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Does Dutch a-scrambling involve movement? Evidence from antecedent priming

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Abstract: The present study focuses on A-scrambling in Dutch, a local word-order alternation that typically signals the discourse-anaphoric status of the scrambled constituent. We use cross-modal priming to investigate whether an A-scrambled direct object gives rise to antecedent reactivation effects in the position where a movement theory would postulate a trace. Our results indicate that this is not the case, thereby providing support for a base-generation analysis of A-scrambling in Dutch.

Keywords: scrambling, movement, cross-modal priming

1 Introduction

There is a wealth of evidence that a variety of deviations from canonical word order must be attributed to movement. An uncontroversial example is given in (1a), where focus movement has displaced the anaphor *himself* (compare (1b), where the anaphor occupies its canonical position).

- (1) a. HIMSELF₁ John₁ admires *t*₁.
b. John₁ admires himself₁.
c. *I expect himself₁ to admire John₁.

The displacement in (1a) belongs to the family of A'-movements, which leave a trace that can be shown to be active for a variety of linguistic processes, including case/agreement and binding, using standard diagnostic tests that

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tap into native speaker judgments. For example, such tests establish that the binding principle responsible for licensing reflexive pronouns applies to (1a) as if it has the structure in (1b), even though the surface c-command relation between *John* and *himself* mirrors that in (1c), where the anaphor fails to be bound. Needless to say, this is immediately explained if (1a) involves movement.

However, not every deviation from canonical order is associated with equally robust evidence for movement. A particularly contentious case is presented by givenness marking through A-scrambling (also known as ‘neutral scrambling’). In languages that exhibit it, A-scrambling obeys the empirical generalization in (2), which goes back to work in the Prague School and has since been endorsed in one form or another by a range of authors (Clark and Clark 1977; Clark and Haviland 1977; Gundel 1988; Skopeteas and Fanselow 2010, among others).

(2) *Given-before-New Principle*

If a language marks givenness via word order, then in the marked order the given material precedes the new material.

Givenness marking is exemplified for Dutch in (3). Since the context provided mentions *dat boek van Haegeman* ‘that book by Haegeman’, an answer that preserves the canonical order, as in (3a), is judged contextually inappropriate. Instead, what is required is a structure in which the discourse-given object scrambles across the discourse-new adverb *morgen* ‘tomorrow’, as in (3b).

(3) Hoe zit het met je review van dat boek van Haegeman?

‘How are you progressing with your review of that book by Haegeman?’

a. # Nou, ik denk dat ik morgen [het boek van Haegeman] ga lezen.

Well, I think that I tomorrow the book by Haegeman go read

b. Nou, ik denk dat ik [het boek van Haegeman] morgen ga lezen.

Well, I think that I the book by Haegeman tomorrow go read

‘Well, I think that I will read Haegeman’s book tomorrow.’

It has long been known that A-scrambling lacks almost all the diagnostic properties of A'-movement and must be analyzed as involving either A-movement across an adjunct or variation in the base-position of the adjunct ‘crossed’ by scrambling. The first type of proposal assumes that the adjunct the object scrambles across has a unique attachment site. The scrambled order therefore involves movement of the object across this adjunct (see (4a) and (4d)). By contrast, the second type of proposal assumes that the adjunct may be attached above or below the surface position of the object (see (4b), (4c) and (4e)). Such base-generation analyses of

scrambling may nevertheless also involve A-movement of the object if it is assumed that the object must be generated as a complement of V (see (4b) and (4e)).

- (4) a. OV – fixed adjunct (Mahajan 1990; De Hoop 1992, a.o.)
 [AgrOP DP₁ [AgrO' [VP Adjunct [VP t₁ V]] AgrO]]
- b. OV – flexible adjunct (Vanden Wyngaerd 1989)
 [AgrOP <Adjunct> [AgrOP DP₁ [AgrO' [VP <Adjunct> [VP t₁ V]] AgrO]]]
- c. OV – flexible adjunct (Neeleman 1991; Bayer and Kornfilt 1994; a.o.)
 [VP <Adjunct> [VP DP [V <Adjunct> V]]]
- d. VO – fixed adjunct (Koster 1999)
 [FP <DP_{given}>₁ F [AgrOP Adjunct [AgrOP <DP_{new}>₁ [AgrO' AgrO [VP V t₁]]]]]
- e. VO – flexible adjunct (Zwart 1993)
 [AgrOP <Adjunct> [AgrOP DP₁ [AgrO' AgrO [VP <Adjunct> [VP V t₁]]]]]

Unfortunately, the choice between the various alternatives in (4) is not easily made solely on the basis of diagnostic tests that rely on native speaker judgments.

The aim of the present paper is to contribute to the debate about the syntax of A-scrambling through an experimental investigation of this phenomenon in Dutch. Our primary objective is to uncover evidence for or against the strongest version of UTAH (Uniformity of Theta-Assignment Hypothesis; Baker 1988),¹ which predicts the presence of an immediately pre-verbal or post-verbal trace in sentences with an A-scrambled object.²

1 UTAH states that identical thematic relationships between items are represented by identical structural relationships between these items at the level of D-structure. The literature contains several variants of UTAH, which are not all equally restrictive (see Baker 1997 for discussion). For some authors, UTAH is just an alternative way of talking about the Thematic Hierarchy. Throughout this paper, we have in mind a stronger version of UTAH, which is similar in spirit to the cartographic theory of argument structure advanced in Hale and Keyser 1993.

2 Our study is restricted to structures in which an object DP scrambles across a modifier. Dutch also permits scrambling of a theme object DP across goal PP. It is however far from clear how such scrambling constructions should be analyzed, particularly because there are no solid syntactic analyses of PP-arguments.

The relevant scrambling pattern is intriguing; a theme DP can scramble across a goal PP, but a theme PP cannot scramble across a goal DP (see Neeleman and Weerman 1999):

- (i') *...dat Jan aan de kou zijn hond blootgesteld heeft.
- (ii) ... dat Jan aan Marie een boek geeft.
 ... that John to Mary a book gives
- (ii') ... dat Jan een boek aan Marie geeft.
 ... that John a book to Mary gives

We report on three online experiments and one off-line experiment. The results of the online experiments indicate that A-scrambling does not involve movement from either a pre-verbal or a post-verbal position, thereby singling out (4c) as the only viable analysis. Finally, in line with these results, the offline experiment indicates that an A-scrambled object does not reconstruct below the adjunct it scrambles across.

The paper is organized as follows. Section 2 sketches the linguistic background to our study and in doing so draws out the now widely accepted distinction between A'-scrambling and A-scrambling and the uncertain nature of A-scrambling. Section 3 turns to the psycholinguistic background. We provide a brief overview of previous experimental work on scrambling and of the efficacy of the cross-modal priming technique for the detection of traces of movement, looking at both A'- and A-relations. In section 4 we use the findings of sections 2 and 3 to motivate the design of our study and give an overview of the experiments, while section 5 summarizes our results. Section 6 presents our main conclusions and discusses the implications of our study for syntactic theory.

2 Linguistic background

In the extensive literature on scrambling in the generative tradition an early split developed between movement and base-generation approaches. Of the base-generation approaches, we put to one side here those that assume a non-configurational phrase structure (see, for example, Hale 1994, on Warlpiri, and Kiss 1987, 1994, 2008, on Hungarian), as these are widely considered inadequate for the Germanic languages.

In Government and Binding Theory, scrambling was initially assumed to be the result of A'-movement. In fact, the theory more or less dictated that this was the only option. However, Webelhuth (1989) argued that scrambling in German exhibited both A- and A'-properties and proposed an adjunction position with mixed properties. This proposal soon gave way to alternatives that assume two types of scrambling, namely A'-scrambling (also sometimes referred to as Focus

Note that this pattern would fall into place right away if the PP is syntactically an adjunct. After all, adjuncts do not undergo scrambling for givenness and we already know that in Dutch a DP can scramble across an adjunct.

Scrambling) and A-scrambling (see Vanden Wyngaerd 1989; Mahajan 1990; Neeleman 1991, among others).

A'-scrambling does not affect binding or secondary predication, gives rise to weak crossover effects, is not clause-bounded, and reconstructs (obligatorily) for scope (see Neeleman 1994a; Jacobs 1997; Haider and Rosengren 1998 for some discussion). These properties can only be properly understood if A'-scrambling is a kind of A'-movement.

By contrast, A-scrambling feeds and bleeds binding and secondary predication, does not give rise to weak crossover effects, is clause-bounded, and does not seem to give rise to scope reconstruction (see Vanden Wyngaerd 1989; Mahajan 1990; Zwart 1993; and Neeleman 1994a). These properties are broadly compatible with either an A-movement or a base-generation analysis of A-scrambling.

Our primary objective is to uncover new empirical evidence that would allow us to choose between these competing analyses of A-scrambling. With this in mind, the remainder of this section serves two goals. We briefly illustrate the distinction between Dutch A'-scrambling and Dutch A-scrambling, so as to clearly delineate the kind of linguistic data that will be relevant to our study. This is followed by some discussion of why it has proved so difficult to ascertain whether A-scrambling involves movement.

As a point of departure, let us see how we can tell apart Dutch word orders formed by A'-scrambling from those formed by A-scrambling. Since A-scrambling is clause-bounded, any case of long-distance scrambling should exhibit A'-properties. This is indeed the case. Example (5a) illustrates long-distance scrambling of a contrastive topic (marked with double-underlining) out of a constituent containing a contrastive focus (rendered in small caps). Contrastive topics and contrastive foci are marked with a B-accent³ and A-accent,⁴ respectively, in Dutch. As shown by the binding possibilities for a pronoun (see (5b)) and a reflexive (see (5c)) undergoing A'-scrambling, this movement reconstructs obligatorily, as expected if we are dealing with an A'-relation.

- (5) a. dat zo'n meisje zelfs JAN niet gelooft dat Piet
 that *such-a girl* even John not believes that Peter

³ See Jackendoff 1972: a B-accent is maximally realized as L + H* followed by a default low tone and a high boundary tone (L H%). See Van Hoof 2003 for corroboration of this pattern for Dutch contrastive topics.

⁴ See Jackendoff 1972: an A-accent is a plain high tone (H*), often followed by a default low tone (see also Büring 2003 and references mentioned there).

- t dit boek zou geven*
this book would give
- b. dat hem_{1/*2} zelfs J_{AN1} niet gelooft dat Piet₂
that him even John not believes that Peter
t dit boek zou geven
this book would give
- c. dat zichzelf_{*1/2} zelfs J_{AN1} niet gelooft dat Piet₂
that himself even John not believes that Peter
t dit boek zou geven
this book would give
 ‘... that even John does not believe that Peter would give this book to such a girl/him/himself.’

With clause-internal scrambling, we find that scrambling across an argument invariably has an A'-character.^{5,6,7} Thus, as one would expect if this characterization of the empirical situation is correct, scrambling an object across an indirect object or a subject cannot repair an illicit binding relation in Dutch (irrespective of intonation):

- (6) a. *dat ik elkaars fans zulke acteurs liever niet voorstel.
that I each other's fans such actors rather not introduce
- b. ??dat zulke acteurs ik elkaars fans _{t_{DP}} liever niet voorstel.
that such actors I each other's fans rather not introduce
- c. ??dat ik zulke acteurs elkaars fans _{t_{DP}} liever niet voorstel.
that I such actors each other's fans rather not introduce
 ‘... that I'd rather not introduce such actors to each other's fans’

It is only when we turn to local scrambling of an argument across an adjunct that we can find evidence for an A-relation. Thus, scrambling across an adjunct can have precisely the beneficial effect on an illicit binding relation that was absent in (6):

- (7) a. *Jan heeft namens elkaar de acteurs gefeliciteerd.
John has on-behalf-of each other the actors congratulated

⁵ Note that A'-scrambling can also affect categories other than DPs, including adverbials.

⁶ Some speakers of Dutch marginally allow A-scrambling of a direct object across an indirect object, a possibility more generally available in German.

⁷ A possible exception to this generalization is provided by scrambling of a theme DP across a goal PP. See footnote 2 for discussion.

- b. Jan heeft de acteurs namens elkaar gefeliciteerd.
John has the actors on-behalf-of each other congratulated
 ‘John has congratulated the actors on behalf of each other.’

To complicate matters, the word orders derived by A-scrambling can also be derived by local application of A'-scrambling, which in Dutch can target a range of landing sites. However, the two types of scrambling are associated with very different interpretive effects. To see this, consider first the example in (8), where mention of *Jan's zoon* ‘John’s son’ in the question favors givenness marking through scrambling in the answer. As a result, (8a), without scrambling, is contextually inappropriate. Scrambling of the non-contrastive object across the subject produces an ungrammatical result, suggesting that we are dealing with A-scrambling in these examples.

- (8) Zeg, weet je of Jan's zoon aanwezig is? Ja, ik geloof ...
 ‘Say, do you know whether John’s son is around? Yes, I believe ...’
- a. #dat Marie tijdens de toespraak Jan's zoon heeft gefotografeerd.
that Mary during the speech John's son has photographed
- b. dat Marie Jan's zoon tijdens de toespraak heeft gefotografeerd.
that Mary John's son during the speech has photographed
- c. *dat Jan's zoon Marie tijdens de toespraak heeft gefotografeerd.
that John's son Mary during the speech has photographed
 ‘...that Mary photographed John’s son during the speech.’

Now consider the context in (9), which makes *Jan's zoon* ‘John’s son’ a contrastive focus in the answer. Unlike the discourse-anaphoric object in (8a), the focus may stay in situ without giving rise to any degradation, as shown in (9a). Alternatively, it may be scrambled across the adjunct, as in (9b), or across the subject, as in (9c), suggesting that in these examples we are dealing with A'-scrambling.⁸

- (9) Zeg, heeft Marie tijdens Jan's toespraak zijn dochter gefotografeerd? Nee, ik zag
 ik zag
 ‘Say, has Peter photographed John’s daughter during his speech? No, I saw ...’

⁸ There is some variation among Dutch speakers regarding the acceptability of A'-scrambling. There is general agreement in the literature that A'-movement across indirect objects and subjects exists. However, whereas all speakers accept A'-scrambling of a topic out of a constituent containing a focus, a subset of speakers reject A'-scrambling of foci – at least across the subject.

- a. dat Marie tijdens de toespraak Jan's ZOON heeft gefotografeerd.
that Mary during the speech John's son has photographed
- b. dat Marie Jan's ZOON tijdens de toespraak heeft gefotografeerd.
that Mary John's son during the speech has photographed
- c. %dat Jan's ZOON Marie tijdens de toespraak heeft gefotografeerd.
that John's son Mary during the speech has photographed
 'that Mary photographed John's son during the speech.'

Importantly, the example in (9b), with a scrambled contrastive focus, is string-identical to example (8b), with a scrambled discourse-anaphoric argument (modulo IS of course).

That the same string can be generated by either A'- or A-scrambling is confirmed by tests probing reconstructive behavior of the scrambled category. We briefly demonstrate this with variable binding. The example in (10b) shows that the A-scrambled category *zijn zoon* 'his son' is unable to reconstruct below the adjunct containing its binder. The relevant binding relation is however correctly established in (10a).⁹

- (10) Ik hoorde dat er helemaal niemand was komen opdagen voor de diploma uitreiking aan deze vijf jongens. Hoe heb je dat opgelost? Nou, ...
 'I heard that absolutely nobody had turned up for the diploma award ceremony for these five boys. How have you dealt with that? Well, ...'
- a. ik heb [namens iedere vader]_i zijn_i zoon gefeliciteerd.
I have on.behalf.of each father his son congratulated
- b. *ik heb zijn_i zoon [namens iedere vader]_i gefeliciteerd.
I have his son on.behalf.of each father congratulated

By contrast, the very same category *can* reconstruct below the adjunct if it is an A'-scrambled contrastive focus:

- (11) Zeg, heb je na de diploma uitreiking namens iedere vader zijn dochter gefeliciteerd? Nee, ...
 'Say, following the diploma award ceremony have you congratulated every

⁹ In (10a) the universal takes scope over a category it does not c-command. See Higginbotham 1980 and Ruys 1992 for discussion of this phenomenon (which Ruys dubs the 'transitivity' property of bound variable licensing).

daughter on behalf of her father? No, ...'
 ik heb [zijn₁ ZOON]₂ [namens iedere vader]₁ t₂ gefeliciteerd.
I have his son on.behalf.of each father congratulated

In summary, Dutch scrambling phenomena divide into two types, exhibiting properties of an A'-relation and an A-relation, respectively. A'-scrambling is much freer in its application than A-scrambling and can target a variety of positions. It is typically associated with a contrastive interpretation of the moved category and exhibits all the hallmarks of A'-movement. A-scrambling, by contrast, is very restricted in its application; it allows an argument to scramble across an adjunct only. It is typically licensed by givenness of the scrambled argument.

We now turn to a consideration of competing analyses of A-scrambling. Does A-scrambling involve movement or is it best to analyze it as involving variation in base-generated structures? We consider some potential empirical and conceptual arguments.

Since the trace of A-movement does not reconstruct for any syntactic relations,¹⁰ it is hard to provide direct empirical evidence to decide on this matter one way or the other. However, it has been argued that A-movement displays quantifier lowering effects (see May 1979; Lebeaux 1998; Fox 1999). Consider the examples in (12). (12a) is ambiguous: *some young lady* may or may not be interpreted in the scope of *every senator*. By contrast, (12b) and (12c) are unambiguous. In (12b), the binding relation with the reflexive forces *some young lady* to take surface scope. The lack of ambiguity indicates that long QR of *every senator* is not an option. The impossibility of long QR is further confirmed by (12c), where the universal fails to take scope over an argument of the matrix verb. In view of these data, the ambiguity in (12a) must be due to reconstruction of the existential rather than raising of the universal.

- (12) a. [_{IP} Some young lady₁ seems [_{XP} t₁ to be likely [t₁ to dance with every senator]]]
 (i) some > every; (ii) every > some
 b. [_{IP} Some young lady₁ seems to herself₁ [_{XP} t₁ to be likely [t₁ to dance with every senator]]]
 (i) some > every; (ii) *every > some

¹⁰ One could argue that A-scrambling reconstructs for thematic interpretation. But there are no empirical effects associated with this kind of reconstruction that could shed any light on the controversy at hand.

- c. [_{IP} Mary₁ seems to some young lady [_{XP} t₁ to be likely [t₁ to dance with every senator]]]
 (i) some > every; (ii) *every > some

In theory, then, one should be able to use scope as a diagnostic for the presence of a trace of A-scrambling. In practice, however, this is rather problematic. Recall that A-scrambling is typically associated with givenness marking. As a result, an A-scrambled indefinite – the primary candidate for diagnosing reconstruction – receives a specific reading and will therefore fail to demonstrate scope interaction even if it were to reconstruct (see Kerstens 1975; De Hoop 1992; Diesing 1992, among others).

Ruys (2001) argues that Dutch A-scrambling can also be motivated by a wide-scope reading of the scrambled DP. When scrambling is licensed in this way, the indefinite may introduce new information. An example from Ruys's article is given in (13), where scrambling allows *een of andere ziekte* 'some disease or other' to take wide-scope with respect to *meestal* 'usually'.

- (13) dat elke arts wel een of andere ziekte meestal met penicilline
that every MD PRT some or other disease usually with penicillin
 behandelde.
treated
 'that every doctor usually treated some disease or other with penicillin.'
 Intended reading: every doctor > some disease or other > usually

Crucially, the indefinite is not partitive (there is no sense of a pre-established set of diseases) or specific (this is excluded because the indefinite depends on the universally quantified subject). Nevertheless, the indefinite in (13) cannot scope below *meestal* 'usually'. This is hardly surprising, given that scrambling here is motivated by the wide scope of the indefinite with respect to the adjunct. Therefore, if the targeted reading has the indefinite in the scope of the adjunct, the scrambling structure is not licensed. We may conclude that scope relations in structures of A-scrambling do not allow us to choose between a movement and a base-generation approach.

With any clear empirical arguments in short supply, we should consider whether there are strong conceptual arguments that favor one analysis over the other. Proposals based on A-movement were originally primarily motivated by the assumption that the direct object be base-generated as the sister to V.¹¹ This

¹¹ It is not clear to us to what extent this view is still current even among minimalists, given the introduction of VP-shells for secondary predication, etc.

assumption makes it impossible for the object to precede an adjunct without at least one step of movement. It follows that an answer must be found to what one might call the ‘trigger problem’: why does the object undergo A-movement? There are two potential answers to this question, which are associated with very different conceptions of A-scrambling.

One could argue that the object always moves to some designated functional projection for purely formal reasons (such as case checking) and that the marked scrambling structure results from attachment of an adjunct below, rather than above, the landing site of the object. On this view, although the derivation of an A-scrambled structure involves movement, this movement does not distinguish the canonical from the marked order. Vanden Wyngaerd (1989) and Zwart (1993) are examples of proposals along these lines.

Alternatively, one may assume that the position of the adjunct is fixed. On this view, the canonical order does not require movement (at least on an OV analysis of Dutch) and it is only the marked order that involves an A-movement step. This idea has been implemented in a range of different ways: (i) the object may receive ‘weak’ case in its base-position next to the verb or ‘strong’ case in the specifier of AgrOP (Mahajan 1990; De Hoop 1992; Adger 1994; Runner 1995; Broekhuis 2008 make proposals in this spirit); (ii) attraction by a designated functional head that is also responsible for the interpretive effect associated with A-scrambling (see, for example, Meinunger 1996, 2000); (iii) attraction by an abstract scrambling feature (see Müller 1998); (iv) triggerless A-movement (Haider and Rosengren 2003).

Of these proposals, those that associate an interpretive effect with a designated position in the syntactic structure have been argued to run into serious difficulties when trying to account for the full range of word-order restrictions in Dutch (see Neeleman and Van de Koot 2008). However, those that link the interpretive effect to a mapping rule of some sort at the LF interface (Müller 1998 is a case in point) should in principle be viable. Proposals relying on an abstract trigger also seem better placed to accommodate the fact that A-scrambling does not seem to have a unique trigger: as already discussed, it can not only be triggered by givenness marking but also by scope considerations. This in turn suggests that any ‘givenness’ head in the extended projection must be able to alternate with a head that triggers movement of a (discourse-neutral) quantified expression.¹²

¹² In fact, it is likely that there are several other interpretive factors that can give rise to A-scrambling. Word order alternations in free word order languages such as the Athabaskan language Navajo have been argued to be sensitive to Silverstein’s 1976 Animacy Hierarchy (Young and Morgan 1987), while Titov (2012) argues that word order in Russian all-focus sentences also obeys a variant of this hierarchy.

The adoption of optional abstract features (other than case features) as the trigger for scrambling also introduces a conceptual difficulty: what is it about these features that makes neutral scrambling an A-relation? As far as we can see, this must simply be stipulated.¹³

No additional A-positions are required in a base-generation approach (Bayer and Kornfilt 1994; Neeleman 1991; Neeleman 1994b; Fanselow 2001, 2003), provided it comes with a sufficiently flexible argument realization mechanism. While this may well constitute a conceptual advantage of the base-generation approach, such a claim must be considered in the context of the overall theoretical complexity of competing approaches and is therefore not easy to evaluate.

We summarize the discussion as follows. A movement theory can simulate the effects of a base-generation theory through the adoption of an abstract trigger. Beyond that, all that is needed for either an A-movement or a base-generation proposal to work is that it produces scrambling structures that can be characterized as having additional complexity (for example, in virtue of having an additional copy of a moved constituent). One can then simply require this additional complexity to have an effect at the interpretive interface that the canonical structure lacks.

The same logic carries over to comparisons of A-movement and base-generation theories that assume that the license for A-scrambling can be found at the PF-interface (see Zubizarreta 1998 for Spanish, Costa 1998; Cruz-Ferreira 1998 for Portuguese, Frascarelli 2000; Samek-Lodovici 2005 for Italian, Neeleman and Reinhart 1998 for Dutch, and Ishihara 2003 for Japanese).

We may conclude, then, that the ‘trigger’ problem is unlikely to provide us with a solid basis for choosing between A-movement and base-generation approaches either.

3 Psycholinguistic background

There is now a considerable body of psycholinguistic work devoted to the verification of linguistic accounts of A'- and A-movement. Thus, the presence of a filler-gap dependency in structures that linguists claim to involve A'-movement has been convincingly demonstrated using a variety of techniques,

¹³ An even more radical proposal by Haider and Rosengren (2003) dispenses with a formal trigger altogether and is notable for being partly motivated by the belief that there is no independent evidence for feature-triggered scrambling to a functional projection or indeed for the presence of its head. However, it remains unclear in this proposal why neutral scrambling should create an A-chain.

including ERP (see particularly Ueno and Kluender 2003, for a study focusing on moved objects in an OV language) and cross-modal priming (see Love and Swinney 1996a; Nakano et al. 2002).¹⁴

Although there has been less experimental work on structures argued to involve A-movement (passives, raising and unaccusatives), here too there is converging evidence pointing towards movement (Osterhout and Swinney 1993; Friedmann et al. 2008).¹⁵

Among the experimental techniques just mentioned, cross-modal priming (CMP; Swinney et al. 1979) is well suited to detecting position-specific reactivation effects. In cross-modal priming, participants listen to spoken words or sentences on headphones while a word or non-word string appears visually on a screen. They are then required to make a lexical decision on the word they see (i.e. is it an existing word of a given language or not). If displaced constituents are mentally reactivated at their corresponding gap sites, then lexical decisions to target words related or identical to the semantic head of the displaced constituent should be facilitated at the gap site, in comparison to lexical decisions to unrelated words. Larger facilitation effects at gap sites than at earlier, non-gap ‘control’ positions would be indicative of antecedent reactivation triggered by the parser’s identifying a gap. CMP is able to provide evidence that the antecedent in a dependency is linked to a trace (the *Trace Reactivation Hypothesis*; see Nicol and Swinney 1989; Love and Swinney 1996; Nakano et al. 2002, among others) rather than directly to a selecting verb (the *Direct Association Hypothesis*; Pickering and Barry 1991). The study by Nakano et al. is a particularly important demonstration of the positional sensitivity of the technique: it was concerned with long-distance scrambling in Japanese and demonstrated reactivation of the scrambled category in its canonical pre-verbal position.

CMP experiments have also found clear differences between sentences with unergative and unaccusative verbs in English, with only the latter exhibiting priming for the surface subject in a position following the verb, an effect that may be plausibly attributed to the presence of a post-verbal trace created by A-movement (see Osterhout and Swinney 1993; Friedmann et al. 2008 for unaccusatives). But the timing of the priming effect found differs substantially: with

14 For fMRI studies focusing on A'-movement, see Ben-Schachar et al. 2003, 2004 and Santi and Grodzinsky 2007, 2010. These studies support the neural reality of syntactic transformations but shed no light on the question of whether the encoding mechanism links a filler to a gap.

15 For fMRI studies of structures involving A-movement, see Shetreet et al. 2010, Shetreet and Friedmann 2012 and Agnew et al. 2014. The studies by Shetreet et al. provide some support for the neural reality of syntactic transformations but shed no light on the question of whether the encoding mechanism links a filler to a gap.

passives and unaccusatives it is found some 750 ms downstream from the gap location. This is a robust finding that has recently been replicated for unaccusatives in an eye-tracking study using the visual world paradigm (Koring et al. 2012).

There have so far been remarkably few attempts to investigate the detailed syntactic structure of sentences involving A-scrambling experimentally, either in normal or clinical populations.¹⁶ Furthermore, studies looking at short scrambling have not generally distinguished between A-scrambling and short A'-scrambling, which may well be responsible for the murky picture that emerges from them (see Sekerina 2003). A notable exception is Clahsen and Featherston's (1999) study on German A-scrambling, which presented test sentences in contexts that strongly favored givenness marking of the scrambled DP and looked for reactivation of the scrambled DP in its canonical (preverbal) position. Their first experiment used sentences with the structure in (14a), in which the verb has been moved to second position leaving a sentence-final trace (t_V) and the direct object has undergone A-scrambling across the indirect object (an option not available in Dutch, as we have seen). As a result, the probe site for the scrambled direct object (t_{DO}) is also sentence-final. A second experiment used particle verbs, so that the probe site preceded a stranded particle (Prt), as in (14b).

- (14) a. SUBJECT V DO IO (t_{DO}) t_V
 b. SUBJECT V DO IO (t_{DO}) t_V Prt

Remarkably, the first experiment yielded no evidence for reactivation of the direct object in sentence-final position, while the second experiment did find reactivation just before Prt. The authors take this as evidence for a trace of A-movement. One might speculate, however, that these results indicate that the sentence processor is able to access thematic information in the preposed verb. In (14a) the remainder of the sentence is compatible with this information, while in (14b) the indirect object can only be thematically licensed once Prt has been encountered. Thus, examples with the structural pattern in (14b) may require reanalysis of the verb's argument structure in a way that examples with the structure in (14a) do not. That reanalysis process would give rise to reactivation of all the verb's arguments. Unfortunately, neither experiment probed for reactivation of arguments other than the direct object, so that we cannot be entirely sure how the results of Clahsen & Featherston's study should be interpreted.

¹⁶ Pechmann et al. (1994), Bader and Meng (1999) and Stolterfoht (2004) investigate the processing of German sentences with non-canonical orders in the Mittelfeld and consider information-structural factors. However, these works are not concerned with the question whether structures derived by A-scrambling involve movement or variation in base-generated structures.

4 The current study

4.1 Design and materials

We used the cross-modal priming paradigm to investigate the structure of Dutch sentences with A-scrambling. As far as we know, there are no previous studies of this type. Our experiments focus on Dutch sentences in which a direct object has been displaced from its canonical pre-verbal position. In experiment 1 we use sentences in which an object has A-scrambled across an adjunct:

(15) Context:

Gisteren heeft een overvaller een winkelier met een mes om het leven gebracht.

‘Yesterday, a robber killed a shopkeeper with a knife.’

Stimulus:

Brechtje hoorde dat hij de winkelier meer dan vijftientig keer**
Brechtje heard that he the shopkeeper more than twenty-five times
 gestoken heeft na de kassa leeg gehaald te hebben.

stabbed has after the till empty got to have

‘Brechtje heard that he stabbed the shopkeeper more than twenty-five times after having emptied the till.’

Experiment 2 is concerned with structures in which the object has undergone WH-movement:

(16) Context:

De politie wist zeker dat de bende het op een aantal banken voorzien had.

‘The police knew for sure that the gang were targeting a couple of banks.’

Stimulus:

Maar ze wisten niet zeker welke bank de misdadigers op maandag**
but they knew not sure which bank the criminals on Monday
 beroofd hadden toen er onvoldoende bewaking was.

robbed had when there insufficient guarding was

‘But they didn’t know for sure which bank the criminals had robbed on Monday when the level of security was insufficient.’

Since we can be relatively confident on the basis of previous studies that A'-movement will give rise to antecedent reactivation at the pre-verbal gap

position, the results of this second experiment should provide a baseline for the interpretation of the results obtained in experiment 1. Experiment 3, finally, uses the same material as experiment 1, but with probe points specifically selected to detect delayed reactivation of a putative post-verbal trace (see analyses (4d) and (4e)).

For experiments 1 and 2, there were six experimental conditions in a 3x2 design with the factors Location (pre-gap, gap, and post-verbal) and Target Type (identical, unrelated). The gap location was at the putative trace position (indicated by the symbol ** in (15) and (16) above), with the pre-gap location 500 ms prior to it and the post-verbal location 750 ms after it. We predict that if displaced constituents are reactivated at their canonical pre-verbal positions, the size of the priming effect should be larger at the second test position (the putative trace position) than at the pre-verbal control position. By contrast, if direct objects in Dutch originate in the post-verbal position, or if priming in A-movement structures is generally delayed (compare Friedmann et al. 2008), then the priming effect should be largest at the post-verbal test positions.

There were 20 critical items similar to (14) for experiment 1 and 20 critical items similar to (15) for experiment 2, which appeared in one of the six experimental conditions (pre-gap/identical, pre-gap/unrelated, gap/identical, gap/unrelated, post-verbal/identical, post-verbal/unrelated). Six different presentation lists were created such that participants would only see a given critical item in one of the conditions only.

For experiment 3, there were four experimental conditions in a 2x2 design with the factors Location (gap, post-verbal) and Target Type (identical, unrelated). As before, the gap location was at the putative pre-verbal trace position (indicated by the symbol ** in (15), while the post-verbal location was 700 ms from verb offset. If constituents displaced from a post-verbal position show delayed reactivation (compare Friedmann et al. 2008), then the size of the priming effect should be larger at the second test position than at the pre-verbal control position. Experiment 3 used the 20 critical items of experiment 1, and these appeared in one of the four experimental conditions (gap/identical, gap/unrelated, post-verbal/identical, post-verbal/unrelated). This meant that four different lists were created such that participants would only see a given critical item in one of the conditions only.

Twenty target (visual probe) words identical to the direct object and 20 target words unrelated to the direct object were used for each experiment. The identical and unrelated targets were matched as closely as possible for frequency using the CELEX Lexical Database (Baayen et al. 1993). For experiments 1 and 3, the mean frequency for the identical targets was 55.2 (standard deviation (SD) = 46.4) while the mean frequency for the unrelated targets was

56.8 (SD = 53.9). For experiment 2, the identical targets had a mean frequency of 63.5 (SD = 69) and the unrelated targets had a mean frequency of 63.6 (SD = 70.3). As revealed by t-tests, there was no significant difference regarding frequency between the identical and unrelated targets within each of the priming experiments (for experiments 1 and 3: $t(19) = -0.106$, $p = 0.917$; for experiment 2: $t(19) = -0.002$, $p = 0.998$). The identical and unrelated targets were also matched pairwise for letter length such that the means and SDs were equal between the identical and unrelated conditions for each experiment (identical and unrelated targets for experiments 1 and 3: mean = 5.8 letters, SD = 1.9 letters; identical and unrelated targets for experiment 2: mean = 6 letters, SD = 1.9 letters).

The critical items for experiments 1 and 3 served as fillers for experiment 2 and vice versa. Additional fillers included 15 items with non-word targets that were similar in structure to the critical items. A further 25 fillers (17 of them with non-word targets) were also created where the targets appeared in various locations other than the critical test points such that the appearance of the targets was not predictable across the entire item set. The context and stimulus sentences were recorded by a female native speaker of Dutch in a soundproof room.

To ensure participants paid attention to the context and stimulus sentences, comprehension questions (yes/no questions) were added to 24 (approximately one third) of the trials with half requiring “yes” answers. Within the questions requiring “yes” answers, half occurred after non-words targets and half after word targets. This was the same for questions requiring “no” as an answer.

All trials were presented in a pseudo-randomized order such that no more than three trials of a given condition occurred consecutively. A second version was created of all experimental lists in which the order of the presented items differed (i.e. the second half of the trials were transposed with the first half) in order to control for any potential effects of tiredness or attention attrition.

In addition to the cross-modal priming experiments, a truth-value judgment task (experiment 4) was designed to verify whether A-scrambled categories are able to undergo scope reconstruction. The value of this additional experiment was twofold. On the one hand, it was meant to put previous informal informant scope judgments on a firmer footing. On the other hand, on an A-movement analysis of scrambling, one could very well imagine that scope reconstruction is permitted precisely when the trigger for scrambling is IS-related. A total of ten critical items were created involving a context and a stimulus sentence. An example can be seen in (17). There were two experimental conditions: (i) Congruent – where there is surface scope and (ii) Incongruent – where there is

inverse scope. For each trial, participants only saw one of the experimental conditions; therefore two versions of the experiment were created. Care was taken to ensure all critical lexical items (i.e. the verb and the head noun of the scrambled DP in the stimulus sentence) occurred commonly in Dutch.

(17) Context:

Fred heeft een drukke baan als tandarts en dus komt hij er meestal niet aan toe om eens een wetenschappelijk artikel te lezen. Maar in zijn recente paasvakantie was het eindelijk eens goed raak: eerst las hij een artikel tijdens de treinreis op de heenweg naar Rome en vervolgens nog één op de terugweg.

‘Fred has a busy job as a dentist and therefore he usually does not get round to reading a scientific article. But during his recent Easter holidays he finally got a decent opportunity: first he read an article during the outbound train journey to Rome and subsequently another one on his way back.’

Stimulus (incongruent/false):

Tijdens de paasvakantie heeft Fred een artikel twee keer gelezen.
during the Easter holiday has Fred an article two times read

OR

Stimulus (congruent/true)

Tijdens de paasvakantie heeft Fred twee keer een artikel gelezen.
during the Easter holiday has Fred two times an article read

The materials also included 20 fillers with a format similar to (17). There were ten incongruent fillers and ten congruent fillers (five of these with the inverse scope reading congruent). Once again, all trials were pseudo-randomized and two additional experimental lists were created to control for tiredness effects and potential decreased attention through the duration of the experiment as described earlier.

4.2 Participants

Eighty-two adult native speakers of Dutch (16 males) were recruited from students and staff at University College London and Utrecht University to take part

in experiments 1 and 2. The mean participant age was 24.7 years ($SD = 8.95$ years, range: 18–59 years). 40 adult native speakers of Dutch (9 males; mean age: 20.9 years, $SD = 3.77$ years, range: 18–33 years) were recruited at Utrecht University to take part in experiment 3. In experiment 4, 120 adult native speakers of Dutch were recruited from University College London and Utrecht University (22 males; mean age: 23.4 years, $SD = 6.52$ years, range: 18–59 years). Sixty of the participants in experiment 4 took part in the CMP experiments 1 and 2. All participants had normal or corrected-to-normal eyesight, normal hearing and no language or literacy difficulties. Consent was obtained prior to testing and subjects were paid a small fee for their participation.

4.3 Procedure

For the cross-modal priming experiments, participants were seated in a chair facing a 15.6" monitor that was 80 cm away such that they were centered with respect to the middle of the monitor. The targets appeared on the screen in lower case using the font New Courier in size 36 and in black. The screen background colour was light grey (rgb 215,215,215). Participants also wore headphones to listen to the context and stimulus sentences. DMDX (Forster and Forster 2003) was used to present the trials and to record responses.

Before the experiment began, participants were given written instructions and were given a chance to ask the experimenter any questions. All forms and instructions were given in Dutch. Participants were asked to look at a fixation point (+) in the middle of the screen and listen to some sentences. While listening to the sentences a word would appear centered on the screen. They would then have to decide as quickly and as accurately as possible whether the word they see is a real word or not in Dutch. The fixation point appeared on the screen at the onset of the auditory context and remained there until the target appeared. The target was presented for 500 ms and participants had a further 1500 ms to respond. The reaction times were recorded from the onset of the target. The next trial then began 2000 ms later.

Participants used a gamepad with the right trigger button indicating a “yes” response and the left trigger button indicating a “no” response. If the participant was left-handed, they were offered amended instructions and the triggers were set to respond in the opposite way. Participants were told they would receive feedback if they made a wrong decision or were too slow. The participants were also told that occasionally they would be asked a question about what they just heard, which was to ensure that they would pay close attention to the auditory material. Once again they were informed that if they answered any

comprehension questions incorrectly they would see some feedback on the screen. There was a timeout of 5000 ms in case they failed to respond. Just prior to the start of the experiment, the key instructions were repeated on-screen and participants completed eight practice trials and were once again allowed to ask any final questions. The testing then began with the participants going through all 80 trials which included two breaks each after 27 trials. The priming experiment lasted approximately 25 minutes.

The truth-value judgment task was presented as a questionnaire using Google Forms. The instructions were presented on-screen. Participants were asked to read the stories carefully and judge whether the sentence that followed matched the story by selecting either “yes” or “no”. To avoid any undue pressure on the participants, they were also told that there were no right or wrong answers and that they simply needed to select the answer they felt was appropriate. There was no time limit in this task. After reading the instructions, participants were free to ask any questions and were provided with two practice items before the experimental trials began. There were a total of 30 trials and the experiment lasted approximately 15 minutes.

For all experiments, participants were tested individually in a quiet room.

4.4 Analysis

Mixed effects logistic regression models were used to analyze the data using the software package R version 2.15.3 (R Development Core Team 2012), and the R package lme4 (Bates and Sarkar 2007). The analyses were performed on the raw data (uncentered but log-transformed for experiments 1 and 2) with no aggregation over conditions, participants or items (Baayen et al. 2008). All incorrect responses were removed prior to analysis and the reaction times were log-transformed. The models were structured such that they contained maximal random effects structures as warranted by the design (Barr et al. 2013). Models were fit to test for subject and item random intercepts and random slopes for each fixed factor (as long as they were warranted and they converged). For the cross-modal priming experiments the fixed factors were Location (pre-gap, gap and post-verbal in experiments 1 and 2; gap, post-verbal in experiment 3), and Target Type (identical and unrelated). For CMP experiments 1 and 2, a second model was run so that all three contrasts for the factor Location could be examined. The first model shows the contrasts pre-gap vs. gap and pre-gap vs. post-verbal, while the second model shows the contrast gap vs. post-verbal (and pre-gap vs. gap again). To explore the differences between conditions, a contrast matrix was specified such that the contrast coefficients summed to 0. The truth-

value judgment task (experiment 4) was also analyzed using mixed effects modelling with Congruency (congruent and incongruent) as the fixed factor. The best fit model was determined using the log-likelihood ratio test. The full results from the best fit models are provided in the Appendix. Effects are significant when the absolute value of the t value is greater than 2 or when the p value is less than or equal to 0.05.

5 Results

5.1 Experiment 1: A-scrambling

The overall lexical decision accuracy was 95%, with an accuracy of 97% on the test items. Timeouts accounted for less than 1% of the data. Data points that were ± 1.5 SDs away from the mean per condition were also removed. This accounted for 11.7% of the data.

The identity conditions yielded faster reaction times across all locations (see Table 1). The priming effect was largest at the pre-gap location (71 ms) followed by the gap (52 ms). The priming effect was smallest at the post-verbal location (15 ms). As described earlier, mixed effects logistic modelling was used to analyze the response times. There was no main effect of Location for any of the comparisons, however there were significant effects of Target Type indicating reactions times in the identical conditions (aggregate mean: 640 ms) were faster than in the unrelated conditions (aggregate mean: 686 ms). Both the pre-gap vs. post-verbal and the gap vs. post-verbal comparisons moreover showed significant interactions between Location and Target Type ($t = 4.0$ and $t = 2.8$, respectively). To explore these interactions separate models were fitted to the

Table 1: Mean reaction times (standard deviations in parentheses) and differences between identical and unrelated priming conditions in milliseconds for experiment 1. Statistically significant differences are indicated by an asterisk.

Condition	Mean RT (SD)	Difference
Pre-gap, identical	634 (102)	
Pre-gap, unrelated	705 (132)	71*
Gap, identical	651 (122)	
Gap, unrelated	703 (119)	52*
Post-verbal, identical	635 (103)	
Post-verbal, unrelated	650 (114)	15*

data for each location. All three locations produced a significant effect of Target Type (pre-gap: $t = 8.0$; gap: $t = 6.0$; post-gap: $t = 2.4$).

The absence of any position-specific priming means that the data provide no evidence that the scrambled direct object was mentally reactivated at its canonical pre-verbal position, or after the verb was encountered. The observed priming pattern may instead be attributed to a memory decay effect, with the direct object's memory representation gradually fading with increasing distance. In short, the results from experiment 1 fail to provide any evidence for scrambling across an adjunct.¹⁷

5.2 Experiment 2: Wh-movement

The accuracy of the test items in experiment 2 was 96%. Timeouts occurred in less than 1% of the data, and removal of response times ± 1.5 SDs away from the mean accounted for 10% of the data.

Once again we find a trend for faster reaction times in the identical conditions (see Table 2), however the greatest facilitation was found at the gap (45 ms) with the pre-gap and post-verbal locations showing a smaller

Table 2: Mean reaction times (standard deviations in parentheses) and differences between identical and unrelated priming conditions in milliseconds for experiment 2. The statistically significant difference is indicated by an asterisk.

Condition	Mean RT (SD)	Difference
Pre-gap, identical	669 (126)	
Pre-gap, unrelated	690 (114)	21
Gap, identical	658 (117)	
Gap, unrelated	703 (137)	45*
Post-verbal, identical	663 (122)	
Post-verbal, unrelated	669 (119)	6

¹⁷ An anonymous reviewer suggests that the slope of the [identical] condition ($634 < 651 > 635$) is incompatible with a memory decay account. We do not think that is the case. Reaction times may be affected by a complicated mix of factors. For this reason, it is not appropriate to consider reaction times to one condition only. It is precisely to factor out reaction time fluctuations due to interference from other processes, that priming is defined as the difference in reaction time between the related and unrelated probe. As shown in the table, this difference shows a clear downward trend.

difference of 21 ms and 6 ms respectively. There were significant Location by Target Type interactions for the contrasts gap vs. pre-gap and gap vs. post-verbal indicative of the larger degree of facilitation found at the gap. To explore these interactions further, separate models were run for each location to determine whether the priming effect was significant. The effect of Target Type was only significant at the gap location ($t = 4.8$) meaning that there was a significant priming effect at the putative trace position but not at the other two test positions. Thus, the priming effect at the gap is position-specific. These results therefore suggest that wh-moved objects were reactivated at their canonical pre-verbal positions.

5.3 Experiment 3: A-scrambling

The overall accuracy was 95% with an accuracy of 97.25% on the critical items. Timeouts (accounting for $\%$ of the data) and outlier data points (accounting for 11.5% of the data) were removed..

As in the previous CMP experiments, the data show a trend for faster reaction times in the identical conditions than in the unrelated conditions. There was a significant effect of Target Type indicating reaction times in the identical conditions (aggregate mean: 616 ms) were faster than in the unrelated conditions (aggregate mean: 668 ms). Looking at Table 3, the amount of facilitation was greater at the gap (68 ms) than post-verbally (37 ms). Although there was no significant effect of Location, there was a significant Location by Target Type interaction ($t = 2.0$). To explore this interaction separate models were run for each location. The priming effect was significant at both the gap and post-verbal locations (gap: $t = 6.9$, post-verbal: $t = 4.3$). As the priming effect is smaller at the post-verbal position, we conclude that there is no evidence for delayed reactivation in structures with A-scrambling.

Table 3: Mean reaction times (standard deviations in parentheses) and differences between identical and unrelated priming conditions in milliseconds for experiment 3. Statistically significant differences are indicated by an asterisk.

Condition	Mean RT (SD)	Difference
Gap, identical	614 (93)	
Gap, unrelated	682 (100)	68*
Post-verbal, identical	618 (90)	
Post-verbal, unrelated	655 (103)	37*

Recall that experiment 3 specifically aimed to check for possible delayed priming effects after the verb was encountered. Hence our design did not include an additional pre-gap control position. For this reason the facilitation at the gap position itself cannot be used to argue for reactivation in this position.

5.4 Experiment 4: Off-line scope reconstruction experiment

In the truth-value judgment task, sentences that were congruent with the context elicited 71% (SD = 46%) “yes” responses, compared with only 25% (SD = 43%) affirmative responses for incongruent sentences. “Yes” responses indicate whether the sentences were considered to match the story participants were presented with. There were three non-responses accounting for 0.25% of the data. Results from a mixed effects analysis confirmed that congruent sentences produced a significantly higher proportion of “yes” responses than incongruent ones ($z = 2.8, p < 0.001$). This indicates that Dutch speakers are significantly more likely to interpret scrambled quantificational objects in their surface positions than to allow for scope reconstruction.

6 Discussion

In this section we consider what the results of our experiments imply about the viability of competing approaches to Dutch A-scrambling.

Our baseline experiment, experiment 2, looked for position-specific reactivation of a *wh*-moved direct object in Dutch embedded clauses and its results show such position-specific reactivation at verb onset. This is entirely in line with our expectations: A'-movement should leave a trace and, Dutch being an OV language, the location of that trace should be just before the main verb.

It is worth pointing out that the results of experiment 2 are sufficiently precise to distinguish gap-related and verb-related effects of antecedent re-activation. Suppose subjects did not postulate a preverbal gap but instead completed the A'-chain by directly integrating the filler with the verbal semantics. In order to do so they would require lexical access to the verb. The average duration of the verb in experiment 2 is 500 ms. Forster and Chambers (1973) show that it takes 600–800 ms to carry out a lexical decision task (with lexical decisions for high frequency words at the lower end and for low frequency words at the higher end). Therefore, if subjects delayed their lexical decision on the target so as to

have lexical access to the verb, their reaction times should have been in excess of 1100 ms. However, the average reaction time in experiment 2 is about 614 ms for related targets and 682 ms for unrelated targets. This demonstrates beyond any reasonable doubt that subjects initiated their lexical decision at verb onset, in other words in the exact location in which the target was presented. Note finally that if priming was triggered by the verb rather than by the gap, we should expect more priming at the postverbal test position than at the gap position. However, the observed priming pattern is exactly the reverse of this.

Experiment 1 looked for position-specific reactivation of an A-scrambled direct object in Dutch embedded clauses. No such reactivation was found at the hypothetical gap location. There was also no evidence for a delayed reactivation about 750 ms downstream from the hypothetical gap location, as previously found with the trace of A-movement in the complement position of passives and unaccusatives. The post-verbal probe point in experiment 1 was on average only 200 ms away from verb offset. Therefore, the lack of reactivation at this point also provides evidence against a post-verbal trace of A-movement.¹⁸

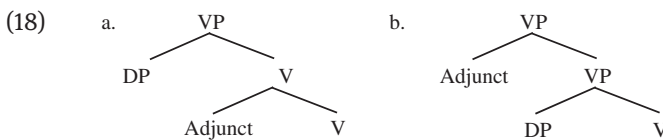
Experiment 3 was a follow-up experiment to experiment 1 that looked specifically for the delayed reactivation of a potential post-verbal trace. However, we found no delayed reactivation at 700 ms from verb offset, providing further evidence against a post-verbal trace in the scrambling structures under investigation.¹⁹

18 One might cast doubt on this interpretation of experiment 1 on the grounds that it relies on the presence of a large priming effect in the pre-gap position (71 ms), which was not found in experiment 2. Detection of a reactivation effect at the purported gap in experiment 1 therefore would have required a priming effect at the gap that was sufficiently larger than 71 ms in order to deliver a reliable Location x Target Type interaction. It is of course true that the priming effect observed at the early test point serves as baseline for comparison with the priming effects at later test points. Assuming that the size of the early priming effect reflects the relative strength of the filler's memory representation at this point, we would expect that highly prominent (i.e. strongly priming) fillers decay more slowly than less prominent ones and are thus also easier to retrieve at gap sites, reflected in correspondingly large priming effects. However, there is no evidence in our data to suggest that the clear downward trend of the priming pattern in experiment 1 is masking a 'hidden' reactivation effect. The priming pattern we observed is as predicted by the memory decay assumption, and unlike the priming pattern thought to indicate antecedent reactivation.

19 One might suggest that the results of experiments 1 and 3 simply reflect the fact that the parser cannot anticipate the gap created by A-scrambling (while it can anticipate the gap in structures with A'-movement). While we agree that A'- and A-movement differ with regard to predictability of the gap, we do not believe that this warrants the conclusion that we should not expect to see any reactivation with A-scrambling. Rather, the lack of anticipation should result

Experiment 4, finally, provides support for what has been assumed in the literature on A-scrambling all along, namely that A-scrambled constituents do not seem to undergo scope reconstruction. While admittedly 25% of the incongruent test items received an affirmative answer, the mixed effects analysis did not reveal any particular pattern. However, since the experiment did not present the test items aurally, it cannot be ruled out that subjects occasionally construed the scrambled category as contrastive (note that scrambling in incongruent sentences was never licensed by scope). On a contrastive interpretation, the scrambled category would have had to reconstruct, which would then have resulted in the congruent scope construal becoming available.

The results of these four experiments must be interpreted together. And, taken together, we think that the results provide strong converging evidence, from different experimental methods, against reconstruction in Dutch neutral scrambling. Put differently, the results do not support an analysis of Dutch A-scrambling in which the object undergoes A-movement from either a pre-verbal or a post-verbal complement position to the specifier of a functional projection located above the adjunct. In fact, the only analysis that is directly corroborated by our findings abandons the strong version of UTAH²⁰ and allows the object to merge with the verbal projection either before or after the adjunct (analysis (4c); Bayer and Kornfilt 1994; Neeleman 1991; Neeleman 1994b; Fanselow 2001, 2003). On this analysis, the canonical order is associated with the representation in (18a), and the scrambled order with the alternative base-generated structure in (18b).



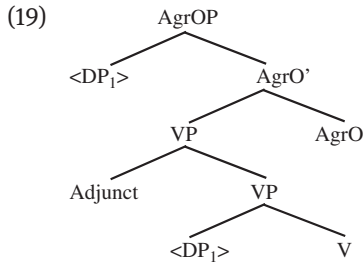
(Let us briefly review why our results do not support the alternative analyses.

Consider first an OV analysis of Dutch with a fixed attachment site for adjuncts (analysis (4a)). This type of proposal goes back to the early adop-

in delayed creation of a copy and hence in delayed reactivation. But, as reported above, no delayed reactivation was observed in any of the experiments.

20 See footnote 1 for discussion.

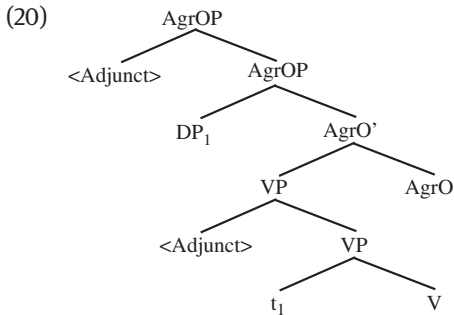
ters of an A-movement approach, whose analysis made use of new landing sites made available by the checking theory of case, as schematically illustrated in (19).



Mahajan (1990), for example, suggested that Hindi indefinite object DPs case-marked internally to VP are obligatorily interpreted as nonspecific, whereas objects assigned case by agreement with the VP-external AgrO head are interpreted as specific. De Hoop (1992) also adopts a proposal along these lines, arguing that non-specific indefinites are licensed in the pre-verbal complement position where they are interpreted as part of the predicate and receive ‘weak case’. The indefinite interpretation is unavailable after scrambling to AgrOP, where an object is assigned ‘strong’ case. Our experiments did not provide any evidence for the existence of the pre-verbal trace postulated by this analysis.

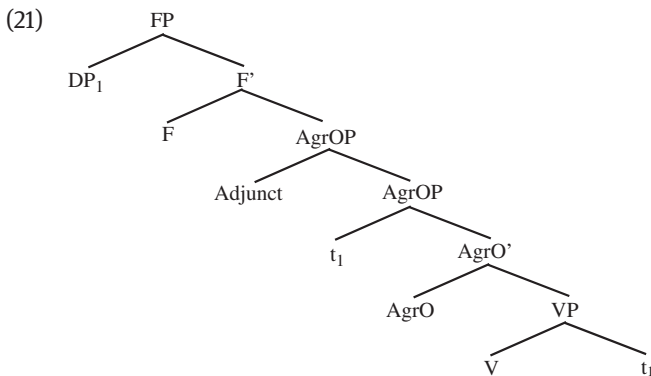
One can think of the analysis in (19) as an early example of a strongly cartographic (or ‘positional’) proposal in that it fixes the base-position of the argument (in line with UTAH) and also adopts a fixed position for the adjunct (in line with later cartographic ideas in the mold of Cinque 1999). We should therefore consider the effect of relaxing the positional requirement on either the argument or the adjunct. Initially, we maintain the hypothesis that Dutch has OV order in the VP, turning to VO analyses of Dutch subsequently.

Still assuming OV order, suppose we allow variation in the attachment site of the adjunct while holding on to a strong version of UTAH (analysis (4b); see Vanden Wyngaerd 1989 for a proposal along these lines). Scrambling can then only be captured by assuming that the adjunct attaches to either VP or AgrOP, as shown in (20). Crucially, the object must move to the specifier of AgrOP, or the scrambled order will not surface. This analysis therefore must also have pre-verbal trace.

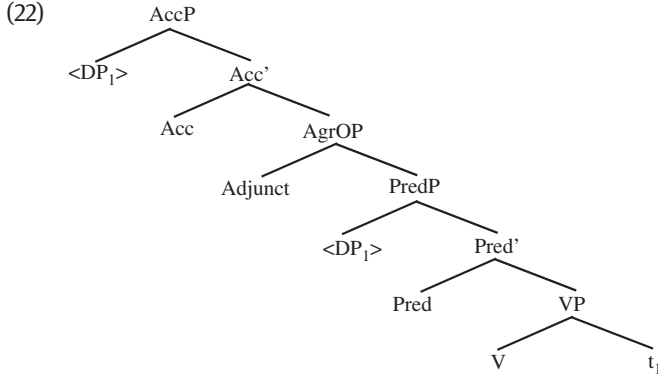


Let us now turn to LCA-based analyses, according to which the object moves from a post-verbal position. As before, scrambling may now be analyzed in one of two ways, depending on whether one is prepared to allow multiple potential attachment sites for the adjunct.

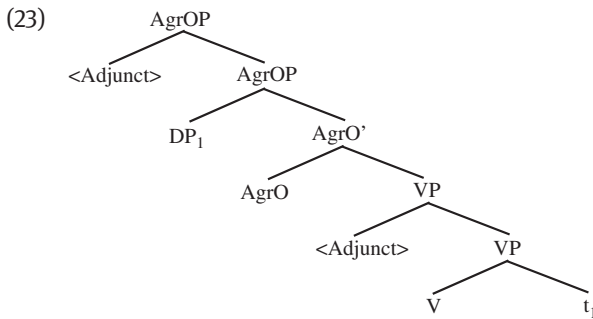
If the adjunct is assigned a fixed position at the edge of AgrOP, one could assume that objects always move to the specifier of AgrOP, but that only given objects move on to the specifier of a higher functional projection (FP in (21)). To the best of our knowledge, this particular proposal has never been made in the literature. It is not supported by our experimental results, as we have not found any evidence for either of the two trace positions it assumes.



Koster (1999) puts forward an analysis that comes very close to (21), but it does not involve an intermediate step in the scrambled structure: weak DPs move from post-verbal position to the specifier of PredP, while scrambled DPs move to the specifier of AccP, which is located above PredP, but without leaving a trace in the specifier of PredP (essentially analysis (4d)). Since adjuncts are assumed to attach to PredP, this captures the word order facts:



Zwart (1993) assumes the alternative analysis, which allows variation in the attachment site of the adjunct (analysis (4e)), as illustrated in (23).



Both Koster’s and Zwart’s analysis postulate a post-verbal trace for which we have found no evidence.

The design of our experiments is based on two working hypothesis. The first is a widely held hypothesis about syntactic movement, namely that it creates copies. The second is a linking hypothesis, namely that the creation of a copy in sentence processing reactivates the antecedent. One might therefore challenge the interpretation of our results by suggesting that they do not stand up under alternative working hypotheses. For this reason, we briefly consider two alternative sets of assumptions and evaluate the experimental outcomes against them.

Suppose one adopts an alternative hypothesis about syntactic movement according to which A’-movement creates copies but A-movement only optionally does so (say, to mediate reconstruction). It can instead leave a ‘bare’ trace (see Lasnik 1999; Fox 1999; see Boeckx 2001 for a close variant). We keep the linking hypothesis constant: creation of a copy in sentence processing reactivates the

antecedent. Recall that we have no evidence that A-scrambling ever reconstructs. Therefore, A-movement in a structure of A-scrambling should leave a bare trace and absence of reactivation at the purported trace is predicted.

While the revised syntactic hypothesis is certainly a logical possibility, it seems to us that it is built on the acceptance of traces for which there is presently no empirical evidence. This seems an unacceptably high price to pay to save the movement analysis of Dutch A-scrambling (and thus the extreme locality of θ -marking that accompanies a strong version of UTAH). The proposal also raises some difficult questions. On the one hand, an explanation is needed of why the trace of A-movement should be different from the trace of A'-movement. On the other, the proposal leaves us without an interpretation of existing results showing reactivation in certain A-movement structures (Osterhout and Swinney 1993; Friedmann et al. 2008).

The proposal just reviewed can be improved upon by pairing the revised syntactic hypothesis with a revised linking hypothesis according to which the creation of a copy created by A'-movement reactivates the antecedent, while the processing of a bare trace in A-movement chains gives rise to delayed reactivation. This set of assumptions has the advantage that it makes verifiable predictions that fit with the existing results showing delayed reactivation with the trace of A-movement in passives and unaccusatives (Osterhout and Swinney 1993; Friedmann et al. 2008). However, it also predicts that delayed reactivation should be found in structures of A-scrambling if that order alternation is mediated by A-movement. We may conclude, then that these alternative assumption also lead to the conclusion that our results do not support a movement analysis of A-scrambling.

7 Conclusion

The vast majority of work on A-scrambling has adopted a movement approach. This tendency reflects the widespread adoption of a 'configurational' model of thematic interpretation (Baker 1988; Hale and Keyser 1993; Ramchand 2008), which greatly reduces the scope for 'flexibility' in the base component.

The results of the study reported here support the view that the positioning of an object with respect to the adjunct it scrambles across is not mediated by movement. This weakens the case for a full-on cartographic approach to A-scrambling, which adopts both a configurational model of thematic interpretation and a cartographic treatment of adjuncts (Cinque 1999). At the very least, then, it seems that multiple potential attachment sites for the same adjunct must be permitted. Our findings also fail to support LCA-based approaches. If our conclusions are sound, then (strong) UTAH-based accounts of Dutch A-scrambling need to be reconsidered.

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References

- Adger, David. 1994. *Functional heads and interpretation*. Edinburgh: University of Edinburgh dissertation.
- Agnew, Zarinah, Hans van de Koot, Caroline McGettigan & Sophie Scott. 2014. Do sentences with unaccusative verbs involve syntactic movement? Evidence from neuroimaging. *Language, Cognition and Neuroscience* 29(9). 1035–45.
- Baayen, Harald, Doug Davidson & Douglas Bates. 2008. Mixed-effects modeling with crossed random effects for subjects and items. *Journal of Memory and Language* 59(4). 390–412.
- Baayen, Harald, Richard Piepenbrock & Hedderik van Rijn. 1993. *The CELEX lexical database on CD-ROM*. Philadelphia, PA: Linguistic Data Consortium.
- Bader, Markus & Michael Meng. 1999. Subject-object ambiguities in German embedded clauses: An across-the-board comparison. *Journal of Psycholinguistic Research* 28(2). 121–43.
- Baker, Mark C. 1988. *Incorporation: A theory of grammatical function changing*. Chicago: University of Chicago Press.
- Baker, Mark C. 1997. Thematic roles and syntactic structure. In Lilliane Haegeman (ed.), *Elements of Grammar: Handbook in Generative Syntax*, 73–137. Dordrecht: Springer.
- Barr, Dale J., Roger Levy, Christoph Scheepers & Harry J. Tily. 2013. Random effects structure for confirmatory hypothesis testing: Keep it maximal. *Journal of Memory and Language* 68(3). 255–78.
- Bates, Douglas & Deepayan Sarkar. 2007. *lme4: Linear mixed-effects models using S4 classes*. <http://lme4.r-forge.r-project.org/> (Accessed 23 October 2013).
- Bayer, Josef & Jaklin Kornfilt. 1994. Against scrambling as an instance of move-alpha. In Norbert Corver & Henk van Riemsdijk (eds.), *Studies on Scrambling*, 17–60. Berlin: Mouton de Gruyter.
- Ben-Schachar, Michal, Talma Hendler, Itamar Kahn & Dafna Ben Bashat. 2003. The neural reality of syntactic transformations: evidence from functional magnetic resonance imaging. *Psychological Science* 14(5). 433–40.
- Ben-Shachar, Michal, Dafna Palti & Yosef Grodzinsky. 2004. Neural correlates of syntactic movement: Converging evidence from two fMRI experiments. *NeuroImage* 21(4). 1320–36.
- Boeckx, Cedric. 2001. Scope reconstruction and A-movement. *Natural Language & Linguistic Theory* 19(3). 503–48.
- Broekhuys, Hans. 2008. *Derivations and evaluations: Object shift in the Germanic languages*. Berlin: Mouton de Gruyter.

- Büring, Daniel. 2003. On D-trees, beans and B-accent. *Linguistics and Philosophy* 26(5). 511–45.
- Cinque, Guglielmo. 1999. *Adverbs and functional heads: A cross-linguistic perspective*. Oxford: Oxford University Press.
- Clahsen, Harald & Sam Featherston. 1999. Antecedent priming at trace positions: Evidence from German scrambling. *Journal of Psycholinguistic Research* 28(4). 415–37.
- Clark, Herbert & Eve Clark. 1977. *Psychology and language: An introduction to psycholinguistics*. New York: Harcourt Brace Jovanovich.
- Clark, Herbert & Susan Haviland. 1977. Comprehension and the given-new contrast. In Roy Freedle (ed.), *Discourse Production and Comprehension*, 1–40. Hillsdale, NJ: Lawrence Erlbaum Associates.
- Costa, Joao. 1998. *Word order variation: A constraint-based approach*. Leiden: HIL/Leiden University dissertation.
- Cruz-Ferreira, Madalena. 1998. Intonation in European Portuguese. In Daniel Hirst & Albert Di Cristo (eds.), *Intonation patterns: A survey of twenty languages*, 167–78. Cambridge: Cambridge University Press.
- De Hoop, Helen. 1992. *Case configuration and noun phrase interpretation*. Groningen: University of Groningen dissertation.
- Diesing, Molly. 1992. *Indefinites*. Cambridge, MA: MIT Press.
- É. Kiss, Katalin. 1987. *Configurationality in Hungarian*. Dordrecht: Reidel.
- É. Kiss, Katalin. 1994. Scrambling as the base-generation of random complement order. In Norbert Corver & Henk Van Riemsdijk (eds.), *Studies on scrambling: Movement and non-movement approaches to free word-order phenomena*, 221–56. Berlin: Mouton de Gruyter.
- É. Kiss, Katalin. 2008. Free word order, (non)configurationality, and phases. *Linguistic Inquiry* 39(3). 441–75.
- Fanselow, Gisbert. 2001. Features, theta-roles, and free constituent order. *Linguistic Inquiry* 32(3). 405–38.
- Fanselow, Gisbert. 2003. Free constituent order. A minimalist interface account. *Folia Linguistica* 37. 191–231.
- Forster, Kenneth I. & Susan M. Chambers. 1973. Lexical access and naming time. *Journal of Verbal Learning and Verbal Behavior* 12. 627–35.
- Forster, Kenneth. I. & Jonathan C. Forster. 2003. DMDX: A windows display program with millisecond accuracy. *Behavior Research Methods, Instruments & Computers* 35. 116–24.
- Fox, Danny. 1999. Reconstruction, binding theory, and the interpretation of chains. *Linguistic Inquiry* 30(2). 157–96.
- Frascarelli, Mara. 2000. *The syntax-phonology interface in topic and focus constructions in Italian*. Dordrecht: Kluwer Academic Publishers.
- Friedmann, Naama, Gina Taranto, Lewis P. Shapiro & David Swinney. 2008. The leaf fell (the leaf): The online processing of unaccusatives. *Linguistic Inquiry* 39(3). 355–77.
- Gundel, Jeanette K. 1988. Universals of topic-comment structure. In Michael Hammond, Edith A. Moravcsik & Jessica R. Wirth (eds.), *Studies in Syntactic Typology*, 209–39. Amsterdam: John Benjamins.
- Haider, Hubert & Inger Rosengren. 1998. Scrambling. In *Sprache und Pragmatik* 49. Lund.
- Haider, Hubert & Inger Rosengren. 2003. Scrambling: Nontriggered chain formation in OV languages. *Journal of Germanic Linguistics* 15(3). 203–66.
- Hale, Kenneth. 1994. Core structures and adjunctions in Warlpiri syntax. In Norbert Corver & Henk Van Riemsdijk (eds.) *Studies on scrambling: Movement and non-movement approaches to free word-order phenomena*, 185–220. Berlin: Mouton de Gruyter.

- Hale, Kenneth & Samuel J. Keyser. 1993. On argument structure and the lexical expression of syntactic relations. In Kenneth Hale & Samuel J. Keyser (eds.) *The view from building 20*, 53–109. Cambridge: MIT Press.
- Higginbotham, James. 1980. Anaphora and GB: Some preliminary remarks. In *Proceedings of the Tenth Annual Meeting of NELS*, 223–36. University of Ottawa, Ontario.
- Ishihara, Shinichiro. 2003. *Intonation and interface conditions*. Cambridge, MA: MIT dissertation.
- Jackendoff, Ray. 1972. *Semantic interpretation in generative grammar*. Cambridge: Cambridge University Press.
- Jacobs, Joachim. 1997. I-Topikalisierung. *Linguistische Berichte* 168. 91–133.
- Kerstens, Johan. 1975. Over afgeleide structuur en de interpretatie van zinnen [On derived structure and the interpretation of sentences]. Ms., University of Amsterdam.
- Koring, Loes, Pim Mak & Eric Reuland. 2012. The time course of argument reactivation revealed: Using the visual world paradigm. *Cognition* 123(3). 361–79.
- Koster, Jan. 1999. The word orders of English and Dutch: Collective vs individual checking. In Werner Abraham (ed.), *Groninger Arbeiten Zur Germanistischen Linguistik*, 1–42. Groningen: University of Groningen.
- Lasnik, Howard. 1999. Chains of arguments. In Samuel David Epstein & Norbert Hornstein (eds.), *Working Minimalism*, 189–215. Cambridge, MA: MIT Press.
- Lebeaux, David. 1998. Where does the binding theory apply (II)? Ms, NEC Research Institute.
- Love, Tracy & David Swinney. 1996. Coreference processing and levels of analysis in object-relative constructions; Demonstration of antecedent reactivation with the cross-modal priming paradigm. *Journal of Psycholinguistic Research* 25(1): 5–24.
- Mahajan, Anoop. 1990. *The A/A-bar distinction and movement theory*. Cambridge, MA: MIT dissertation.
- May, Robert. 1979. *The grammar of quantification*. Cambridge, MA: MIT dissertation.
- Meinunger, André. 1996. Discourse-dependent DP (de)placement. *Groninger Arbeiten Zur Germanistischen Linguistik* 39.
- Meinunger, André. 2000. *Syntactic aspects of topic and comment*. Amsterdam: John Benjamins.
- Müller, Gereon. 1998. *Incomplete category fronting*. Dordrecht: Kluwer.
- Nakano, Yoko, Claudia Felser & Harald Clahsen. 2002. Antecedent priming at trace positions in Japanese long-distance scrambling. *Journal of Psycholinguistic Research* 31(5). 531–71.
- Neeleman, Ad. 1991. Scrambling as a D-structure phenomenon. In *Proceedings of the Tilburg Workshop on Scrambling*, 387–429.
- Neeleman, Ad. 1994a. Complex predicates. Utrecht: Utrecht University dissertation.
- Neeleman, Ad. 1994b. Scrambling as a D-structure phenomenon. In Norbert Corver & Henk Van Riemsdijk (eds.), *Studies on scrambling: Movement and non-movement approaches to free word-order phenomena*, 387–430. Berlin: Mouton de Gruyter.
- Neeleman, Ad & Tanya Reinhart. 1998. Scrambling and the PF interface. In Miriam Butt & Wilhelm Geuder (eds.), *The projection of arguments*, 309–53. Stanford, CA: CSLI.
- Neeleman, Ad & Hans van de Koot. 2008. Dutch scrambling and the nature of discourse templates. *The Journal of Comparative Germanic Linguistics* 11(2). 137–89.
- Neeleman, Ad & Fred Weerman. 1999. *Flexible syntax: A theory of case and arguments*. Dordrecht: Kluwer Academic.
- Nicol, Janet & David Swinney. 1989. The role of structure in coreference assignment during sentence comprehension. *Journal of Psycholinguistic Research* 18(1). 5–19.
- Oosterhout, Lee & David Swinney. 1993. On the temporal course of gap-filling during comprehension of verbal passives. *Journal of Psycholinguistic Research* 22(2). 273–86.

- Pechmann, Thomas, Hans Uszkoreit, Johannes Engelkamp & Dieter Zerbst. 1994. Word order in the German Middlefield. Report no. 43. *Computational Linguistics at the University of the Saarland*.
- Pickering, Martin & Guy Barry. 1991. Sentence processing without empty categories. *Language and Cognitive Processes* 6(3). 229–59.
- Ramchand, Gillian. 2008. *Verb meaning and the lexicon: A first-phase syntax*. Cambridge: Cambridge University Press.
- R Development Core Team. 2012. *R: A language and environment for statistical computing*. Vienna, Austria: R Foundation for Statistical Computing.
- Runner, Jeffrey T. 1995. Noun phrase licensing and interpretation. Amherst: University of Massachusetts Amherst dissertation.
- Ruys, Eddy G. 1992. *The scope of indefinites*. Utrecht: Utrecht University dissertation.
- Ruys, Eddy G. 2001. Dutch scrambling and the strong-weak distinction. *The Journal of Comparative Germanic Linguistics* 4(1). 39–67.
- Samek-Lodovici, Vieri. 2005. Prosody-syntax interaction in the expression of focus. *Natural Language and Linguistic Theory* 23. 687–755.
- Santi, Andrea & Yosef Grodzinsky. 2007. Working memory and syntax interact in Broca's area. *NeuroImage* 37(1). 8–17.
- Santi, Andrea & Yosef Grodzinsky. 2010. fMRI adaptation dissociates syntactic complexity dimensions. *NeuroImage* 51(4). 1285–1293.
- Sekerina, Irina A. 2003. Scrambling and processing: Dependencies, complexity and constraints. In Simin Karimi (ed.), *Word order and scrambling*, 301–24. Malden, MA: Blackwell Publishers.
- Shetreet, Einat & Naama Friedmann. 2012. Stretched, jumped and fell: An fMRI investigation of reflexive verbs and other intransitives. *NeuroImage* 60(3). 1800–1806.
- Shetreet, Einat, Naama Friedmann & Uri Hadar. 2010. The neural correlates of linguistic distinctions: Unaccusative and unergative verbs. *Journal of Cognitive Neuroscience* 22(10). 1–10.
- Silverstein, Michael. 1976. Hierarchy of features and ergativity. In Robert M. W. Dixon (ed.), *Grammatical categories in Australian languages*, 112–171. Canberra: Australian Institute of Aboriginal Studies.
- Skopeteas, Stavros & Gisbert Fanselow. 2010. Effects of givenness and constraints on free word order. In Malte Zimmermann and Caroline Féry (eds.), *Information structure: Theoretical, typological, and experimental perspectives*, 307–331. Oxford: Oxford University Press.
- Stolterfoht, Britta. 2004. *Processing word order variations and ellipses: The interplay of syntax and information structure during sentence comprehension*. Leipzig: Max Planck Institute for Human Cognitive and Brain Sciences dissertation.
- Swinney, David, William Onifer, Penny Prather & Max Hirshkowitz. 1979. Semantic facilitation across sensory modalities in the processing of individual words and sentences. *Memory & Cognition* 7. 159–65.
- Titov, Elena. 2012. *Information structure of argument order alternations*. London: UCL dissertation.
- Ueno, Mieko & Robert Kluender. 2003. Event-related brain indices of Japanese scrambling. *Brain and Language* 86(2). 243–71.
- Vanden Wyngaerd, Guido. 1989. Object shift as an A-movement rule. *MIT Working Papers in Linguistics* 11. 256–271.
- Van Hoof, Hanneke. 2003. The rise in the risefall contour: Does it evoke a contrastive topic or a contrastive focus? *Linguistics* 41(3). 515–563.
- Webelhuth, Gert. 1989. Syntactic saturation phenomena and the modern Germanic languages. Amherst: University of Massachusetts Amherst dissertation.

Young, Robert W. & William Morgan. 1987. *The Navajo language: A grammar and colloquial dictionary*. Albuquerque, NM: University of New Mexico Press.

Zubizarreta, Maria Luisa. 1998. *Prosody, focus and word order*. Cambridge, MA: MIT Press.

Zwart, C. Jan-Wouter. 1993. *Dutch syntax: A minimalist approach*. Groningen: University of Groningen dissertation.

Appendix²¹

Fixed effects from best fit model for experiment 1.

	Estimate	SE	t value
(Intercept)	2.800e+00	7.5453-03	371.2
Location (pre-gap vs. gap)	9.231e-03	5.081e-03	1.8
Location (pre-gap vs. post-verbal)	6.9231e-03	5.133e-03	0.0
Target Type (identical vs. unrelated)	4.159e-02	5.191e-03	8.0*
Location × Target Type (pre-gap vs. gap)	-8.842e-03	7.167e-03	-1.2
Location × Target Type (pre-gap vs. post-verbal)	-2.876e-02	7.2103-03	-4.0*

	Estimate	SE	t value
(Intercept)	2.809508	0.007460	376.6
Location (gap vs. post-verbal)	-0.009162	0.005232	-1.8
Location (gap vs. pre-gap)	-0.009231	0.005081	-1.8
Target Type (identical vs. unrelated)	0.032744	0.005134	6.4*
Location × Target Type (gap vs. post-verbal)	-0.019915	0.007163	-2.8*
Location × Target Type (gap vs. pre-gap)	0.00842	0.007167	1.2

Note: Formula in R: $\text{DepVar} \sim \text{Location} \times \text{Target Type} + (1 + \text{Location} + \text{Target Type} | \text{Part}) + (1 | \text{Item})$.²²

21 Any statistically significant effects and interactions in the following tables are indicated by an asterisk.

22 An anonymous reviewer states that the formula in R should read: $\text{DepVar} \sim \text{Location} * \text{Target} + (1 + (\text{Location} * \text{Target}) | \text{Part}) + (1 + (\text{Location} * \text{Target}) | \text{Item})$ (the random slopes for participant and item are in bold). Barr et al. do indeed advise having a maximal random effects structure, and indeed that is what it would be - i.e. having the interaction term as the random slope. However, Barr et al. also state that these terms should only be included where they are warranted. In other words: just because we can have them in the formula, it does not mean that it always makes sense for the data. Furthermore, the random slope for participants includes those variables that are properties of *items*, and the random slope for items includes those variables that are properties of *participants*. In the present case, location and target are properties of items, which means they go into the value for the random slope of participants. However, there are no variables that are properties of participants, and hence the random slope for items is 0. If having the interaction term in the random slope does not produce a good fit, then stepping down to two variable (location + target) is usually considered the next sensible option.

Fixed effects for the best fit model when the data is subsetting by location for experiment 1.

	Estimate	SE	t value
<i>Pre-gap fixed effects:</i>			
(Intercept)	2.799701	0.007233	387.1
Target Type (identical vs. unrelated)	0.041760	0.005249	8.0*
<i>Gap fixed effects:</i>			
(Intercept)	2.808875	0.007891	356
Target Type (identical vs. unrelated)	0.033989	0.005683	6*
<i>Post-gap fixed effects:</i>			
(Intercept)	2.799642	0.006933	403.8
Target Type (identical vs. unrelated)	0.012056	0.005124	2.4*

Note: Formula in R: $\text{DepVar} \sim \text{Target Type} + (1 + \text{Target Type} | \text{Part}) + (1 | \text{Item})$.

Fixed effects from best fit model for experiment 2.

	Estimate	SE	t value
(Intercept)	2.8203080	0.0072736	387.7
Location (pre-gap vs. gap)	-0.0061289	0.0053740	-1.1
Location (pre-gap vs. post-verbal)	-0.0043854	0.0053732	-0.8
Target Type (identical vs. unrelated)	0.0105232	0.0055670	1.9
Location × Target Type (pre-gap vs. gap)	0.0162822	0.0076491	2.1*
Location × Target Type (pre-gap vs. post-verbal)	-0.0006828	0.0076547	-0.1
	Estimate	SE	t value
(Intercept)	2.814179	0.007983	352.5
Location (gap vs. post-verbal)	0.001743	0.005355	0.3
Location (gap vs. pre-gap)	0.00619	0.005374	1.1
Target Type (identical vs. unrelated)	0.026905	0.005548	4.8*
Location × Target Type (gap vs. post-verbal)	-0.016965	0.007641	-2.2*
Location × Target Type (gap vs. pre-gap)	-0.16282	0.007649	-2.1*

Note: Formula in R: $\text{DepVar} \sim \text{Location} \times \text{Target Type} + (1 + \text{Location} + \text{Target Type} | \text{Part}) + (1 | \text{Item})$.

Fixed effects for the best fit model when the data is subsetted by location for experiment 2.

	Estimate	SE	t value
<i>Pre-gap fixed effects:</i>			
(Intercept)	2.820808	0.007732	364.8
Target Type (identical vs. unrelated)	0.010864	0.006321	1.7
<i>Gap fixed effects:</i>			
(Intercept)	2.813048	0.007864	357.7
Target Type (identical vs. unrelated)	0.026882	0.005619	4.8*
<i>Post-gap fixed effects:</i>			
(Intercept)	2.86061	0.007727	364.5
Target Type (identical vs. unrelated)	0.008787	0.005566	1.6

Note: Formula in R: $\text{DepVar} \sim \text{Target Type} + (1 + \text{Target Type} | \text{Part}) + (1 | \text{Item})$.

Fixed effects from best fit model for experiment 3.

	Estimate	SE	t value
(Intercept)	2.785372	0.008120	343.0
Location (gap vs. post-verbal)	0.002349	0.006133	0.4
Target Type (identical vs. unrelated)	0.042910	0.006695	6.4*
Location \times Target Type	-1.017821	0.009012	-2.0*

Note: Formula in R: $\text{DepVar} \sim \text{Location} \times \text{Target Type} + (1 + \text{Location} \times \text{Target Type} | \text{Part}) + (1 | \text{Item})$.

Fixed effects for the best fit model when the data is subsetted by location for experiment 3.

	Estimate	SE	t value
<i>Gap fixed effects:</i>			
(Intercept)	2.783722	0.008006	347.7
Target Type (identical vs. unrelated)	0.044845	0.006517	6.9*
<i>Post-verbal fixed effects:</i>			
(Intercept)	2.788149	0.007424	375.6
Target Type (identical vs. unrelated)	0.024910	0.005775	4.3*

Note: Formula in R: $\text{DepVar} \sim \text{Target Type} + (1 + \text{Target Type} | \text{Part}) + (1 | \text{Item})$.

Best fit model for the truth-value judgment task.

	Estimate	SE	z value	p value
(Intercept)	-1.1315	0.5053	-2.239	0.025149
Congruency (congruent vs. incongruent)	0.013544	0.004789	2.8	0.000519*

Formula in R: $\text{DepVar} \sim \text{Congruency} + (1 + \text{Congruency} | \text{Part}) + (1 | \text{Item})$.