Processing object A'-dependencies: the role of case

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Abstract

We present a self-paced reading study and comprehension task with 39 native German adult speakers investigating the effect of lexical versus structural case-marking on processing object A'-dependencies. We included relative clauses as well as wh-questions. Object A'-dependencies have been argued to be more difficult than subject A'-dependencies because the subject acts as an intervener in object A'-dependencies. Feature dissimilarity between the subject and object has been argued to decrease this processing difficulty. According to memory interference accounts of intervention, any type of feature dissimilarity could matter, whereas on Relativized Minimality accounts of intervention, only morphosyntactic features, specifically the ones triggering movement, are relevant. We tested whether dissimilarity in terms of case features (structural accusative vs. lexical dative case) would alleviate intervention effects. Relativized Minimality predict it does not, since case features are not movement triggering features. The memory interference account predict it does, since this account poses no restrictions on the type of features that are relevant for intervention. Our results show that dative case does not alleviate the processing difficulty of object A'-dependencies. On the contrary, dative conditions were more difficult to process. Thus, our results provide no supporting evidence for the memory interference account but are in line with Relativized Minimality. We hypothesize that the increased processing difficulty associated with dative case has to do with the additional structural processing that comes with dative assigning verbs.

Keywords: Subject/object asymmetries, intervention, Relativized Minimality, memory interference, A'-dependencies, A'-movement.

1. Introduction

In this paper, we report on a self-paced reading study investigating subject/object asymmetries in German A'-dependencies. We focus on intervention effects, in particular the extent to which case-features can cause intervention. An example of a subject and object A'-dependency can be found in (1a) and (1b) below, respectively:

(1) a. That's the secretary who ___ called the director.
b. That's the secretary who the director called ____.

The examples in (1) instantiate relative clauses. The head of the relative clause (*the secretary*) thematically belongs to the verb *called* in the embedded clause. The thematic position of the head is indicated by ___. The term A'-dependency comes from generative grammar and refers to the fact that an argument is outside of its canonical A(rgument)-position and instead appears in a non-argument position in the left periphery of the clause, a so-called A-bar position (written as A'). The dependency in question is traditionally considered to be the result of movement and can be observed in wh-

questions, relative clauses and topicalization constructions (Chomsky 1977). It turns out that when the argument syntactically functions as an object, as in (1b), the sentence is more difficult to process compared to when it functions as a subject, as in (1a). This difficulty is visible in comprehension, production and processing, and can be attested in typically and a-typically developing children in various languages (Brown 1972; Sheldon 1974; Lempert & Kinsbourne 1980; Tavakolian 1981; Corrêa 1982; Roth 1984; McKee et al. 1998; Adams 1990; de Villiers et al. 1994; Corrêa 1995; Berman 1997; Håkansson & Hansson 2000; Friedmann & Novogrodsky 2004; Diessel & Tomasello 2005, Novogrodsky & Friedmann 2006; Friedmann et al. 2009; Costa et al. 2014; Hamann & Tuller 2015; Schouwenaars, Hendriks & Ruigendijk 2018) as well as in adults with aphasia (Caplan & Futter 1986, Grodzinsky 1989, Lukatela et al. 1995; Sanfelici et al. 2014; Hanne et al. 2015), but even in adults without any cognitive impairments (Wanner & Maratsos 1978; King & Just 1991; King & Kutas 1995; Just et al. 1996; Stromswold et al. 1996; Müller et al. 1997; Münte et al. 1997; Caplan et al. 1998; 1999; 2000; 2001 and 2008; Cooke et al. 2001; Fiebach et al. 2002; Traxler et al. 2002; Constable et al. 2004; Chen et al. 2006).

Although the distance between the moved constituent and its gap appears to play some role in the difficulty associated with object A'-dependencies, the core of the difficulty is the type of material that is intervening the dependency. Specifically, similarity between the subject and the object appears to result in increased processing difficulty, in the sense that similarity causes a so-called intervention effect (Rizzi 2013). Conversely, dissimilarity between the subject and the object makes object A'-dependencies relatively easier to process. Below, we will define the concept of intervention in more detail and discuss how similarity can be defined, since this issue is central to our research. In doing so, we will distinguish between the formal syntactic definition of intervention and the cognitive-based view on intervention. In our study, we compared structurally accusative case-marked objects to lexically dative case-marked objects. Our underlying hypothesis is that when the object bears structural case, it crosses the subject, which also bears a structural case feature, thus potentially inducing an intervention effect. Conversely, when the object bears lexical case, it could alleviate an intervention effect. We investigated this in two types of A'-dependencies: relative clauses and wh-questions, to increase the reliability of our results. Previous studies on subject/object asymmetries have focused on both types of A'-dependencies, and it is generally assumed that they are formed in the same way (Chomsky 1977). We therefore expect the same type of intervention effects in both types of dependencies.[1] Our main research question is as follows: does dissimilarity of lexical vs. structural case features alleviate intervention effects in object A'-dependencies? We will specifically test diverging predictions made by syntactic accounts of intervention versus cognitive-based accounts. In the latter, any type of feature dissimilarity is potentially relevant for intervention, whereas in the former, only the features attracting movement count. As will become evident, our results provide no supporting evidence for purely cognitive accounts of intervention, since dative case-

[1] In line with other studies on intervention effects (e.g. Friedmann et al. 2009), we are assuming a raising analysis for relative clauses (Schachter 1973; Vergnaud 1974; Kayne 1994; Zwart 2000; Bianchi 1999; 2000; De Vries 2002; Bhatt 2002; Henderson 2007). Within the raising analysis, it is assumed that not only the relative operator, but also the head noun moves from the gap position in the relative clause. As a result, features of the head noun (in particular a so-called NP-feature) can cause intervention.

marking does not appear to make the processing of object A'-dependencies easier. However, the results are in line with syntactically based accounts of intervention.

The outline of this paper is as follows. In the next section, we discuss the concept of intervention in more detail. After that, we give a brief overview of case-marking in German, paying specific attention to dative (lexical) case-marking. Next, we outline our predictions and then continue to the methods and results. We close off with a discussion and conclusions.

2. Intervention versus interference

In this section, we will present two different explanations of intervention: the formal syntactic view on intervention, and the cognitive-based view on intervention, which we will refer to as interference.

The concept of intervention is schematized in (2), where X refers to the moved constituent (typically referred to as a filler in the processing literature), which has moved to a position called the probe in current syntactic Minimalist theory. Y refers to the position where the filler is interpreted, i.e. where its thematic role is assigned. In the processing literature, this position is referred to as the gap, and in Minimalism as the goal. In syntactic theory, the dependency between X and Y is assumed to be the result of movement from Y to X.

(2)

X	Z	Y
Filler (probe)	intervener	gap (goal)

In the dependency between X and Y, Z can potentially act as an intervener if it is in some relevant sense similar to X and Y (Rizzi 2013). There is an ongoing discussion as to how similarity should be defined: do any cognitively or perceptually salient features cause intervention (Bever 1974; Gordon et al. 2001; 2002; 2004; 2006; Lee et al. 2007) or do only very specific, syntactic features count (Rizzi 2004)? This discussion relates to a more general question, which concerns the degree to which syntactic constraints, such as island effects, can be reduced to processing factors (see, amongst others, Philips 2013 and the collection of papers in Sprouse & Hornstein 2013). That is, intervention is invoked to explain why certain A'-dependencies, such as wh-islands, illustrated in (3), are ungrammatical:

(3) *__What__ do you think __who__ stole ___?

In (3), *who* acts as an intervener in the dependency between *what* and its gap (___). Both *who* and *what* are endowed with an interrogative feature [+Q]. The ungrammaticality of (3) has led to a narrow syntactic definition of intervention, of which there are various definitions. For the purpose of this paper, we adopt the definition below from Belletti & Rizzi (2013: 296):

(4) **Relativized Minimality**
In the configuration [X, Z, Y], X and Y cannot be locally connected when Z intervenes between X and Y, and Z fully matches the relevant featural specification of X.

The 'relevant featural specification' is then defined as the features triggering movement, i.e. a Q-feature for wh-questions and an R-feature for relatives. From this, it follows that *who* acts as an intervener for *what*, even though they differ in their phi-feature specification.[2]

As Belletti & Rizzi (2013) point out, full feature identity between X and Z results in a break-down (see example 3), whereas partial feature overlap is visible as a processing and comprehension difficulty, which in children and certain syntactically impaired populations can also lead to a complete break-down (i.e. they are not successful at all in computing object A'-dependencies with partial feature overlap). In sum, the subject-object asymmetry observed in object A'-dependencies can now be explained as follows: in object A'-dependencies as in (1b), the object crosses the subject. The subject, another potential candidate for A'-movement, thus acts as an intervener if it shares features with the object. This results in an increased processing and/or comprehension difficulty for object dependencies compared to subject dependencies.

The syntactic definition of intervention in (4) is known as Relativized Minimality, going back to Rizzi (1990; 2004) and Starke (2001). Conversely, the memory interference definition of intervention is not limited to morphosyntactic features triggering movement. The explanation for intervention effects within this line of research is as follows: when processing an object A'-dependency, the object has to be stored in memory and retrieved until it can be semantically and syntactically integrated with the verb. The subject, which is also integrated at this point, greatly increases the demands on memory storage and retrieval if it has similar representations. In addition to morphosyntactic features such as gender, number, animacy, case and person, Gordon et al. (2001) suggest that also lexical-semantic features, or even more general factors such as frequency or morphological paradigm may cause intervention (Gordon et al. 2001: 1421). The role of memory interference in sentence processing has been formalized in so-called cue-based models (cf. Lewis et al. 2006; VanDyke & McElree 2006; 2011). In what follows, we will refer to this cognitively-based definition of intervention as memory interference, and to the syntactically grounded definition as Relativized Minimality.

Recently, several studies have been devoted to discovering the set of morphosyntactic features relevant for Relativized Minimality (on the feature +NP, see Friedmann et al. 2009; on the features +NP and animacy, see Bentea et al. 2016; on gender, see Belletti et al. 2012 and Biran & Ruigendijk 2015, on gender and number see Adani et al. 2010; on grammatical category and function, see Costa et al. 2014). The picture that emerges from these studies is that the set of relevant features needs to be defined very specifically, i.e. in terms of the narrow definition in (4). Striking evidence in favor of this view comes from the study by Belletti et al. (2012) which shows that gender features cause intervention in Hebrew, but not in Italian. Belletti et al. explain this by pointing out that in Hebrew, contrary to Italian, gender features are involved in triggering movement. The studies mentioned above all focused on intervention effects in children, both typically and

[2] Rizzi (2004) explains this by assuming that interrogative features and argumental features belong to different classes and that only features from the same class can cause an intervention violation (i.e. a configuration resulting in ungrammaticality). It is not ruled out altogether, however, that distinctive phi-features could alleviate the strength of an island effect.

a-typically developing. In addition, there are some studies investigating the role of intervention in the comprehension of A'-dependencies by aphasics (Grillo 2008; Varlokosta et al. 2015; Adelt et al. 2017; Friedmann et al. 2017). Aside from the memory interference studies by Gordon et al. (2001; 2002; 2004 & 2006) and Lee et al. (2007), very few studies have looked at the processing of intervention effects in normally developed, non-brain-damaged adults.[3] The current study fills an important gap in this respect, since it investigates the online processing of intervention effects in healthy adults.

The role of case-morphology in intervention effects has previously been investigated by Friedmann et al. (2017). They report on a series of experiments in Hebrew with typically developing children, children with syntactic Specific Language Impairment and individuals with aphasia. In their experiments, they tested comprehension of object A'-dependencies, contrasting sentences in which the object was overtly case-marked with the accusative marker *et* (5) to those where this was not the case (6).

(5) Et eize pil ha-arie martiv?
ACC which elephant the-lion wets?

(6) Eize pil ha-arie martiv?
Which elephant the-lion wets?

The first experiment, using wh-questions as in (5) and (6) above, showed that the presence of an overt case-marker did not significantly improve performance on object questions. Subsequently, Friedmann et al. report on experiments with hearing-impaired children, adults with aphasia and adults and adolescents with SLI using topicalization constructions. All these populations have been shown to have great difficulty understanding and producing object A'-dependencies. However, in processing object topicalization constructions, the results showed that participants were sensitive to case-marking information: in the majority of cases, they performed at or above chance level, that is: they did not generally mistake an object topicalization construction for a simple SVO structure. Friedmann et al. conclude from this that case-marking information is processed, and that it is used for interpreting the sentences, but that it does not diminish the interpretational difficulty of object A'-dependencies.[4] They argue that this is due to the fact that case-features play no role in intervention: (uninterpretable) case features are active on the goal, but not on the probe, i.e. they do not trigger movement. However, another possible explanation, suggested by Biran & Ruigendijk (2015) is that structural case features are not relevant (or visible) for the principle of Relativized Minimality, since they are automatically and obligatorily assigned.[5] In other words, it might not be felicitous at all to look at structural (accusative) case.

[3] That is, there are of course (older) online processing studies that have looked at the online processing of subject-object asymmetries in unimpaired adults, but these were not specifically designed to test predictions made by intervention/interference accounts.

[4] In other words: it is obvious that case-marking serves to identify and distinguish the grammatical roles of arguments, and can also help as a cue for thematic role assignment, but such information does not help to resolve the A'-dependency.

[5] They attribute this idea to Martin Everaert, as cited in Grillo (2008: 79).

In the current study, we are therefore comparing German subject and object A'-dependencies using DPs that are both overtly case-marked. Secondly, we compare two types of objects: objects with accusative case-marking versus objects with dative case-marking. Thus, in the current study, the objects do not only differ in terms of their (overt) case feature specification, but also in terms of the type of case feature: structural vs. lexical. In order to compare how these dependencies are processed, we used the self-paced reading technique, combined with comprehension questions, to determine how accurate participants are in interpreting these dependencies.

3. Case-marking in German

In Case theory, a distinction is made between structural and nonstructural case (Chomsky 1981; 1986a). Structural case is assigned in a specific structural position, such as the specifier of TP (nominative case) or the complement of V (accusative case). Lexical case, on the other hand, is idiosyncratically determined: it is lexically selected and licensed by specific lexical heads.

In German, case is marked on determiners, adjectives, and in some cases on the noun itself as well. For masculine DPs, there is no case-syncretism, and these have therefore been used in the current experiment. Nominative and accusative case is assigned structurally, whereas dative and genitive case are traditionally analyzed as inherent cases, dependent on theta-marking (Haspelmath 2009). Dative, genitive and accusative case can also occur as lexical cases, dependent on the lexical properties of the governing head. In the current experiment, we focus on the lexical dative case that is assigned to objects of a limited set of transitive verbs such as *helfen* (help) and *gratulieren* (congratulate). Dative case is traditionally considered to be assigned idiosyncratically, but it has argued to be highly predictable based on the semantics of the verb itself (cf. Blume 2000: Meinunger 2007).

Dative case has traditionally been considered a lexical case because dative objects cannot be promoted to subject (Haider 1985, Chomsky 1986b). That is, when dative objects are passivized, they retain their case and do not agree with the verb, unlike accusative objects, that do receive nominative case when passivized. This has been explained by assuming that in passives, structural accusative case is absorbed, so that the object can be promoted to subject and receive nominative case. However, lexical case was considered to be unaffected by case-absorption, so that dative objects could retain their case. Furthermore, in the GB framework, there was initially also only one position for direct objects, i.e. the complement of VP, in effect also forcing a different type of (non-structural) case assignment for dative objects. The introduction of VP shells, however, allowed for a designated position for dative objects. In more recent discussions of dative objects, it has therefore been assumed that dative objects in German are generated in a so-called Applicative Phrase, situated in between vP and VP (McFadden 2006). There is quite some discussion in the literature as to how case in general and lexical case in particular is assigned. In fact, by assuming a designated position for dative objects makes their case-assignment mechanisms not much different from those of canonical accusative objects: what is different between accusative and dative objects is that they are introduced at different positions. For our current study, where we wish to test whether case features are relevant to intervention or not, this is not a crucial issue. Under the Relativized Minimality definition of intervention, case features are predicted not to play

a role at all, regardless of whether they are lexical or structural, since case features do not trigger movement. Under the memory interference view on intervention, however, dative case-marking can be argued to be clearly distinct from nominative and accusative case, since the latter are assigned structurally, whereas dative case is a lexical exception. Therefore, under Relativized Minimality, no alleviating effect of dative case-marking is expected, whereas the memory interference view of intervention does predict a facilitating effect for dative case. For German, there are several studies (with healthy adults) that have investigated the processing of dative vs. accusative case with transitive verbs (Hopf et al. 1998; Bader & Meng 1999; Bader et al. 2000; Bornkessel et al. 2004; Schlesewsky & Bornkessel 2006; Bayer et al. 2001; Czypionka et al. 2018 and Czypionka & Eulitz 2018). These studies generally differ from our study in at least two respects: they have looked at (temporarily) case-ambiguous DPs and/or case attraction phenomena. As summarized in Bornkessel-Schlesewksy & Schlesewsky (2009), studies that have looked at case-ambiguous DPs show a preference for accusative over dative, but only after nominative case is ruled out earlier. Case-attraction studies show that dative, in contrast to accusative case, can overwrite nominative case. More generally, the processing studies suggest that dative case comes at a higher processing cost than accusative case (cf. Czypionka & Eulitz 2018). Different explanations for this higher processing cost have been offered. Firstly, dative verbs do not have the prototypical semantics of accusative verbs with an agentive subject and a patient object (Blume 2000). Instead, the object often has agentive features and is also more frequently animate (Meinunger 2007; Bader & Häussler 2010; Czypionka & Eulitz 2018). Another explanation is that dative case is syntactically more complex because it involves an additional functional layer on top of the DP, a so-called K(ase)Phrase (Bader et al. 2000; Bayer et al. 2001). In light of the hypothesis that dative case could alleviate intervention effects, it might seem counterintuitive that dative case is more difficult to process. Note, however, that we are specifically investigating whether case-marking interacts with movement of unambiguously case-marked objects. Even though dative case-marking comes at a higher processing cost, it could help in resolving an object A'-dependency. In this respect, a parallel can be drawn to intervention effects with NP-features: Complex wh-phrases of the type *which NP* can alleviate intervention effects compared to pronominal wh-phrases, even though the former are associated with more processing difficulty (Schippers 2007; Boxell 2012; Donkers et al. 2013).

4. Predictions

In (7) and (8), the featural specification of dative and accusative object relative clauses and wh-questions is laid out.

(7) a. Das ist [der Dieb, dem]$_{\text{+R +NP + L-CASE}}$ [der Detektiv]$_{\text{+NP +S-CASE}}$ gefolgt ist.
That is the thief who.DAT the.NOM detective followed is
'That the thief, who the detective followed'

b. Das ist [der Dieb, den]$_{\text{+R +NP +S-CASE}}$ [der Detektiv]$_{\text{+NP +S-CASE}}$ erschreckt hat
That is the thief, who.ACC the.NOM detective scared has

'That is the thief who the detective scared'

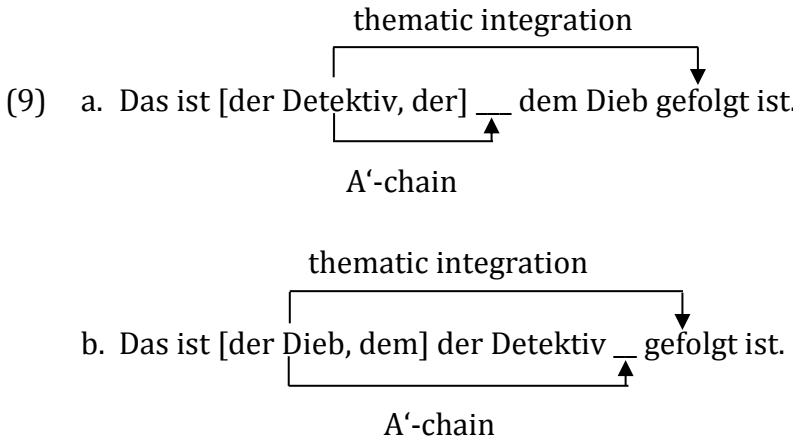
(8) a. Der Notar weiß, [welche-m Juristen] [der Manager] geschmeichelt hat.
+Q +NP + L-CASE
+NP +S-CASE
The notary knows which-DAT lawyer the.NOM manager flattered has
'The notary knows which lawyer the manager flattered'

b. Der Notar weiß, [welche-n Juristen] [der Manager] geächtet hat.
+Q +NP +S-CASE
+NP +S-CASE
The notary knows which-ACC lawyer the.NOM manager respected has
'The notary knows which lawyer the manager respected'

The head of a relative A'-dependency is endowed with a feature +R in case of relatives (7) and +Q in case of wh-questions (8), which attracts the relative DP/wh-phrase. Since we assume a raising analysis of relative clauses, the head of the A'-dependency and the subject intervener have a feature +NP. The NP-feature has been argued to be a movement attracting feature and can thus invoke intervention effects (Friedmann et al. 2009). Next, the case features have been specified, which are different for dative conditions (i.e. lexical (L-case) for the object vs. structural (S-Case) for the subject, as in 7a and 8a), but identical for accusative conditions (both DPs have a structural case feature, as in 7b and 8b).[6]

Predicting what the timing and locus of the intervention effect in German will be is by no means a trivial matter. First of all, since we are using overtly case-marked DPs, filler-gap dependencies can be established before processing the verb (Fiebach et al. 2002). Thematic integration of the DP, however, occurs only once the lexical verb is processed. Since German is SOV, thematic integration of both the subject and the object has to wait until the verb is reached. That means that both subject and object have to cross another argument (the object or subject, respectively), and in effect, that intervention can be expected for both subject and object A'-dependencies. In terms of chain formation, however, there is only intervention for object A'-dependencies. The two different types of dependencies are illustrated below in (9a) and (9b) for subject and object dependencies, respectively.[7]

[6] We omitted the actual case specifications (i.e. NOM, ACC, DAT, since these result in feature dissimilarity between subject and object in both dative and accusative conditions and are therefore irrelevant.
[7] For presentational purposes, we are omitting glosses here, but the examples correspond to the first two conditions exemplified in Table 1 further on, where full glosses and paraphrases are provided.



Here, Relativized Minimality on the one hand, and the memory interference explanation on the other make divergent predictions with respect to a subject/object asymmetry in German: Relativized Minimality, which refers to chains, predicts intervention for object A'-dependencies, but not for subject dependencies. Memory interference approaches, on the other hand, put the burden of processing on the retrieval cue for the filler, which is the lexical verb (i.e. the point of thematic integration). In an SVO language like English, the retrieval cue for subject dependencies comes earlier than for object dependencies. But in an SOV language like German, the retrieval cue is equidistant for subject and object A'-dependencies. Therefore, in German, memory interference approaches predict memory interference for both subject and object A'-dependencies, i.e. they predict there to be no asymmetry at all.[8]

We identified three regions of interests: (1) the DP in the embedded clause, the earliest point at which an effect of chain formation could become visible, the participle (retrieval cue and point of thematic integration), and finally the auxiliary, where spill-over effects may occur. Since there is not a lot of research on the online processing of memory interference and Relativized Minimality violations, it is difficult to say beforehand what the exact timing of the effects will be. As mentioned before, proponents of memory interference and cue-based retrieval models expect the effect to show up at the lexical verb.[9] With respect to Relativized Minimality effects, no specific predictions have been proposed with regards to how they are processed. Part of the problem is that Relativized Minimality was not designed to deal with left-to-right, top-down language processing. Since it is a condition on movement chains, and there is evidence that filler-gap dependencies are established before processing the verb in German, we could expect intervention effects to show up as early as a chain is formed and an intervener is processed, which would be at the embedded DP. However, it could very well be the case that Relativized Minimality effects show up relatively late, once complete syntactic and semantic representation of sentences are formed and evaluated.

[8] As one of the anonymous reviewers points out, this (somewhat surprisingly) means that earlier studies that have established subject/object asymmetries in SOV-languages like German cannot be explained under memory interference accounts (or cue-based retrieval models more generally). This conclusion indeed seems to be correct to us and forms a serious problem for memory interference accounts.

[9] On this matter, see Lee et al. (2006), p. 525 as well as Vasishth & Drenhaus (2007) for a study investigating object relative clauses in German. Vasishth & Drenhaus specifically define the region before the verb as precritical. Interestingly, they do already find an effect of distance between the filler and gap in this region.

In this experiment, there are two variables of interest, each of which come with their own predictions: (1) type of argument and (2) case-marking. Regarding the factor type of argument, Relativized Minimality predicts slower reading times and lower accuracy on object conditions compared to subject conditions. All object conditions in our study involve at least one violation of the principle of Relativized Minimality, since we used referential arguments. Recall that referential NPs have been argued to be endowed with a feature +NP, which is considered to be a movement-triggering feature (Friedmann et al. 2009). As discussed above, memory interference accounts do not predict a subject/object asymmetry for German because it occurs at the point of thematic integration, which is clause-final for both subject and object dependencies (see example 9).

With respect to the factor case-marking, Relativized Minimality predicts no facilitating effect of dative case and hence no difference in accuracy and reading times between dative and accusative object conditions. Under a memory interference definition of intervention, we do expect faster reading times and better accuracy for dative conditions compared to accusative conditions. Finally, neither memory interference accounts nor Relativized Minimality accounts predict an interaction between the two main factors.

5. Methods

To investigate the online processing of intervention effects in relatives and wh-questions, we used the self-paced reading technique. In addition, we used comprehension questions in order to verify that participants had interpreted the experimental items correctly, i.e. whether they had established the relevant dependency. Furthermore, the comprehension questions functioned as a secondary measure of processing difficulty. In the following subsections, we present our materials, the experimental procedure and the participants. We end the section with a description of the statistical analyses that we carried out.

5.1 Materials

We investigated intervention effects in two types of A'-dependencies: wh-questions and relative clauses, which were presented to the participants in one experimental session. For each sentence type, there are two factors: case (dative (DAT) vs. accusative (ACC)) and (type of) argument (subject (SUB) vs. object (OBJ)), leading to eight different conditions. We initially selected twenty dative and twenty accusative transitive verbs and twenty DP pairs that allowed for equally plausible subject and object readings.[10] All of the verbs were morphologically simplex, i.e. no particle verbs were used. With these, we

[10] One of the reviewers pointed out that in German, certain dative verbs have an unmarked object-first order in sentences without A'-movement (cf. Bader 1996; Bornkessel et al. 2004), which may act as a potential confounding factor. In our dataset, there is only one such verb, namely the object experiencer verb *behagen*. Inspection of the reading times of this verb and the auxiliary following it revealed that the reading times were generally higher than the average reading time for dative conditions. This could (partly) be a frequency effect, since it was one of the most infrequent dative verbs that was used. The slowdown was bigger for object conditions compared to subject conditions. In that respect, there does not appear to be an object advantage for this verb in A'-movement constructions. This is in line with acceptability judgment data from Fanselow, Häussler & Weskott (2016), who also did not find an object-first advantage for wh-questions with object experiencer verbs. Exclusion of the items with *behagen* from the statistical analysis did not affect the conclusions; we therefore decided to include the items with *behagen* in the analysis.

created twenty different item sets, which we divided over two lists and then pretested for plausibility on a 7-point Likert scale. Items that were scored more than two standard deviations below the mean of a condition were either discarded or modified. In doing so, we ended up with sixteen different item sets in total. This meant that each participant saw eight items per condition (so 64 experimental items in total), and that each participant saw a particular verb twice per experiment, and a particular DP set four times, since DPs were held constant across dative and accusative conditions. We carefully matched the dative and accusative verbs in terms of length (characters and syllables) and frequency. Since relative clauses are always embedded, we decided to embed the wh-questions as well using the matrix verbs *fragen* 'ask' and *wissen* 'know', so that the two types of A'-dependencies were more similar in terms of complexity.[11] An example of one item set, exemplifying all conditions in the experiment, is in Table 1. The full set of verbs and DPs that were used to construct the experimental items can be found in Appendix 1.

Table 1: Sample item set with examples for all 8 conditions

Relative clauses		
Case	**Arg**	**Example**
Dat	**Sub**	Das ist der Detektiv, der dem Dieb gefolgt ist. That is the detective who.NOM the.DAT thief followed is 'That is the detective who followed the thief'
	Obj	Das ist der Dieb, dem der Detektiv gefolgt ist. That is the thief who.DAT the.NOM detective followed is 'That is the thief who the detective followed'
Acc	**Sub**	Das ist der Detektiv, der den Dieb erschreckt hat. That is the detective who.NOM the.ACC thief scared has 'That is the detective who scared the thief'
	Obj	Das ist der Dieb, den der Detektiv erschreckt hat. That is the thief, who.ACC the.NOM detective scared has 'That is the thief who the detective scared'
Wh-questions		
Case	**Arg**	**Example**
Dat	**Sub**	Der Notar weiß, welche-r Manager dem Juristen geschmeichelt hat. The notary knows which-NOM manager the.DAT lawyer flattered has 'The notary knows which manager flattered the lawyer'
	Obj	Der Notar weiß, welche-m Juristen der Manager geschmeichelt hat. The notary knows which-DAT lawyer the.NOM manager flattered has 'The notary knows which lawyer the manager flattered'
Acc	**Sub**	Der Notar weiß, welche-r Manager den Juristen geächtet hat. The notary knows which-NOM manager the.ACC lawyer respected has 'The notary knows which manager respected the lawyer'
	Obj	Der Notar weiß, welche-n Juristen der Manager geächtet hat. The notary knows which-ACC lawyer the.NOM manager respected has 'The notary knows which lawyer the manager respected'

[11] However, adding an extra embedding to the wh-questions also resulted in these conditions having an extra referential DP. Some of our participants complained about this.

To each list, we added 36 filler items that consisted of passive sentences as in (10) below. For each list, we also created a reverse version, to control for order effects. These versions were equally distributed over participants.

(10) Der Anwalt wird von dem Mandanten belogen.
The lawyer is from the client lied.to
'The lawyer is being lied to by the client'

5.2 Procedure

The experiment was ran using the E-prime software version 2 (Psychology Software Tools 2012). Participants responded by pressing buttons on a Chronos response box. Each trial started with a fixation cross in the middle of the screen. Participants could then let the words appear one at the time in the center of the screen by pressing a button on the response box. The experimental items and fillers were pseudo-randomized and divided into four presentational blocks of 25 sentences. After the last word appeared, there was a pause of 2000 ms. after which an asterix appeared on the screen for 1000 ms., followed by a comprehension question that corresponded to either a subject or an object reading of the moved constituents, and was thus either right or wrong. Example (11) below gives an example of one of the experimental sentences and the right and the wrong answer. Participants had to answer the question with 'yes' or 'no' by again pressing a button on the response box. There was a time limit of 3000 ms. for responding to ensure that participants gave their answer as quickly as possible. After giving the answer, the experiment automatically continued to the next trial. Between the 4 presentational blocks, participants took a break of at least one minute, after which they could continue whenever they desired.

(11) Das ist der Detektiv, der dem Dieb gefolgt ist.
That is the detective who.NOM the.DAT thief followed is
'That is the detective who followed the thief'

Verification question (answer: yes)
Folgte jemand dem Dieb?
Followed someone.NOM the.DAT thief
'Did someone follow the thief?'

Verification question (answer: no)
Folgte der Dieb jemand-em?
Followed the.NOM thief someone-DAT
'Did the thief follow someone?'

At the beginning of the experiment, participants first went through a practice phase of 10 sentences, in which they received feedback after each response. If their accuracy on the practice round was below 80%, they could take another round of 10 sentences. If their accuracy then remained below 70%, the experiment was aborted. In total, one experimental session lasted for about half an hour.

5.3 Participants

We set out testing 80 participants. By mistake, eleven participants gave keyboard responses instead of the Chronos response box, we therefore had to exclude their data from the analysis. Twenty-nine participants did not make it through the practice rounds and we therefore did not collect further data from them.[12] Of the 40 remaining participants, we excluded one participant who had extremely slow reading times. Twenty-eight of the tested participants were female. Their age ranged between 19 and 49 (M = 24.6, SD = 5). One participant was left-handed. The participants were predominantly students from the [*removed for review*] and reported to be from this region originally. The participants received five euro in compensation for their participation.

5.4 Analysis

We analyzed both responses to the comprehension questions and reading time per word in the critical sentences, focusing on three regions of interest: the embedded DP (word 6 & 7), the participle (word 8) and the sentence final auxiliary (word 9). Data obtained from relative clauses and wh-questions were analyzed separately.[13] The responses to the comprehension questions were analyzed using binomial generalized linear mixed-effects models (lme4; Bates et al. 2014). Based on the experimental design, the fixed effects of argument and case as well as their interaction were included in the models. Covariates such as trial order were tested for warranted inclusion by model comparisons (cf. Baayen et al. 2008). A maximal random effect structure, that still allowed the models to converge, was used. The statistical models are listed in Appendix B.

For the reading times of the words in the self-paced reading task, only the sentences for which a correct response was given to the comprehension question were taken into account, which resulted in 17.2% data removal. Residual reading times were then calculated by computing a regression, which predicts reading times for each participant for each word based on word length. This predicted reading time was subtracted from the raw reading time, resulting in residual reading times. These residual reading times were analyzed using linear mixed-effects models (lme4; Bates et al. 2014). As with the responses, the fixed effects of argument and case as well as their interaction were included in the models and covariates were tested for warranted inclusion by model comparisons. We used a maximal random effect structure that still allowed the models to converge. Separate models were constructed for each of the critical words for each sentence type. These models are listed in Appendix B.

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[12] It is customary in these types of experiments to only analyze data of experimental items that were answered correctly, since for items that are answered incorrectly, it is very likely the case that participants did not successfully construct the intended A'-dependency. We reasoned that participants that already had a relatively high error rate in the practice phase would likely not improve during the experiment, and therefore chose not to collect further data from them. This resulted in a relatively high exclusion rate, which we attribute to the demanding nature of the task (a speeded judgment task). However, we have no reason to suspect that the data that we ended up collecting is unreliable. It must be kept in mind though that the data is only representative of a specific population, i.e. university students that can be characterized as 'good comprehenders'.

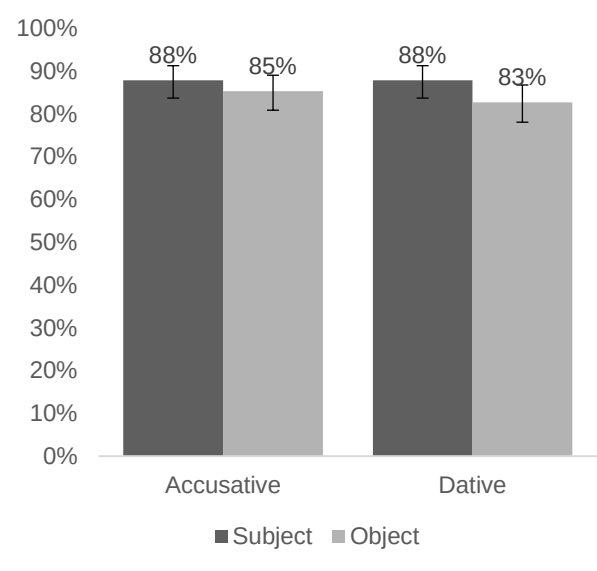
[13] We chose to do so since including all conditions in one model would lead to very conservative Type I error correction, increasing the chance of a Type II error. What this essentially means is that we are treating the experiment as two subexperiments that were conducted in one experimental session.

6. Results

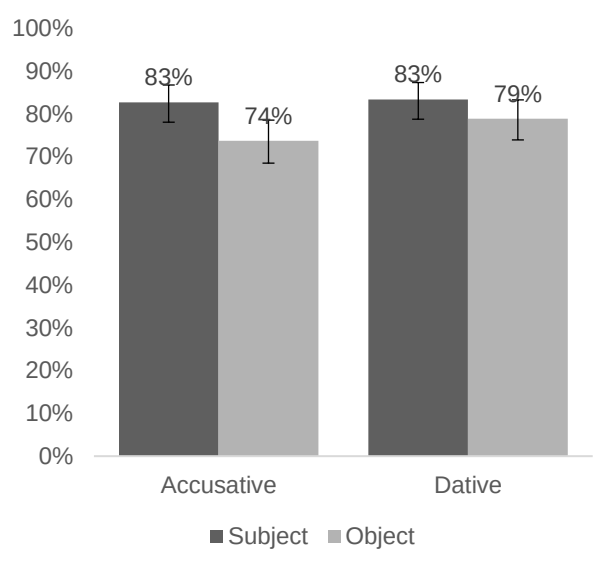
6.1 Accuracy

The results for the comprehension questions for relatives are depicted in Graph 1 and those for the wh-questions in Graph 2. As can be seen, comprehension questions for wh-questions were answered slightly less accurately than those for relatives.

The statistical analysis for the relative clauses revealed a main effect of argument (β = 0.35, z = 1.97, $p < 0.05$), but not of case (β = 0.15, z = 0.70, p = 0.48), and no interaction between the two factors (β = -0.21, z = -0.61, p = 0.54). For wh-questions, there was also a significant effect of argument (β = 0.48, z = 2.59, $p < 0.01$), but not of case (β = -0.23, z = -0. 39, p = 0.35), and no interaction (β = 0.30, z = 0.99, p = 0.32). That is, for both sentence types, comprehension was better for subject than for object extracted sentence, but case had no effect on accuracy in general, nor on the subject/object asymmetry specifically.



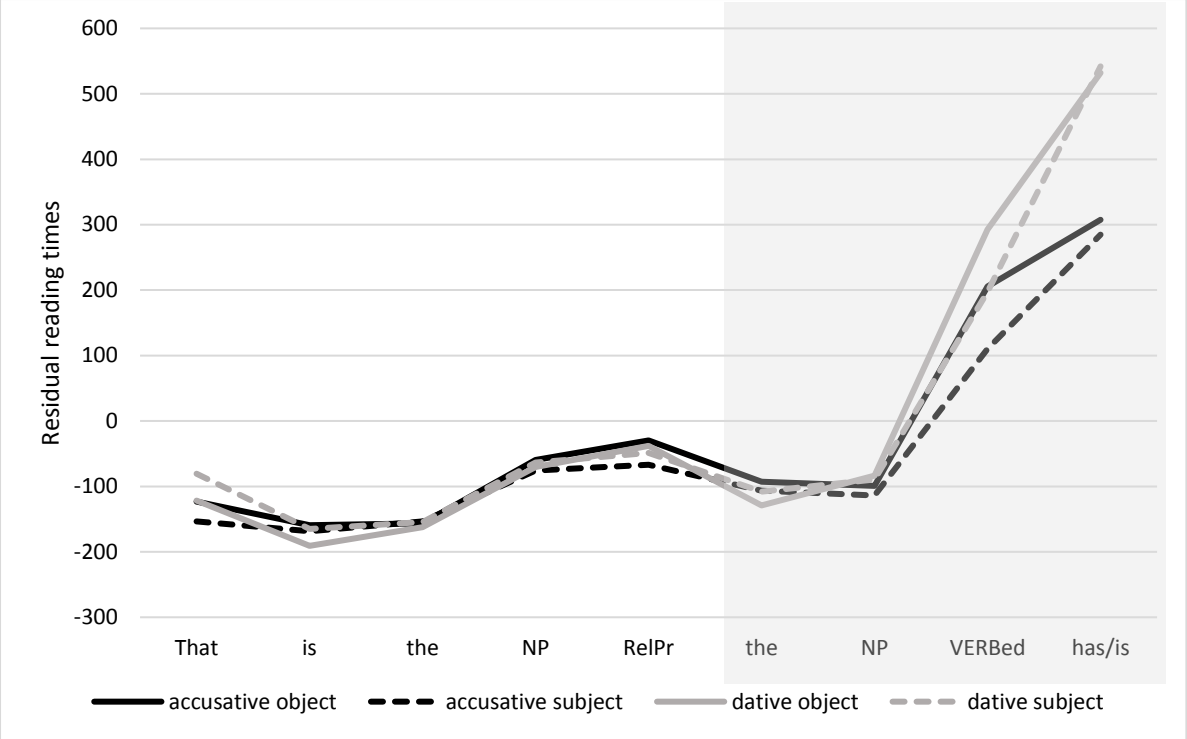
Graph 1: Accuracy relative clauses



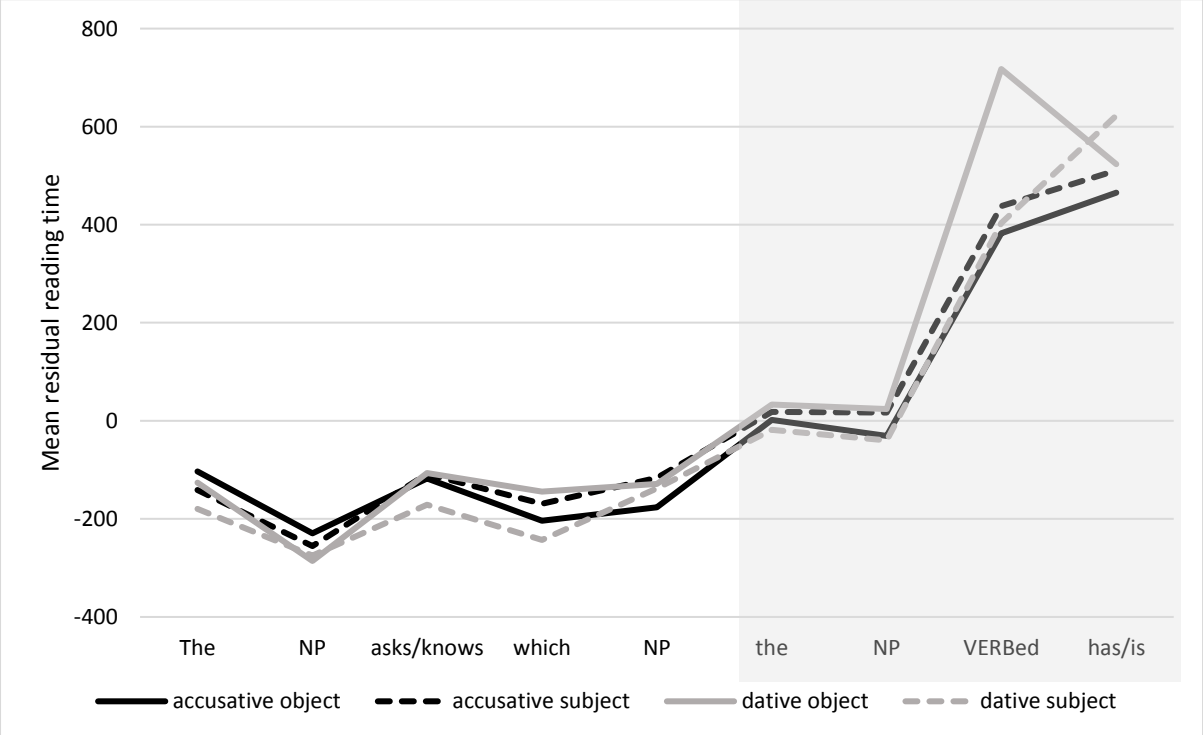
Graph 2: Accuracy wh-questions

6.2 Reading times

Graph 3 shows the residual reading times for relative clauses, and Graph 4 those for wh-questions. We've shaded the regions of interest for which statistical analyses were carried out in grey. The graphs show that reading times only clearly start to diverge from the participle onwards. Although the overall patterns are very similar, there is a clear difference at the participle: for wh-questions, the dative object condition deviated from the other three conditions in being read slower. For relative clauses, both dative conditions were read slower than the two accusative conditions, starting at the participle.



Graph 3: Residual reading times relative clauses



Graph 4: Residual reading times wh-questions

The statistical analysis for relative clauses revealed the following. There were no significant differences at the embedded DP (*the* + *NP*) or at the participle (*VERBed*). At the sentence-final auxiliary (*has/is*), there was a significant effect of case: dative conditions were read slower than accusative conditions (β = -252.55, z = -2.794, $p < 0.05$).

There were no significant effects for argument (β = 1.95, z = 39.09, p = 0.98), or interactions between case and argument (β = 40.68, z = 0.27, p = 0.78).

For wh-questions, the statistical analysis also did not reveal any significant effects at the embedded DP. At the participle, there was a significant interaction between case and argument (β = -336.45, z = -2.57, $p < 0.05$), indicating that the dative object condition was read slower than the other conditions. Finally, at the sentence-final auxiliary, there were no significant effects.

7. Discussion

From the results presented in the previous section, the following picture emerges. In terms of comprehension, there was a significant effect of argument for both relatives and wh-questions, with worse performance on object conditions. In terms of reading times, there was a (relatively) late effect for case, with dative conditions being read slower than accusative conditions. For relatives, this was visible as a spill-over effect on the sentence-final auxiliary, although there is already a visible increase in reading times for dative conditions at the participle. For wh-questions, the increased processing difficulty of dative conditions only emerged as an interaction between argument and case at the participle, with dative object conditions being read slower than all other conditions.

We will now discuss each of our predictions in turn. First, in accordance with previous research, we did find a significant subject/object asymmetry, but only for the offline comprehension questions. Recall that for a head-final language like German, a subject/object asymmetry is predicted by Relativized Minimality, but not by memory interference accounts. This is due to the fact that memory interference accounts put the burden of processing on the retrieval cue, the lexical verb, which is at the end of the clause in German for both subject and object A'-dependencies. Thus, the offline results are in line with Relativized Minimality. However, the subject/object asymmetry was not reflected in the online data, i.e. object conditions were not read significantly slower. We believe there are various reasonable explanations for this latter null result. First, in German, the processing difficulty of object A'-dependencies is relatively mild in healthy young adults, especially when the DPs in the sentences are unambiguously case-marked (cf. Friederici et al. 1998), as was the case in our experiment. An obvious explanation for this is that overt case-marking is a strong cue for syntactic role, facilitating the integration of the filler. According to Ortega-Santos (2011), the presence of overt case-marking could potentially have an effect on what counts as an intervener. Ortega-Santos argues that Relativized Minimality is a grammatically conventionalized form of memory interference and that its effects may vary crosslinguistically depending on the strength of retrieval cues such as agreement and case-marking. Specifically, he argues that the presence of overt case-marking on wh-phrases can diminish intervention effects. Secondly, the difference between subject and object extractions might have been more pronounced if the distance between the filler and the gap would have been larger, for example by inserting an adjunct phrase in the middlefield, as was done in a self-paced reading study by Fanselow et al. (2002), which featured two adjunct phrases in between the filler and

the gap.[14] In other words, the fact that the filler could easily be integrated because it was relatively close to the verb and carried overt case-marking could have greatly diminished the processing difficulty that is typically witnessed for object A'-dependencies. Thirdly, we had a relatively large group of participants that did not make it through the practice rounds, which had the result that the participants that did participate in the experiment can be characterized as relatively good comprehenders. Thus, we believe it is more likely that the null-result for argument is mainly due to the morphosyntactic properties of German, methodological factors and a ceiling effect in processing. Furthermore, as we pointed out in section 4, it could be the case that Relativized Minimality effects only show up at a relatively late stage of processing, namely at the point at which complete syntactic and semantic representation of the sentence are formed and evaluated.

Turning to our prediction regarding case, recall that our hypothesis was that under the Relativized Minimality account of intervention, no (facilitating) effect of case is expected, since case-features are not movement attracting features. The comprehension data are in line with this, since no main effect was observed for the factor case. Moreover, the online data showed that dative case impeded, rather than facilitated the processing of object A'-dependencies. This runs counter to the memory interference account of intervention, which predicts dative conditions to be easier than accusative conditions, because it makes the direct object 'stand out'. However, this prediction was not borne out: if any, dative conditions were more difficult to process than accusative conditions. Thus, the results do not support memory interference accounts in which any type of feature distinctiveness between the subject and the object facilitates the processing of object A'-dependencies. The fact that the participants in our study did show a significant effect for case shows that they are sensitive to subtle case distinctions like the difference between structural and lexical case. In other words, they did process the dative case features, but it did not enhance the processing of object A'-dependencies. This is in line with earlier studies on case intervention (Biran & Ruigendijk 2015; Friedmann et al. 2017).

There are various possible explanations for the increased processing difficulty of dative case. First of all, it could be argued that dative case is a much less reliable cue for a specific syntactic role: apart from one exception, accusative case reliably identifies a DP as an object. The exception is a very small subset of verbs in German that assign so-called accusative case to a quirky subject (e.g. *mich friert* 'me freezes', although the subject status of such DPs is rather unclear). In all other cases, however, accusative case is associated with the role of object. Dative case, on the other hand, is more versatile and can correspond to a variety of different roles: (quirky) subject, direct object and indirect object. Longer reading times for dative conditions could reflect this temporary uncertainty. However, note that this temporal uncertainty should resolve as soon as the subject is processed. Since the effects for dative conditions occurred only later on, we do not consider this a valid explanation. Alternatively, the increased processing difficulty of dative verbs could be due to their non-standard semantics, i.e. they are not associated with prototypical agent/patient roles and more frequently occur with animate objects, as

[14] Fanselow et al. 2002 report significant differences in reading times between subject and object wh-questions at the two adjunct phrases directly following the wh-phrase. They report that the difference disappears as soon as the second argument (i.e. the subject or object DP) is encountered. Unfortunately, they do not report on the reading times at the verb itself. The raw reading times do show longer reading times for object wh-questions compared to subject wh-questions.

pointed out in section 3. A previous study by Czypionka & Eulitz (2018) has shown that the increased processing difficulty of dative verbs is attenuated with animate objects. In an ERP study, they compared dative and accusative transitive verbs that either had an animate or an inanimate object. For accusative conditions, a negative waveform was visible for animate conditions compared to inanimate conditions, whereas no such difference was visible for the dative conditions, which patterned with the (unmarked) accusative inanimate condition. In our study, we only used animate objects, which should decrease the processing difficulty of dative verbs relative to accusative verbs. However, dative conditions were associated with more processing difficulty. This suggest that the increased processing difficulty of dative verbs is not due to their special semantics, but rather their syntax, a conclusion also arrived at by Czypionka & Eulitz (2018), albeit on different grounds. Another explanation for the greater difficulty for dative conditions is that this is due to the special mechanisms by which dative case is assigned. Under traditional approaches of dative case, it could be argued that structural case can be considered the default: it is far more frequent than lexical case-marking and independent of lexical specifications – it is automatically assigned to arguments in specific positions (cf. Hopf et al. 1998). Assigning lexical case on the other hand, would require access to the lexical feature specification of the verb in question, which can be argued to be associated with an additional processing step. In more recent (Minimalist) approaches that define the difference between dative and accusative case in structural terms, it could be argued that dative verbs are structurally more complex, since they project an additional Applicative Phrase (cf. McFadden 2006). We hypothesize that projecting such additional structure in case of dative verbs is associated with a delay in reading times at the participle.[15] This is indeed the pattern of results we find for relative clauses, although the difference between accusative and dative conditions only becomes significant one word later, at the auxiliary. In wh-questions, however, the effect for dative case is only significant for object extractions. We suspect that this has to do with the kind of integrations made at the verb, which could be argued to be easier for wh-questions than for relative clauses (Hawkins 2004). Namely, in relative clauses, not only the head of the relative clause has to be integrated with the verb, but the relative pronoun as well, whereas for wh-questions, it is just the wh-phrase itself that needs to be integrated. We would like to propose that in wh-questions, the effect of case thus only shows up in what could be argued to be the most difficult type of extraction, namely object A'-dependencies. In itself, the difference between subject and object A'-dependencies was not significant in terms of reading times, but in our experiment it does become visible under the added cost

[15] This proposal is very much in the spirit of an explanation proposed in Bader et al. (2000), Bayer et al. (2001) and Bader & Bayer (2006), though instead of proposing an extra structural layer within the VP, they propose it is rather the object DP itself that has an additional structural layer, which they term KP (Kase-Phrase). However, in the experiments they report on (which also includes the ERP-study by Hopf et al. 1998), they used case-ambiguous DPs that were disambiguated once the verb was encountered, which was either a dative or accusative assigning verb. In our experiment, the DPs were case-unambiguous. If processing a dative object involves the projection of an additional KP, the processing cost should be visible on the DP, and not necessarily on the verb itself. However, this was not the case: reading times for dative conditions only started to diverge once the lexical verb was encountered. Therefore, we believe our results are more in line with analyses in which dative case is seen as the result of the different verbal structure they occur in, rather than a property of dative objects themselves.

associated with dative case. In other words, what we see in wh-questions is a type of superadditive effect.

8. Conclusion

In this paper, we have reported on a self-paced reading experiment investigating the role of case features in processing object A'-dependencies. Object A'-dependencies are more difficult to process than subject A'-dependencies, and this has been attributed to the fact that in object A'-dependencies, the subject interferes. It has been argued that feature similarity between the subject and the object negatively impacts the processing of object A'-dependencies and that conversely, feature dissimilarity facilitates processing. Since there is an ongoing discussion as to which features are relevant for intervention, we were specifically interested in determining whether the presence of a lexical (dative) case feature would alleviate intervention effects, since in that situation, the subject carries a structural case feature and the object a lexical case feature, whereas for (canonical) accusative objects, both the subject and the object carry a structural case feature.

We contrasted two diverging approaches: on the one hand, there is the Relativized Minimality account which claims that only morphosyntactic features cause intervention, specifically those that trigger movement. On the other hand, there are cognitive approaches that define intervention effects in terms of memory interference: for these approaches, any type of feature (dis)similarity could be relevant for intervention. Since case features are not movement triggering features, the Relativized Minimality account predicts no facilitating effect for dative case-marking. On memory interference accounts, however, the different types of case-marking (lexical vs. structural) could be argued to facilitate processing.

In this study, we have looked at the online processing and comprehension of constructions involving intervention in healthy, young adults, contrary to earlier studies that mainly looked at children or impaired populations. It is clear that intervention effects that do not involve a complete overlap of features are relatively unproblematic for healthy adults. In our study, we did not find a significant subject/object asymmetry in reading times, but only for the comprehension questions. With respect to case, the results showed that dative case-marking had no facilitating effect for object A'-dependencies, and these results thus do not contradict the Relativized Minimality account of intervention. In terms of processing, participants did show sensitivity to case-marking, since dative conditions were read slower than accusative conditions. This, however, runs counter to the predictions made by memory interference accounts and we have thus not been able to find supporting evidence in favor of this account.

Abbreviations

ACC = accusative, DAT = dative, NOM = nominative, LEX = lexical, OBJ = object, Q = question, R = relative S = subject, STR = structural.

Competing interests

The authors declare that they have no competing interests.

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Appendix 1. Experimental materials

Table A: Set of DPs and verbs used per item set

Set	Matrix DP	DP1	DP2	Dat. verb 1	Dat. verb 2	Acc. verb 1	Acc. verb 2
1	Intendant	Schauspieler	Komiker	danken	ähneln	loben	kritisieren
3	Richter	Detektiv	Dieb	folgen	drohen	attackieren	erschrecken
4	Notar	Manager	Jurist	helfen	schmeicheln	ächten	suchen
5	Beamte	Bürgermeister	Jubilar	gratulieren	huldigen	besuchen	grüßen
6	Schwimmer	Notarzt	Bademeister	gehorcht	dienen	belügen	hassen
7	Bassist	Sänger	Chorleiter	behagen	kondolieren	beleidigen	verteidigen
9	Stewardess	Pilot	Ingenieur	gleichen	begegnen	verraten	beraten
10	Köchin	Verwalter	Gärtner	schaden	winken	unterstützen	kontaktieren
11	Kollege	Chef	Buchhalter	schaden	winken	unterstützen	kontaktieren
12	Pharmazeut	Apotheker	Chemiker	gleichen	begegnen	verraten	beraten
14	Lektor	Professor	Student	behagen	kondolieren	beleidigen	verteidigen
15	Schiedsrichter	Gegner	Rivale	gehorcht	dienen	belügen	hassen
16	Galerist	Künstler	Poet	gratulieren	huldigen	besuchen	grüßen
17	Handwerker	Geselle	Lehrling	helfen	schmeicheln	ächten	suchen
18	Nachbarin	Mieter	Pächter	folgen	drohen	attackieren	erschrecken
20	Polizist	Junge	Cousin	danken	ähneln	loben	kritisieren

Table B: Sample experimental items set 1

Item no.	List	Set	Condition	Sentence
1	1	1	wh_dat_sub	Der Intendant fragt, welcher Komiker dem Schauspieler gedankt hat.
2	2	1	wh_dat_obj	Der Intendant fragt, welchem Schauspieler der Komiker gedankt hat.
3	2	1	wh_acc_sub	Der Intendant fragt, welcher Komiker den Schauspieler kritisiert hat.
4	1	1	wh_acc_obj	Der Intendant fragt, welchen Schauspieler der Komiker kritisiert hat.
5	2	1	rel_dat_sub	Das ist der Komiker, der dem Schauspieler geähnelt hat.
6	1	1	rel_dat_obj	Das ist der Schauspieler, dem der Komiker geähnelt hat.
7	1	1	rel_acc_sub	Das ist der Komiker, der den Schauspieler gelobt hat.
8	2	1	rel_acc_obj	Das ist der Schauspieler, den der Komiker gelobt hat.

Appendix 2. Statistical models used for the analysis of the responses and reading times.

Measure	Model
Responses to relative clauses	StatementACC ~ Argument * Case + SeqTrial.c + (1 + Arg_c + Case_c || Participant) + (1 | Item)
Responses to wh questions	StatementACC ~ Argument * Case + SeqTrial.c + (1 + Arg_c + Case_c ||Participant) + (1 + Case_c || Item)
relative clauses reading time determiner	ResidRT ~ Argument * Case + SeqTrial.c + (1 + Arg_c || Participant) + (1 + Case_c || Item)
relative clauses reading time noun	ResidRT ~ Argument * Case + SeqTrial.c + (1 + Arg_c || Participant) + (1 + Arg_c + Case_c || Item)
relative clauses reading time participle	ResidRT ~ Argument * Case + (1 + Arg_c || Participant) + (1 + Arg_c + Case_c || Item)
relative clauses reading time auxiliary	ResidRT ~ Argument * Case + SeqTrial.c + (1 + Arg_c + Case_c || Subject) + (1 + Case_c || Item)
wh questions reading time determiner	ResidRT ~ Argument * Case + SeqTrial.c + (1 | Participant) + (1 | Item)
wh questions reading time noun	ResidRT ~ Argument * Case + SeqTrial.c + (1 + Arg_c || Participant) + (1 + Arg_c || Item)
wh questions reading time participle	ResidRT ~ Argument * Case + (1 + Case_c || Participant) + (1 + Arg_c + Case_c || Item)
wh questions reading time auxiliary	ResidRT ~ Argument * Case + SeqTrial.c + (1 + Arg_c + Case_c || Participant) + (1 + Arg_c + Case_c || Item)