with reanalysis towards a dative-initial order in sentences with active verbs. Evidence for qualitative distinctions between these two types of revisions would suggest that an unmarked dative-initial word order is generally available to the processing system, because active verbs are not thought to lexically code a dative-initial word order. The influence of lexical information will be examined in Experiment 2.

Examples of the critical sentences for Experiment 1 are shown in Table 1. In all conditions, the word order of the subordinate clause is compatible with both a nominative- and a non-nominative-initial analysis until the clause-final verb is processed. Construction (B) represents the typical reanalysis case previously examined, where the number marking on the verb disconfirms the initial nominative assignment to the initial argument and forces reanalysis towards an accusative-initial structure. Construction (D) is analogous to (B) except that the verb assigns dative case and the number agreement forces reanalysis towards a dative-initial structure, which we assume to be possible without alterations of the phrase marker. The two nominative-initial structures in (A) and (C) were chosen as control conditions for accusative and dative constructions, respectively. We chose initially ambiguous controls rather than analogous unambiguous sentences because a number of studies examining similar constructions in German have shown that there are principled differences between the processing of unambiguous and ambiguous structures even before the disambiguating region (Bornkessel et al., 2002a; Fiebach, Vos, & Friederici, in press; Frisch, Schlesewsky, Saddy, & Alpermann, 2002; Schlesewsky & Bornkessel, 2004;) The constructions in (A) and (C) control for general effects of ambiguity so that differences can be more precisely localized to the reanalysis operations.

Table 1
Example sentences for each of the four critical conditions in Experiment 1

Condition	Example
(A) SO accusative	... dass Maria Sängerinnen besucht, obwohl... ... that Maria$_{NOM/ACC/DAT.SG}$ singers$_{NOM/ACC/DAT.PL}$ visits$_{SG.ACC}$, although ...
(B) OS accusative	... dass Maria Sängerinnen besuchen, obwohl ... ... that Maria$_{NOM/ACC/DAT.SG}$ singers$_{NOM/ACC/DAT.PL}$ visit$_{PL.ACC}$
(C) SO dative	... dass Maria Sängerinnen folgt, obwohl ... ... that Maria$_{NOM/ACC/DAT.SG}$ singers$_{NOM/ACC/DAT.PL}$ follows$_{SG.DAT}$
(D) OS dative	... dass Maria Sängerinnen folgen, obwohl ... ... that Maria$_{NOM/ACC/DAT.SG}$ singers$_{NOM/ACC/DAT.PL}$ follow$_{PL.DAT}$

Note that each sentence was completed by an adjunct clause in order to avoid confounding sentence wrap-up effects at the position of the critical verb.

As noted above, the ERP effects should differ between (B) and (D) if there are qualitative differences between revisions of case properties and revisions of the phrase marker representation. We expect to observe a P600 for constructions like (B) (Friederici & Mecklinger, 1996; Friederici et al., 2001), so a different ERP signature is expected for constructions like (D). Alternatively, if the differences are only quantitative in nature, such that reanalysis proceeds in a similar manner in both constructions but with reduced processing costs for dative structures, then we expect either a smaller P600 or an early positivity (possibly with a reduced amplitude) for structures like (D) as compared to (B).

Method

Participants

Twenty-four undergraduate students from the University of Leipzig participated in Experiment 1 after giving informed consent (11 female; mean age 25.0 years; age range 21–29 years). All participants in this and the following experiments were right handed, monolingual native German speakers with normal or corrected-to-normal vision. Four participants were subsequently excluded from the final data analysis on the basis of EEG artifacts and/or too many errors in the behavioral control task.

Materials

Eighty sets of the four conditions shown in Table 1 were constructed (see Appendix). As discussed above, only dative active verbs were included in the dative conditions. To ensure that disambiguation towards an object-initial order was effected by a singular verb form as often as by a plural verb form, an additional 80 sets of the critical conditions were generated by reversing the order of the proper noun and bare plural NP and changing the verb form from singular to plural or vice versa. The resulting 640 sentences (320 with accusative and 320 with dative verbs) were assigned to eight lists of 80 sentences each, four with dative constructions and four with accusative constructions. The presentation of dative vs. accusative verbs was thus designed as a between subjects factor in order to ensure that the conflict resolution strategies for the two types of constructions would not mutually influence one another. Each participant was presented with 40 sentences per condition (subject–object vs. object–subject), of which 20 included a singular and 20 included a plural verb. Each set of critical stimulus items was combined with an equal number of filler items such that each participant read 160 sentences in total. The filler sentences were structurally similar to the critical stimulus items, but unambiguously case marked. Object case marking (accusative vs. dative) and word order (nominative- vs. non-nominative-initial) were counterbalanced.

Procedure

Participants were assigned to the dative or the accusative group at random at the beginning of an experimental session. Stimulus items were randomized individually for each participant.

Sentences were presented visually in the center of a computer screen in a word-by-word manner with a presentation time of 450 ms per word and an inter-stimulus interval (ISI) of 100 ms. Each trial began with the presentation of an asterisk (300 ms plus 300 ms ISI) and ended with a 1000 ms pause, after which participants were required to complete a comprehension task. This task involved judging whether a declarative main clause presented on the screen in its entirety correctly described the content of the preceding experimental sentence or not. The comprehension task required the answer ‘yes’ equally as often as the answer ‘no’ in each of the experimental conditions; questions requiring a 'no' response reversed the assignment of subject and object in the experimental sentence. The assignment of the left and right buttons to the answers 'yes' and 'no' for the comprehension task was counterbalanced across participants.

Participants were asked to avoid movements and to only blink their eyes between their response to the comprehension task and the presentation of the next sentence. The experimental session began with a short training session followed by four experimental blocks comprising 40 sentences each, between which the participants took short breaks. The entire experiment (including electrode preparation) lasted approximately 2 h.

The EEG was recorded by means of 58 AgAgCl-electrodes fixed at the scalp by means of an elastic cap (Electro Cap International, Eaton, OH). The ground electrode was positioned above the sternum. Recordings were referenced to the left mastoid, but rereferenced to linked mastoids offline. The electro-oculogram (EOG) was monitored by means of electrodes placed at the outer canthus of each eye for the horizontal EOG and above and below the participant's right eye for the vertical EOG. Electrode impedances were kept below 5 kΩ.

All EEG and EOG channels were amplified using a Twente Medical Systems DC amplifier (Enschede, The Netherlands) and recorded continuously with a digitization rate of 250 Hz. The plots of grand average ERPs were smoothed off-line with a 10 Hz low-pass filter, but all statistical analyses were computed on unfiltered data.

Average ERPs were calculated per condition per participant from the onset of the critical stimulus item (i.e., the verb) to 1000 ms post onset, before grand-averages were computed over all participants. Averaging took place relative to a baseline interval from −200 to 0 ms before the onset of the verb. Trials for which the comprehension task was not performed correctly were excluded from the averaging procedure, as were trials containing ocular, amplifier-saturation or other artifacts (the EOG rejection criterion was 40 μV).

Data analysis

For the behavioral data, error rates and reaction times were calculated for each condition. Incorrectly answered trials were excluded from the reaction time analysis. We computed a repeated-measures analysis of variance (ANOVA) involving the between subjects factor VERB (accusative vs. dative), the within subjects factor ORDER (nominative-initial vs. non-nominative-initial) and the random factors subjects (F_1) and items (F_2).

For the statistical analysis of the ERP data, repeated-measures ANOVAs involving the between subjects factor VERB (accusative vs. dative) and the within subjects factor ORDER (nominative-initial vs. non-nominative-initial) were calculated for mean amplitude values per time window per condition in six regions of interest (ROIs). Time windows were chosen on the basis of previous studies and visual inspection of the data. Regions of interest were defined as follows: *left-anterior* (F9, F7, F5, FT9, FT7, and FC5); *left-posterior* (TP9, TP7, P5, P9, P7, and P5); *central-anterior* (F3, FZ, F4, FC3, FCZ, and FC4); *central-posterior* (CP3, CPZ, CP4, P3, PZ, and P4); *right-anterior* (F10, F8, F6, FT10, FT8, and FC6); and *right-posterior* (TP10, TP8, CP6, P10, P8, and P6). The statistical analysis was carried out in a hierarchical manner, i.e., only significant interactions ($p \leqslant .05$) were resolved. To avoid excessive type 1 errors due to violations of sphericity, we applied the correction of Huynh and Feldt (1970) when the analysis involved factors with more than one degree of freedom in the numerator.

Results

Behavioral data

The error rates and reaction times for the comprehension task are shown in Table 2. Differences in the speed and accuracy of responding to the comprehension question are off-line measures that provide a general measure of the probability of correctly interpreting the structures.

A repeated measures ANOVA on the error rates showed a main effect of ORDER ($F_1(1,18) = 9.27$, $p < .01$; $F_2(1,158) = 20.15$, $p < .001$), with lower accuracy for non-nominative-initial orders. The main effect of VERB ($F_1(1,18) = 3.70$, $p = .07$; F_2 $(1,158) = 19.36$, $p < .001$) and the interaction VERB × ORDER (F_1 $(1,18) = 1.89$, $p = .19$; $F_2(1,158) = 4.10$, $p < .05$) were significant in the analysis by items only. For the reaction times, there was again a main effect of ORDER ($F_1(1,18) = 11.62$, $p < .01$; $F_2(1,158) = 5.69$, $p < .02$), while the main effect of VERB was significant in the analysis by items only ($F_1 < 1$; F_2 $(1,158) = 5.69$, $p < .02$).

Table 2
Error rates and reaction times for the four critical conditions in Experiment 1

Condition	Errors in% (*SD*)	Reaction times in ms (*SD*)
SO-ACC	5.75 (4.42)	1075 (296)
OS-ACC	15.00 (15.23)	1156 (355)
SO-DAT	2.50 (2.36)	1077 (139)
OS-DAT	6.00 (5.80)	1116 (166)

These off-line measures provide evidence that participants were less likely to correctly interpret non-nominative-initial than nominative-initial orders. The differences are consistent with the notion that the former require a potentially error-prone reanalysis process, which leads to lower levels of interpretability. Although error rates were higher for accusative-initial structures than dative-initial structures, these differences were not reliable across the subject-based (F_1) analyses. Hence, there is no clear evidence that the two types of non-nominative-initial differ in their ultimate interpretability, even though, as illustrated below, they do appear to differ in the types of reanalysis operations performed.

ERP data

Figs. 2 and 3 show grand average ERPs at the position of the disambiguating verb for accusative and dative sentences, respectively.

Fig. 2 illustrates that the present results replicate previous findings of a late (approximately 600–900 ms), parietal positivity (P600) for accusative- vs. nominative-initial structures at the position of a disambiguating accusative verb. Fig. 3 shows that, for dative verbs, the analogous contrast gave rise to a centro-parietal negativity between approximately 350 and 600 ms (N400).

For the statistical analysis, the accusative and dative verbs were not compared directly, since the ERP responses to the two classes of verbs differ from one another independently of the word order manipulation. This is shown in Fig. 4, which depicts differences between accusative and dative verbs averaged across word order and ambiguity. Also included in these averages were case unambiguous constructions drawn from the filler items.

Fig. 4 shows that there are principled differences in the ERP response to accusative and dative verbs that are independent of ambiguity (i.e., of whether the type of verb was predictable on the basis of the arguments or not) and word order. These differences therefore appear to result from general lexical differences between the two verb classes, rather than from additional processing costs attributable to unexpectedly encountering a dative verb.

Two time windows were chosen for the statistical analysis of the ERP data: 400–600 ms for the N400 and 650–900 ms for the P600.

N400 time window: 400–600 ms

In the N400 time window, a global repeated measures ANOVA revealed a main effect of ORDER for dative verbs ($F(1,9) = 5.15$, $p < .05$), with dative-initial structures more negative than their nominative-initial counterparts. For accusative verbs, by contrast, there was no effect of ORDER in this time window ($F < 1$).

P600 time window: 650–900 ms

The statistical analysis of the P600 time window showed an effect of ORDER for accusative verbs ($F(1,9) = 6.48$, $p < .04$), with accusative-initial structures engendering a more positive ERP response, but not in the case of dative verbs ($F < 1$).

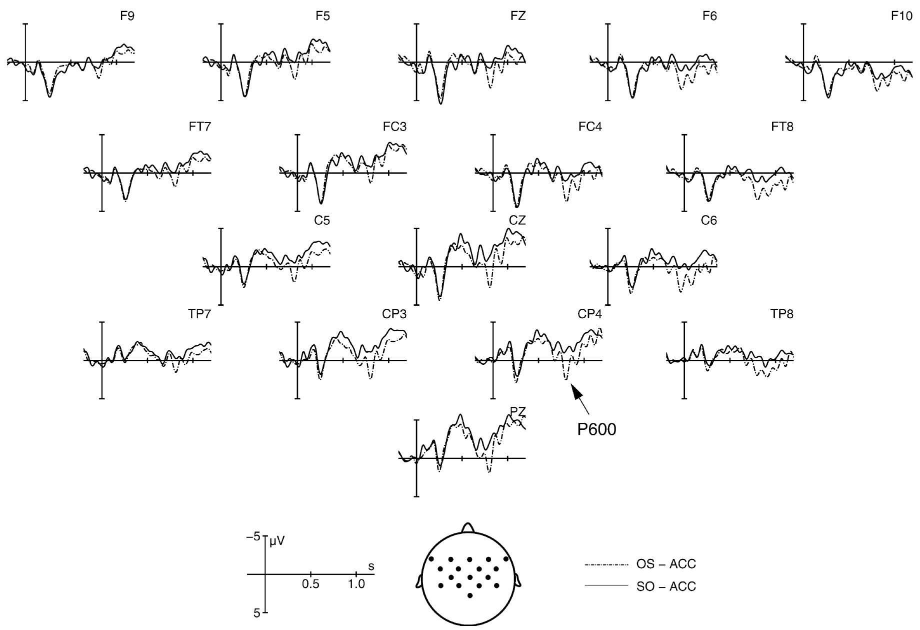

Fig. 2. Grand average ERPs at selected electrodes at the position of the disambiguating verb (onset at the vertical bar) for object-initial sentences with accusative verbs (OS-ACC) vs. subject-initial sentences with accusative verbs (SO-ACC) in Experiment 1. Negativity is plotted upwards.

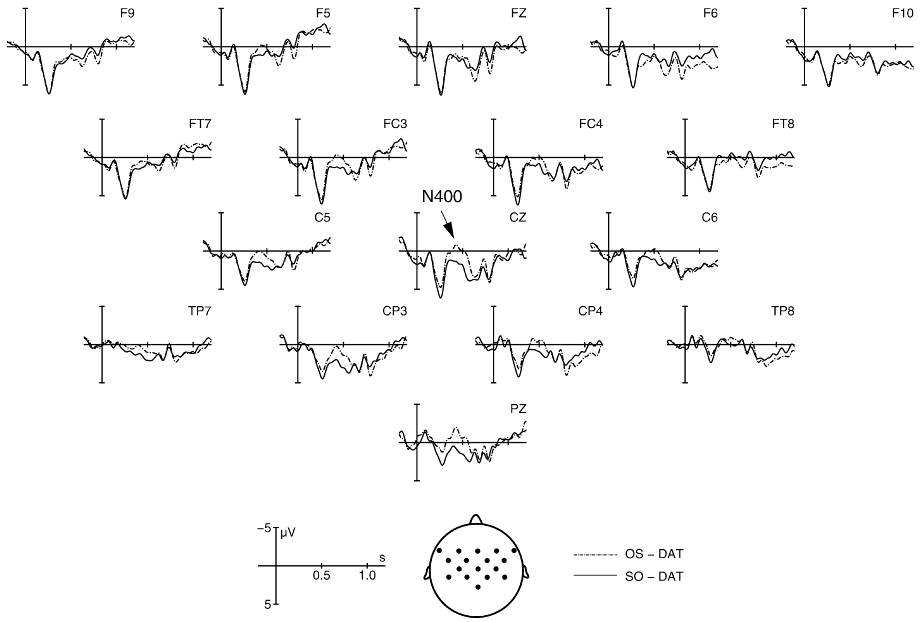

Fig. 3. Grand average ERPs at selected electrodes at the position of the disambiguating verb (onset at the vertical bar) for object-initial sentences with dative verbs (OS-DAT) vs. subject-initial sentences with dative verbs (SO-DAT) in Experiment 1. Negativity is plotted upwards.

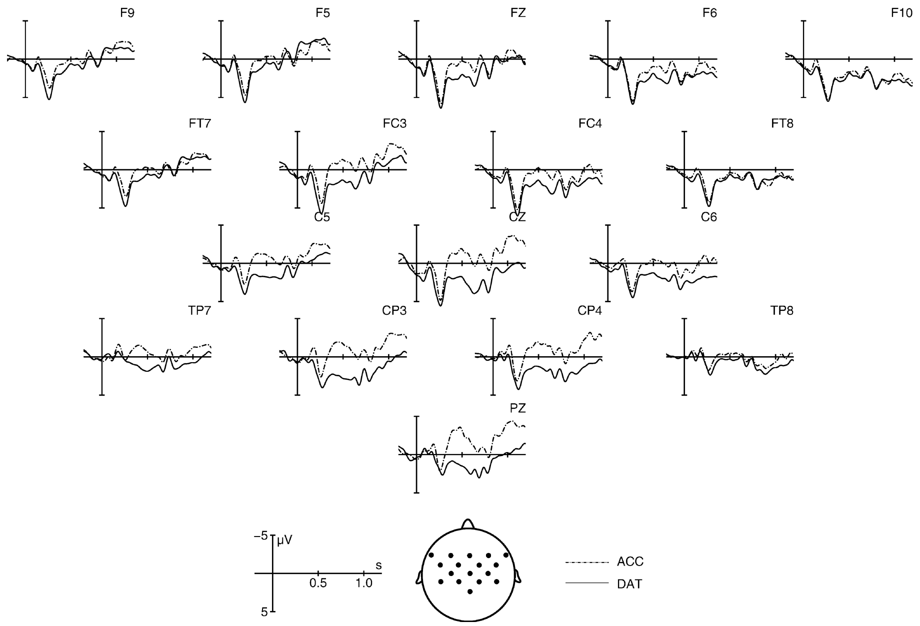

Fig. 4. Grand average ERPs at selected electrodes at the position of the disambiguating verb (onset at the vertical bar) for dative vs. accusative verbs. Note that both the critical ambiguous structures and unambiguous structures from the filler items were included in this average. Negativity is plotted upwards.

Discussion

Experiment 1 replicated previous findings of a P600 component for reanalysis towards an accusative-initial order. Crucially, however, this study revealed the novel finding of an N400 effect for reanalysis towards a dative-initial order. These distinct ERP components for the two types of reanalyses are consistent with the hypothesis that qualitatively different reanalysis mechanisms were operative in the two structures.

While the P600 has often been associated with reanalysis processes, the N400 is typically thought to reflect manipulations of lexical–semantic factors rather than manipulations that trigger reanalysis (cf. Kutas & Federmeier, 2000). In keeping with this literature, one might interpret the observed N400 effect as the detection of some implausibility rather than a reflection of reanalysis. We tested this hypothesis more directly in Experiment 3, where we show that the N400 component occurs in conditions that have a slower processing time-course, as predicted by a reanalysis account. Here, however, we note several reasons to doubt that the detection of implausibility alone can provide a principled explanation of the observed N400 in dative-initial constructions. First, dative- and accusative-initial structures are approximately equal in their frequency of occurrence (cf. Bornkessel, Schlesewsky, & Friederici, 2002b), so it is unlikely that any inherent difference in co-occurrence frequency can explain the pattern. Second, the absence of an N400 component in the accusative-initial structures shows that non-nominative-initial orders, as a class, are not less plausible than nominative-initial orders. Hence, in order to interpret the N400 for the dative-initial structures as an implausibility effect, one would have to argue that dative verbs are more semantically constrained than accusative verbs, and that, as a result, they are less plausible in non-nominative-initial structures. However, to the contrary, Fig. 4 illustrates that accusative verbs elicit a larger negativity in the N400 time window than dative verbs, independently of word order and argument ambiguity. This finding suggests the opposite: If—hypothetically—there are differences in this respect, accusative verbs appear to be more constrained semantically than dative verbs.

Other experimental findings also suggest that the observed N400 effect is more properly viewed as a reflex of a reanalysis process. First, dative-initial structures exactly analogous to those examined here are judged less acceptable than their nominative-initial counterparts in a task requiring speeded acceptability judgments (Schlesewsky & Bornkessel, 2003). Such patterns are typical for reanalysis constellations (e.g., Bader & Meng, 1999). Finally, and perhaps most importantly, there are prima facie grounds to assume that both the accusative and dative sentences in Experiment 1 require some form of reanalysis. Both conditions were identical up to the point of the verb, and should therefore equally induce a nominative-initial analysis. When the verb is encountered and the initial number agreement mismatch to the first argument detected, reanalysis is necessary if both non-nominative-initial sentences are to be understood correctly. Of course, the N400 effect could simply reflect the detection of an implausibility if participants adopted a nominative-initial analysis for the dative-initial structures but did not attempt to reinterpret these sentences. However, the low (6%) error rate for the dative-initial sentences in the comprehension task attests to the fact that the correct, object-initial analysis was indeed computed in most trials.

Consequently, we believe that the observed differences in ERP components—a P600 for accusative-initial structures and an N400 for dative-initial structures—support the hypothesis that revisions of case assignments differ qualitatively from revisions of phrase structure. Moreover, the finding of an N400 for a reanalysis in sentences with dative *active* verbs suggests that the qualitative difference between reanalyses in dative and accusative structures stems from the general availability of a dative-initial base order rather than from specific lexical properties. The precise role of lexical information in this process will be examined more closely in Experiment 2.

Experiment 2

In Experiment 2, we explored further the finding of an N400 in the revision of dative-initial structures. In particular, we examined whether the same ERP component is observable in sentences with verbs that lexically require a dative-initial order. A strong influence of this type of lexical information would be expected on the basis of several recent accounts of sentence processing, which have emphasized the role of lexical information in language comprehension and, particularly, its effect on the likelihood of misanalysis and subsequent recovery (e.g., Ford, Bresnan, & Kaplan, 1982; MacDonald, Pearlmutter, & Seidenberg, 1994; Trueswell, Tanenhaus, & Kello, 1993).

Interestingly, Experiment 1 revealed qualitative differences in reanalysis even though none of the material included lexical information *specifically* requiring a dative–nominative structure, such as a dative object-experiencer verb or a passivized ditransitive verb (cf. examples 3 and 4). This suggests that the observed effects result from an application of general syntactic knowledge, which specifies that dative–nominative is a possible unmarked order in German. Nevertheless, lexical information may affect reanalysis and, as a consequence, may modulate the ERP effects. We addressed the effect of lexical information by comparing reanalysis towards a dative-initial order in constructions with dative active verbs and dative object-experiencer verbs. The critical materials are shown in Table 3.

The conditions for Experiment 2 were identical to those used in Experiment 1 with the exception that the accusative verbs were replaced by dative object-experiencer verbs. Crucially, as discussed in the Introduction, dative object-experiencer verbs provide explicit lexical information for a dative-initial order whereas dative active verbs do not. As the verbs all occurred sentence-finally,

Table 3
Example sentences for each of the four critical conditions in Experiment 2

Condition	Example
(A) SO active	... dass Maria Sängerinnen folgt, obwohl... ... that Maria$_{NOM/ACC/DAT.SG}$ singers$_{NOM/ACC/DAT.PL}$ follows$_{SG}$, although ...
(B) OS active	... dass Maria Sängerinnen folgen, obwohl ... ... that Maria$_{NOM/ACC/DAT.SG}$ singers$_{NOM/ACC/DAT.PL}$ follow$_{PL}$
(C) SO obj-exp	... dass Maria Sängerinnen gefällt, obwohl ... ... that Maria$_{NOM/ACC/DAT.SG}$ singers$_{NOM/ACC/DAT.PL}$ pleases$_{SG}$
(D) OS obj-exp	... dass Maria Sängerinnen gefallen, obwohl ... ... that Maria$_{NOM/ACC/DAT.SG}$ singers$_{NOM/ACC/DAT.PL}$ please$_{PL}$

As in Experiment 1, each sentence was completed by an adjunct clause in order to avoid confounding sentence wrap-up effects at the position of the critical verb.

lexical information would not prevent participants from adopting a nominative-initial analysis of the ambiguous NPs, but it might affect the ease of reanalysis. This may be the case if the dative-initial target structure is rendered more accessible by the processing of a dative object-experiencer verb than by the processing of a dative active verb. Indeed, as discussed in the Introduction, data from a speeded acceptability judgment task showed that dative-initial structures with object-experiencer verbs do not engender the acceptability decrease in comparison to nominative-initial structures that is evident with dative active verbs (Schlesewsky & Bornkessel, 2003).

We hypothesize that dative-initial structures with both types of verbs require revision of case assignments as a consequence of the strong preference for a nominative-initial analysis. Hence, based on the results of Experiment 1, we predict that both will engender an N400 component relative to the control constructions (A and C in Table 3). However, if the lexical information associated with dative object-experiencer verbs facilitates revision processes, then there may be a reduction of the 'reanalysis N400' in terms of its amplitude, latency or topographical distribution.

Method

Participants

Sixteen undergraduate students from the University of Leipzig participated in Experiment 2 (8 female; mean age 23.1 years; age range 20–27 years) after giving informed consent. None had participated in Experiment 1.

Materials

The materials for Experiment 2 were generated in the same manner as those for Experiment 1, except that the accusative verbs were replaced with dative object-experiencer verbs (see Appendix). Thus, there were again 80 basic sets of the 40 conditions in Table 2 and a second version of each set, in which the order of the singular and plural NPs was reversed and, consequently, the number marking on the clause-final verbs interchanged. In this way, 640 critical experimental sentences were created. These were assigned to four lists of 160 critical items (40 per condition) in a counterbalanced manner such that each participant saw two sentences from one set of lexical items, one with an initial singular NP and one with an initial plural NP. These 160 critical items were randomly interspersed with 160 filler items to yield the stimulus material for one experimental session. The filler sentences were structurally similar to the critical experimental items but unambiguously case marked.

Procedure

The experimental procedure, task, and EEG recording parameters were identical to Experiment 1, except that the EEG was amplified using a Neuroscan synamps amplifier (DC—50 Hz) in this experiment.

Data analysis

For the behavioral data, error rates and reaction times were calculated for each condition. Incorrectly answered trials were excluded from the reaction time analysis. We computed a repeated-measures analysis of variance (ANOVA) with the within subjects factors VERB (dative active vs. dative object experiencer) and ORDER (nominative-initial vs. dative-initial) and the random factors subjects (F_1) and items (F_2).

The statistical analysis of the ERP data was carried out as for Experiment 1, though involving the within subjects factors VERB (dative active vs. dative object experiencer) and ORDER (nominative-initial vs. dative-initial). Regions of interest were also defined as in Experiment 1.

Results

Behavioral data

Table 4 shows the error rates and mean reaction times for the comprehension task in Experiment 2.

Table 4
Error rates and reaction times for the four critical conditions in Experiment 2

Condition	Errors in % (*SD*)	Reaction times in ms (*SD*)
SO-Active	2.83 (4.90)	1204 (342)
OS-Active	12.67 (17.31)	1320 (383)
SO-Experiencer	9.50 (9.96)	1359 (385)
OS-Experiencer	14.33 (13.77)	1464 (433)

The statistical analysis of the error rates for the comprehension task revealed significant main effects of ORDER ($F_1(1,15) = 5.91$, $p < .03$; $F_2(1,79) = 45.74$, $p < .0001$) and VERB ($F_1(1,15) = 8.06$, $p < .02$; $F_2(1,79) = 14.98$, $p < .0002$). These effects were due to higher error rates for dative-initial structures (13.5%) in comparison to nominative-initial structures (6.2%) and for structures involving object-experiencer verbs (11.9%) in comparison to structures involving active verbs (7.8%). The interaction ORDER × VERB reached significance only in the analysis by items ($F_1(1,15) = 1.83$, $p = .20$; $F_2(1,79) = 6.14$, $p < .02$).

With regard to the reaction times, there were again main effects of ORDER ($F_1(1,15) = 14.03$, $p < .01$; $F_2(1,79) = 10.81$, $p < .01$) and VERB ($F_1(1,15) = 32.48$, $p < .0001$; F_2 $(1,79) = 26.32$, $p < .0001$), with dative-initial structures eliciting longer reaction times (1392 ms) than nominative-initial structures (1282 ms) and object-experiencer verbs eliciting longer reaction times (1412 ms) than their active counterparts (1262 ms).

As in Experiment 1, participants were less accurate at and responded slower to questions about sentences with non-nominative-initial orders, which is consistent with the idea that these structures require a reanalysis operation. That object-experiencer verbs produced less accurate and slower responses than active verbs may indicate that these verbs are in some unknown sense more complex than their active counterparts.

ERP data

Figs. 5 and 6 show grand-average ERPs for subject- vs. object-initial structures at the position of the verb for active and object-experiencer verbs, respectively.

Visual inspection of Figs. 5 and 6 reveals that, for both active and object-experiencer verbs, dative-initial structures elicited a broad, centro-parietal negativity between approximately 350 and 550 ms post onset of the verb. This effect appears to be less pronounced in the object-experiencer structures (Fig. 6) than in the active structures (Fig. 5). Additionally, in approximately the

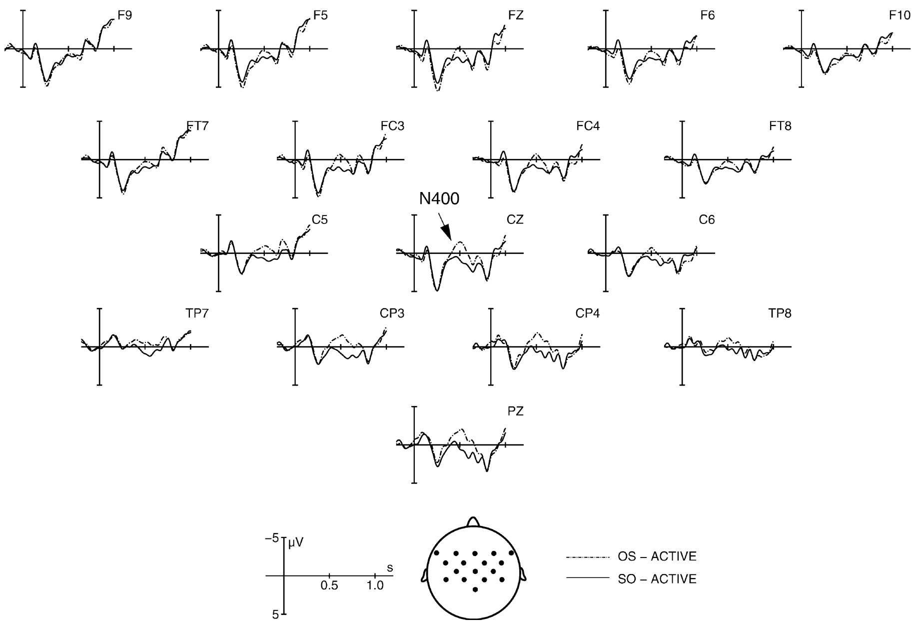

Fig. 5. Grand average ERPs at selected electrodes at the position of the disambiguating verb (onset at the vertical bar) for object-initial sentences with active verbs (OS-ACTIVE) vs. subject-initial sentences with active verbs (SO-ACTIVE) in Experiment 2. Negativity is plotted upwards.

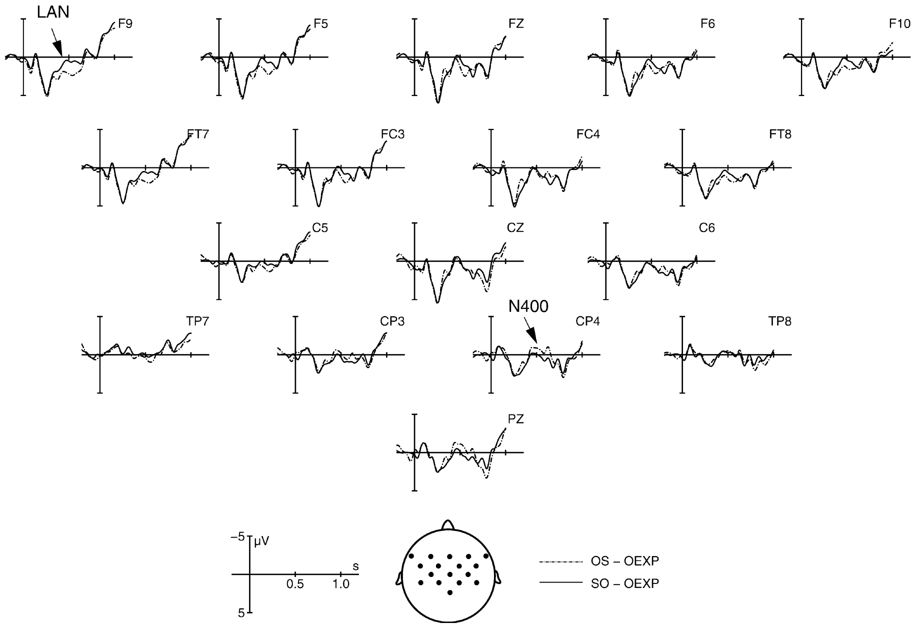

Fig. 6. Grand average ERPs at selected electrodes at the position of the disambiguating verb (onset at the vertical bar) for object-initial sentences with object-experiencer verbs (OS-OBJECT EXP) vs. subject-initial sentences with object-experiencer verbs (SO-OBJECT EXP) in Experiment 2. Negativity is plotted upwards.

same time range, Fig. 6 reveals a left-anterior negativity for nominative-initial structures with object-experiencer verbs in contrast to their dative-initial counterparts.

The statistical analysis revealed significant interactions ORDER × VERB in both the left-anterior ($F(1,15) = 5.82$, $p < .03$) and the left-posterior ($F(1,15) = 10.14$, $p < .01$) ROIs, as well as a significant main effect of ORDER in the central-posterior ROI ($F(1,15) = 12.35$, $p < .01$) and a marginal main effect of order in the right-posterior ROI ($F(1,15) = 3.63$, $p < .08$). In both cases, the ORDER effect was due to more negative ERP wave-forms in the dative-initial condition.

The two interactions ORDER × VERB were both resolved by VERB to examine differences in the processing of nominative-initial vs. dative-initial sentences between the two verb classes. In the left-anterior ROI, planned comparisons revealed a main effect of ORDER for object-experiencer verbs ($F(1,15) = 5.09$, $p < .04$; nominative-initial structures more negative), but not for active verbs ($F < 1$). In the left-posterior ROI, by contrast, there was a main effect of ORDER for active ($F(1,15) = 17.60$, $p < .01$; dative-initial structures more negative), but not for object-experiencer verbs ($F < 1$).

Discussion

Experiment 2 replicated the finding of an N400 effect for reanalyses towards a dative-initial order. This component was less pronounced with dative object-experiencer verbs than with dative active verbs, which supports the hypothesis that both dative-initial structures require reanalysis but that the processing costs are lower with object-experiencer verbs. Additionally, object-experiencer verbs in subject-initial sentences elicited a second ERP effect, namely a left-anterior negativity (LAN). This component, which we argue reflects a mismatch between the thematic hierarchy and the case hierarchy, is discussed further in the General discussion section.

The finding that both dative object-experiencer and dative active verbs engender an N400 effect, but that this component is more pronounced for the latter, also speaks against interpreting the N400 as a lexical–semantic implausibility effect. It is generally agreed that dative object-experiencer verbs are more strongly associated with a dative–nominative base order than are dative active verbs. Consequently, they should be *less* compatible with nominative-initial structures than dative active verbs and, correspondingly, should be perceived as *more* implausible in a nominative-initial interpretation. Exactly the opposite pattern is found in the data.

By contrast, if the N400 effect observed here indeed reflects reanalysis in the dative-initial constructions, as we have hypothesized, then the fact that this component is smaller for object-experiencer than for active verbs can be interpreted straightforwardly: lexical information in object-experiencer verbs eases the reanalysis process and thereby reduces the amplitude of the N400 effect. This follows from an assumption that German speakers have generalized knowledge that dative–nominative is a possible unmarked order in German, but that this information is more salient with dative object-experiencer verbs than it is with dative active verbs. The information is more salient because the dative object-experiencer verbs provide a strong lexical cue for the dative-initial order. Consequently, the information crucial to the reanalysis is more accessible following the processing of a dative object-experiencer verb than it is following the processing of a dative active verb. While Experiment 1 demonstrated that the differences between reanalysis towards a non-nominative-initial order in dative and accusative constructions are qualitative in nature, eliciting either an N400 or a P600 effect, the results of the current experiment suggest that lexical differences within the dative construction engender quantitative differences, as reflected in a modulation of the N400 component. We suggest that this pattern is explicable under the assumption that the availability of an unmarked dative–nominative word order enables a simple reassignment of cases, which gives rise to an N400 rather than a P600 effect. The specific lexical evidence provided by object-experiencer verbs, by contrast, reduces the cost of reanalysis by rendering the dative-initial word order more accessible. We view this lexical difference as a quantitative difference, as we assume that the same basic operations are used in the reanalysis of dative-initial structures with both types of verbs.

This account hinges on the assumption that different ERP components (e.g., N400 vs. P600 effects) reflect qualitatively different processes, and that modulations of a single component reflect quantitative variations in the same underlying process. The first assumption appears well founded, since there is little or no evidence to suggest that identical processes will elicit distinct ERP components. The second assumption, however, is less certain, as it is well known that there is a many-to-one mapping between cognitive (or even linguistic) subdomains and ERP components. Hence, it is possible that different processes could be reflected in a single component. It is therefore desirable to seek alternative means of testing the claim that both types of dative-initial structures require reanalysis, but that the two verb forms, dative active and dative object-experiencer verbs, differ in how well they cue the unmarked dative–nominative word order. The next experiment tests both of these ideas.

Experiment 3

Reanalysis requires recomputation, which requires additional processing time. Thus, if ambiguous dative-initial constructions require a reanalysis of case assignments as a result of an initial (incorrect) nominative-initial analysis, it should take longer to compute a dative-initial interpretation than to compute the analogous nominative-initial interpretation. Hence, if the N400 effect observed here is a reflection of a reanalysis process, as we have argued, then conditions that engender an N400 effect should take longer to process than control conditions. As both object-experiencer and dative active verbs in dative-initial structures engender an N400 effect, we predict that readers should process both structures more slowly than their nominative-initial counterparts. This follows from an assumption that the underlying computational steps in the revision of case assignments are the same for dative-initial structures with both object-experiencer and dative active verbs.

Experiment 2 demonstrated that dative-initial structures with object-experiencer verbs engender a smaller N400 effect than dative-initial structures with dative active verbs. We suggested that this difference reflects the fact that the unmarked dative–nominative word order, which is crucial to the correct revision of case assignments, is more strongly associated with object-experiencer verbs. If this interpretation of the difference in the magnitude of the N400 effect is correct, then it minimally suggests that readers will be more likely to correctly revise the case assignments in a dative-initial sentence with an object-experiencer verb. Hence, we predict that readers will be more likely to recover from a misanalysis when disambiguation is effected by an object-experiencer verb rather than by an active verb.

In terms of the speed and accuracy of processing dative-initial structures, then, our interpretation of the ERP findings crucially predicts the following: (i) readers will process dative-initial structures with both object-experiencer and dative active verbs more slowly than their nominative-initial counterparts and (ii) readers will be more likely to correctly interpret dative-initial structures with object-experiencer than with active verbs. Whether dative-initial structures with object-experiencer verbs also differ in processing speed from dative-initial structures with active verbs depends of several factors, as discussed more fully below.

Testing the two predictions above requires conjoint measures of the probability of successfully interpreting a structure and the time-course for computing that interpretation. Reading time (eye-movement tracking or self-paced) procedures are often used as a natural and unintrusive measure of processing time. However, these measures do not provide an estimate of the likelihood that readers have successfully processed a sentence and, conversely, do not provide a direct estimate of the time it takes to compute an interpretation. A reading time difference can reflect the time needed to compute a particular interpretation, but it can also reflect the likelihood that readers can compute that interpretation or how plausible readers finds the resulting interpretation (McElree, 1993, 2000; McElree, Foraker, & Dyer, 2003; McElree & Griffith, 1995, 1998; McElree & Nordlie, 1999). A standard solution to this problem is to derive a full time course function that measures how the accuracy of processing varies with processing time (Wickelgren, 1977). The response-signal, speed-accuracy trade-off (SAT) procedure provides the required conjoint measures of processing speed and accuracy.

SAT methodology

In our application of the procedure, participants were asked to judge whether a string was a well-formed, meaningful sentence by discriminating acceptable from unacceptable strings. The materials included acceptable sentences like those in Table 3, as well as an equal number of unacceptable strings like those in (9).

(9) Gestern wurde erzählt, ...
'Yesterday, someone said ...'
a. *... dass der Kommissar Pastoren abraten.
... that [the superintendent]$_{\text{NOM.SG}}$ pastors$_{\text{NOM/ACC/DAT.PL}}$ dissuade $_{\text{PL}}$
b. *... dass Pastoren der Kommissar abraten.
... that pastors$_{\text{NOM/ACC/DAT.PL}}$ [the superintendent]$_{\text{NOM.SG}}$ dissuade $_{\text{PL}}$
c. *... dass der Kommissar Pastoren auffallen.
... that [the superintendent]$_{\text{NOM.SG}}$ the superintendent]$_{\text{NOM.SG}}$ notice$_{\text{PL}}$ pastors$_{\text{NOM/ACC/DAT.PL}}$ notice $_{\text{PL}}$
d. *... dass Pastoren der Kommissar auffallen.
... that pastors$_{\text{NOM/ACC/DAT.PL}}$

In the variant of the procedure used here (see also, McElree, 1993), participants were trained to respond (yes or no) within a trial to several tones at 350 ms intervals following the onset of a string. The range of selected times (0–6 s) spanned the full time-course of comprehension, from times that were too short to compute an interpretation to times that enabled complete processing of the expression. [McElree (1993) and several unpublished studies have shown that participants can dynamically modulate their responses within a trial to reflect ongoing cognitive states. This is supported by detailed analysis of within-trial data and by empirical findings of non-monotonic multiple response SAT functions.] This served to chart the full time-course of processing, measuring when discrimination departs from a chance level, the rate at which discrimination grows as a function of processing, and the asymptotic level of discrimination accuracy reached with (functionally) unlimited processing time.

Fig. 7 presents illustrative SAT functions derived from this procedure. The accuracy of discriminating acceptable from unacceptable sentences is measured in d' units (the z transform of the probability of correctly accepting an acceptable sentence minus z transform of the probability of falsely accepting an unacceptable sentence). Fig. 7 illustrates that typical SAT functions display three distinct phases: a period of chance performance ($d' = 0$), followed by a period of increasing accuracy, followed by an asymptotic period where further processing does not improve performance. In a sentence acceptability task, the SAT asymptote provides a measure of the probability (across trials and materials) that readers arrive at an interpretation sufficient to support an "acceptable" response. If two conditions differ in asymptote, as illustrated in Fig. 7A, it indicates that they differ in the likelihood that a meaningful interpretation can be computed or in overall acceptability/plausibility of the respective interpretation.

The point at which accuracy departs from the chance level (the intercept of the function) and the rate at which accuracy grows over processing time are joint measures of the underlying speed of processing. If one type of structure can be interpreted more quickly than another, the SAT functions will differ in rate, intercept, or some

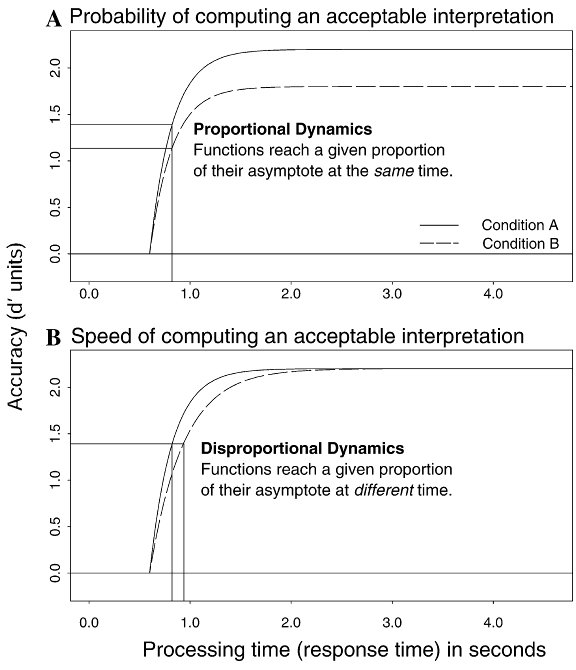

Fig. 7. Idealized SAT functions illustrating asymptotic differences (A) vs. dynamics differences (B).

combination of the two parameters. This follows from the fact that the SAT rate and intercept are determined by the underlying finishing time distribution for the processes that are necessary to accomplish the task. The time to compute an interpretation will vary across trials and materials, yielding a distribution of finishing times. Intuitively, the SAT intercept corresponds to the minimum of the finishing time distribution, and the SAT rate is determined by the variance of the distribution. For example, if the interpretation of one condition requires additional computational operations, then, relative to a condition with few operations, either the finishing time distribution will be shifted towards longer times, leading to an intercept difference, or the distribution will be more positive skewed, leading to a difference in rate. Fig. 7B depicts a case where the functions differ in rate of approach to asymptote, leading to disproportional dynamics; the functions reach a given proportion of their asymptote at different times.

Dynamics (rate and/or intercept) differences are independent of potential asymptotic variation. Readers may be less likely to compute an interpretation for one structure or may find that interpretation less acceptable (e.g., less plausible) than another; however, they may not require additional time to compute that interpretation (McElree, 1993, 2000; McElree et al., 2003; McElree & Nordlie, 1999). For example, McElree and Nordlie (1999) found that asymptotic accuracy was lower for figurative than literal expressions, suggesting that readers are less likely to retrieve and integrate the semantic and pragmatic information necessary to construct a figurative interpretation or that they found metaphoric expressions less acceptable than literal expressions. However, despite different (asymptotic) acceptability rates, the corresponding SAT function did not differ in either rate or intercept. These data indicate that figurative and literal interpretations were computed in comparable time.

SAT predictions

Our interpretation of the N400 effects observed in Experiments 1 and 2 leads to the following SAT predictions. First, the SAT functions for dative- and nominative-initial structures are predicted to differ in terms of processing dynamics, with dative-initial structures associated with a slower rate or longer intercept (or some combination of the two parameters) than nominative-initial structures. This prediction follows directly from the hypothesis that the former require additional operations to reanalyze the case assignments projected from a nominative-initial strategy. Whether the dynamics difference is expressed in SAT intercept or rate is not crucial for present purposes, as it depends on factors such as how long it takes to revise case relations relative to the overall variability in the time it takes to perform other operations.[3] It is reasonable to expect that asymptotic accuracy will also be higher for nominative-initial structures than dative-initial structures because the latter require a reanalysis process that may fail on some trials and lead readers to judge an acceptable dative-initial structure as unacceptable (a "miss" in signal detection terms). But, crucially, processing dynamics are predicted to be slower for both dative-initial structures as compared to the two nominative-initial structures whether or not the two structures differ in asymptotic accuracy, provided of course, readers attempt and succeed at reanalysis on some proportion of trials.

Note that this prediction contrasts with what is predicted by an account that attributes the N400 effect to perceived implausibility. If this effect simply reflects the detection of an implausibility without a concomitant reanalysis process, then SAT functions are predicted to differ in asymptotic level only, reflecting either the failure to compute an acceptable interpretation on a proportion of trials or that readers judge the resulting interpretation less acceptable.

Our second prediction is that object-experiencer verbs should engender a higher level of asymptotic performance than dative active verbs in dative-initial structures. This follows from the hypothesis that the dative–nominative target structure is more accessible following the processing of an object-experiencer verb. As a consequence, there is a greater likelihood of correctly computing this structure with object-experiencer than with active verbs. It is possible that dative-initial structures may also be processed faster with object-experiencer verbs than with active verbs, although this need not be the case. Dynamics differences could arise if readers retrieve the dative–nominative target structure

[3] The SAT functions represent the cumulative form of the underlying finishing time distributions for interpreting the sentences. If the time required for reanalysis is large with respect to the time required for other processes, and the variability in time (across trials and materials) for other processes is modest, then the leading edge of the finishing time distributions for conditions requiring reanalysis will be longer than the leading edge for conditions that do not require reanalysis by an amount equal to the average time required for reanalysis. Under such conditions, the dynamics difference will be expressed in SAT intercept because the SAT intercept directly reflects the leading edge of the finishing time distribution. If the amount of time require for reanalysis is more modest with respect to the variability of other processes, then differences in dynamics will be expressed in SAT rate exclusively or as combination of intercept and rate differences (see McElree, 1993, for specific simulations). Another reason why reanalysis effects may engender rate rather than intercept differences is that readers may not adopt a nominative-initial strategy on all trials with dative-initial structures. If this is the case, then minima of the finishing time distributions may not differ for nominative–dative and dative–nominative structures.

more quickly with object-experiencer verbs than with active verbs, or if readers attempt alternative analyses with active verbs before adopting the correct dative-initial analysis.

Method

Participants

Thirteen students of the University of Leipzig participated in Experiment 2 (10 female; mean age 22.6 years; age range from 20 to 27 years). Three further participants were excluded from the final data analysis on account of not having performed well enough on at least one of the control tasks (see below). None of the participants had taken part in either of Experiments 1 and 2.

Materials

Sixteen sentences for each of the four conditions illustrated in Table 2 were selected from the materials used in Experiment 2. An unacceptable variant of each of the conditions was generated by replacing the case ambiguous NP that did match the clause-final verb's number marking with a NP unambiguously marked for nominative case (cf. example 9 above). These 64 unacceptable strings served as the baseline false alarm rate for d' scaling (see below). The set of experimental materials was combined with 152 filler sentences. Fifty percent of these fillers were unacceptable at different regions of the sentence to ensure that participants were required to carefully read the complete string, including the matrix clause, both arguments and the verb.

Procedure

Participants read an individual sentence presented on a computer screen, and simultaneously judged whether it was acceptable or not. They indicated their current assessment of the acceptability of the string by pressing one of two keys denoting a ''yes'' or ''no'' judgment. They did so at 17 time points, spaced at 350 ms interval signaled by a response tone (50 ms duration, 1000 Hz tone), starting at the onset of the test string. Participants were first trained for approximately 30 min to respond to the auditory tones presented at a 350 ms rate, entering each response concurrently with each auditory cue. After this training session, participants completed a 90-min experimental session, which consisted of 8 blocks of 35 sentences each. The sentences were presented in one of two pseudo-randomized orders. The randomizations, the order of blocks and the assignment of 'yes' and 'no' to the left and right keys were counterbalanced across subjects.

Each trial began with a fixation point, followed by a letter denoting the default answer key for that trial. A default key was employed to reduce subjects' possible a priori biases: for each condition, the first item began with a default of Y, and the next item of that condition began with a default of N, or vice versa, depending on the overall randomization of the stimuli. The default key (Y or N) was then pressed (concurrently with the tones) until the point where enough information became available to the subject to make informed judgments about the acceptability of the sentence. After each trial, participants were required to complete a comprehension task of the same form as in Experiments 1 and 2.

Data analysis

For the comprehension question, error rates and reaction times were calculated for each condition. Incorrectly answered trials were excluded from the reaction time analysis. The statistical analysis made use of a repeated-measures ANOVA with the critical factors ORDER (nominative–dative vs. dative–nominative) and VERB (active vs. object-experiencer) and the random factors subjects (F_1) and items (F_2).

For the SAT-data, all analyses were performed on the individual participants' data. Consistent patterns across participants were summarized by analyses of the average data. To correct for response bias, d' scores were computed by scaling the z score of the probability of saying ''yes'' to acceptable strings in each of the four conditions against the z score of the probability of saying ''yes'' to corresponding unacceptable strings. Accuracy (d') was plotted and analyzed as a function of processing time by computing the accuracy of responding within each of 350 ms time bins defined by the time of the response cues (tones).

Potential differences in asymptote, rate, and intercept were assessed by fitting the d' accuracies at various processing times (t) with an exponential approach to a limit:

$$d'(t) = \lambda(1 - e^{-\beta(t-\delta)}), \quad \text{for} \quad t > \delta, \text{ else } 0. \tag{1}$$

In Eq. (1), λ reflects the asymptote of the function, δ denotes the intercept or discrete point in time when accuracy departs from chance, and β indexes the rate at which accuracy grows to asymptote. Hierarchically nested models were fit to the data, ranging from a null model, in which all four experimental conditions were fit with a single asymptote (λ), rate (β), and intercept (δ), to a fully saturated model 12-parameter model, in which each experimental condition was fit with a unique set of parameters. Eq. (1) was fit to the data with an iterative hill-climbing algorithm (Reed, 1976), similar to STEPIT (Chandler, 1969), which minimized the squared deviations of predicted values from observed data. Fit quality was assessed by an adjusted-R^2 statistic—the proportion of variance accounted for by the fit adjusted by the number of free parameters (Judd & McClelland, 1989)—and by an evaluation of the consistency of the parameter estimates across the subjects. To verify that differences were reliable across materials, we computed a separate function for each sentence (averaged across participants), and fit each of the functions with Eq. (1) to estimate an asymptote (λ), rate (β), and intercept (δ).

Results

Comprehension question

The statistical analysis for the comprehension question revealed significant effects neither for the error rates (mean error rate, 6.49%; *SD*, 3.98) nor for the reaction times (mean reaction time, 1081 ms; *SD*, 449).

SAT

Fig. 8 shows the average (over participants) d' data as a function of processing time for subject-initial (squares) and object-initial (circles) constructions with the two verb types. Inspection of the figure suggests that there were asymptotic differences in the probability of judging the constructions as acceptable. Competitive model fits confirmed that impression. A $1\lambda - 1\beta - 1\delta$ (null) model, in which all four conditions were fit with a common set of parameters, produced an adjusted-R^2 value of .948 in

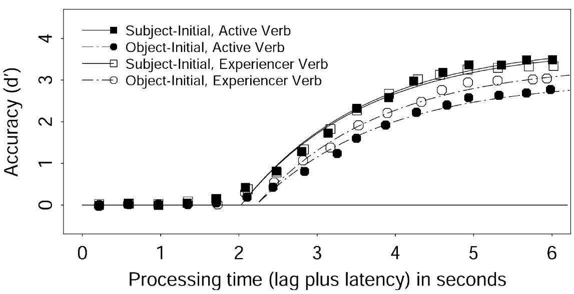

Fig. 8. SAT data points (symbols) and best fitting SAT functions (lines) for the four critical conditions in Experiment 3.

the average data, ranging from .714 to .981 across participants; by contrast, a $4\lambda - 1\beta - 1\delta$ model, with separate asymptotes (λs) for each construction type, increased the adjusted-R^2 to .991 in the average data, ranging from .878 to .942 across subjects. Subsequent fits demonstrated that the differences among conditions were not restricted to asymptote. The best fitting model was found to be a $4\lambda - 1\beta - 2\delta$ model, in which one intercept was allotted to subject-initial constructions and another to object-initial constructions, independent of verb type. This model produced an adjusted-R^2 value of .993 in the average data, ranging from .926 to .986 across participants. Model fits that varied rates or intercepts between verb types, either with or without allocating two intercepts to the nominative- and dative-initial constructions, produced lower adjusted-R^2 values and, crucially, did not produce a consistently ordered set of parameter estimates across participants.

Table 5 presents the parameter estimates for the $4\lambda - 1\beta - 2\delta$ fits of the average and individual participants' data. Consider first the asymptotic (λ) parameter estimates, which measure the likelihood of computing an interpretation of the sentence that met the criteria to be judged acceptable. A repeated measures ANOVA for the asymptote estimates revealed a main effect of ORDER ($F_1(1,12) = 44.46$, $p < .0001$; $F_2(1,47) = 70.95$, $p < .0001$), with nominative-initial constructions leading to higher asymptotes than dative-initial structures (3.82 vs. 3.20 in d' units), and an interaction ORDER × VERB ($F_1(1,12) = 8.41$, $p < .02$; $F_2(1,47) = 9.25$, $p < .01$). Single comparisons show significant effects of ORDER for both active ($F_1(1,12) = 34.45$, $p < .0001$; $F_2(1,47) = 61.27$, $p < .0001$) and object-experiencer verbs ($F_1(1,12) = 9.95$, $p < .01$; $F_2(1,47) = 6.69$, $p < .02$). Asymptotic differences alone would indicate that readers are simply less likely to compute an acceptable interpretation of dative-initial structures, and particularly so

Table 5
Exponential parameter estimates for individual participants in Experiment 3

Parameter estimates	Av	Participants												
		1	2	3	4	5	6	7	8	9	10	11	12	13
Asymptotes (λ)														
Subject, Active	3.85	3.74	3.45	3.06	4.00	4.00	4.00	3.19	3.76	4.00	3.70	3.71	3.29	4.00
Object, Active	3.00	3.00	3.00	3.00	2.51	2.27	2.58	3.00	3.00	1.77	3.00	2.36	2.26	3.00
Subject, Experiencer	3.78	3.90	3.90	2.97	3.90	3.90	3.90	3.13	3.66	2.83	3.67	2.56	3.90	3.90
Object, Experiencer	3.40	3.40	3.26	3.06	3.32	2.55	3.40	2.33	3.402	2.29	3.40	3.40	2.96	3.34
Dynamics														
Common rate (β)	0.623	0.844	0.599	0.917	0.505	0.848	0.870	0.984	1.975	0.913	1.452	0.701	0.949	1.556
Subject-Intercept (δ)	2.029	2.464	2.257	1.283	3.000	2.627	2.191	2.303	1.909	1.605	2.331	3.000	2.011	2.881
Object-Intercept (δ)	2.224	2.737	2.633	1.631	3.000	2.821	2.299	2.375	1.876	1.796	2.289	3.00	2.053	2.735
Adjusted-R^2	.992	.956	.964	.977	.923	.977	.961	.986	.977	.964	.954	.931	.978	.961

when they involve active verbs. However, the dynamics differences, best fit as differences in intercept, indicate that this notion alone cannot adequately account for the observed differences. The average intercept for the dative-initial structures was nearly 200 ms later than the intercept for nominative-initial structures (2.029 vs. 2.224), and that difference was reliable across participants and items ($F_1(1,12) = 5.73$, $p < .04$; $F_2(1,47) = 27.24$, $p < .0001$).

One might be concerned that the reported dynamics differences are particular to the exponential model fits. However, application of other time-course models is unlikely to substantially modify the conclusion drawn from the exponential model fits. Any viable model requires separate dynamics and asymptotic parameters to fit the functions in Fig. 8, as some asymptotic differences covary with dynamics differences, while others do not. Alternative models will capture the exponential differences in intercept in one or another of its dynamics parameters. For example, we fit the average data with a (3-parameter) sigmoid function, systematically varying the 3 parameters as we did with the exponential model

$$d'(t) = \lambda/(1 - e^{-\beta(t-\delta)}), \quad \text{for } t > \delta, \text{ else } 0. \tag{2}$$

The quality (adjusted-R^2) of the sigmoid fits was not as good as that of the exponential fits: $1\lambda - 1\beta - 1\delta = .932$ vs. .948; $4\lambda - 1\beta - 1\delta = .961$ vs. .991; $4\lambda - 2\beta - 1\delta = .962$ vs. .991; $4\lambda - 1\beta\text{-}2\delta = .961$ vs. .993; and $1\lambda - 1\beta - 1\delta = .932$ vs. .948. The poorer quality of fit results from the fact that the empirical SAT functions do not show the "S-ing" property that is predicted by the sigmoid, particularly the negative accelerating portions of the function as it is approaching asymptote. Crucially, however, dynamics differences are also evident in the sigmoid fits. In contrast to the exponential function, where the dynamics differences are best fit as a difference in intercept (δ), the sigmoid function tends to put the dynamics differences between normative-dative vs. dative–nominative orders in its rate (β), viz., 774 ms vs. 877 ms average processing speed (in $1/\beta$) units. That one function may capture the dynamics difference in one dynamics parameters and another in a different dynamics parameter has no real theoretical import for our purposes here. At issue is whether processing speed varies between two structures, one that engenders an N400 and another than does not. Both model fits indicate that processing speed does vary in the predicted direction.

Discussion

The time-course profile strongly implicates reanalysis mechanisms in the processing of ambiguous structures that are resolved in favor of a dative-initial analysis. A reanalysis explanation is directly motivated by the fact that the intercept was delayed by approximately 200 ms in these sentences. This estimate is surprisingly similar to a 166 ms difference reported in McElree (1993) for a comparison of early- vs. late-closure ambiguities (*While Bill watched Mary at/started work...*), which have been argued to be initially resolved in favor of a late-closure analysis. One interpretation of this difference is that it takes approximately 200 ms to perform the reanalysis operation. However, this estimate is an average over trials and materials. On some (unknown) proportion of the trials, readers may not have initially committed to a nominative-initial analysis. On that proportion of trials, no reanalysis process would be needed. A more conservative interpretation of this estimate is that it sets the lower bound on the time it takes to recover from an initial misanalysis. If some proportion of the dative-initial trials were initially parsed correctly, this overall difference will underestimate the true time needed for reanalysis.

In addition to dynamics differences between nominative- and dative-initial structures, there was also a reliable difference in asymptotic performance, with nominative-initial structures engendering higher levels of performance. This asymptotic difference could simply indicate that readers were less likely to find dative-initial structures acceptable. However, given the observed dynamics differences, a principled explanation of this effect is that readers failed to recover from the initial misanalysis on a proportion of trials.

The observed difference in dynamics between nominative-initial and dative-initial structures supports our hypothesis that the latter require a reanalysis operation. Our second hypothesis was also confirmed: In dative-initial structures, asymptotic accuracy was higher for object-experiencer verbs than for dative active verbs. This suggests that the lexical argument hierarchy associated with the object-experiencer verbs—and its association with a dative-initial word order—provides a salient cue to effectively guide the reanalysis process, thereby increasing the probability that the dative-initial analysis is recovered.

General discussion

The present experiments examined several aspects of the reanalysis mechanisms drawn upon in the processing of case ambiguities in German. While German speakers generally adopt a nominative-initial analysis in the face of a case ambiguity, the data indicate that misanalyses resulting from this strategy are not revised in a uniform way. Experiment 1 showed that reanalysis towards a dative-initial order elicits an N400 component, while reanalysis towards an accusative-initial order in otherwise identical sentences gives rise to a P600 component. In Experiment 2, lexical information was shown to modulate the N400 effect for dative sentences, in that this effect was less pronounced with object-experiencer than with active verbs. Finally, the SAT procedures used in Experiment 3 demonstrated that conditions that gave rise to the N400 effect in Experiments 1 and 2 are associated with approximately 200 ms slower processing dynamics. Additionally, the N400 modulation elicited by the verb class variation corresponds to a difference in asymptotic accuracy with no concomitant difference in processing speed.

The N400 as a reanalysis effect

The N400 component is typically thought to reflect effortful lexical–semantic processing, with its amplitude modulated by the predictability of an item (Kutas & Federmeier, 2000). Although the mapping between cognitive processes and ERP components can be many-to-one, it is commonly accepted that the N400 component is a marker of semantic processing, and that it does not arise from, as Kutas and Federmeier state, "anomalies in language that are non-semantic in nature such as grammatical violations" (p. 464). Taken together, our results indicate, to the contrary, that an N400 effect can index a type of grammatical reanalysis, namely the revision of case assignments and, consequently, of subject–verb agreement.

Several pieces of positive evidence support this alternative interpretation of the N400 effect. First, given the strong nominative-initial preference in German, there is prima facie evidence that syntactically ambiguous dative-initial structures, like syntactically ambiguous accusative-initial structures, must engage some type of reanalysis operation to compute the correct interpretation. The high levels of accuracy for both the comprehension questions (Experiments 1 and 2) and the acceptability judgments (Experiment 3) indicate that participants did in fact correctly interpret the dative-initial structures. This fact cannot be explained by any account in which the N400 effect simply reflects the implausibility associated with a nominative-initial analysis of a dative-initial structure. Second, the object-experiencer structures, which are more strongly associated with a dative-initial analysis, gave rise to a smaller, rather than a larger N400 effect than their active counterparts. Again, this finding is unexpected if the N400 were only a reflection of an implausible subject-initial analysis.

Furthermore, the measurably slower processing time (SAT intercept) for dative-initial as compared to nominative-initial structures indicates that the correct interpretation of the former required additional processing operations. The 200 ms delay in intercept for dative-initial sentences is consistent with "garden-path" effects in ambiguous English structures (McElree, 1993). Again, standard N400 interpretations do not provide an explanation of these time-course differences. Thus, the pattern of effects in our experiments suggests that this ERP component cannot be reduced to the lexical–semantic domain.

Lexical reaccess?

Based on results with stimuli superficially similar to the ones explored here, Hopf et al. (1998) proposed that the N400 might reflect lexical reaccess. They reported an "N400 like" component for a dative interpretation of an accusative–dative ambiguity and argued that, because accusative and dative objects occupy the same syntactic position, the revision towards a dative analysis does not involve structural alterations, but only the assignment of a [+dative] feature. As they assume that dative is always a lexical case and thereby requires a special type of lexical licensing, they interpret the negativity as a reflection of a *lexical reaccess*, which is required in order for the dative assignment to succeed.

Despite the superficial similarity between the revision processes required in the Hopf et al. (1998) study and in the present experiments, it is unlikely that our N400 effect reflects lexical reaccess. First, the structures used by Hopf et al. do not involve an ambiguity with regard to nominative case assignment. Second, any proposed account of our results that appeals to the distinction between dative as a "lexical" and accusative as a "structural" (object) case incorrectly predicts that *all* of the dative structures in our experiments should have engendered an N400 effect, irrespective of word order. As the arguments in our sentences were all three-way ambiguous between nominative, accusative, and dative case, the comprehension system should assign accusative case to the second NP on the basis of the accusative-over-dative preference. *All* sentences completed by a dative verb would then require lexical reaccess in order for dative case to be correctly assigned to either the first or second NP.[4]

The N400 as revision of case marking

We have suggested that German has a dative-initial base order and, consequently, that dative-initial structures require the revision of case assignment only and not the revision of phrase structure, as in the case of accusative-initial sentences. As we have noted, base orders can be analyzed as direct reflections of the lexical argument hierarchy projected by a verb. However, our results demonstrate that the reanalysis towards a

[4] An account of these results assuming that dative case may have been assigned by default in our experiment on the basis of an experiment-specific strategy is excluded by Hopf et al.'s findings as well as by the results reported in Kulik (2000). By virtue of the sentences used, these studies should be equally as prone as our experiments to a default dative assignment, though both show a clear, preference-based accusative-assignment.

dative-initial order engenders a N400 effect with both dative object-experiencer and dative active verbs. This suggests that the dative–nominative base order is also accessible to dative active verbs, which are not thought to be lexically associated with a dative-initial order because they do not project an "inverse" argument hierarchy (e.g., a thematic structure where a dative-marked Experiencer is argued to outrank a nominative-marked Theme). It appears that the dative active class benefits from the fact that other constructions (viz. sentences with dative object-experiencer verbs and passivized ditransitives) allow for an unmarked dative-initial reading. In this sense it may be appropriate to view general access to the dative-initial base order as an emergent property.

Another explanation for this "parasitic access" to the dative-initial base order may lie in the notion that the language processing system operates on "good enough" representations (Christianson et al., 2001; Ferreira, 2003; Ferreira et al., 2001; Ferreira, Ferraro, & Bailey, 2002). During reanalysis, the processing system may not fully revise incorrect initial assignments. Rather, it may only revise to a point at which the representation is sufficient for an interpretation, even though it is still less than ideal from a strictly grammatical point of view. In the particular case of dative-initial sentences with an active verb, the parser should construct a permuted structure. However, it may instead capitalize on the general availability of an unmarked dative–nominative structure, perhaps exploiting the fact that reanalysis towards a base order might be quicker and easier than computing a permuted order. Thus, the unmarked dative–nominative structure provides a "good enough" representation for the dative-initial sentences with active verbs, circumventing the need for a more engaging phrase structure revision.

Even though dative-initial structures with active verbs may exploit the fact that dative–nominative is a possible base order, we subscribe to the standard assumption that dative object-experiencer verbs are more strongly associated with this order because, unlike dative-active verbs, they directly encode an argument hierarchy that correlates with a dative-initial order in their lexical representation. We suggest that this property makes the dative-initial order more accessible with object-experiencer verbs, and that this is reflected (a) in the less pronounced N400 effect in Experiment 2, and (b) in the higher SAT asymptote in Experiment 3.

Conflicting hierarchies

Experiment 2 provides independent support for the strong link between dative object-experiencer verbs and the dative-initial base order. Object-experiencer verbs elicited a LAN effect in nominative-initial structures (Condition A in Table 3). As this component is typically associated with (functional) mismatches such as agreement violations (e.g., Gunter et al., 1997; Gunter, Friederici, & Schriefers, 2000; Osterhout & Mobley, 1995), it is likely that it here reflects a mismatch between the case hierarchy and the thematic hierarchy (Bornkessel et al., 2003; Schlesewsky & Bornkessel, 2004). Ideally, the case hierarchy and the thematic hierarchy align. For example, nominative case is considered the most unmarked case,[5] and should therefore mark the argument that is thematically highest. However, this correspondence is broken in a nominative-initial sentence with an object-experiencer verb: The case hierarchy (nominative > dative) calls for a hierarchical relationship between the two arguments in which the first NP dominates the second, whereas the thematic hierarchy (specifically: Experiencer (Actor) > Theme (Undergoer)) requires exactly the opposite hierarchical ordering. We believe this mismatch engenders the LAN effect. If true, this LAN suggests that the object-experiencer verbs, as a class, are associated with a brief processing advantage for a dative-initial word order that derives from a preference for parallel thematic and syntactic hierarchical dependencies (cf. Ferreira, 1994), which increases the accessibility of the dative-initial target structure in the reanalysis process. Again, this finding is consistent with the assumption that the role of lexical information in the present studies was to improve access to the dative–nominative base order.

Functional characterization of the N400

The proposal that revisions towards dative-initial structures in German proceed via the revision of case marking can be situated in more general, neurophysiologically based characterizations of the language processing architecture. In Friederici's (2002) neurocognitive model of language comprehension, for example, sentence processing is subdivided into three phases: (a) an initial phase of basic constituent analysis, in which only word category information is taken into account (phase 1), (b) a phase in which lexical and relational properties come into play and in which functional, syntactic and interpretive processes proceed in parallel but autonomously from one another (phase 2), and (c) a generalized mapping phase, in which the different information types processed during phase 2 are associated with one another and, if necessary, reanalysis and/or repair is initiated (phase 3). Several ERP studies have provided evidence for the existence of independent (syntactic vs. lexical)

[5] The case hierarchy essentially expresses the relative markedness of morphological coding categories (cf. Primus, 1999; Van Valin & LaPolla, 1997). Nominative case is considered the most unmarked case because it is often expressed via zero marking and has the fewest number of allomorphs.

processing pathways within phase 2, while the different information types have been shown to interact in phase 3 (e.g., Gunter et al., 1997, 2000; cf. also Bornkessel, 2002).

An explanation for why we observed distinct N400 and P600 effects in the two types of structures can be couched in terms of this 3-phase model. A number of studies have provided evidence that the processing of case information takes place in phase 2 of comprehension (Bornkessel et al., 2002a,b, 2003; Coulson et al., 1998; Friederici & Frisch, 2000; Frisch & Schlesewsky, 2001; Hopf et al., 1998; Rösler, Pechmann, Streb, Röder, & Henninghausen, 1998; Schlesewsky & Bornkessel, 2004; Schlesewsky, Bornkessel, & Frisch, 2003). Thus, it appears plausible to assume that revisions of case marking are also performed during this processing phase, therefore giving rise to an N400.

By contrast, phrase structure revisions have typically been associated with phase 3 of comprehension and, hence, with the P600 component (e.g., Friederici & Mecklinger, 1996; Friederici et al., 2001; Hagoort et al., 1993; Kaan & Swaab, 2003; Osterhout & Holcomb, 1992, 1993; Osterhout, Holcomb, & Swinney, 1994; Van Berkum, Brown, & Hagoort, 1999). A possible reason for this delay to the third phase may be that a number of different information types must be taken into consideration in order for the reanalysis to be successful (e.g., lexical information, phrase structure rules, etc.). As described above, interactions between lexical and rule-based knowledge can only occur in phase 3 of comprehension, since the two information types are processed independently of one another in earlier phases. The P600 observed for reanalysis towards an accusative-initial order in Experiment 1 is therefore the predicted reflex of this integrative conflict resolution.

Implications for models of reanalysis

Research on reanalysis has typically focused on either (a) different operations that may serve to restructure phrase markers (e.g., Sturt & Crocker, 1996) or (b) characterization of the domains within which phrase structure reanalysis is costly (e.g., Ferreira & Henderson, 1998). The present studies suggest that reanalysis is not a unitary process. Rather, successful revision requires the interaction of several subcomponents, two of which have been identified here: phrase structure revision and revision of case marking. Our data suggest that reanalysis models need to posit different operations for structural and case-based revisions, certainly in the processing of languages in which these properties are potentially separable but perhaps also in languages like English where these properties are less easily isolated.

Additionally, the results of the SAT study highlight the need to define and measure the theoretical construct 'processing difficulty' more precisely than has been typical in past research. Differences in asymptotic accuracy indicate that processing difficulty may sometimes reflect the accessibility of the solution to the problem. Differences in dynamics (SAT rate and/or intercept) indicate that other forms of processing difficulty may reflect the complexity of the reanalysis process itself, with increased complexity resulting from the deployment of additional cognitive operations.

Most generally, the joint application of ERP and SAT methodologies serves to demonstrate that the surface behavior exhibited by structures requiring a reanalysis—the behavior that is measured, for example, by acceptability judgments—can result from the interaction of a multitude of factors varying in different dimensions (e.g., phrase structure vs. case marking; dynamic vs. non-dynamic aspects; and lexical vs. general syntactic knowledge). These findings are incompatible with accounts that place the burden of explanation entirely on the symptom triggering the reanalysis (e.g., Fodor & Inoue, 1998). Similarly, the data show that surface-based distinctions cannot always predict reanalysis difficulty: while it is generally agreed that accusative is the unmarked object case in transitive German sentences, the present results show that reanalyses towards an accusative-initial order are, in fact, more difficult than reanalyses towards a dative-initial order. Our findings thus suggest that models of reanalysis must incorporate a range of very fine-grained distinctions if they are to capture the true sources of the processing difficulty arising from reanalysis phenomena.

Summary and conclusion

We have identified two subcomponents of reanalysis: phrase structure revision and revision of case marking. Whereas the former is associated with a P600 component in terms of ERP measures, the latter elicits an N400 component. In German, revisions of case marking only may be elicited in subject–object ambiguities requiring a reanalysis towards a dative-initial order, whether or not this potentially unmarked order is lexically supported. These results—which received convergent support from direct time course (SAT) measures—suggest the availability of a general dative–nominative base order that may be accessed even in the absence of specific lexical information. However, when a dative–nominative order is lexically required (e.g., in sentences with dative object-experiencer verbs), the target structure is rendered more accessible, thereby (quantitatively) reducing reanalysis cost.

Appendix. Sentence materials for Experiments 1–3

Only the critical constituents of the experimental sentences are listed with word-by-word translations:

proper noun—bare plural NP—dative active verb (singular agreement; sg)—dative active verb (plural agreement; pl)—accusative verb (sg)—accusative verb (pl)—dative object-experiencer verb (sg)—dative object-experiencer verb (pl)

Sentences were constructed with dative active and accusative verbs for Experiment 1 and with dative active and dative object-experiencer verbs for Experiments 2 and 3. Experiment 3 drew upon a subset of the materials listed here.

01 Christian Pastorinnen abrät abraten sieht sehen auffällt auffallen
Christian pastors discourages discourage sees see notices notice

02 Kerstin Studentinnen antwortet antworten anhört anhören behagt behagen
Kerstin students answers answer listens-to listen-to feels-comfortable-with feel-comfortable-with

03 Reinhold Autorinnen applaudiert applaudieren auslacht auslachen einfällt einfallen
Reinhold authors applauds applaud laughs-at laugh-at occurs-to occur-to

04 Lisa Poetinnen berichtet berichten schlägt schlagen entfällt entfallen
Lisa poets reports report hits hit escapes-the-memory-of escape-the-memory-of

05 Lena Probandinnen dankt danken anruft anrufen entgeht entgehen
Lena participants thanks thank phones phone eludes elude

06 Stefan Schwimmerinnen droht drohen stöß t stoß en gefällt gefallen
Stefan swimmers threatens threaten pushes push pleases please

07 Heike Läuferinnen entflieht entfliehen liebt lieben behagt behagen
Heike runners escapes escape loves love feels-comfortable-with feel-comfortable-with

08 Rudolf Präsidenten folgt folgen lobt loben missfällt missfallen
Rudolf presidents follows follow praises praise displeases displease

09 Karin Agentinnen hilft helfen grüß t grüß en einfällt einfallen
Karin agents helps help greets greet occurs-to occur-to

10 Wolfgang Käuferinnen gratuliert gratulieren braucht brauchen passt passen
Wolfgang buyers congratulates congratulate needs need accepts accept

11 Erwin Patientinnen huldigt huldigen zwickt zwicken passt passen
Erwin patients pays-homage-to pay-homage-to tweaks tweak suits suit

12 Birgit Journalisten nachgibt nachgeben sucht suchen gefällt gefallen
Birgit journalists gives-in-to give-in-to searches search pleases please

13 Thomas Professoren nachschaut nachschauen ruft rufen missfällt missfallen
Thomas professors watches watch calls call displeases displease

14 Peter Soldatinnen nachsieht nachsehen haut hauen auffällt auffallen
Peter soldiers watches watch hits hit notices notice

15 Ines Terroristen opfert opfern fängt fangen gefällt gefallen
Ines terrorists sacrifices-to sacrifice-to catches catch pleases please

16 Sandra Kolleginnen widerspricht widersprechen bremst bremsen entfällt entfallen
Sandra colleagues disagrees-with disagree-with slows-down slow-down escapes-the-memory-of escape-the-memory-of

17 Roland Prinzessinnen winkt winken ärgert ärgern entgeht entgehen
Roland princesses beckons beckon annoys annoy eludes elude

18 Jürgen Richterinnen zusieht zusehen anzeigt anzeigen einfällt einfallen
Jürgen judges watches watch reports report occurs-to occur-to

19 Anja Kandidaten zustimmt zustimmen hört hören behagt behagen
Anja candidates agrees-with agree-with hears hear feels-comfortable-with feel-comfortable-with

20 Karsten Diplomaten zuwinkt zuwinken trifft treffen auffällt auffallen
Karsten diplomats waves-to wave-to meets meet notices notice

21 Nadine Intendanten abrät abraten meidet meiden passt passen
Nadine directors discourages discourage avoids avoid suits suit

22 Norbert Klientinnen antwortet antworten anlacht anlachen entfällt entfallen
Norbert clients answers answer laughs-at laugh-at escapes-the-memory-of escape-the-memory-of

23 Martha Reiterinnen applaudiert applaudieren anhält anhalten missfällt missfallen
Martha riders applauds applaud stops stop displeases displease

24 Ludwig Dirigenten berichtet berichten fesselt fesseln entgeht entgehen
Ludwig conductors reports-to report-to enthrals enthral eludes elude

25 Astrid Dozentinnen dankt danken wählt wählen gefällt gefallen
Astrid lecturers thanks thank chooses choose pleases please

26 Alfred Doktoranden droht drohen anbrüllt entgeht entgehen
Alfred PhD-students threatens threaten shouts-at shout-at eludes elude

27 Kirsten Diplomanden entflieht entfliehen abhört abhören entfällt entfallen
Kirsten graduate-students escapes-from escape-from bugs bug escapes-the-memory-of escape-the-memory-of

28 Frieda Artistinnen folgt folgen angrinst angrinsen einfällt einfallen
Frieda artists follows follow grins-at grin-at occurs-to occur-to
29 Wilhelm Astronauten gratuliert gratulieren anstöß t anstoß en behagt behagen
Wilhelm astronauts congratulates congratulate nudges nudge feels-comfortable-with feel-comfortable-with
30 Inge Kameraden hilft helfen findet finden auffällt auffallen
Inge companions helps help finds find notices notice
31 Anne Räuberinnen huldigt huldigen anzieht anziehen auffällt auffallen
Anne robbers pays-homage-to pay-homage-to attracts attract notices notice
32 Josef Floristinnen nachgibt nachgeben einlädt einladen behagt behagen
Josef florists gives-in-to give-in-to invites invite pleases please
33 Anke Bäuerinnen nachschaut nachschauen ablenkt ablenken einfällt einfallen
Anke farmers watches watch distracts distract occurs-to occur-to
34 Günther Sängerinnen nachsieht nachsehen ausraubt ausrauben entfällt entfallen
Günther singers watches watch robs rob escapes-the-memory-of escape-the-memory-of
35 Paula Pilotinnen opfert opfern hasst hassen entgeht entgehen
Paula pilots sacrifices-to sacrifice-to hates hate eludes elude
36 Martin Lehrerinnen widerspricht widersprechen kämmt kämmen gefällt gefallen
Martin teachers disagrees-with disagree-with combs comb pleases please
37 David Künstlerinnen winkt winken malt malen missfällt missfallen
David artists beckons beckon paints paint displeases displease
38 Christa Leserinnen zusieht zusehen rettet retten missfällt missfallen
Christa readers watches watch rescues rescue displeases displease
39 Sascha Schneiderinnen zustimmt zustimmen anschwärzt anschwärzen passt passen
Sascha tailors agrees-with agree-with denounces denounce suits suit
40 Hanna Kellnerinnen zuwinkt zuwinken schätzt schätzen passt passen
Hanna waiters waves-to wave-to appreciates appreciate accepts accept
41 Detlef Bürgerinnen abrät abraten tritt treten behagt behagen
Detlef citizens discourages discourage kicks kick pleases please
42 Sonja Passantinnen antwortet antworten kennt kennen einfällt einfallen
Sonja passers-by answers answer knows know occurs-to occur-to
43 Vincent Fahnderinnen applaudiert applaudieren schützt schützen entfällt entfallen
Vincent investigators applauds applaud protects protect escapes-the-memory-of escape-the-memory-of
44 Britta Mörderinnen hilft helfen mag mögen missfällt missfallen
Britta murderers helps help likes like displeases displease
45 Christoph Schmugglerinnen berichtet berichten tötet töten gefällt gefallen
Christoph smugglers reports-to report-to kills kill pleases please
46 Tina Siegerinnen dankt danken trägt tragen passt passen
Tina winners thanks thank carries carry suits suit
47 Johann Masseurinnen droht drohen ablehnt ablehnen auffällt auffallen
Johann masseurs threatens threaten rejects reject notices notice
48 Silke Stewardessen folgt folgen schüttelt schütteln entgeht entgehen
Silke flight-attendants follows follow shakes shake eludes elude
49 Erich Nachbarinnen entflieht entfliehen stört stören einfällt einfallen
Erich neighbours escapes escape disturbs disturb occurs-to occur-to
50 Annett Fälscherinnen gratuliert gratulieren warnt warnen auffällt auffallen
Annett forgers congratulates congratulate warns warn notices notice
51 Heiner Ordnerinnen nachgibt nachgeben einstellt einstellen passt passen
Heiner keepers gives-in-to give-in-to employs employ suits suit
52 Susann Anwältinnen nachschaut nachschauen rügt rügen behagt behagen
Susann lawyers watches watch scolds scold feels-comfortable-with feel-comfortable-with
53 Jochen Touristinnen nachsieht nachsehen weckt wecken entgeht entgehen
Jochen tourists watches watch wakes wake eludes elude
54 Grete Cellistinnen huldigt huldigen pflegt pflegen missfällt missfallen
Grete cellists pays-homage-to pay-homage-to cares-for care-for displeases displease
55 Werner Zauberinnen opfert opfern heilt heilen entfällt entfallen
Werner magicians sacrifices sacrifice heals heal escapes-the-memory-of escape-the-memory-of
56 Marga Enkelinnen winkt winken einführen einführt gefällt gefallen
Marga grandchildren beckons beckon introduces introduce pleases please
57 Siegfried Helferinnen widerspricht widersprechen aufregt aufregen behagt behagen
Siegfried helpers disagrees-with disagree-with upsets upset feels-comfortable-with feel-comfortable-with
58 Marlies Chirurginnen zuwinkt zuwinken nervt nerven entgeht entgehen
Marlies surgeons waves-to wave-to annoys annoy eludes elude

59 Simon Notärztinnen zustimmt zustimmen tadelt tadeln einfällt einfallen
Simon doctors agrees-with agree-with scolds scold occurs-to occur-to

60 Antje Juristinnen zusieht zusehen lobt loben passt passen
Antje jurists watches watch praises praise suits suit

61 Markus Zöllnerinnen abrät abraten feuert feuern entfällt entfallen
Markus customs-officers discourages discourage fires fire escapes-the-memory-of escape-the-memory-of

62 Gabi Rednerinnen antwortet antworten tröstet trösten auffällt auffallen
Gabi speakers answers answer comforts comfort notices notice

63 Axel Kanzlerinnen applaudiert applaudieren grüß t grüß en gefällt gefallen
Axel chancellors applauds applaud greets greet pleases please

64 Judith Bastlerinnen berichtet berichten tröstet trösten missfällt missfallen
Judith tinkerers reports-to report-to comforts comfort displeases displease

65 Wolfram Hehlerinnen dankt danken foltert foltern einfällt einfallen
Wolfram dealers thanks thank tortures torture occurs-to occur-to

66 Ilse Königinnen droht drohen anhält anhalten behagt behagen
Ilse queens threatens threaten stops stop feels-comfortable-with feel-comfortable-with

67 Burkhard Pilgerinnen folgt folgen jagt jagen entfällt entfallen
Burkhard pilgrims follows follow hunts hunt escapes-the-memory-of escape-the-memory-of

68 Edith Flötistinnen entflieht entfliehen kitzelt kitzeln auffällt auffallen
Edith flautists escapes escape tickles tickle notices notice

69 Bertram Surferinnen gratuliert gratulieren schickt schicken missfällt missfallen
Bertram surfers congratulates congratulate sends send displeases displease

70 Maren Ketzerinnen hilft helfen achtet achten passt passen
Maren heretics helps help respects respect suits suit

71 Birte Dompteurinnen nachgibt nachgeben abholt abholen entgeht entgehen
Birte tamers gives-in-to give-in-to picks-up pick-up eludes elude

72 Robert Siedlerinnen nachschaut nachschauen löchert löchern gefällt gefallen
Robert settlers watches watch pesters pester pleases please

73 Tanja Fleischerinnen nachsieht nachsehen würgt würgen behagt behagen
Tanja butchers watches watch strangles strangle feels-comfortable-with feel-comfortable-with

74 Gerhard Pächterinnen widerspricht widersprechen fasst fassen einfällt einfallen
Gerhard tenants disagrees-with disagree-with catches catch occurs-to occur-to

75 Gertrud Kaiserinnen huldigt huldigen knebelt knebeln gefällt gefallen
Gertrud emperors pays-homage-to pay-homage-to gags gag pleases please

76 Willi Seglerinnen winkt winken badet baden entfällt entfallen
Willi sailors beckons beckon bathes bathe escapes-the-memory-of escape-the-memory-of

77 Waltraud Anglerinnen zusieht zusehen mustert mustern auffällt auffallen
Waltraud fisherwomen watches watch examines examine notices notice

78 Friedrich Gönnerinnen opfert opfern liebt lieben passt passen
Friedrich patrons sacrifices-to sacrifice-to loves love suits suit

79 Dagmar Fahrerinnen zustimmt zustimmen stellt stellen entgeht entgehen
Dagmar drivers agrees-with agree-with catches catch eludes elude

80 Hubert Spielerinnen zuwinkt zuwinken filmt filmen missfällt missfallen
Hubert players waves-to wave-to films film displeases displease

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