

## Word order constraints on event-internal modifiers

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**Abstract:** There is a long-standing debate whether adverbials occupy fixed base positions in German clause structure. While some analyses propose fixed base positions dependent on adverbial class membership, others allow free generation of adverbials unless adverbials from different classes modify the same event. Based on two experimental studies on event-internal modifiers we present an analysis which rejects both proposals.

Instead, we will provide evidence that event-internal modifiers may be realized in several positions in German clause structure. Whether a position is licit is determined by the interaction of a structural condition on the interpretation of the adverbials together with linear precedence (LP) constraints. Event-internal adverbials combine with a verbal projection (identifying the respective event variables) but require the identification of an individual variable. The latter condition already prohibits the realization of event-internal modifiers in positions where a possible identifier is not accessible. In addition, event-internal modifiers are affected by LP constraints equally applying to arguments and adjuncts. The interaction of the identification requirement with the LP constraints accounts for the diverging patterns of serializations observed. We assume that the identification condition cannot be violated, while LP constraints can (and sometimes must) be violated. We provide an analysis of the LP constraints in terms of a Maximum Entropy Grammar, a probabilistic interpretation of Optimality Theory.

**Keywords:** German; adverbial modification; syntax-semantics interface; experimental syntax; Maximum Entropy Grammar

## 1 Serialization patterns of event-internal modifiers

The comparatively free arrangement of arguments in German clause structure does not imply that arguments can be realized in any order, and various analyses of the order of arguments in German clause structure have been proposed (for an overview, see Frey 2015). The serialization of modifiers, however, has been disregarded for quite some time. It was taken for granted that “adverbial phrases can be interspersed freely among the arguments of the verb” (Uszkoreit 1987: 145, see also Neeleman & Reinhart (1998), among others). This view has been challenged in the past 25 years. Frey & Pittner (1998), Frey (2003; 2015), Haider (2000; 2010), Maienborn (1995; 2001; 2003), and Maienborn et al. (2016) apply word order constraints to adverbial modifiers as well.

In this paper, we focus on the serialization of *event-internal* modifiers, such as comitatives, instrumentals, mental attitude adverbials, and internal locatives. Serialization patterns of event-internal modifiers have been analyzed in Frey & Pittner (1998) and Maienborn (2001; 2003), but we will concentrate on the analysis of comitatives and instrumentals, which differ from the other two instances of event-internal modifiers in allowing affirmative and privative senses, depending on the prepositional head of the adverbial. Using event-internal modifiers of the *same* type with *different* senses facilitates an understanding of their serialization patterns, which are dependent on their semantics to a large extent.<sup>1</sup>

Syntactically, event-internal modifiers belong to the class of adverbials proper, which means that they adjoin to a verbal projection. But semantically, they show a peculiar behavior, which distinguishes them from the well-known class of event-related modifiers: they do not only modify an event, but also a participant within the event. Adapting Frey & Pittner’s (1998: 511) terminology, we call the phrase denoting the modified participant the *reference phrase* (*Bezugselement*) of the adverbial. It is a somewhat surprising aspect of Frey & Pittner’s analysis that the relationship between the reference phrase and the adverbial is implicitly acknowledged as being a necessary one, and that Frey & Pittner also require a (minimal) c-command relationship between the two, without relating the informal necessity and the structural condition to each other. We will address this point in the present analysis by showing that a formal characterization of *orientation* can only be cast in terms of a structural condition resulting in a c-command relationship between the reference phrase and the adverbial.

We agree with Frey & Pittner (1998) in that event-internal adverbials either display variable orientation or are oriented towards the phrase bearing the *agent* role, which usually is the subject. We will analyze comitatives – illustrated in (1) and (2) for subject- and object orientation respectively – as instances of the former and instrumentals as instances of the latter, illustrated in (3) – for a detailed analysis of the semantics of instrumentals and an overview of the respective literature, see Rissman & Rawlins (2017).<sup>2</sup>

- (1) a. Da hat Ida **zusammen mit einem Berater** was unterzeichnet.  
       there has Ida.NOM together with a.DAT counsellor.DAT what.ACC sign.PTCP  
       b. Da hat Ida was **zusammen mit einem Berater** unterzeichnet.

<sup>1</sup> Internal locatives (Maienborn 2001; 2003) share with comitatives the ability to show *variable orientation* (see below) but differ from comitatives and instrumentals in allowing *affirmative* interpretations only. Since we restrict ourselves to event-internal adverbials showing affirmative and privative senses, we base our discussion predominantly on Frey & Pittner (1998).

<sup>2</sup> Frey & Pittner (1998: 511) agree with basically all analyses of instrumental modifiers that being agent-oriented, instrumentals can be classified as subject-oriented (the subject can of course be demoted in case of passive and other operations), see e.g. Baker (1997).

- ‘Ida signed something together with a counsellor.’
- (2) a. Da hat Hans **zusammen mit einem Handtuch** was gewaschen.  
 there has Hans.NOM together with a.DAT towel.DAT what.ACC wash.PTCP  
 b. Da hat Hans was **zusammen mit einem Handtuch** gewaschen.  
 ‘Hans washed something along with a towel.’
- (3) a. Da hat Hans **mittels eines Graphikeditors** was erstellt.  
 there has Hans.NOM by.means.of a.GEN graphic.editor.GEN what.ACC create.PTCP  
 b. Da hat Hans was **mittels eines Graphikeditors** erstellt.  
 ‘Hans created something using a graphic editor.’

We see a necessity to investigate the serialization patterns of event-internal modifiers by looking into comitatives and instrumentals for a variety of imperfections in prior analyses. From an empirical perspective, we observe a relative scarcity of data, resulting not only in a disregard of lexical variation (*which prepositions allow comitative or instrumental interpretations?*) but also in neglecting the distinction between affirmative – illustrated in (1) to (3) – and privative senses – illustrated in (4) and (5).

- (4) a. Da hat Hans **ganz ohne einen Kollegen** was überprüft.  
 there has Hans.NOM entirely without a.ACC colleague.ACC what.ACC sift.PTCP  
 b. Da hat Hans was **ganz ohne einen Kollegen** überprüft.  
 ‘Hans sifted something without a colleague.’
- (5) a. Da hat Ida **ganz ohne ein Hilfsmittel** was angeschlossen.  
 there has Ida.NOM entirely without a.ACC means.ACC what.ACC connect.PTCP  
 b. Da hat Ida was **ganz ohne ein Hilfsmittel** angeschlossen.  
 ‘Ida connected something without using a means.’

While the lack of lexical variation may show minor impact on the analysis, neglecting the distinction between affirmative and privative interpretation proves to be highly problematic, as the serialization patterns vary with the interpretations (see the discussion around table 1 below). From a conceptual point of view, we observe that the analyses in the literature are cast in terms of categorical constraints (a minimal c-command condition in the analysis of Frey & Pittner (1998)), while most judgments on which the analyses are based are gradient. The discrepancy between gradient judgments and a categorical constraint is not even mentioned in the analysis of Frey & Pittner (1998).

Frey & Pittner (1998: 511) conclude that event-internal modifiers show unique base positions, which must be minimally c-commanded by their reference phrases. However, the diagnostics applied by Frey & Pittner (1998) to arrive at this conclusion must be doubted under closer scrutiny (see the discussion in section 2). The proposals by Haider (2000) and Maienborn et al. (2016) do not discuss event-internal modifiers but are still relevant for the present discussion. The proposals differ from Frey & Pittner (1998) in replacing unique base positions by relative constraints, which restrict the serialization patterns of one class of adverbials, given that adverbials of another class are present in the same minimal clause. We agree with the latter proposals that the semantics of the adverbials play a crucial role in determining their respective positions, but we dispute that these positions are only constrained if more than one adverbial appears in the same minimal clause.

Finally, all aforementioned approaches share the – mostly tacit – assumption that serialization constraints do not have to be expressed as such. Instead, structural conditions lead to configurations which are mapped to linear orders. Expressed linearization conditions are hence descriptive devices originating from configurational constraints. The analysis presented below is based on rather different tenets.

Regarding the empirical base of the present analysis, consider subject-oriented comitatives and instrumentals, headed by the affirmative prepositions *mit* 'with' and *mittels* 'by means of' in (1) and (3), and by the privative preposition *ohne* 'without' in (4) and (5).

The a.- and b.-examples differ with respect to the relative positions of the adverbial phrases and objects. The latter are realized as existential *wh*-indefinites (*was*, 'something'), which are assumed to be scrambling-invariant (cf. Diesing 1992; Haider 2010).<sup>3</sup> As Frey & Pittner (1998: 511) assume that event-internal modifiers must be minimally c-commanded by their reference phrases, it follows that objects must not interfere between the adverbial and the subject in (1), (3), (4), and (5). Hence, all a.-examples should be grammatical, while all b.-examples should be ungrammatical.<sup>4</sup> The object in the b.-examples is assumed to be scrambling-invariant, so that its position cannot be derived from scrambling understood as re-merger to the left (see Frey & Pittner 1998: 525). Since the PPs are not in their presumed base position in the b.-examples, and the position of the object cannot be derived by scrambling, the only remaining alternative would be to derive the b.-examples by scrambling as lowering. Lowering, however, violates Frey & Pittner's (and almost everybody else's) analysis of scrambling as raising. According to the same line of reasoning, object-oriented comitatives should not appear to the left of the objects, if the latter are scrambling-invariant, as is illustrated in (2) for affirmative object-oriented comitatives.

While we agree with Frey & Pittner's assessment that (2a) should be considered ungrammatical, evidence from the experimental studies reported in section 3 shows that the preferred patterns for (1), (3), (4), and (5) diverge from Frey & Pittner's predictions. The general pattern is shown in table 1: For comitatives, structures of the type (1a) are preferred over structures of the type (1b) (affirmative), while there is almost no preference for the types (4a) vs. (4b) (privative). Instrumentals (3, 5) differ from affirmative and privative subject-oriented comitatives in preferring (3b), and (4b), respectively. From now on, we will use the following abbreviations for the event-internal adverbials discussed: COM(S) for *subject-oriented comitatives*, COM(O) for *object-oriented comitatives*, and INSTR for *instrumentals*. In addition, we will use the subscripts A for affirmative, and P for privative senses, respectively. We will use  $A < B$  to indicate that A precedes B in a given structure, and  $X < Y$  to express that X is required to precede Y (as required by a linear precedence (LP) constraint).

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<sup>3</sup> Diesing (1992) and Haider (2010) represent the predominant view of scrambling-invariance of existential *wh*-indefinites. This view is not completely without contenders. Lechner (1998: 279) assumes that *wh*-indefinites leave the VP to be realized within AgrOP, but also points out that the mechanism is controversial when dealing with remnant topicalization. Struckmeier (2014: 225ff.) takes up Lechner's assumption but makes clear that a potential movement of the *wh*-indefinite is semantically triggered to escape the scope of negation, which is not an issue in the structures discussed here. Doubts on Lechner's analysis can also be raised if the convincing arguments are considered that Haider (2010) provides against the stipulation of functional projections between  $V^0$  and  $C^0$  in German clause structure.

<sup>4</sup> Frey & Pittner (1998) mostly provided graded judgments, indicated by ?, ?? etc. Yet, the condition they propose is categorical.

**Table 1:** Word order preference for different event-internal modifiers based on experimental evidence (see section 3)

Ex.	Adverbial	Preferred order	Preference	Frey & Pittner	Constraints on multiple adverbials
(1)	COM(S) <sub>A</sub>	PP < OBJ	(1a)	(1a)	(1a)/(1b)
(2)	COM(O)	OBJ < PP	(2b)	(2b)	(2a)/(2b)
(3)	INSTR <sub>A</sub>	OBJ < PP	(3b)	(3a)	(3a)/(3b)
(4)	COM(S) <sub>P</sub>	OBJ < PP PP < OBJ	(4a)/(4b)	(4a)	(4a)/(4b)
(5)	INSTR <sub>P</sub>	OBJ < PP	(5b)	(5a)	(5a)/(5b)

We have added a further column to indicate the (non-)preferences deriving from an analysis in the spirit of Haider (2000) and Maienborn et al. (2016), where positional constraints for adverbial classes are relative, and hence based on the presence of elements from other adverbial classes in the same minimal clause. Since there are no such elements present in (1) to (5), such an analysis will not propose any preference for the examples.

The present analysis will account for the pattern observed in (1) to (5) in the following way:

We will not assume that event-internal modifiers occupy fixed base positions because we do not assume that there is a *base order* in the first place. Event-internal modifiers must appear within the c-command domain of their reference phrases because event-internal modifiers cannot identify the event variable and the individual variable at once. Consider example (1) for illustration: The COM(S)<sub>A</sub> will identify its event variable with the event variable of the modified phrase in syntactically adjoining to the verbal projection. But it cannot syntactically combine with one of the arguments of the verbal projection at the same time. Hence, the individual variable (which determines *with whom* some participant in the event is signing something) will be suspended, and is projected up the tree, until it can be identified with the individual variable of the subject. This identification does not only provide the information that *Ida* is signing something together with a counsellor, but also that the counsellor assumes the same thematic role as *Ida* in the event, viz. *agent*. This mechanism does not only provide an analysis for Baker's (1997: 108) observation that comitatives introduce secondary agents or themes, it has consequences for the serialization of the adverbial phrase since *agents* are placed to the left of *non-agents* in German clause structure. While we assume that the identification requirement of the individual variable cannot be violated because its working is mandatory to provide an interpretation for the variable, LP constraints can be violated. We thus do not assume that serialization can be derived completely from structural conditions. On the contrary, we propose that regulative LP constraints restrict possible phrase structures. Heads and phrases may merge in various ways, but the resulting phrases must obey LP constraints. We hence do not only reject a base order of adverbials, but also an entirely free generation of adjuncts even if only a single adverbial occurs in a minimal clause, as illustrated in examples (1) to (5).

For COM(S)<sub>P</sub> (4), we will assume that LP constraints based on thematic roles are not relevant because privative modifiers do not require the introduction of additional thematic roles. The remaining LP constraints, however, cannot be satisfied at the same time for the relevant orders. Given their slightly different weight, the analysis provides a mild preference for OBJ < PP. For INSTR (3, 5), a single constraint applies, which is met in (3b) and (5b) and violated in (3a) and (5a), so the latter examples are marked in comparison to the former. All event-internal modifiers in (1), (3), (4), and (5) satisfy the identification requirement if realized before or after the object, but this is not the case for the examples in (2), where the reference phrase is the object. Here, we will argue that the serialization (2a) is not just marked but ungrammatical. The

experimental studies show, however, that even this ungrammatical order is sometimes chosen by the participants of the study. We will assume that this is due to a repair mechanism, and the (necessary) design of the sentences in the study (see section 4.4). In sum, the present analysis can account for the preferences observed in (1) to (5). The comparison with the analyses of Frey & Pittner (1998), and analyses in the spirit of Haider (2000) and Maienborn et al. (2016) in table 1 show that the predictions by these analyses do not match the observed preferences.

Neither the identification constraint, nor the LP constraints must be specifically defined for the class of event-internal modifiers. The three LP constraints employed (*causer* < *-causer*, *animate* < *inanimate*, *NP* < *PP*) are well-established in existing proposals dealing with the serialization of arguments. The identification constraint takes care of individual variables that cannot be resolved during the immediate combination of the modifier with the modified phrase. They can thus be considered unbound variables that can only receive an interpretation through structural binding, which may only happen in configurations where the binder and the issuer of the variable stand in a c-command relation.

The remaining paper will be structured as follows:

In section 2, we will review two diagnostic tests proposed in Frey & Pittner (1998) for the putative base position of instrumental modifiers. We concentrate on the diagnostics proposed in this analysis, because other works – Maienborn (1995; 2001; 2003), Haider (2000), and Maienborn et al. (2016) – either do not recognize the class of event-internal modifiers or draw different distinctions to separate possible event-internal modifiers from other types of modifiers, or do not consider event-internal modifiers that show affirmative and privative interpretations.

Section 3 will present the results of two experimental studies on the position of comitatives and instrumentals in German clause structure, presenting both the empirical distributions, and the corresponding statistical models, with a focus on categorical features. The full models are available in the supplementary data (see section Data availability below).

In the first part of section 4, we will present the preliminaries of the analysis, including the assumed structure of German clauses, the concept of marked and unmarked word orders, and LP rules as regulative constraints over competing syntactic structures.

The second part of section 4 will focus on the formal analysis of the identification requirement, beginning with a discussion of the implications of the semantics of event-internal modifiers. The analysis will be illustrated with  $COM(S)_A$ . The third part of section 4 discusses the application of the LP constraints, and in particular, the implications of the different semantics of affirmative and privative event-internal modifiers with regard to the LP constraint placing causers in front of non-causers. The fourth part of section 4 discusses the consequences of the division between the inviolable identification requirement and the violable order constraints for the grammar of  $COM(O)$ , and its implications for the relation between (un-)grammaticality and acceptability. The fifth part of this section briefly raises issues emerging from scope and focus started in section 2, and the final part summarizes the results. Appendix A discusses the Maximum Entropy Grammar (Goldwater & Johnson 2003; Wilson 2006; Hayes 2022), a probabilistic interpretation of Optimality Theory (Prince & Smolensky 2004; Müller 2015).

## 2 Serializations of event-internal modifiers in Frey & Pittner (1998): Instrumentals

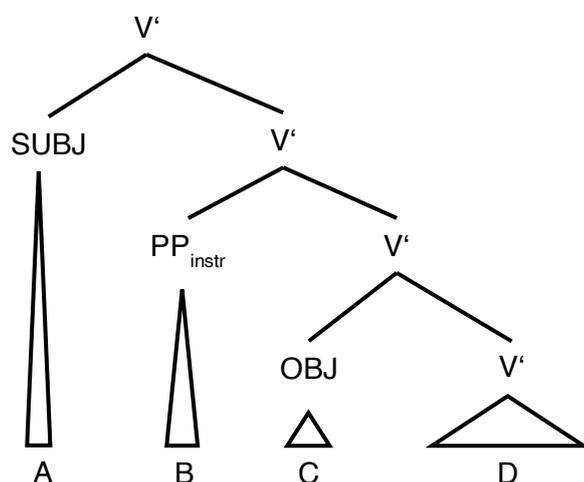
Frey & Pittner (1998: 524f.) propose that adverbials occupy base positions that are determined by the class membership of the modifiers, which ultimately relates to their semantics. If adverbials show up in a position that is not determined by its class membership, the position must be the result of scrambling, which is assumed to be adjunction to the verbal projection and

hence can only apply upward and to the left (Frey & Pittner 1998: 525). Frey & Pittner (1998) do not define the class of event-internal modifiers. We will hence employ the following characterization of event-internal modifiers taken from Maienborn (1995; 2001; 2003):

“Event-internal modifiers are [...] related to the verb’s eventuality argument, [but do] not express [an adverbial modification] for the whole [...] event, but only for one of its parts [...] internal modifiers are linked up to a referent that is related to the verb’s eventuality argument” (Maienborn 2001: 191, 198) “[They] elaborate [the event’s] internal structure [...]” (Maienborn 1995: 238) “So-called event-external modifiers relate to the full eventuality, whereas event-internal modifiers relate to some integral part of it.” (Maienborn 2003: 475)<sup>5</sup>

As was already pointed out in section 1, Frey & Pittner (1998: 511) characterize event-internal modifiers by their orientation towards a reference phrase (Maienborn’s *referent that is related to the verb’s eventuality argument* in the above quotation). Frey & Pittner further assume that the base position of an event-internal modifier can be derived from a necessary minimal c-command relationship between the reference phrase and the modifier. Hence, instrumentals (INSTR) should occupy a position that immediately follows the position of the subject, because the subject must minimally c-command the INSTR. This is schematically depicted in (6): the PP is minimally c-commanded by the subject, and c-commands the object in turn (as will be made clear in section 4, we share with Haider (2010) the assumption that German shows a binary right-branching clause structure). The c-command relationships can be mapped to word order (see also Kayne 1994): if a subject A minimally c-commands B, it follows that  $A < B$ . The same considerations apply to  $B < C$ , and hence  $A < B < C$ .

(6) Schematic structure of instrumentals in German clause structure



If the structure in (6) is assumed and the position of the object is taken to be fixed (because it is realized as a scrambling-invariant existential *wh*-indefinite), the positions of INSTR in (3b) and (5b) –  $A < C < B$  – can only be the result of – illicit – lowering. It follows that examples showing this serialization should be ungrammatical. They justify their assumptions by looking into scope determination and focus projections.

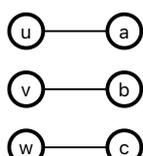
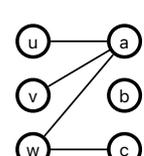
Frey’s (1993) Scope Principle, which is assumed in Frey & Pittner (1998), accounts for scope ambiguities by assuming that a quantifier  $Q_2$  may take scope over a quantifier  $Q_1$  if  $Q_2$  either

<sup>5</sup> The term *event-external* is used in Maienborn (2001; 2003) relates to the term *event-related* in Frey & Pittner (1998).

c-commands  $Q_1$  or the trace of  $Q_1$ . Hence, a scope ambiguity emerging from [ ...  $Q_2$  ... [ ...  $Q_1$  ...]] must be the result of scrambling: in [ ...  $Q_2$  ... [ ...  $Q_1$  ... [ ...  $Q_2$  ...]] one reading emerges from  $Q_2$  c-commanding  $Q_1$ , and the other from  $Q_1$  c-commanding the trace of  $Q_2$ . Let us take this argument for granted and apply it to the analysis in Frey & Pittner (1998: 505f.).<sup>6</sup> Since Frey & Pittner assume that the base position of an INSTR should be minimally c-commanded by the subject, the serialization in (7) must be the result of scrambling, as indicated.

- (7) Otto hat jedes Fenster mit genau einem Wischtuch jedes Fenster  
 Otto.NOM has every.ACC window.ACC with exactly one.DAT floor.cloth.DAT every window  
 geputzt.  
 clean.PTCP  
 'Otto cleaned every window with exactly one floor cloth.'

Given the structure indicated in (7), Frey & Pittner have to assume that the example is scope-ambiguous. Let us illustrate the implications with the two contexts in (8). In (8),  $u$ ,  $v$ , and  $w$  are windows, and  $a$ ,  $b$ , and  $c$  are floor clothes, respectively, and the connecting lines represent the relation *clean*( $e$ ,  $Otto$ ,  $x$ ) & *instrument* ( $e$ ,  $y$ ).

- (8) a. Context 1
- 
- b. Context 2
- 

If (7) were scope-ambiguous, it should be possible to utter (7) to describe (8a), where it holds for each window that it has been cleaned by a floor cloth, and (8b), where it holds that exactly one floor cloth was used to clean each window. But (7) cannot be true in the context (8b). Hence, (7) is not ambiguous.

Next consider focus projection. Haider (2010: 182ff.) assumes that an example containing a scrambled argument like (9c) does not allow maximal focus projection, which means – among other things – that (9c) cannot be an answer to (9a).

- (9) a. Was ist geschehen?  
 what is happen.PTCP  
 'What has happened?'  
 b. Soeben hat jemand einem Verletzten einen ARZT besorgt.  
 just.this.minute has someone.NOM a.DAT casualty.DAT a.ACC doctor.ACC get.PTCP  
 c. Soeben hat jemand einen Arzt einem VerLETZTEN besorgt.  
 'Just this minute, someone send for a doctor to help a casualty.'

According to Haider (2010: 183), stress must fall on the lowest phrase position in the clause to allow for maximal focus. This position is occupied by a trace in (9c), which cannot bear stress. The presence of a trace yielding minimal focus only is hence taken as evidence for scrambling. Frey & Pittner (1998: 505) make use of an analogous argument to provide evidence for a base position of INSTR above the object, but do not provide question/answer pairs.

<sup>6</sup> This is by no means necessary: Kiss (2001) has shown that scope ambiguities can be derived without assuming traces of quantifier raising. Recently, Fanselow et al. (2022) have provided experimental evidence that inverse scope can be found in German sentences showing no indication of scrambling.

This is problematic because different foci can be identified by comparing whether a sentence with a given stress pattern can be the answer to a set of questions. In the present case, it suffices to find out whether the sentence in question can be the answer to the question *Was ist geschehen?* ‘What has happened?’, because only then, we can assume maximal focus. Consider the examples in (10b, c), where small caps indicate stress.

- (10) a. Was ist geschehen?  
       what is happened.PTCP  
       ‘What has happened?’  
       b. Otto hat mit einem Schraubenzieher eine WOHnungstür geöffnet.  
       Otto.NOM has with a.DAT screwdriver.DAT a.ACC apartment.door.ACC open.PTCP  
       c. Otto hat eine Wohnungstür mit einem SCHRAUBenzieher geöffnet.  
       ‘Otto opened an apartment door with a screwdriver.’

In contrast to Frey & Pittner (1998), we assume that both (10b) and (10c) are plausible answers to (10a), hence show maximal focus.<sup>7</sup> Following the argumentation of Haider (2010), this means that stress falls on the lowest phrase in the structure, which would be the object in (10b), and the instrumental PP in (10c). While the focus structure of (10b) is in line with their reasoning, Frey & Pittner (1998) are forced to assume that (10c) shows narrow focus only. Maximal focus cannot be derived in (10c) from their analysis as scrambling of INSTR to the right is prohibited as lowering. The remaining option would be to assume scrambling of the object, leaving behind a trace. But this trace would then be the lowest phrase and cannot bear stress. It follows from a scrambling analysis that (10c) should be an inappropriate answer to (10a), counter to facts. Thus, focus does not provide evidence for a base position of INSTR above the object. To the contrary, the examples suggest that INSTR may show up to the left and to the right of an object, thus providing evidence against a minimal c-command constraint on the realization of event-internal modifiers.

The empirical evidence provided by Frey & Pittner (1998) for specific base positions of event-internal modifiers is inconclusive, neither quantification nor focus projection suggest that a base position of INSTR ought to be proposed to the left of the object. The following section will adduce further evidence from controlled experimental studies.

### 3 Experimental Studies

Test environments to determine order preferences are complex, and the resulting judgments are subtle and often far from stable, calling for controlled experimental studies. Here, test items are controlled and systematically varied, based on a small set of factors, which are hidden from linguistically naïve participants. In this section, we report two *Two Alternative Forced Choice studies* (2AFC).<sup>8</sup> A 2AFC aims at detecting differences between conditions by direct comparison. Hence, a choice based on minimal pairs forms the dependent variable, which in the present case leads to picking one serialization from two alternatives. The minimal pairs presented systematically vary hidden properties, which are considered relevant for the selection. In fact,

<sup>7</sup> Ideally, our judgments of the adequacy of the answers to the focus question should be underpinned by experimental evidence. As collecting focus related judgments is connected to a more complicated experimental set-up (e.g. recording adequate auditive stimuli) and thus beyond the scope of this article, we will leave it up to further research.

<sup>8</sup> Participants were recruited online via prolific (<https://www.prolific.co>). Uncooperative behavior of participants, common to crowdsourcing, was addressed by various methods discussed in Pieper et al. (2023).

the pairs provided in examples (1), (3), (4), and (5) illustrate the choices from the first experimental study (EXP1): the items are drawn from two adverbial types, subject-oriented comitatives and instrumentals, and from affirmative and privative senses of both types, yielding a  $2 \times 2$  factorial design. In examples (1) and (4), the adverbial type – COM(S) – is kept constant, and the sense is varied, and the same consideration applies to examples (3) and (5). The resulting cross product can thus be represented in a  $2 \times 2$  table, as illustrated in table 2, where the choice (a) corresponds to PP < OBJ, and (b) to OBJ < PP (the order shown in table 2 reflects the design of EXP1):

**Table 2:**  $2 \times 2$  factorial design in EXP1

		Adverbial Type	
		COM(S)	INSTR
Sense	affirmative	(1a) vs. (1b)	(3a) vs. (3b)
	privative	(4a) vs. (4b)	(5a) vs. (5b)

Different hypotheses can be made explicit by establishing proportions of choices, i.e. choices of (a) or (b) items, respectively for the four different cells. According to Frey & Pittner's proposal, there should be a strong preference for picking serializations of type (a) in the cell for affirmative COM(S). The resulting proportion should be roughly identical to the proportions picked for the other cells. Thus, neither changes of adverbial type nor of the sense should affect the choices. Of course, this hypothesis is not supported by the preferences in table 1.

The 2AFC format allows the inclusion of properties which may lead to confounding effects in isolation, but not so if the alternatives are provided together. Existential *wh*-indefinites provide the least complex test environment proposed by Frey & Pittner (1998), but the status of *wh*-indefinites as elements of oral communication may result in problematic effects in a written presentation.<sup>9</sup> The 2AFC format reduces such effects because the potentially problematic property is kept constant across the items presented.

As we have already pointed out in section 1, we assume that *wh*-indefinites in existential interpretation are scrambling-invariant. But this assumption presupposes that the existential reading of the *wh*-indefinite is forced, which again implies that the test items must be prepared accordingly. We have thus extended the examples by addenda blocking a specific reading of the *wh*-indefinite. Given the addenda, a specific reading leads to a contradiction, which is illustrated with test items for INSTR from EXP1 in (11).

- (11) a. Max hat erzählt, dass ein Pfleger über eine Pipette  
 Max has told that a.NOM care.assistant.NOM by.means.of a.ACC pipet.ACC  
 was verabreicht hat. Was es war, weiß ich aber nicht.  
 what.ACC administer.PTCP has what.NOM it was know I but not  
 'Max said that a care assistant administered something using a pipet. But I don't know what it was.'
- b. Eva hat erzählt, dass eine Hausfrau ganz ohne ein Spülmittel  
 Eva has told that a.NOM housewife.NOM entirely without a.ACC detergent.ACC  
 was gereinigt hat. Was es war, weiß ich aber nicht.  
 what.ACC clean.PTCP has what.NOM it was know I but not  
 'Eva said that a housewife cleaned something without using any detergent. But I don't know what it was.'

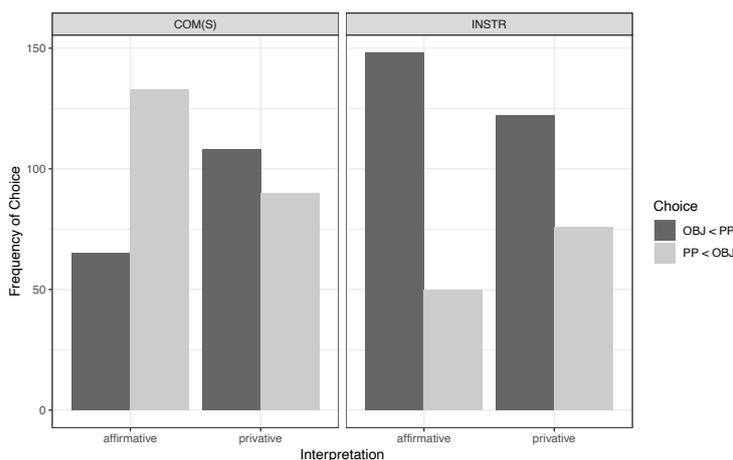
<sup>9</sup> Schütze & Sprouse (2013: 36f.) suggest that participants should be directed towards oral modality in an experiment with written data via carefully worded instructions. We followed this advice.

In the following sections, we will discuss the design and results of the experimental studies.

### 3.1 Experimental Study 1 on the position of event-internal modifiers

As was already illustrated in table 2, we have compared COM(S) and INSTR in EXP1, both of which are subject-oriented, using prepositions showing affirmative and privative senses. Data from 33 participants entered the analysis, who rated 24 minimal pairs each. The empirical distribution of choices in EXP1 is given in figure 1.

**Figure 1:** Empirical Distribution of EXP1



The overall preferred choice for the serialization in figure 1 is OBJ < PP, with a higher proportion for privative senses, and for INSTR<sub>A</sub>. Only COM(S)<sub>A</sub> show a preference for the serialization PP < OBJ. It follows of course that the serialization preference for INSTR and COM(S), as well as the serialization preferences for affirmative and privative senses within the adverbial types differ from one another. Further, the empirical distribution of choices suggests an interaction between the two effects *adverbial type* and *preposition sense*.<sup>10</sup> To model the data, we have used a Binomial Generalized Linear Mixed Model (GLMM, Bates et al. 2015) with *adverbial type* and *preposition sense* as treatment-coded fixed effects, where INSTR is taken as reference value for *adverbial type*, and *affirmative* as reference value for *preposition sense*. The inclusion of an interaction between *adverbial type* and *preposition sense* provides individual predictions for all four combinations. We have chosen a random structure for the model that again takes the interaction between the two effects into account to determine random slopes for participants. In addition, we have included a random intercept for the items since items do not vary across conditions. The model predictions are shown in table 3, the complete analysis is available as part of the supplementary material.

<sup>10</sup> In an interaction, each level of a given factor (as *comitative* or *instrumental* in the present case) provides individual predictions in combination of each level of another factor (*affirmative* or *privative*).

**Table 3:** Modelled probabilities for PP < OBJ in EXP1

Effect	Probability	Std. Error	lower conf. limit (95 %)	upper conf. limit (95 %)
Intercept = INSTR <sub>A</sub>	0.221	0.043	0.148	0.317
TYPE = COM(S)	0.690	0.044	0.596	0.770
SENSE = P	0.347	0.065	0.233	0.482
TYPE × SENSE	0.445	0.064	0.325	0.571

As is indicated in table 3, the model predicts INSTR<sub>A</sub> to show a strong preference for the serialization OBJ < PP ( $\beta_0 = -1.26$ ,  $p < 0.0001$ ). We observe a strong effect of adverbial type towards PP < OBJ ( $\beta_{TYPE} = 2.06$ ,  $p < 0.0001$ ). There is also an effect of preposition sense in the same direction, which, however, is not significant ( $\beta_{SENSE} = 0.63$ ,  $p < 0.1$ ). Finally, we notice a strong and significant interaction effect towards OBJ < PP ( $\beta_{TYPE \times SENSE} = -1.65$ ,  $p < 0.0001$ ). The resulting probabilities for all four conditions are shown in table 3. The model predictions thus confirm what has been observed for the sample: subject-oriented event-internal modifiers neither behave uniformly across types, nor across senses. Both influence the serialization preferences of the adverbial. COM(S)<sub>A</sub> are predicted to show the pattern PP < OBJ, while COM(S)<sub>P</sub> and INSTR irrespective of their sense are predicted to show the pattern OBJ < PP.

### 3.2 Experimental Study 2 on the position of event-internal modifiers

As in EXP1, the second experimental study (EXP2) employs a full factorial design for two factors with two levels each. As the first factor (*adverbial type*) we compare *object-oriented* comitatives (COM(O)) and *subject-oriented* instrumentals (INSTR). As the second factor, we varied the *form of the object*, which can either be a *wh*-indefinite, or a full-fledged indefinite NP, as is illustrated in (12) and (13) for INSTR.

- (12) a. Eva hat erzählt, dass ein Mediziner was mittels einer Spritze  
 Eva has told that a.NOM physician.NOM what.ACC by.means.of a.ACC syringe.ACC  
 injiziert hat. Was es war, weiß ich aber nicht.  
 inject.PTCP has what.NOM it was know I but not
- b. Eva hat erzählt, dass ein Mediziner mittels einer Spritze was injiziert hat. Was es war,  
 weiß ich aber nicht.  
 'Eva said that a physician injected something using a syringe. But I don't know what  
 it was.'
- (13) a. Eva hat erzählt, dass ein Mediziner eine Substanz mittels einer  
 Eva has told that a.NOM physician.NOM a.ACC substance.ACC by.means.of a.ACC  
 Spritze injiziert hat. Was für eine es war, weiß ich aber nicht.  
 syringe.ACC inject.PTCP has what.PTCP for one it was know I but not
- b. Eva hat erzählt, dass ein Mediziner mittels einer Spritze eine Substanz injiziert hat.  
 Was für eine es war, weiß ich aber nicht.  
 'Eva said that a physician injected a substance using a syringe. But I don't know which  
 one it was.'

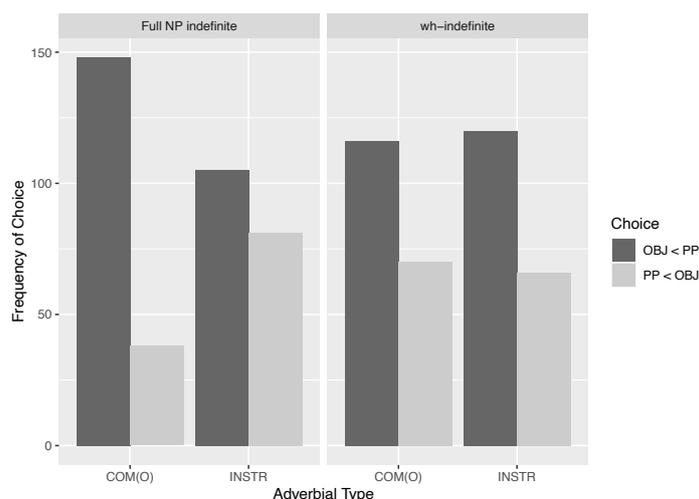
The reason to vary the form of the object is to adduce evidence against a possible explanation of serialization pattern OBJ < PP. If the object is not invariant, an analysis relying on scrambling as re-merger to the left might propose that – as an alternative to being base generated – the serialization may result from scrambling the object, as is illustrated in (15).

- (14) a. [<sub>V</sub> OBJ [<sub>V</sub> PP ... ]]
- b. [<sub>V</sub> OBJ<sub>i</sub> [<sub>V</sub> PP [<sub>V</sub> OBJ<sub>i</sub> ... ]]]

The analysis in (14), however, cannot be applied to account for the position of scrambling-invariant objects to the left of an event-internal adverbial. If the form of the object does not show a sufficiently strong effect, then an analysis that relies on scrambling – as in (14b) – cannot be maintained. Frey & Pittner (1998) assume that COM(O) should appear behind the object, because the object must minimally c-command the PP. For the same reason, they assume that INSTR invariably must appear before the object (and after the subject). Hence, they would predict that the serialization patterns for COM(O) and INSTR diverge, with the former being realized after the object, and the latter in front of them. COM(O) in the test items in EXP2 can also be used as a touchstone for analyses which assume relative constraints only, such as Haider (2000) and Maienborn et al. (2016), since they appear as solitary modifiers in a smallest clause. The present analysis agrees with Frey & Pittner (1998) regarding the position of COM(O) and hence disputes the positional freedom implied by Haider (2000) and Maienborn et al. (2016). As for the position of INSTR, both experimental studies tell a different story.

Data from 31 participants entered the analysis, who rated 24 minimal pairs each. The empirical distribution of choices in EXP2 is given in figure 2.

**Figure 2:** Empirical Distribution of EXP2



There is a general preference for the pattern OBJ < PP across the adverbial types and the forms of the object (with a nearly identical distribution in the case of *wh*-indefinites). To model the data, we have again used a Binomial Generalized Linear Mixed Model (GLMM, Bates et al. 2015) with *adverbial type* and *form of object* as treatment-coded fixed effects, where *COM(O)* is taken as reference value for *adverbial type*, and *full indefinite NP* as reference value for *form of object*. The inclusion of an interaction between *adverbial type* and *form of object* provides individual predictions for all four combinations. We have chosen a random structure for the model that again takes the interaction between the two effects into account to determine random slopes for participants. In addition, the model contains a random intercept for the items (which do not vary and only show a negligible influence). The model predictions are shown in table 4, the complete analysis is available as part of the supplementary material.

**Table 4:** Model predictions for PP < OBJ in EXP2

Effect	Probability	Std. Error	lower conf. limit (95 %)	upper conf. limit (95 %)
Intercept (TYPE = COM(O), FORM = NP)	0.140	0.049	0.068	0.266
TYPE = INSTR	0.423	0.078	0.281	0.579
FORM = wh	0.314	0.097	0.159	0.525
TYPE × FORM	0.321	0.071	0.200	0.472

The model predicts a very low probability (0.14) for the serialization COM(O) < NP (full indefinite NPs) ( $\beta_0 = -1.81$ ,  $p < 0.0001$ ). There is an effect for adverbial type ( $\beta_{TYPE} = 1.50$ ,  $p < 0.01$ ), but it is not strong enough for a reversal of serialization preferences, so the order OBJ < PP is also predicted to be preferred for INSTR and full indefinite NPs. Surprisingly, the model predicts an effect towards PP < OBJ for COM(O) and *wh*-indefinites ( $\beta_{FORM} = 1.03$ ,  $p < 0.05$ ) – see the discussion in section 4.4. The most remarkable effect can be observed if INSTR and *wh*-indefinites are considered: the predicted probability for the pattern PP < OBJ *drops* if the object is realized as a *wh*-indefinite ( $\beta_{TYPE \times FORM} = -1.46$ ,  $p < 0.05$ ). There is a general preference across adverbial types and forms of the object for the serialization OBJ < PP. What is more, there is an even stronger tendency for INSTR if the object is realized as a scrambling-invariant *wh*-indefinite, which raises serious doubts on the analysis (14b).

The results of both experimental studies contradict the assumption that the base position of INSTR is found in adjacency to the subject. The only way to derive the latter conclusion would be to allow for scrambling to the right. The distributions and their models do not only contradict Frey & Pittner’s minimal c-command analysis, but also proposals which attribute positional freedom to adverbials in the absence of adverbials of other classes, such as Haider (2000) and Maienborn et al. (2016).

The experiments have further shown that the relation to the reference phrase plays a role: although a small number of choices for COM(O) placed the PP before the object, we conclude that event-internal modifiers must follow their reference phrases (see section 4.4). Event-internal modifiers with subjects as reference phrases allow greater freedom than modifiers with objects as reference phrases, but in sum, event-internal modifiers prefer a position to the right of the object – except for affirmative COM(S).

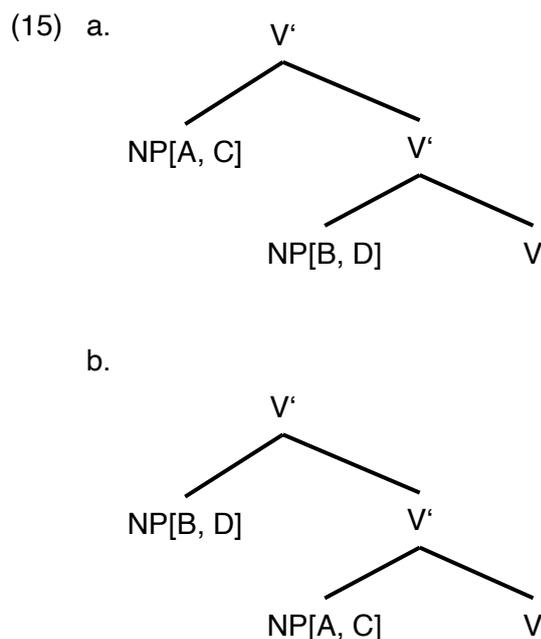
## 4 The Analysis

### 4.1 On German clause structure, and linear precedence

We follow Haider (2010) in assuming that German clauses consist of a right-branching binary verbal projection. A saturated verbal projection (S) forms the complement of C, which hosts complementizers or finite verbs, thus yielding verb final, verb initial, and verb second clauses. Following the evidence adduced by Haider (2010: 58–67) against functional projections between V and C, we do not assume additional functional projections between V and C. The present analysis differs, however, from Haider’s proposal in allowing arguments and adjuncts to combine with the verbal projection in any order. The combination must be licensed by categorial or thematic selection, or by conditions on modification (event identification in particular), to which we return immediately. The order of combinations within the projection of a head is subject to LP constraints. In general, an LP constraint of the form  $X < Y$  requires that the daughter bearing feature X found within the projection of a head must be realized to the left of

a daughter bearing feature Y within the projection of the same head, while the basic projection of the head is retained.

This interpretation of LP constraints differs from earlier proposals such as Gazdar et al. (1985) and Uszkoreit (1987) for German, which led to assumptions on German phrase structure that contradict most proposals, including Frey & Pittner (1998), Fanselow (2003), Haider (2010), and the present one. We assume that LP constraints do not apply to *local trees* but to maximal projections of a given head. Linear precedence constraints are thus regulative conditions on candidates for projections of a head. In the case of German, all these candidates must obey the basic right-branching structure of verbal projections. It follows that (15a) satisfies  $A < B$  in contrast to (15b).<sup>11</sup>



LP constraints can be violated, and violations may lead to markedness. Ideally, structures are unmarked if they satisfy all applicable LP constraints, or if the satisfied LP constraints are stronger than the ones being violated. Following Goldwater & Johnson (2003) and Hayes (2022), the present analysis differs from standard Optimality Theory in assuming that violable constraints are weighted. This has the consequence to allow for more than a single unmarked serialization: if two constraints receive equal or similar weight, structures satisfying one of the two constraints are equally unmarked. If one constraint outweighs the other one, then the structure which satisfies the stronger constraint will yield an unmarked order while the other order is considered marked. In assuming weights instead of a ranking all available constraints interact to determine the relative markedness of a structure.

Let us add a further LP constraint  $D < C$  in (15) to illustrate this point. If the two constraints show equal weights, then the serializations in (15) are truly optional, and both structures are unmarked. If, however, one of the constraints (let us say  $D < C$ ) strongly outweighs the other one, then (15b) remains as the only unmarked structure, while (15a) is marked in comparison. We will assume three LP constraints, which are listed below in terms of their weight, and briefly explained. A more detailed explanation follows below, the implementation in terms of a Maximum Entropy Grammar will be discussed in Appendix A.<sup>12</sup>

<sup>11</sup> Formally, the regulative function of LP constraints can be achieved by building a flat list of all non-head daughters in a given projection, while retaining strict binary branching.

<sup>12</sup> The formal analysis in Appendix A will require an additional constraint *\*Downward*, which blocks all structures that would result in realizing a phrase with higher grammatical function below a fixed

(16) Linear Precedence Constraints:

- a. Agentivity: [agent] < [¬agent] (Uszkoreit 1987; Jacobs 1988; Müller 1999; Frey 2015 among others).
- b. Order of categories: NP < PP (Gazdar et al. 1985; Müller 1999)
- c. Animacy: [animate] < [inanimate] (Müller 1999; Fanselow 2003)

None of the constraints given in (16) is specifically designed to deal with event-internal modifiers, all three are well-established in the research literature and refer to the ordering of constituents according to their thematic role, their category, and their animacy.

The interaction of the LP constraints with a semantic identification requirement for the external (nominal) argument of the comitative will be discussed in more detail below. At this point, however, it should be clear that an application of the constraint (16a) requires that a phrase bears the appropriate role in the first place. Only if the role has been determined, it will follow that subject-oriented comitatives are identified as agents, and hence will fall under the LP constraint (16a).

While this sounds trivial, it is not in the analysis of comitatives. Baker (1997: 108) has postulated that “comitative[s] [are] usually either [...] second agent[s] or [...] second theme[s]” but is silent on how it is determined whether they are *agents* or *themes*. Also, it remains unclear in Baker’s approach whether comitatives are restricted to *agents* and *themes*, or whether they may assume other roles as well.<sup>13</sup> The present analysis derives the role of the internal argument of the comitative dynamically, in the process of identifying its external argument with an argument of the verb, and thus taking over the respective role of the argument. Without this process, the role of the external argument of the comitative would either have to be stipulated, or not be given at all, the latter precluding an application of (16a).

#### 4.2 The semantics of event-internal modifiers

We assume that the positions of event-internal modifiers are largely based on their semantics, and on requirements imposed by them on the compositional make-up of the clause in which they appear. Here, we will focus on the semantics of comitatives because the processes required to determine their contribution to the meaning of a sentence are more complex than the ones required for instrumentals. Comitatives show variable orientation, and hence their internal argument may assume various thematic roles, while instrumentals are fixed in their orientation. It is a well-known fact that sentences containing subject- or object-oriented comitatives (COM(S); COM(O)) can be paraphrased by coordinating the reference phrase of the comitative with the comitative’s internal argument (see also Frey & Pittner 1998: 506), as is illustrated in (17).

- (17) a. Ida hat zusammen mit einem Berater einen Vertrag unterzeichnet.  
 Ida.NOM has together with a.DAT counsellor.DAT a.ACC contract.ACC sign.PTCP  
 ‘Ida signed a contract together with a counsellor.’
- b. Ida und ein Berater haben einen Vertrag unterzeichnet.  
 Ida.NOM and a.NOM counsellor.NOM have a.ACC contract.ACC sign.PTCP

---

phrase with lower grammatical function. This constraint would not be required to analyze the preferences illustrated in (1) to (5).

<sup>13</sup> Comitatives may occur in a variety of constructions in which complements bear various roles, as e.g. in clauses headed by experiencer-object verbs, and may take over the respective roles dynamically, given the condition (26).

‘Ida and a counsellor signed a contract.’

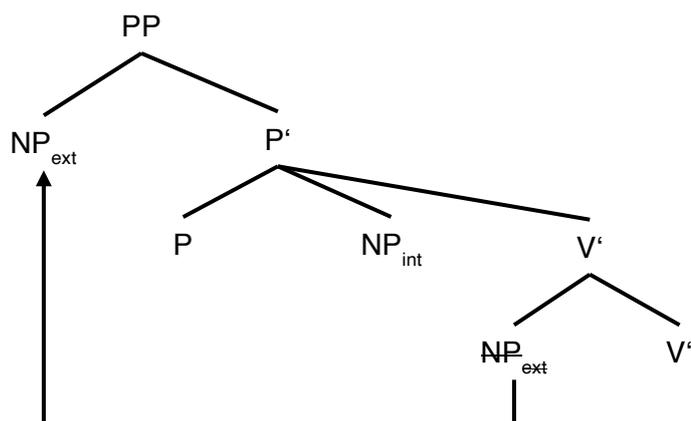
- c. Hans hat ein T-Shirt zusammen mit einem Handtuch gewaschen.  
 Hans.NOM has a.ACC t-shirt.ACC together with a.DAT towel.DAT wash.PTCP  
 ‘Hans washed a t-shirt along with a towel.’
- d. Hans hat ein T-Shirt und ein Handtuch gewaschen.  
 Hans.NOM has a.ACC t-shirt.ACC and a.ACC towel.ACC wash.PTCP  
 ‘Hans washed a t-shirt and a towel.’

It is important to realize that the meaning of the coordinated examples (17b, d) is not identical to the meaning of the sentences modified by comitatives, because the examples (17b, d) allow a reading where there are multiples signings of the contract, and multiple washings, while the examples (17a, c) assume single events. We follow Stolz et al. (2006: 86, 140) in assuming that comitative relations require two entities to be “co-present in the same space (including metaphorical readings of space)”, from which contemporaneity also follows. Nevertheless, the b-examples can be taken to be paraphrases of the a-examples in the reading where spatio-temporal co-presence is enforced. It is then the question how compositional semantics arrives at the readings of the respective a.-examples, so that the paraphrase can be derived. To achieve this, the following conditions must be met:

- The event arguments of the comitative PP and the verbal projection, respectively, must be identified.
- The role assumed by the comitative’s internal argument must be identified with the respective role of the reference phrase in the verbal projection.

To meet the first condition, we may assume that the combination of an event-internal modifier and a verbal projection is one of adjunction syntactically, and one of event identification (Kratzer 1996: 122) semantically. Event-internal modifiers differ, however, from the more familiar event-related modifiers (such as temporal and spatial modifiers) in that they do not only require the identification of the event, but also the identification of the individual variable of the event-internal modifier’s external argument, with the individual variable introduced by the modifier’s reference phrase, which eventually may yield an identification of the respective roles of the modifier’s external and internal arguments. The semantic type of an event-internal modifier thus differs from the type required for event identification in (Kratzer 1996) so that general principles of type-driven translation prohibit a direct combination (see Gazdar et al. 1985: 209–211). Syntactically, we could consider three alternatives to the present analysis, all of which prove to be futile under closer scrutiny. The first idea would be to assume that prepositions heading event-internal modifiers are syntactically special in that they take their internal (nominal) argument, as well as the verbal projection as arguments, and one argument of the verbal projection (the reference phrase) as its specifier, as illustrated in (18).

(18) Untenable syntactic analysis of event-internal modifiers



Although this analysis would allow the identification of the event variable provided by the verbal projection ( $V'$ ), as well as the identification of the individual variable with the one of  $NP_{ext}$ , it should be obvious that this analysis turns the modifier into the head of the whole phrase, as well as resulting in the assumption that modified verbal projections are in fact complex prepositional phrases, which goes against a mainstay of the grammar of modification in German, namely that processes affecting unmodified verbal projections do not differ from processes affecting modified verbal projections. In addition, the combination of further arguments and adjuncts with the prepositional projection would remain mysterious. Finally, it would be a side effect of the analysis in (18) that the reference phrase and the PP (in this case, the sequence [P NP ...]) have to appear in strict adjacency. This analysis is clearly untenable.

A second alternative would be to assume that the arguments of the verbal projection project their individual variables once realized as complements, so that the combination of an event-internal modifier with a verbal projection proceeds by event identification plus an additional identification process of the individual variables. Such an analysis would yield serialization patterns in which the event-internal modifier is realized to the left of its reference phrase, which contradicts the serialization patterns observed in Frey & Pittner (1998) and in the present analysis. A third alternative would be to allow the verb to project the variables of its arguments, but this would allow event-internal modifiers to occupy all kinds of positions, and again would not account for the preferences observed in (1) to (5). It should be noted that the last two alternatives have to assume that the identification of the individual variable proceeds in a fashion different from the identification of the event variable.

Since a type mismatch is at the heart of matter, we will assume that the type mismatch can be resolved by suspending the individual variable introduced by the event-internal modifier. This results in the application of Event Identification, as proposed by Kratzer (1996: 122). Consider the definition in (19a) with its illustration in (19b).

(19) Event Identification

- a.  $f_{\langle e, \langle s, t \rangle \rangle} + g_{\langle s, t \rangle} \Rightarrow h_{\langle e, \langle s, t \rangle \rangle}$   
 b.  $\lambda x \lambda e R(e, x) + \lambda e' P(e') \Rightarrow \lambda x \lambda e [R(e, x) \wedge P(e)]$

Both the event-internal PP and the modified phrase are of type  $\langle e, \langle s, t \rangle \rangle$ , while event identification expects the PP being of type  $\langle s, t \rangle$ . Let us assume that we can shift the type of the modifier to  $\langle s, t \rangle$ , thus dropping the individual variable. This variable, however, cannot be omitted entirely, and will hence be stored as a suspended variable in the syntactic structure of the PP. It becomes a syntactically dependent element, which must be bound by identification with a more prominent syntactic element in the same clause. Let us illustrate this for the bracketed part of (20), for COM(S).

- (20) Da hat<sub>i</sub> [Ida mit einem Berater was unterzeichnet t<sub>i</sub>].  
 there has Ida.NOM with a.DAT counsellor.DAT what.ACC sign.PTCP  
 'Ida signed something together with a counsellor.'

Following Stolz et al. (2006), we will introduce a ternary *comitative* relation, which expresses that two individuals ( $z$  and  $x$ ) are co-present in the same space and time, and hence participants in the same event  $e$ . The internal argument of the comitative –  $x$  – is not related to  $e$  through a further relation – a thematic role – but will eventually receive the very role borne by the external argument –  $z$  – in the main event, as will be discussed below. Assuming existential quantification over *counsellor*, the PP *mit einem Berater* receives the representation in (21).

(21)  $\lambda z \lambda e \exists x [\text{comitative}(e, z, x) \wedge \text{counsellor}(x)]$

The verbal projection *was unterzeichnet hat* ('has signed something') can be represented as follows (we will ignore the auxiliary, as it does not affect the analysis, and assume existential quantification for the existential *wh*-indefinite):

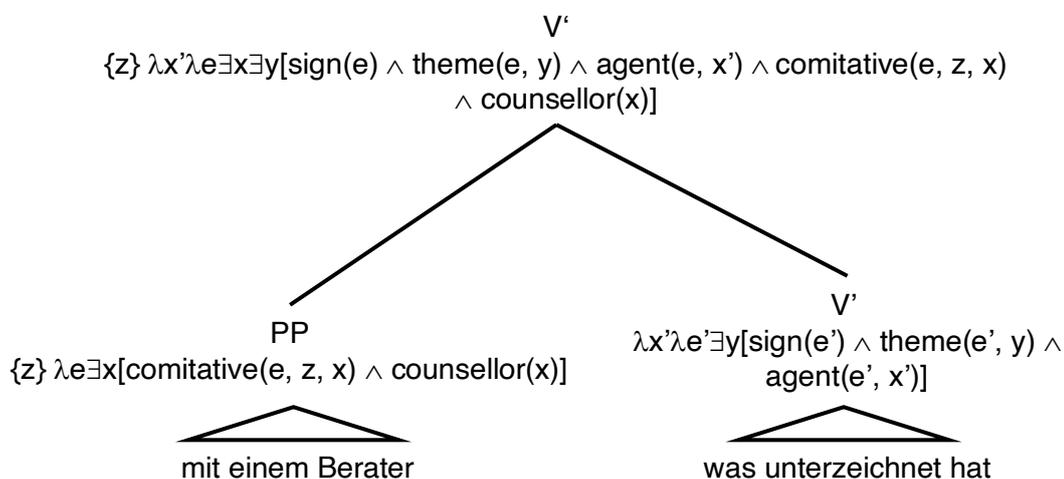
(22)  $\lambda x' \lambda e' \exists y [\text{sign}(e') \wedge \text{theme}(e', y) \wedge \text{agent}(e', x')]$

To meet Event Identification (where  $e'$  and  $e$  are identified), it becomes necessary to get rid of the individual variable, which will be suspended, represented by prefixed curly brackets, i.e.  $\{z\}$ .<sup>14</sup> The resulting representation in (23) provides a suitable input for Event Identification, but of course the suspended variable cannot remain in suspension.

(23)  $\{z\} \lambda e \exists x [\text{comitative}(e, z, x) \wedge \text{counsellor}(x)]$

The combination of (22) and (23) is shown in (24). Crucially, Event Identification results in  $e$  being equated with  $e'$ , and all predicates constraining the event variables in (22) and (23) are combined. Consequently, the denotation of the sentence is constrained to events in which two (sets of) individuals take part in signing something, and that one individual is constrained to belong to the set of counsellors. Without a proper identification of the suspended variable  $z$  and a determination of its role in the sentence, the semantic representation does not provide insights about the other individual taking part in the signing event, and the possible role of the *counsellor*.

(24) mit einem Berater was unterzeichnet hat

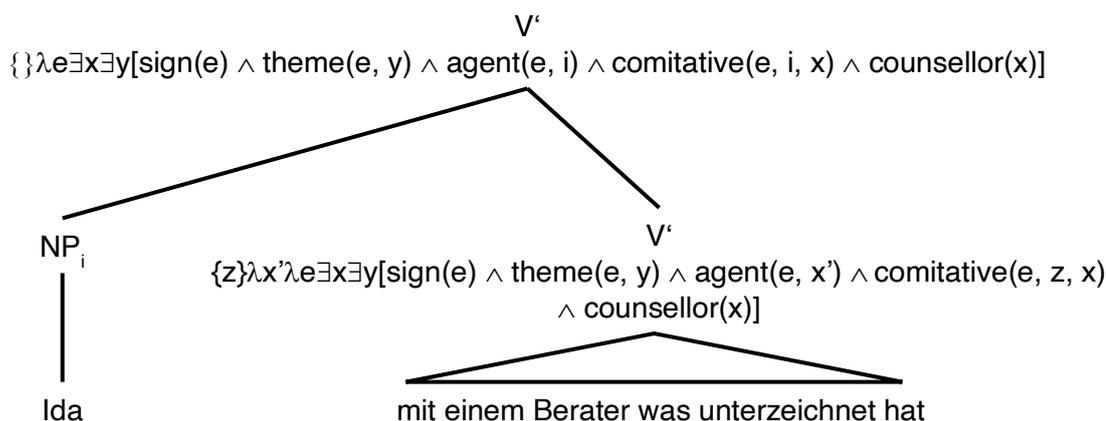


Being suspended,  $z$  becomes syntactically dependent element. Just as other syntactically dependent elements (*SLASH* in Gazdar et al. (1985), dependent anaphors in Kiss (2012), among others), it must be present in each projection of the tree until it can be identified with an individual variable provided by another element combined with the phrase bearing the projected index of the suspended variable. The identification of the suspended variable thus follows the pattern of variable binding, from which it follows that the binder must c-command the position

<sup>14</sup> *Suspension* is defined as a lexical operation which turns prepositions with event-internal senses (and hence: with two external arguments) into prepositions that only show a single (event-type) external argument.

of the PP that issued the suspended variable.<sup>15</sup> The combination of the subject with the verbal projection, as illustrated in (25), affects the individual variable of the subject –  $i$  – in two ways: First, it is identified with the open individual variable  $x'$  of the verbal projection, and it *binds* the suspended element  $\{z\}$  projected by the verbal projection. If such an element is bound, it is identified with the binder and will no longer be suspended – hence,  $i = x' = z$ . In the following, we will call this necessary cancellation of suspension the *Identification Requirement for event-internal modifiers* (IR). In contrast to the LP constraints, we assume that IR must not be violated. Consequences of this assumption will be discussed in sections 4.3 and 4.4.

(25) Ida mit einem Berater was unterzeichnet hat



While the representation now provides information about the individuals participating in the comitative relation, we still have to account for the thematic role assigned to the internal argument of the comitative relation –  $x$ . To this end, we will assume that comitatives are constrained by the following meaning postulate provided in (26), where  $\theta$  must be instantiated by a specific thematic role.

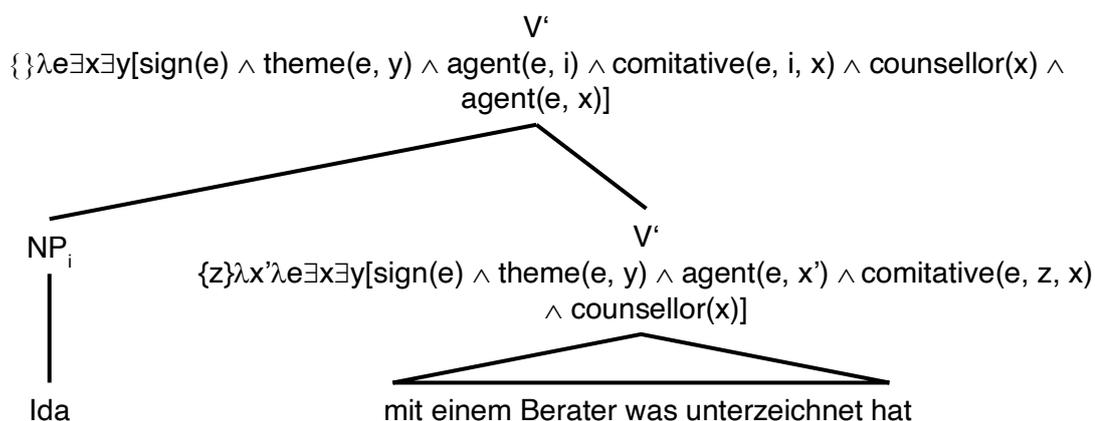
(26) Comitative Meaning Postulate<sup>16</sup>  
 $\forall \theta \forall e \forall x \forall y [[\text{comitative}(e, x, y) \wedge \theta(e, x)] \rightarrow \theta(e, y)]$

The meaning postulate (26) states that the role that relates the variable of the external argument of the *comitative* relation to the modified event is the same role that relates the *internal* argument of the *comitative* relation to that event. In the present case, this variable is the one issued by [<sub>NP</sub> Ida] in (25). And so, a second thematic role is introduced in the event structure, which relates the internal argument of the *comitative* –  $x$  – to the main event  $e$  using the very same role that relates  $i$  to  $e$ , i.e. *agent*.

<sup>15</sup> Heim & Kratzer (1998: 262) provide the following formulation: “ $\beta^n$  (semantically) binds  $\alpha^m$  iff the sister of  $\beta^n$  is the largest subtree [of the smallest tree containing both  $\beta^n$  and  $\alpha^m$ ] in which  $\alpha^m$  is (semantically) free”, which captures the relationship between variable binding and the respective positions of binder and bound variable in a syntactic structure.

<sup>16</sup> We assume that this postulate can be derived from the requirement of co-spatiality and contemporaneity in the definition of comitatives provided by Stolz et al. (2006: 86, 140).

(27) *Ida mit einem Berater was unterzeichnet hat*



The resulting semantic representation on the top node in (27) describes a set of event, which are a signing events in which the theme of the signing is non-specific, and in which *Ida* and a counsellor are both acting as *agents*. The very same semantic representation would give rise to a clause describing the same event by coordinating the participants of the comitative relation:

(28) *Da haben Ida und ein Berater was unterzeichnet.*  
 there have *Ida.NOM* and *a.NOM counsellor.NOM* *what.ACC sign.PTCP*  
 ‘*Ida* and a counsellor signed something.’

The analysis proceeds in the same fashion for COM(O), as illustrated in (2). The individual variable of the comitative is suspended, allowing Event Identification. After combination of the modified verbal projection with an object, the individual variable of the object is identified with the suspended variable, giving rise to object-orientation. Finally, the Comitative Meaning Postulate is applied, providing the information that the internal argument of the comitative is a further *theme*. An interpretation as COM(O) is ruled out by IR if the object is combined with the verbal projection prior to the modification. The violation observed in (2a) is thus not only an indication of markedness but of ungrammaticality – an issue to which we will return in the following section, and section 4.4 in particular.

#### 4.3 The serialization of event-internal modifiers

As far as IR is concerned, subject-oriented event-internal modifiers may appear in any position to the right of the subject. IR only discriminates between the serializations of COM(O): An identification of the external argument of the comitative in (2a) with the subject – thus erroneously leading to an interpretation as COM(S) – is implausible, because it would require agency of an inanimate object (*Handtuch*, ‘towel’). But an identification with the individual variable of the object is impossible because the object is realized in a sister of the adverbial. Hence, an example like (2a) can either receive an implausible reading, or no interpretation of the comitative at all, yielding ungrammaticality.<sup>17</sup> Comitatives, of course, can be genuinely ambiguous if

<sup>17</sup> This conclusion does not preclude that a minority of speakers considered the example acceptable, which will be discussed in section 4.4.

no other conditions (such as inanimacy of the object) block this.<sup>18</sup> Consider the examples in (29), where both arguments of the verb *beliefern* ‘supply’ are animate.

- (29) a. Da hat ein Verleger einen Gutachter zusammen mit einem  
 there has a.NOM publisher.NOM a.ACC reviewer.ACC together with a.DAT  
 Herausgeber beliefert.  
 editor.DAT supply.PTCP
- b. Da hat ein Verleger zusammen mit einem Herausgeber einen Gutachter beliefert.  
 ‘A publisher supplied a reviewer together with an editor.’

According to the analysis presented in section 4.2, (29a) is ambiguous, but (29b) is not. The syntactic structure of (29a) allows an identification of the external argument of the comitative with the individual variable of the subject or the object since IR does not assume a minimality condition. In case of an identification with the subject, the serialization pattern seems to contrast the preference in (1), but we will shortly see that this is not the case. Example (29b), however, is unambiguous according to IR because the individual variable of the object again is contained in the phrase which is modified by the event-internal modifier.

The question hence emerges how the preferences in (1) to (5) are accounted for, and how this account deals with examples like (29) if subject orientation is given. We will start with COM(S) and will turn to INSTR subsequently.

As was pointed out in section 4.1, we employ violable LP constraints, which apply to maximal projections. For the present purposes, the constraints provided in section 4.1 suffice to deal with the observed serializations. A comparative treatment of German word order will surely establish a larger inventory of LP constraints (see also 4.5 below). The three constraints in (16) are ordered according to their strength or weight, following the concepts of a Maximum Entropy Grammar. The strength of a constraint reflects the reduction in probability of occurrence of a candidate that violates the constraint. Given the make-up of the examples, it is not possible to satisfy all the applicable constraints. While example (1a) for COM(S)<sub>A</sub> violates the constraint (16b) – order of categories – example (1b) violates *Agentivity* (16a) and *Animacy* (16c). The violation of the constraints (16a) and (16c) lowers the probability of realization to a much larger degree than the violation of (16b). It should be noted that the examples in (29) differ from the examples in (1) in that *Animacy* is not at issue here. But still, *Agentivity* (16a) is stronger than the categorial constraint (16b), which yields again a preference for placing COM(S)<sub>A</sub> in front of the object, albeit a lower one than for (1a).

But of course, this does not apply to COM(S)<sub>P</sub> (4), where the preference is switched. Here, the interaction between IR and the linearization constraints comes into play. The analysis in section 4.2 assumes that COM(S)<sub>A</sub> take over the thematic role borne by their reference phrase, but we do not see a reason to apply this to privative event-internal modifiers as well. Consider the interpretation of the COM(S)<sub>P</sub> in the first sentence in (30).

- (30) Monika hatte ohne einen Kollegen was getestet. Sie hatte  
 Monika.NOM had without a.ACC colleague.ACC what.ACC test.PTCP she.NOM had  
 keinen gefunden.  
 none.ACC find.PTCP  
 ‘Monika tested something without a colleague. She hadn’t found any.’

<sup>18</sup> In the experimental design reported in section 3, we chosen the inanimacy of the object deliberately to avoid ambiguity.

There is no assertion in the first sentence in (30) that there are *no* colleagues, but only an assertion that there are no colleagues that stand in a comitative relation to *Monika* in *e*. In addition, (30) does not presuppose that there are no colleagues and can thus be continued as shown.

We can thus conclude that  $\text{COM}(S)_P$  neither assert nor presuppose that the restriction of their complement – *Kollege* ‘colleague’ in (30) – denotes the empty set. Logically, this can be captured by considering that the appropriate representation of the meaning of (30) –  $\neg\exists x[\text{colleague}(x) \wedge \text{comitative}(e, m, x)]$  – is logically equivalent to a universal quantification with negated restriction. We thus assume the representation for the  $\text{COM}(S)_P$  in (30) provided in (31).

(31) ohne einen Kollegen:  $\lambda z\lambda e\forall x[\text{colleague}(x) \Rightarrow \neg\text{comitative}(e, z, x)]$

If  $\text{COM}(S)_P$  introduce a universal quantification which scopes over the *negated* comitative predicate, the lack of an existential presupposition as well as the lack of a negation of an existential presupposition is captured. And since the *comitative* relation is negated, the introduction of a further thematic role is not licensed by the *Comitative Meaning Postulate* (26) because the comitative relation is in the scope of negation. But without the introduction of an additional thematic role *agent* in (4), *Agentivity* (16a) cannot apply, and we are left with an application of the constraints (16b) and (16c), one of which is violated in either serialization. Since the categorial constraint (16b) is stronger than *Animacy*, the preference for the serialization (4b) is accounted for.<sup>19</sup>

<sup>19</sup> The preposition *ohne* ‘without’, showing the privative meaning of  $\text{COM}(S)$  and  $\text{INSTR}$ , and the preposition *mit* ‘with’ showing the affirmative meaning of  $\text{COM}(S)$ , had to be combined with P-modifiers (*ganz* ‘entirely’, *zusammen* ‘together’) in the experimental items to block confounding attachment ambiguities. We cannot exclude that these additional elements may influence judgments insofar as the elements may also function as focus markers. We considered it more important to avoid attachment ambiguities, which we encountered in pilot studies: An insertion of a P-modifier makes an interpretation of the PP as a postnominal modifier unlikely. An unmodified P (see (i) in comparison to (11b)) allows an interpretation as a postnominal modifier. Such a reading is blocked in (11a) because it would require a different case of the prepositional object.

(i) Eva hat erzählt, dass  $\text{NP}[\text{eine Hausfrau}] \text{PP}[\text{ohne ein Spülmittel}]$  was gereinigt hat.

‘Eva has told that a housewife, who doesn’t own any detergent at all, cleaned something.’

An anonymous reviewer has raised the question of focus marking through *ganz* and suggested that an alternative analysis of privative event-internal modifiers would be possible, which would be compliant with Frey & Pittner’s proposal that event-internal modifiers show a base position above the object. According to this suggestion, the preferred order  $\text{OBJ} < \text{PP}$  comes about because of the (necessary) movement of the object to avoid focus. In the presumed base position, the adverbial would c-command the object. This assumption is problematic in three aspects: First, it must be acknowledged that the preference for the object preceding the adverbial extends from  $\text{INSTR}_P$  and  $\text{COM}(S)_P$  to  $\text{INSTR}_A$ . Test items featuring  $\text{INSTR}_A$  do not require the insertion of a P-modifier such as *ganz* because the case of the preposition’s object already serves to disambiguate (see examples (3), (11a), (12), and (13), as well as the Supplementary Material). Since there is no focus marker, an analysis based on focus would fall short of accounting for the order preference of  $\text{INSTR}_A$ . Secondly, the analysis requires the object to move across the base position of the adverbial, thus ignoring the status of *wh*-indefinites as scrambling-resistant items. Thirdly, even if we ignore the first two aspects, the assumption will predict that (7) can be used with a wide scope reading of the adverbial, counter the observations made in section 2.

We agree with the reviewer that a general theory of word order must include focus as a decisive factor and will briefly touch this issue in section 4.5. A comprehensive theory of word order, however, is beyond the scope of the present paper.

COM(S)<sub>P</sub> share their preference for a position to the right (and hence below) the object with affirmative and privative INSTR. As event-internal modifiers, it holds for INSTR as well that they have to obey IR, which of course they could in positions to the right of the subject, because they are oriented towards the agent, which is realized as the subject in examples like (3) and (5). Again, the application of the LP constraints determines the clear preference for a position to the right (and hence below) of the object. The only applicable rule in this case is (16b), which is satisfied in (3b) and (5b) and violated in (3a) and (5a).<sup>20</sup>

#### 4.4 Ungrammatical but acceptable?

Let us return to the analysis of object-oriented comitatives (COM(O)). It follows from the analysis of the Identity Requirement (IR) presented in section 4.2 that example (2a), repeated here under (32) is not just marked because of the violation of the LP constraint (16b), but is ungrammatical because IR cannot be met with the object being contained in the phrase modified by the adverbial.

- (32) Da hat Hans **zusammen mit einem Handtuch** was gewaschen.  
 there has Hans.NOM together with a.DAT towel.DAT what.ACC wash.PTCP  
 ‘Hans washed something along with a towel.’

This conclusion obviously contradicts the findings of EXP2, where the empirical findings – as reported in figure 2 – were reflected in a model in which the serialization pattern COM(O) < OBJ receives a low, but not a zero probability. In our view, this discrepancy is best accounted for by endorsing the idea that even ungrammatical examples can be judged as acceptable if they can be repaired easily. Haider (2007: 389 ff.) has proposed that “acceptability [is] a function of ease of repair ... [t]he degree of rejection seems to be inversely related to the ease of processing and repair”. Haider’s observation fits the characteristics of the test items used in EXP2: there is only one phrase which shows the same animacy value as the internal argument of the comitative, and hence the violation can be repaired easily. Similarly, Juzek & Häussler (2019: 351f.) argue that participants may repair ungrammatical test items if the repair yields a plausible interpretation, and the test item is intelligible in the first place. Again, associating the comitative with the object yields the only plausible interpretation.<sup>21</sup> In a study by Leivada & Westergaard (2020), the comparative illusion is presented as a case of ungrammaticality that yields acceptable ratings, again because participants in the experimental studies apply repair mechanism to provide interpretations.

We will thus maintain our conclusion that the serialization pattern observed in (32) is ungrammatical because it violates IR. Further corroboration for this conclusion comes from examples in which a COM(S) is placed in front of the subject, as is illustrated in (33), a variation of (29):

<sup>20</sup> And if the inanimate object in (3) and (5) is substituted by an animate one, the preference for the order OBJ < INSTR would of course gain even more strength as both (16b) and (16c) would be violated by the order INSTR < OBJ.

<sup>21</sup> While examples like (32)/(2a) might be taken to be acceptable because of a *prima facie* implausible reinterpretation of the comitative as being subject-oriented, we do not assume that this is the reason for the acceptability. Making the object-orientation explicit in such examples does not change the acceptability (as determined in an informal survey):

(i) Da hat Hans **zusammen mit einem Handtuch** was gewaschen und dann beides  
 there has Hans.NOM together with a.DAT towel.DAT what.ACC wash.PTCP and then both  
 zur Seite gelegt.  
 to.the side put.PTCP  
 ‘Hans washed something together with a towel and put both away.’

- (33) Da hat zusammen mit einem Herausgeber ein Verleger einen Gutachter  
 there has together with a.DAT editor.DAT a.NOM publisher.NOM a.ACC reviewer.ACC  
 beliefert  
 supply.PTCP  
 ‘A publisher supplied a reviewer together with an editor.’

We would even argue that (33) is less acceptable than (32) because the processing load is much higher, given that the comitative PP may take the subject and the animate object as its reference phrases.

#### 4.5 Serialization effects of scope and focus

In section 2, we have disputed Frey & Pittner’s conclusion that focus and scope adduce evidence for a specific base position of INSTR. Although the present paper cannot provide a comprehensive treatment of the serialization effects of scope and focus, let us consider example (7) – repeated here under (34a) – and a version of example (9) with an event-internal modifier in (35) – in light of the analysis proposed in section 4.3.

- (34) a. Otto hat jedes Fenster mit genau einem Wischtuch geputzt.  
 Otto.NOM has every.ACC window.ACC with exactly one.DAT floor.cloth.DAT clean.PTCP  
 ‘Otto cleaned every window with exactly one floor cloth.’  
 b. Otto hat mit genau einem Wischtuch jedes Fenster geputzt.  
 Otto.NOM has with exactly one.DAT floor.cloth.DAT every.ACC window.ACC clean.PTCP  
 ‘Otto cleaned used exactly one floor cloth to clean every window.’
- (35) Otto hat mit einem Schraubenzieher eine Wohnungstür geöffnet.  
 Otto.NOM has with a.DAT screwdriver.DAT a.ACC apartment.door.ACC open.PTCP  
 ‘Otto used a screwdriver to open an APARTMENT door.’

The examples in (34) differ not only regarding the position of INSTR, but also with regard to their scope options. As for (34a), we have already argued that this example does not allow a wide scope reading of INSTR, while a wide scope reading is present in (35b). All examples in (34) and (35) are grammatical, but examples (34b) and (35) violate the constraint (16b). The examples employed so far (originating in the test items in EXP1 and EXP2) contained event-internal modifiers the objects of which were indefinite NPs. And objects realized as *wh*-indefinites are unlikely to be foci. Therefore, neither scope nor focus were at issue in the examples discussed. It is well-known that scope and focus influence word order, and additionally, we may conclude that example (34b) is not marked with respect to (34a), nor is (35) marked. This raises the question of how scope and focus are captured in terms of LP constraints. Frey (2015: 522) discusses the following two LP constraints covering scope and focus (see also Jacobs 1988 for the latter):

- (36) a. non-focal < focal  
 b. scope bearer < scope taker

It should be clear that the examples in (34) cannot be compared directly to the pairs of serializations covered by the LP constraints discussed so far – e.g. (1), (3), (4), and (5), because the examples in (34) differ in their interpretation. We would thus not assume that they belong to the same candidate set, and hence that the question of markedness does not appear in

comparing (34a) and (34b). Similar considerations apply to variations of (35) with different focus potentials. For the time being, we will assume that the LP constraints in (36) will outweigh the LP constraints introduced in (16). Hence, choosing the serialization (34a) for a wide scope reading of INSTR would be highly marked in comparison to the serialization (34b).

## 5. Summary

The serialization of event-internal modifiers requires a closer look into their semantics. First, event-internal modifiers are special insofar as they introduce two external argument variables, only of which can be identified directly. Since the second variable must be bound syntactically, it follows that its binder must c-command the position in which the adverbial is realized. Secondly, a possible assignment of thematic roles to the internal argument of the comitative depends on the identification process, as well as on the sense of the head of the adverbial: for affirmative, but not for privative, senses, the internal argument receives a thematic role. Whether or not such a role is present has an influence on the serialization options of the event-internal modifier, which are captured by general LP constraints applying equally well to arguments and adjuncts. Therefore, we are confronted with a superficially erratic pattern of different serialization preferences if the *class* of event-internal modifiers are considered, which however gives way to individual factors once these are uncovered and taken into consideration.

The identification requirement for event-internal modifier is a constraint on interpretation, and as such cannot be violated because it introduces a syntactic dependency that can only be resolved if the identifier and the adverbial issuing the variable to be bound stand in a specific syntactic configuration, which is structurally identical to c-command. The LP constraints differ from the identification requirement in being violable, and not giving rise to (un-)grammaticality, but to markedness. In the Appendix, we provide a brief discussion of a Maximum Entropy Grammar (Goldwater & Johnson 2003; Hayes 2022), which determines the weights for the violable constraints, and the probabilities for different serializations, which are summarized in table 4, and compared to the predictions of Frey & Pittner (1998). An analysis in the spirit of Haider (2000) and Maienborn et al. (2016) would not constrain serializations since it would assume relative order constraints only, which require the presence of more than one adverbial in a minimal clause. The probabilities given in table 4 are provided for realizations from a given candidate set, which e.g. means for examples (1a, b) that the serialization  $\text{COM}(\text{S})_A < \text{OBJ}$  is more than three times as likely than the probability for  $\text{OBJ} < \text{COM}(\text{S})_A$ . As for (29a, b), we have grouped the examples into two different candidate sets (one assuming object-orientation, one assuming subject-orientation), since the two differ in interpretation. In case a serialization violates the identification requirement – as in (2a) and (29b) with object-orientation – we do not provide the probability for the LP constraints, but instead 0.00 to indicate that the respective examples are ungrammatical.

**Table 4:** Summary of predictions and comparison to competing analyses<sup>22</sup>

Ex.	Order	IR	Agentivity	NP < PP	Animacy	P(Order)	Frey & Pittner
(1a)	COM(S) <sub>A</sub> < OBJ	✓	✓	*	✓	0.63	✓
(1b)	OBJ < COM(S) <sub>A</sub>	✓	*	✓	*	0.19	*
(2a)	COM(O) < OBJ	*		*		0.00	*
(2b)	OBJ < COM(O)	✓		✓		1.00	✓
(3a)	INSTR <sub>A</sub> < OBJ	✓		*		0.21	✓
(3b)	OBJ < INSTR <sub>A</sub>	✓		✓		0.78	*
(4a)	COM(S) <sub>P</sub> < OBJ	✓		*	✓	0.35	✓
(4b)	OBJ < COM(S) <sub>P</sub>	✓		✓	*	0.55	*
(5a)	INSTR <sub>P</sub> < OBJ	✓		*		0.21	✓
(5b)	OBJ < INSTR <sub>P</sub>	✓		✓		0.76	*
(29a)	OBJ < COM(O) <sub>A</sub>	✓		✓		1.00	✓
(29b)	COM(O) <sub>A</sub> < OBJ	*		*		0.00	*
(29a)	OBJ < COM(S) <sub>A</sub>	✓	*	✓		0.35	*
(29b)	COM(S) <sub>A</sub> < OBJ	✓	✓	*		0.51	✓

#### Appendix: A Maximum Entropy Grammar for LP constraints

A Maximum Entropy Grammar (MEG, Goldwater & Johnson 2003; Wilson 2006; Hayes 2022) diverges from standard Optimality Theory (OT, Prince & Smolensky 2004; Müller 2015) in defining rescaled violation profiles with weights. Given a set of constraints,  $C = \{c_1, \dots, c_n\}$  and a set of candidates  $GEN = \{y_1, \dots, y_m\}$  a violation profile for a candidate  $y_i$  can be determined by counting the violations for each member of  $C$ , and weighing the individual violations:  $w_i \times f_i(y)$ , where  $f_i$  is the frequency of violations of constraint  $c_i$ , and  $w_i$  is the weight of the violation of constraint  $c_i$ . A violation profile of a candidate consists of summing up all individual violation profiles of the constraints:  $\sum_{i \in C} w_i \times f_i(y)$ . The violation profile is usually interpreted as a penalty score for the candidate, which is also known as the candidate's *Inverted Harmony* (Hayes 2022):

(37) *Inverted Harmony*:  $\exp(-\sum_{i \in C} w_i \times f_i(y))$ , where  $\exp(x)$  is the exponential function.

It should be noted that the maximal value for (37) can be 1 if there is no violation at all. The higher the product of weights and frequencies of constraint violations is, the lower will *Inverted Harmony* be. An *Inverted Harmony* score can be transformed into a probability by dividing an individual score through the sum of all scores of the candidates. As Hayes (2022) argues, MEG thus considers all available evidence from the constraints. A plausible MEG rests on the calculation of the constraint weights, which can be achieved using the methods described in Hayes & Wilson (2008).

In the present case, gauging the sum of all *Inverted Harmony* scores requires determining violation profiles for all possible serializations of subjects, objects, and event-internal adverbials. The candidate set for each of the examples provided in the paper thus must be extended to include serializations that have not been tested in the experimental studies, because the research literature agrees in assuming that the pertinent combinations are illicit. Among these

<sup>22</sup> Probabilities provided (P(Order)) for candidates do not have to sum up to 1 because we only represent probabilities for serializations tested in the experimental studies, see the Appendix.

are all serializations in which the event-internal PP precedes the subject and the object, and all serializations in which the object precedes the subject. As for the latter case, we introduced a constraint called *\*Downward*, that does not play a discriminating role for the serializations discussed so far. *\*Downward* penalizes structures that resulting from realizing a phrase with higher grammatical function below a fixed phrased with lower grammatical function. As a fixed phrase, we take a phrase – such as existential *wh*-indefinites – that is considered scrambling-invariant in analyses treating word order variation through movement. Let us illustrate the candidate set for a sentence with an affirmative instrumental:

(38) Candidate set for INSTR<sub>A</sub>:

Candidate	*Downward	Agentivity	Animacy	NP < PP
SUBJ < OBJ < INSTR <sub>A</sub>				
SUBJ < INSTR <sub>A</sub> < OBJ				*
INSTR <sub>A</sub> < SUBJ < OBJ		*	*	**
INSTR <sub>A</sub> < OBJ < SUBJ	*	*	**	**
OBJ < INSTR <sub>A</sub> < SUBJ	**	**	**	*
OBJ < SUBJ < INSTR <sub>A</sub>	**	*	*	

The weights for the constraints have been determined as 11.31, 1.64, 0.83, and 1.28, respectively. Since the first candidate with the order SUBJ < OBJ < INSTR<sub>A</sub> does not violate any constraint, its violation profile amounts to 0, and its *Inverted Harmony* accordingly to 1. In contrast, the second candidate with the order SUBJ < INSTR<sub>A</sub> < OBJ violates NP < PP, yielding a violation profile of 1.28, and an *Inverted Harmony* of 0.28, which is still small, but sufficient to determine an overall probability of SUBJ < OBJ < INSTR<sub>A</sub> of almost 78 %, and of almost 22 % for SUBJ < INSTR<sub>A</sub> < OBJ. The first serialization is thus clearly preferred, and to be considered unmarked. The second serialization is not ungrammatical – it satisfies IR – but is to be considered marked because the first serialization does not violate any of the constraints.

The calculated weights allow the determination of violation profiles and probabilities of examples not considered in the experimental studies, such as examples (29a, b) with subject-orientation of the affirmative comitatives and compare the results to the observed data.<sup>23</sup>

(39) Comparison of violation profiles of (1a, b) vs. (29a, b)

Ex.	Order	Agentivity	Animacy	NP < PP	Score	P(Order)
(1a)	OBJ < COM(S) <sub>A</sub>	*	*		2.47	0.19
(1b)	COM(S) <sub>A</sub> < OBJ			*	1.28	0.63
(29a)	OBJ < COM(S) <sub>A</sub>	*			1.63	0.35
(29b)	COM(S) <sub>A</sub> < OBJ			*	1.28	0.51

The violation profiles of (1b) and (29b) are identical, but the ones of (1a) and (29a) are not. Hence, the Harmony for (1b) and (29b) is identical, but the probability of their realization differs because of the much higher violation profile for (1a) in comparison to (29a).

<sup>23</sup> The constraint *\*Downward* is not violated by the examples in question.

## Abbreviations

ACC = accusative, DAT = dative, GEN = genitive, NOM = nominative, PTCP = participle

## Data availability

The data and models discussed in the present paper can be found in

<https://github.com/Linguistic-Data-Science-Lab/Kiss-et-al-23-word-order-constraints>

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## Competing interests

The authors have no competing interests to declare.

## References

- Baker, Mark C. 1997. Thematic roles and syntactic structure. In Haegeman, Liliane (ed.), *Elements of grammar: Handbook of generative syntax*, 73–137. Dordrecht: Kluwer. [https://doi.org/10.1007/978-94-011-5420-8\\_2](https://doi.org/10.1007/978-94-011-5420-8_2)
- Bates, Douglas & Mächler, Martin & Bolker, Ben & Walker, Steve. 2015. Fitting Linear Mixed-Effects Models using lme4. *Journal of Statistical Software* 67(1). 1–48. <https://doi.org/10.18637/jss.v067.i01>
- Diesing, Molly. 1992. *Indefinites*. Cambridge; Mass.: MIT Press.
- Fanselow, Gisbert. 2003. Free constituent order. A minimalist interface account. *Folia Linguistica* 37(1/2). 191–232. <https://doi.org/10.1515/flin.2003.37.1-2.191>
- Fanselow, Gisbert & Zimmermann, Malte & Philipp, Mareike. 2022. Assessing the availability of inverse scope in German in the covered box paradigm. *Glossa: A Journal of General Linguistics* 7(1). 1–24. <https://doi.org/10.16995/glossa.5766>
- Frey, Werner. 1993. *Syntaktische Bedingungen für die semantische Interpretation: Über Bindung, implizite Argumente und Skopus*. Berlin: Akademie Verlag.
- Frey, Werner. 2003. Syntactic conditions on adjunct classes. In Lang, Ewald & Maienborn, Claudia & Fabricius-Hansen, Cathrine (eds.), *Modifying adjuncts*, 163–209. Berlin: Mouton de Gruyter. <https://doi.org/10.1515/9783110894646.163>
- Frey, Werner. 2015. Word order. In Kiss, Tibor & Alexiadou, Artemis (eds.), *Syntax – Theory and analysis: An international handbook*, vol. 1, 514–562. Berlin/New York: Mouton de Gruyter. <https://doi.org/10.1515/9783110377408>
- Frey, Werner & Pittner, Karin. 1998. Zur Positionierung der Adverbiale im deutschen Mittelfeld. *Linguistische Berichte* 176. 489–534.

- Gazdar, Gerald & Klein, Ewan & Pullum, Geoffrey K. & Sag, Ivan A. 1985. *Generalized Phrase Structure Grammar*. Cambridge, Massachusetts: Harvard University Press.
- Goldwater, Sharon & Johnson, Mark. 2003. Learning OT constraint rankings using a Maximum Entropy model. In Spenader, Jennifer & Eriksson, Anders & Dahl, Östen (eds.), *Proceedings of the Stockholm workshop on 'Variation Within Optimality Theory,'* 111–120. Stockholm: Stockholm Univ.
- Haider, Hubert. 2000. Adverb placement: Convergence of structure and licensing. *Theoretical Linguistics* 26. 95–134. <https://doi.org/10.1515/thli.2000.26.1-2.95>
- Haider, Hubert. 2007. As a matter of facts – comments on Featherston's sticks and carrots. *Theoretical Linguistics* 33.3. 381–394. <https://doi.org/10.1515/TL.2007.025>
- Haider, Hubert. 2010. *The syntax of German*. Cambridge: Cambridge University Press. <https://doi.org/10.1017/CBO9780511845314>
- Hayes, Bruce & Wilson, Colin. 2008. A maximum entropy model of phonotactics and phonotactic learning. *Linguistic Inquiry* 39. 379–440.
- Hayes, Bruce. 2022. Deriving the wug-shaped curve: A criterion for assessing formal theories of linguistic variation. *Annual Review of Linguistics* 8:1. 473–494.
- Heim, Irene & Kratzer, Angelika. 1998. *Semantics in generative grammar*. Malden, MA: Blackwell.
- Jacobs, Joachim. 1988. Probleme der freien Wortstellung im Deutschen. In: *Arbeitsbericht Nr. 5 des Forschungsprogramms Sprache und Pragmatik*, 8–37. Lund.
- Juzek, Tom & Häussler, Jana. 2019. Semantic influences on syntactic acceptability judgments. In Gattnar, Anja & Hörnig, Robin & Störzer, Melanie & Featherston, Sam (eds.) *Proceedings of Linguistic Evidence 2018: Experimental data drives linguistic theory*. Tübingen: University of Tübingen. <http://dx.doi.org/10.15496/publikation-32605>
- Kayne, Richard. 1994. *The antisymmetry of syntax*. Cambridge, London: MIT Press.
- Kiss, Tibor. 2001. Configurational and relational scope determination in German. In Meurers, Walt Detmar & Kiss, Tibor (eds.), *Constraint-based approaches to Germanic syntax*, 141–176. Stanford: CSLI Publications.
- Kiss, Tibor. 2012. Reflexivity and dependency. *Linguistische Arbeiten* 547. 155–185.
- Kratzer, Angelika. 1996. Severing the external argument from its verb. In Rooryck, Johan & Zaring, Laurie (eds.) *Phrase structure and the lexicon*, 109–137. Dordrecht: Kluwer.
- Lechner, Winfried. 1998. Two kinds of reconstruction. *Studia Linguistica* 52(3). 276–310.
- Leivada, Evelina & Westergaard, Marit. 2020. Acceptable ungrammatical sentences, unacceptable grammatical sentences, and the role of the cognitive parser. *Frontier in Psychology* 11:364. <https://doi.org/10.3389/fpsyg.2020.00364>
- Maienborn, Claudia. 1995. Towards a compositional semantics for locative modifiers. In Simons, Mandy & Galloway, Teresa (eds.), *Proceedings from Semantics and Linguistic Theory V*, 237–254. Ithaca N.Y.: Cornell University Linguistic Publications.
- Maienborn, Claudia. 2001. On the position and interpretation of locative modifiers. *Natural Language Semantics* 9. 191–240. <https://doi.org/10.1023/A:1012405607146>
- Maienborn, Claudia. 2003. Event-internal modifiers: Semantic underspecification and conceptual interpretation. In: Lang, Ewald & Maienborn, Claudia & Fabricius-Hansen, Catherine

- (eds.), *Modifying adjuncts*, 475–509. Berlin: Walter de Gruyter. <https://doi.org/10.1515/9783110894646.475>
- Maienborn, Claudia & Gese, Helga & Stolterfoht, Britta. 2016. Adverbial modifiers in adjectival passives. *Journal of Semantics* 33(2). 299–358. <https://doi.org/10.1093/jos/ffv004>
- Müller, Gereon. 1999. Optimality, markedness, and word order in German. *Linguistics* 37. 777–818. <https://doi.org/10.1515/ling.37.5.777>
- Müller, Gereon. 2015. Optimality-theoretic syntax. In Kiss, Tibor & Alexiadou, Artemis (eds.), *Syntax – Theory and analysis: An international handbook*, vol. 2., 875–936. Berlin/New York: Mouton de Gruyter. <https://doi.org/10.1515/9783110363708-003>
- Neeleman, Ad & Reinhart, Tanya. 1998. Scrambling and the PF interface. In Butt, Miriam & Geuder, Wilhelm (eds.), *The projection of arguments: Lexical and compositional factors*, 309–353. Stanford: CSLI.
- Pieper, Jutta, Börner, Alicia Katharina & Kiss, Tibor. 2023. Identifying non-cooperative participation in web-based elicitation of acceptability judgments – How to get rid of noise in your data. Forthcoming in *Journal of Research Design and Statistics in Linguistics and Communication Science*.
- Prince, Alan & Smolensky, Paul. 2004. Optimality Theory: Constraint interaction in Generative Grammar. In McCarthy, John (ed.), *Optimality Theory in phonology. A reader*, 1–71. Oxford, UK: Blackwell. <https://doi.org/10.1002/9780470756171.ch1>
- Rissman, Lilia & Rawlins, Kyle. 2017. Ingredients of instrumental meaning. *Journal of Semantics* 34(3). 507–537. <https://doi.org/10.1093/jos/ffx003>
- Schütze, Carson T. & Sprouse, Jon. 2013. Judgment data. In Podesva, Robert J. & Sharma, Devyani (eds.), *Research methods in linguistics*, 27–50. Cambridge: Cambridge University Press.
- Stolz, Thomas & Stroh, Cornelia & Urdze, Aina. 2006. *On comitatives and related categories. A typological study with special focus on the languages of Europe*. Berlin/New York: Mouton de Gruyter.
- Struckmeier, Volker. 2014. *Scrambling ohne Informationsstruktur?: Prosodische, semantische und syntaktische Faktoren der deutschen Wortstellung*. Berlin: Akademie Verlag. <https://doi.org/10.1524/9783110347715>
- Uszkoreit, Hans. 1987. *Word order and constituent structure in German*. Stanford: CSLI Publications.
- Wilson Colin. 2006. Learning phonology with substantive bias: an experimental and computational investigation of velar palatalization. *Cognitive Sciences* 30. 945–982. [https://doi.org/10.1207/s15516709cog0000\\_89](https://doi.org/10.1207/s15516709cog0000_89)