



## Persistence of emphasis in language production: A cross-linguistic approach

Sarah Bernolet<sup>a,\*</sup>, Robert J. Hartsuiker<sup>a</sup>, Martin J. Pickering<sup>b</sup>

<sup>a</sup> Department of Experimental Psychology, Ghent University, Henri Dunantlaan 2, 9000 Ghent, Belgium

<sup>b</sup> Department of Psychology, University of Edinburgh, 7 George Square, Edinburgh EH8 9JZ, United Kingdom

### ARTICLE INFO

#### Article history:

Received 6 September 2007

Revised 7 May 2009

Accepted 18 May 2009

#### Keywords:

Spoken sentence production

Syntactic priming

Information structure

Emphasis

Thematic roles

Bilingualism

### ABSTRACT

This study investigates the way in which speakers determine which aspects of an utterance to emphasize and how this affects the form of utterances. To do this, we ask whether the binding between emphasis and thematic roles persists between utterances. In one within-language (Dutch–Dutch) and three cross-linguistic (Dutch–English) structural priming experiments, we measured persistence effects for four different Dutch transitives (actives, PP-initial passives, PP-medial passives, and PP-final passives). Whereas English allows only one passive (PP-final passive), Dutch allows three different variants with the same functional assignment, but different constituent structures. Additionally, the degree of emphasis on the agent differs significantly between the PP-initial passive and the other passives (Experiment 1). Experiment 2 showed persistence of actives, PP-medial, and PP-final passives in Dutch, but no priming between passives with different constituent structures. Experiments 3 and 4, however, showed that both PP-medial and PP-final passives prime the use of English passives. Experiment 5 confirmed that the emphasis on thematic roles persists: the proportion of passives in the PP-initial passive condition fell midway between the proportions produced in the active and PP-medial passive condition.

© 2009 Elsevier B.V. All rights reserved.

### 1. Introduction

When speakers decide what to say, they have to make many choices. As well as deciding what to talk about and which words to use, they have to decide which aspects of the sentence should be emphasized. For example, the active sentence *Lightning strikes the church* emphasizes the agent, namely the lightning; whereas *The church is struck by lightning* emphasizes the patient, namely the church. Thus, such differences in emphasis (or perspective) are associated with different sentence forms (e.g., Fillmore, 1977; MacWhinney, 1977; see Levelt, 1989, pp. 96–100). Many linguists assume that emphasis is captured at a level of information structure, which is separate from levels associated with semantics or syntax (e.g., Vallduví, 1992). They also standardly assume that one element of each sentence receives

emphasis (with this element often being called the topic<sup>1</sup>; e.g., Reinhart, 1982), but it is also possible that sentences contain more than one emphasized element. Psychologists have documented how differences in emphasis may affect sentence form (e.g., Bock, 1977; Osgood, 1971; Prat-Sala & Branigan, 2000). But they have not tended to incorporate a level of information structure into their models of grammatical encoding, which are largely concerned with the effects of syntactic, semantic, and (to a lesser extent) phonological influences on choice of sentence form. In this paper, we use structural priming to investigate the nature of information structure and its influence on syntactic choices.

As Büring (2007) observes, there is no consensus on what and how many categories of information structure

<sup>1</sup> Terminology is extremely confusing. Psychologists often refer to this element as the focus, though linguists use focus to refer to non-topics. Other related terms include theme (vs. rheme), and thematic subject (typically used of a protagonist of a text).

\* Corresponding author. Tel.: +32 9 264 86 27; fax: +32 9 264 64 96.  
E-mail address: [sarah.bernolet@ugent.be](mailto:sarah.bernolet@ugent.be) (S. Bernolet).

should be distinguished, or how these can be identified. One aspect that characterizes all information structure constructs is the dichotomy between information the speaker considers to be important for his or her addressee and information that is considered to be less important. Depending on the language they speak, speakers use different means to emphasize the important part(s) of the sentences they produce. In most languages, they use sentence prosody: By varying pitch, duration and loudness, speakers can indicate which elements they want to emphasize (Büring, 2007). In some languages, such as Cantonese and Japanese, emphasis is marked morphologically, rather than by variations in prosody (Féry, 2008). Finally, information structure can be realized syntactically. As Levelt (1989) notes, both subjects and first-mentioned elements are emphasized. Consequently, if more than one syntactic alternative is available to form the intended utterance (e.g., an active vs. a passive transitive, or an *It*-cleft vs. a dislocated active), they can opt for the syntactic alternative that allows the most important entity to occur first and/or in subject position.

Prat-Sala and Branigan (2000) provided evidence for influences of information structure on syntactic choices, by showing that the relative saliency of the different entities in the discourse (e.g., the agent and the patient of transitive actions) affects their order of mention. They asked Spanish- and English-speaking students to describe pictures of transitive actions after hearing stories that introduced both the agent and the patient of the action, but in which one of the entities was more salient than the other. In both languages, speakers produced more passives following patient-salient than agent-salient stories. But patient-salient stories also led to more dislocated actives in Spanish, such as *A la mujer la atropelló el tren* (to the woman her ran over the train), in which the first-mentioned entity is the patient but not the subject. Comparable effects have been obtained in Japanese (Ferreira & Yoshita, 2003) and Odawa (Christianson & Ferreira, 2005). In conclusion, speakers typically emphasize elements by assigning them the subject function or placing them first.

Our interest is how information structure, and in particular emphasis, influences grammatical encoding in sentence production. Following Levelt (1989), we assume a level of conceptualization, at which the message is constructed; a subsequent level of grammatical encoding, at which the message is converted into syntactic and phonological form; and a final level of articulation, at which speech motor plans are programmed and executed. We hypothesize that the message binds together concepts (e.g., for lightning and church) and their relation (e.g., one of striking), as well as information about thematic roles (e.g., lightning is agent, and church is patient) and information structure (e.g., lightning is emphasized). In this case, the most likely realization would be *lightning strikes the church*, because the active sentence allows the emphasized agent to take the subject role and the first sentence position. It is therefore plausible that the sets of bindings at the message level include bindings between information structure and thematic roles, so that the speaker represents the degree of emphasis assigned to agent, patient, and so on.

To investigate this binding of emphasis to thematic roles, we ask whether speakers tend to persevere with particular bindings. Thus if they encounter a sentence that emphasizes the patient, are they more likely to emphasize the patient in the next sentence too? There are two reasons why one might expect such perseveration. First, at least one other type of binding, between conceptual features and grammatical roles (Bock, Loebell, & Morey, 1992, see below) tends to be repeated across sentences; it is thus possible that in general, bindings in language production are preserved after the sentence has been formulated. Second, bindings involving emphasis may be particularly good candidates for perseveration, because this might contribute to coherence between subsequent utterances. Thus, if the first sentence emphasizes the patient *church* (e.g., *the church was struck by lightning*), it may be easier for both the speaker and listener to carry over this emphasis to the next sentence (*it was severely damaged*) than to change emphasis to the other role (*it was the brightest in years*). In line with this, Tannenbaum and Williams (1968) found that speakers needed less time to complete a sentence if its subject fulfilled the same thematic role (e.g., agent) as the topic of a preceding paragraph. More recently, an ERP study by Cowles, Kluender, Kutas, and Polinsky (2007) indicated that violations of information structure hamper the comprehension of *it*-clefts: If the referent emphasized in the *it*-cleft (*it was the priest that prayed for the farmer*) was not emphasized in the preceding *Wh*-question (*who did the priest pray for, the farmer or the laborer?*), a larger N400 occurred than when this referent was emphasized in the preceding question.

In this study, we used a structural priming paradigm. Many studies show that speakers tend to re-use the syntactic structure of a previously encountered sentence when formulating a new sentence (see Pickering & Ferreira, 2008). In particular, Bock (1986) had people repeat sentences and describe unrelated pictures, and showed that they produced more passive descriptions after passive than active primes (and conversely more active descriptions after active than passive primes). Similarly, they tended to persevere in choice of form used to describe a dative event (e.g., *the man is reading a story to a boy* vs. *the man is reading the boy a story*). Such priming effects are strong and reliable, and occur in different languages (e.g., Hartsuiker & Westenberg, 2000), and with a range of methods such as sentence completion (Pickering & Branigan, 1998) and sentence recall (Potter & Lombardi, 1998), and also occur between comprehension and production (Branigan, Pickering, & Cleland, 2000). Importantly, structural priming takes place between languages, and occurs for several constructions and pairs of languages. Moreover, it occurs both from the speaker's first language to the second language and vice versa (see Hartsuiker & Pickering, 2008).

Bock (1986) interpreted her results as showing priming of syntactic structure. Subsequent research has provided strong evidence that syntactic structure can indeed be primed (see Pickering & Ferreira, 2008). For example, Bock (1989) found dative priming occurred just as strongly when prime and target involved different prepositions (*for* and *to*) as when they involved the same preposition (*to*). Thus structural priming occurs in the absence of any

lexical repetition. Additionally, Bock and Loebell (1990) found that priming occurred when thematic roles differed across prime and target; for example, locative sentences (*the foreigner was loitering by the broken traffic light*) primed passives (*the boy was stung by the bee*). Priming also occurs across many pairs of constructions whose meanings are very similar, such as order of verb and auxiliary in Dutch (Hartsuiker & Westenberg, 2000), and presence vs. absence of the complementizer *that* (Ferreira, 2003).

However, in addition to syntactic structure, other aspects of a particular sentence can also persist, and it is possible that such persistence occurs at many different levels (Pickering & Garrod, 2004). These include choice of referring expression (*dancer* or *ballerina*; Brennan & Clark, 1996), frame of reference to spatial arrangements (*above* vs. *left* for an object on its side; Watson, Pickering, & Branigan, 2004), and aspects of sound (Pardo, 2006). Importantly, such perseverance also includes bindings involving aspects of the message. Bock et al. (1992), for example, showed persistence of the binding between conceptual features (animate/inanimate) and grammatical functions (subject/object/oblique): Target descriptions featuring inanimate subjects (e.g., *the alarm clock awakened the boy*) were more frequent after primes with inanimate subjects (*the boat carried five people* or *the boat was carried by five people*) than after primes with animate subjects (*five people carried the boat* or *five people were carried by the boat*), irrespective of the prime's constituent structure. Additionally, repetition of the number of thematic roles may affect priming (Griffin & Weinstein-Tull, 2003).

One study is compatible with the suggestion that the binding between emphasis and thematic roles may persist (although the authors interpreted the findings differently). Chang, Bock, and Goldberg (2003) found that when speakers had to recall a spray-load construction (*the short order cook splattered grease on his apron*), they tended to persist in the thematic role order they used on a previous trial (*loaded the truck with boxes* vs. *loaded boxes onto the truck*). Because these sentences have the same order of phrasal constituents (verb, noun phrase, prepositional phrase), the effects are unlikely to be syntactic. They interpreted this effect as showing priming of the order of thematic roles (theme-location vs. location-theme). However, this explanation requires that either thematic roles are involved in syntactic processing (contra Bock & Levelt, 1994) or that the message represents linear order, which contradicts most accounts of message representation (e.g., Levelt, 1989). But alternatively *loaded the truck with boxes* emphasizes the truck, and *loaded the boxes onto the truck* emphasizes the boxes (cf. Levelt, 1989, p. 97), and the priming might reflect a tendency for thematic emphasis to persist. In sum, structural priming suggests that bindings in production may perseverate, and it is possible that one such binding may occur between thematic roles and the aspect of information structure concerned with emphasis.

To investigate the persistence of information structure, we used actives and several types of passives in Dutch as prime sentences. If the binding of emphasis to thematic roles persists, passives should be more likely after passive than active primes. But of course any such priming could

be due to syntactic structure. The effects need to be dissociated from possible priming effects at other levels of representation too. One possibility is that there is priming at the level of grammatical function assignment (Hartsuiker, Kolk, & Huiskamp, 1999), with actives involving a subject and a direct object, and passives involving a subject and an oblique element. Such an account is consistent with theories in which speakers construct a functional representation before a constituent structure representation (Bock & Levelt, 1994; Garrett, 1980). Additionally, functional level priming might reflect a tendency to bind thematic relations to particular grammatical functions (agent to subject vs. patient to subject). Finally, priming of actives and passives might be explained by lexical repetition (auxiliary, *by*, or passive morphology), although this is not compatible with Bock (1989); or in terms of the repetition of the order of thematic roles (Chang et al., 2003), although this is difficult to reconcile with Bock and Loebell (1990). To determine whether priming (at least partly) reflects a tendency to assign emphasis to the element with the same thematic role, we need to create experimental situations in which this account makes different predictions from alternative accounts.

It is difficult to accomplish this in English, because of the lack of word-order variation. English actives and passives differ in information structure, but they also differ in many other ways, such as syntactic structure, functional representations, words (e.g., *by*), morphology (e.g., past tense vs. past participle), and order of thematic roles. But Dutch has more word-order freedom, and has at least four ways to express the message that lightning strikes the church<sup>2</sup>:

- (1a) De bliksem treft de kerk. (*Lightning strikes the church*)
- (1b) Door de bliksem wordt de kerk getroffen. (*By lightning is the church struck*)
- (1c) De kerk wordt door de bliksem getroffen. (*The church is by lightning struck*)
- (1d) De kerk wordt getroffen door de bliksem. (*The church is struck by lightning*)

As in English, (1a) emphasizes the agent (*De bliksem*), both because it is the subject and because it occurs first in the sentence. In addition, (1c–d) emphasize the patient (*De kerk*), because it appears first and is the subject. Furthermore, (1c) and (1d) might differ in the emphasis given to the agent (*de bliksem*), because it takes a different sentence position in the two sentences. More importantly, (1b) places more emphasis on the agent than do (1c–d), because it appears first (though it is not the subject).

Structural priming between Dutch and English, therefore, allows us to dissociate differences in the emphasis

<sup>2</sup> We collected frequency data on the use of the different transitives in a picture description experiment (32 Dutch–English bilinguals described 76 transitive pictures). This pretest yielded 7.3% non-transitives, 82.1% active transitives and 10.6% passives (4.9% PP-final passives, 2.4% PP-medial passives and 3.3% short passives, in which the agent is not expressed). In our pretest, no PP-initial passives were produced, but this passive is observed in larger corpora: Cornelis (1997) counted 11 PP-initial passives out of over 3000 passives (0.4%) in the Eindhoven Corpus (Uit den Boogaart, 1975).

on agent and patient from other differences between sentences that are potential loci for priming. To see how this works, consider priming from the Dutch active (1a) and the two patient-initial passives (1c–d) to English transitives. The active (1a) and passive (1d) share information structure with the English active and passive, but also their constituent structure, order of thematic roles, functional representation, and morphological complexity. But while the passive (1c) has a similar information structure to the English passive, the same order of thematic roles and an identical functional representation, it has a different constituent structure. Previous research has demonstrated that constituent structure priming is highly sensitive to word order repetition (Bernolet, Hartsuiker, & Pickering, 2007; Hartsuiker & Westenberg, 2000; Pickering, Branigan, & McLean, 2002; Salamoura & Williams, 2007). Thus, if constituent structure is the *only* level of representation that is being primed, Dutch passives like (1c) should not prime English passives, because the word order is different. But if there are also priming effects at the level that determines information structure (i.e., emphasis to agent vs. patient), thematic role order, or grammatical functions, Dutch passives (1c–d) should prime passives in English to a similar degree. We tested these predictions in Experiments 3 and 4.

Next, consider Dutch passives (1b) and (1c). Neither of these sentences has the same constituent structure as the English passive, so if constituent structure is the only level of representation that is primed, neither of them should prime English passives. Importantly, in this case the predictions are different for an account that assigns a role to information structure and for all other accounts. Specifically, (1c) is like an English passive in that it emphasizes the patient. But as noted above, (1b) places more emphasis on the agent, which appears in first position. Thus, if information structure plays a role, we predict that (1c) should prime English passives to a greater extent than (1b). In contrast, (1b) and (1c) are identical in their functional-level representations (and also in terms of passive morphology). Thus if the functional level (or morphology) is a locus of priming, we predict that (1b–c) should prime English passives to an equivalent degree. Finally, if thematic role order plays a role, passives such as (1b) should prime the use of English actives, instead of English passives, as (1b) and (1a) have the agent before the patient. These predictions were tested in Experiment 5. Before the cross-linguistic experiments, we report the results of a within-language priming experiment, in which we investigated priming effects for the Dutch active, PP-medial passive, and PP-final passive.

First, however, we need to verify whether the four different Dutch transitives do indeed differ in information structure, that is in the relative emphasis assigned to the agent and the patient of the transitive action. To this aim, we conducted a norming study, in which 48 transitive sentences were visually presented in their active (1a), PP-initial passive (1b), PP-medial passive (1c) or PP-final passive (1d) form. If it is true that subjects and first-mentioned elements are emphasized, the perceived emphasis on the agent of the transitive action should be stronger in the active condition than in all passive conditions, because only

in the active the agent is the subject of the sentence. Among the three passives, the perceived emphasis on the agent should differ according to the position of the agent: The emphasis on the agent should be stronger in the PP-initial passive condition (agent first) than in the PP-medial and PP-final passive conditions (agent not first). If the effect of word order is determined by the relative position of the agent (first vs. not first), there should be no difference between PP-medial and PP-final. But alternatively the emphasis on the agent might be weaker in the PP-final condition than in the PP-medial passive condition, because in the former condition the agent is sentence-final.

## 2. Experiment 1: norming study

### 2.1. Method

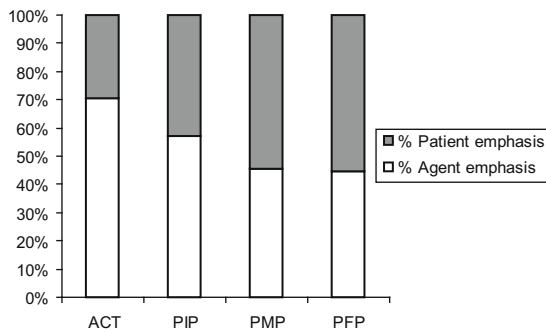
#### 2.1.1. Participants

Thirty-six students at Ghent University (18 females and 18 males) participated in exchange for course credit. All participants were native speakers of Dutch and had normal or corrected to normal vision.

#### 2.1.2. Materials

The materials consisted of 48 critical sentences and 48 filler sentences. The critical sentences were transitive sentences, presented in their active (ACT; 1a), PP-initial passive (PIP; 1b), PP-medial passive (PMP; 1c) or PP-final passive (PPF; 1d) form, depending on the list in which they occurred. In 16 of these sentences (*AA items*) the action involved an animate agent and an animate patient (e.g., *a nun chasing a burglar*), 16 sentences (*IA items*) involved an inanimate agent and an animate patient (e.g., *a ship transporting a passenger*), and 16 sentences (*II items*) involved an inanimate agent and an inanimate patient (e.g., *lightning striking a church*). The filler sentences were either it-clefts (24 items), in which the first mentioned referent was stressed (e.g., *Het is de politieman die de piraten achtervolgt [It is the policeman that chases the pirates]*), or pseudo-cleft sentences with a dummy pronoun in the sentence-initial position (24 items), in which the last mentioned referent was stressed (e.g., *Degene die de inbrekers straft, is de monnik [The one that punishes the burglars, is the monk]*). In order to avoid ambiguities, both referents in the filler sentences always differed in number. The number of the stressed referent (singular or plural), the thematic role of the stressed referent (agent or patient), and the voice of the sentence (active or passive) were counterbalanced across all filler items, in order to bring enough variation in the set of fillers. In all critical and filler items, both the agent and the patient of the action were underlined. Underneath the referent that was mentioned first, the number 1 was printed; underneath the second referent, the number 2 was printed.

Four counterbalanced pseudo-random lists were constructed so that each critical target sentence occurred once with one of the four structures (active, PP-initial passive, PP-medial passive, and PP-final passive) across the four different lists and that, within each list, the four different structures were used equally often.



Note: ACT = Active condition, PIP = PP-initial passive condition  
PMP = PP-medial passive condition, PFP = PP-final passive condition

**Fig. 1.** Percentages of trials with Agent emphasis and Patient emphasis in all conditions of Experiment 1.

### 2.1.3. Procedure

The participants were tested in groups of 4. They were seated in front of a PC and were asked to read the instructions that appeared on the screen. The instructions read as follows: “One by one, sentences will appear at the centre of the screen. In each sentence, two constituents will be underlined; the first underlined constituent will be marked with the number 1, the second one will be marked with number 2. Read the sentences in silence and indicate which of both constituents carries the strongest emphasis, by pressing ‘1’ for constituent number 1, or ‘2’ for constituent number 2. When one of both keys is pressed, the next sentence will immediately appear on the screen”. The participants’ responses were registered and written to a data file. The experiment lasted about 10 min.

### 2.2. Results

For 1970 of the 3456 target sentences (57%) participants indicated that the first constituent carried the strongest emphasis; for the remaining 1486 target sentences the second constituent was chosen. For every item and participant, we computed the proportion of responses in which the chosen constituent was the Agent of the transitive action (see Fig. 1). ANOVAs with random effects for participants ( $F_1$ ) and items ( $F_2$ ) and sentence type (ACT, PIP, PMP, and PFP) as within-participant and within-item factor were run on these proportions. The analyses showed a main effect of sentence type [ $F_1$  (3, 33) = 11.94,  $MSE = 0.04$ ,  $p < .001$ ;  $F_2$  (3, 45) = 30.65,  $MSE = 0.02$ ,  $p < .001$ ]. Planned comparisons between the different conditions indicated that the percentage of Agent choices was significantly higher in the active condition (70.6%) than in all passive conditions: the PP-initial passive condition (57.2% Agent choices) [ $F_1$  (3, 33) = 8.87,  $MSE = 0.07$ ,  $p < .01$ ;  $F_2$  (3, 45) = 18.31,  $MSE = 0.05$ ,  $p < .001$ ], the PP-medial passive condition (45.6% Agent choices) [ $F_1$  (3, 33) = 16.28,  $MSE = 0.14$ ,  $p < .001$ ;  $F_2$  (3, 45) = 53.62,  $MSE = 0.06$ ,  $p < .001$ ], and the PP-final passive condition (44.7% Agent choices) [ $F_1$  (3, 33) = 16.18,  $MSE = 0.15$ ,  $p < .001$ ;  $F_2$  (3, 45) = 89.87,  $MSE = 0.04$ ,  $p < .001$ ]. In its turn, the percentage of Agent choices in the PP-initial passive condition (57.2%) was significantly higher than in the PP-

medial passive condition [ $F_1$  (3, 33) = 6.24,  $MSE = 0.08$ ,  $p < .05$ ;  $F_2$  (3, 45) = 13.46,  $MSE = 0.05$ ,  $p < .005$ ], and the PP-final passive condition [ $F_1$  (3, 33) = 7.40,  $MSE = 0.08$ ,  $p < .05$ ;  $F_2$  (3, 45) = 30.65,  $MSE = 0.07$ ,  $p < .001$ ]. The 0.9% difference between the PP-medial passive and the PP-final passive condition was not significant ( $F_s < 1$ ).

### 2.3. Discussion

The results of our norming study indicate that the different transitives indeed have a different information structure. The percentage of choices for the agent as emphasized constituent was highest in the active condition, where the agent came first and was the subject of the sentence, and lowest in the PP-medial passive and the PP-final passive conditions, where the agent did not come first and took the function of oblique object. The percentage of agent choices in the PP-initial passive condition (where the agent still came first, but was the oblique object) was significantly higher than the percentage of agent choices in the other passive conditions, but significantly lower than the percentage of agent choices in the active condition. In fact, it fell midway between the active and the other passive conditions, indicating that both the grammatical function of the agent and the position of the agent affect the perceived emphasis on this agent. Additionally, the results of our norming study suggest that it is not the absolute position of the agent and the patient that influences the information structure of transitives, rather their relative position: The perceived emphasis on the agent was equally strong in the PP-medial passive (patient before agent, agent before main verb) and the PP-final passive condition (patient before agent, agent sentence-final).

To summarize, our norming study showed that, when sentences are presented visually, the structural differences among Dutch actives, PP-initial passives, and non-PP-initial passives influence their perceived information structure.<sup>3</sup> In a series of cross-linguistic syntactic priming experiments, we now investigate whether the information structure of these Dutch transitives persists between utterances. First however, we need to establish that active and passive primes indeed exert structural priming effects in Dutch. A previous study in Dutch was in fact inconclusive in this respect: Hartsuiker and Kolk (1998) found priming for PP-medial (1c) and PP-final passives (1d), but not for actives (1a). Consistent with the claim that priming is strongly influenced by word order repetition (see above), passives primed passives with an identical word order, but not with a different word order. This is why, in Experiment 2, we investigated priming for these structures in a within-language priming experiment. Our experiment differed in two important respects from that of Hartsuiker and Kolk. First, we used a confederate-scripting paradigm in which a confederate and naïve participant took turns to describe each other pictures (Branigan et al., 2000). At least numerically,

<sup>3</sup> Of course, there is no one-on-one correspondence between structural form and information structure. In their spoken form, the information structure of these sentences can be turned around by the use of contrastive pitch or pauses.

priming effects appear to be larger in this paradigm than in Bock's (1986) original paradigm (also used by Hartsuiker & Kolk). Second, we repeated the verb between prime and target, as many studies have shown that such lexical repetition greatly enhances syntactic priming (e.g., Branigan et al., 2000; Cleland & Pickering, 2003; Hartsuiker, Bernolet, Schoonbaert, Speybroeck, & Vanderelst, 2008; Pickering & Branigan, 1998; Schoonbaert, Hartsuiker, & Pickering, 2007).

### 3. Experiment 2: priming between Dutch transitives

#### 3.1. Method

##### 3.1.1. Participants

Twenty-seven students at Ghent University (18 females and 9 males) were paid to take part. All participants were native speakers of Dutch and had normal or corrected to normal vision. A female undergraduate student acted as confederate.

##### 3.1.2. Materials

Two sets of 108 pictures were constructed for the participants, one verification set and one description set. On each of these pictures, an action was displayed, accompanied by a Dutch verb in the infinitive, describing the action. Thirty-six of the pictures in the participant's description set were experimental target pictures, depicting a transitive action involving an agent and a patient. On 12 of these pictures (*AA items*) the action involved an animate agent and an animate patient (e.g., *a pirate chasing a boxer*, see Fig. 2), 12 pictures (*IA items*) involved an inanimate agent and an animate patient (e.g., *an arrow hitting a bird*), and 12 pictures (*II items*) involved an inanimate agent and an inanimate patient (e.g., *a ball knocking over cans*). In order to increase the production of passives, the patient of the action was always depicted on the left side of the picture (Bock, 1986; Bock & Griffin, 2000; Hartsuiker et al., 1999). The remaining 72 pictures in the description set were filler items, displaying actions that could be described by using intransitive verbs (e.g., *to run*, *to die*). The pictures in the participant's verification set were used as filler items in the cover task of matching pictures with the confederate's descriptions.

Half of the pictures in the participant's verification set matched the descriptions in the confederate's description set, which contained 108 Dutch prime sentences. Thirty-six of these sentences (a subset of the norming study items) were critical transitive prime sentences. There were 12 sentences with an animate agent and an animate patient (AA), 12 with an inanimate agent and an animate patient (IA), and 12 with an inanimate agent and an inanimate patient (II), such that an experimental target picture was always preceded by a transitive prime sentence with the same animacy for the agent and the patient. This repetition of animacy is a consequence of our decision to repeat the verb in prime and target descriptions: Some of our target verbs were less common with animate patients (e.g., *destroy*), while others could not be combined with inanimate agents (e.g., *weighing*), so, in order to avoid semantically anomalous prime sentences, we primed AA-



Fig. 2. Target picture: a pirate chasing ("achtervolgen") a boxer.

items with AA-primers, IA-items with IA-primers, and II-items with II-primers. Note that in 67% of the trials (i.e., for the II-items and the AA-items), any animacy-to-function repetition effect of the type Bock et al. (1992) reported would not influence syntactic choice.<sup>4</sup> The remaining 72 sentences were fillers that were similar to those in the participant's description set. In addition to the prime sentences, 108 pictures were selected for the confederate's verification set. These pictures were used as filler items in the cover task of matching pictures with the participant's descriptions.

Three counterbalanced pseudo-random lists were constructed so that each target picture occurred once in each prime condition (active prime, PP-medial passive prime, and PP-final passive prime) across the three different lists. The verb was always repeated in prime and target sentences. The agent and the patient in the prime–target-pairs were never related in form or meaning.

An experimental trial consisted of a Dutch transitive prime sentence, produced by the confederate, followed by a transitive target picture (see Fig. 1), described by the naïve participant. The experimental trials were preceded by at least one filler trial. Separate sublists for the confederate and the naïve participant were derived from the three master lists.

##### 3.1.3. Procedure and design

The experimenter treated the participant and the confederate in the same way. Both the participant and the confederate sat in front of a PC, and they were told that they would be playing a game in which they would have to describe pictures to each other and verify each other's descriptions. They sat opposite each other, with the PCs between them (see Fig. 3). Neither of them could see what appeared on the opposite screen. First, they were familiarized with the material in a study session, where all objects and all characters that appeared on the pictures in the experiment were presented together with their names. The participant and the confederate were instructed to look at the pictures and to memorize the corresponding

<sup>4</sup> For all experiments, additional analyses were carried out on the subset of items with the same animacy for agent and patient (only Animate-animate and inanimate-inanimate items). Since the priming effects obtained in these analyses never differed from the effects obtained in the analyses involving all items, we did not report the additional analyses.

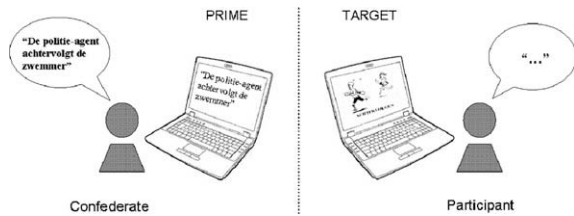


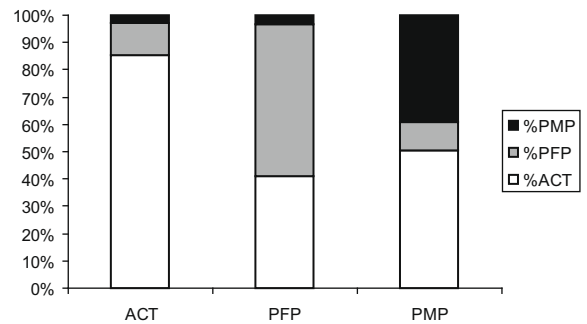
Fig. 3. Computerized version of dialogue game.

names. After that, the participant's first verification picture was shown in order to explain how the objects were arranged on the screen and how the participants were supposed to respond. The participant and the confederate were informed that their speech would be recorded on minidisk. The program was set up so that the confederate always took the first turn. The lists for the confederate and the naïve participant were designed to be run simultaneously on two different PCs.

The sequence of events during the experiment was as follows: (1) a picture appeared on the screen of the participant's PC (Fig. 2). This picture was necessary for the verification task; (2) the confederate read the (critical) prime description from the screen of her PC, using the proper intonation (i.e., emphasis in intonation corresponding with the emphasis indicated by the structural form); (3) the participant responded to the prime description by pressing '1' if this description matched the picture on his/her screen or '2' if the description and the picture did not match. When either key was pressed, the verification picture changed into a description picture. At the same time, a beep notified the confederate that the participant had responded; (4) at the sound of the beep, the confederate pressed '3', to change the prime sentence into a verification picture; (5) the participant produced a description for the action depicted on the (critical) description picture; (6) the confederate responded to the participant's description by pressing '1' (match) or '2' (mismatch). By doing this, the picture was automatically replaced by the prime sentence for the next trial. At the same time, a beep notified the participant that the confederate had responded; (7) at the sound of the beep, the participant had to press '3', in order to make the verification picture for the next trial appear on the screen. There was a match between the description and the verification pictures on 50% of the trials. Sessions lasted about 25 min.

### 3.1.4. Scoring

The responses were manually coded as active sentences (1a), PP-medial passives (1c), PP-final passives (1d), or "Other" responses. A response was coded as an active sentence when the agent of the transitive action was mentioned first, followed by the verb and the patient. When the patient was mentioned first, either the main verb of the sentence or the prepositional phrase expressing the agent could take the sentence-final position. Passive sentences that ended with the prepositional phrase were coded as PP-final passives; passive sentences that ended with the main verb were coded as PP-medial passives. "Short passives", in which the agent was not overtly real-



Note: ACT = Active condition, PFP = PP-final passive condition, PMP = PP-medial passive condition

Fig. 4. Percentages of actives (ACT), PP-final passives (PFP), and PP-medial passives (PMP) in each condition of Experiment 2.

ized (e.g., *the doctor was killed*), were coded as "Other" responses, as were all other responses. (Note that there were no *by-phrase* initial responses.)

### 3.2. Results

Twenty-four of the 972 target responses were "Other" responses (2.5%). The remaining 948 target responses were classified either as actives (561, 57.7%), PP-final passives (247, 25.4%), or PP-medial passives (140, 14.4%). The proportions of active, PP-final passive and PP-medial passive responses out of all allowable responses (active + PP-medial passive + PP-final passive) were calculated for each participant (Fig. 4) and item and subsequently arcsine-transformed (as were the proportions of target responses of the other experiments reported in this paper).

ANOVAs were run on these proportions with Prime Type (active/PP-final passive/PP-medial passive) as a within-participants and within-items factor. The analyses revealed a significant effect of Prime Type on the production of PP-final passives [ $F_1(2, 25) = 55.08$ ,  $MSE = 9.17$ ,  $p < .001$ ;  $F_2(2, 34) = 113.28$ ,  $MSE = 11.40$ ,  $p < .001$ ], the production of PP-medial passives [ $F_1(2, 25) = 30.11$ ,  $MSE = 5.95$ ,  $p < .001$ ;  $F_2(2, 34) = 142.40$ ,  $MSE = 7.73$ ,  $p < .001$ ], and the production of active sentences [ $F_1(2, 25) = 35.05$ ,  $MSE = 7.46$ ,  $p < .001$ ;  $F_2(2, 34) = 77.54$ ,  $MSE = 9.43$ ,  $p < .001$ ]. Paired *t*-tests (two-tailed) on the proportions of PP-final passive responses in primed and unprimed conditions showed that more PP-final passives were produced in the PP-final passive condition (55.8%) than in the other conditions (11.0% on average in the PP-medial and the active condition). This 44.8% priming effect was significant [ $t_1(1, 26) = 8.23$ ,  $MSE = .12$ ,  $p < .001$ ;  $t_2(1, 35) = 13.25$ ,  $MSE = .07$ ,  $p < .001$ ]. Likewise, the number of PP-medial passives was higher in primed (39.0%) than in unprimed conditions (3.0% on average in the PP-final passive and the active condition), yielding a 36.0% effect of priming [ $t_1(1, 26) = 5.73$ ,  $MSE = .14$ ,  $p < .001$ ;  $t_2(1, 35) = 12.70$ ,  $MSE = .06$ ,  $p < .001$ ]. Finally, the percentage of actives was also higher in primed (85.5%) than in unprimed conditions (45.9% on average in both passive conditions), resulting in a 39.6% effect of priming [ $t_1(1, 26) = 6.54$ ,  $MSE = .14$ ,  $p < .001$ ;  $t_2(1, 35) = 13.40$ ,  $MSE = .06$ ,  $p < .001$ ].

The percentage of PP-final passives was comparable in the active (11.6%) and the PP-medial passive condition (10.3%) [ $t_s < 1$ ]. Also, the percentage of PP-medial passives did not differ in the active (2.8%) and the PP-final passive condition (3.1%) [ $t_s < 1$ ], suggesting that the passives in this experiment only elicited passives with the same constituent structure.

### 3.3. Discussion

This experiment showed a clear effect of structural priming with Dutch actives and passives. Participants tended to preserve the structure of the primes in the description of the target pictures. Therefore they produced more PP-final passives after PP-final passive primes; more PP-medial passives after PP-medial passive primes; and, importantly, more actives after active primes (in contrast to Hartsuiker & Kolk, 1998). Similar to Hartsuiker and Kolk's findings, PP-medial, and PP-final passives did not prime each other: The percentage of passive targets after passive primes with the alternative constituent structure was not different from the percentage of passives in the active condition.

Thus, these results suggest that priming for Dutch transitives occurs at a level where actives, PP-medial passives, and PP-final passives all have separate representations. As we mentioned in the introduction, a candidate level is constituent structure, because all three sentence types have a different constituent structure. This account is consistent with a different distribution of PP-medial and PP-final responses in the PP-medial and PP-final passive conditions.

However, the results are also consistent with accounts that assume there is an additional locus (or loci) of priming, such as information structure, functional structure, morphology, or order of thematic roles, because perseveration of constituent structure in this experiment necessarily means perseveration of emphasis, functional-level representations, morphological structure, and thematic role order. All these accounts, however, predict that priming would occur between PP-medial and PP-final passives, because both constructions emphasize the patient to the same extent (see Experiment 1), have the same functional and morphological structure and the same order of thematic roles. The reason why no such priming occurred is probably that the structure of the prime could always be re-used for the description of the target: If a PP-medial passive can be used, there is no reason to use the next best alternative, the PP-final passive.

We therefore turn to cross-linguistic priming to further investigate whether information structure is persistent across messages. The first cross-linguistic experiment (Experiment 3) is identical to Experiment 2, except for the fact that the target language is English. As the PP-medial passive does not occur in English, it is not possible to repeat the exact structure of the primes in all conditions. Thus the participant's responses in the PP-medial passive condition will indicate whether or not priming can occur between structures with a different constituent structure.

## 4. Experiment 3: priming between Dutch (L1) and English (L2) transitives

Given the fact that we obtained strong within-language priming effects for Dutch actives, PP-medial passives, and PP-final passives (39.6%, 36.0%, and 44.8% priming, respectively) and that cross-linguistic priming is often strong (see Pickering & Ferreira, 2008), we expect that cross-linguistic priming will occur between Dutch and English transitives. Whereas we tried to boost the priming effects in Experiment 2 by repeating the verb between and target, we did it in the current experiment by using translation equivalent verbs between prime and target. Because the translation equivalent verbs are only semantically related, we expect this boost to be smaller than in Experiment 1 (Schoonbaert et al., 2007).

If information structure tends to persist across sentences with different constituent structures, we predict that, after a Dutch PP-medial passive, participants will produce the English PP-final passive, because the PP-medial and PP-final passive in Dutch do not differ significantly in information structure (see Experiment 1) and it is reasonable to assume that their information structure is similar to that of the English passive. Additionally, it is possible that passive priming is somewhat stronger for the PP-final than the PP-medial passive (as was the case in Experiment 2), because a PP-final passive response not only preserves information structure but also some aspects of constituent structure. The same predictions can be made if the functional or morphological structure of transitives, or their order of thematic roles, produce priming. If, however, full representation of constituent structure is needed for priming and if this is the only level where priming occurs, Dutch PP-medial passives should not prime passives in English.

### 4.1. Method

#### 4.1.1. Participants

Thirty-three further students from Ghent University (23 females and 10 males) were paid to take part. All participants were native speakers of Dutch with English as a second language (L2). They all reported having at least 4 years of experience with English as their second language (mean of 12 years of experience). A male and a female undergraduate student with Dutch as L1 and English as L2 acted as confederates (the male student for 17 participants, the female student for 16 participants).

#### 4.1.2. Materials

The materials of Experiment 3 were identical to the materials of Experiment 2, except that the verbs on the description pictures of the participant and on the verification pictures of the confederate were printed in English. The verbs on the verification pictures of the participants were printed in Dutch, as the participants had to respond to Dutch prime descriptions.

#### 4.1.3. Procedure and design

The procedure and design were almost identical to those of Experiment 2. Now, however, the participants were

**Table 1**

Self-assessed ratings (7-point scale) of L1 and L2 proficiency and scores on the past participle test (Experiments 3–5).

Language	Skill	Experiment 3	Experiment 4	Experiment 5
L1 (Dutch)	Writing	6.27 (0.76)	5.73 (1.06)	6.36 (0.78)
	Speaking	6.12 (0.89)	5.93 (1.04)	6.20 (0.88)
	Reading	6.42 (0.79)	6.13 (0.77)	6.56 (0.62)
	General proficiency	6.24 (0.75)	5.80 (0.90)	6.34 (0.64)
L2 (English)	Writing	4.94 (0.90)	4.72 (1.09)	4.93 (1.06)
	Speaking	5.09 (0.80)	5.00 (1.08)	4.86 (1.03)
	General proficiency	5.24 (0.66)	5.09 (0.91)	5.09 (0.77)
	Participle formation test (%)	84 (0.11)	83 (0.11)	81 (0.09)

Note: Standard deviations are indicated in parentheses. L1, native language; L2, second language.

instructed to describe the target pictures in English (their L2). Therefore, the pictures in the study session now showed the Dutch and the English name of the objects and the characters that could appear in the experiment. The participants were told that if they did not know or could not remember the English name of one of the objects or the characters during the experiment, they could use an English synonym or, if necessary, a hyponym (e.g., *man* instead of *judge*). If they could not think of another English word that adequately described the object or the person in question, they were allowed to use the Dutch name of the object.

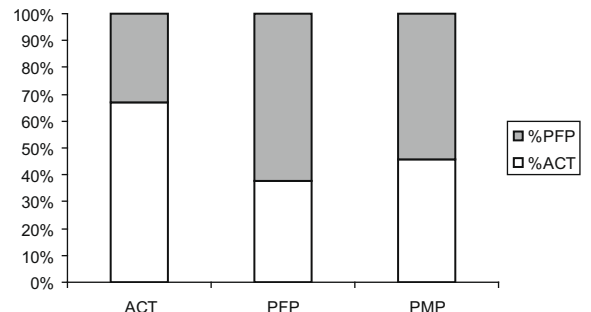
After this experiment and the other two cross-linguistic experiments (Experiments 4 and 5), the participants rated their L1 (Dutch) and L2 (English) proficiency with respect to several skills (reading, writing, speaking, general proficiency) on 7-point scales ranging from *very bad* to *very good* (see Table 1 for the means of the self-ratings of L1 and L2 proficiency for Experiments 3, 4, and 5). Ratings were consistently higher for participants' L1 than for their L2. The ratings for L2 were quite high and very similar in all three experiments, indicating that all participants were highly proficient in English. The participants also completed a test in which they had to write down the past participle for the transitive verbs that had to be used for the description of the experimental items; poor mastery of past participle formation could lead participants to avoid the use of passive sentences. The participants of all three experiments scored quite high on the test (see Table 1), indicating that they were in fact quite familiar with the formation of the past participle.

#### 4.1.4. Scoring

The responses were manually coded as active sentences or PP-final passives. "Short passives", without the agentive prepositional phrase (e.g., *the doctor was killed*), were coded as "Other" responses, as were (ungrammatical) PP-medial or PP-initial responses. If a past participle was morphologically incorrect (e.g., *striked* or *strucked* instead of *struck*, *lift* instead of *lifted*) the response still counted as an allowable response. But if a different verb was used than the verb that appeared on the target picture, the response was coded as "Other".

#### 4.2. Results

Sixty-nine of the 1188 target responses were coded as 'Other' (5.8%). None of these 'Other' responses were PP-



Note: ACT = Active condition, PFP = PP-final passive condition, PMP = PP-medial passive condition

**Fig. 5.** Percentage of actives (ACT) and PP-final passives (FPF) in each condition of Experiment 3.

medial or PP-initial passives. The remaining 1119 target responses were coded either as actives (563, 47.4%) or as PP-final passives (556, 46.8%). The proportions of PP-final passives out of all allowable responses (active + PP-final passive) were calculated for each participant and item and subsequently arcsine-transformed (see Fig. 5).

ANOVAs were run on the proportions of passives with Prime Type (active/PP-final passive/PP-medial passive) as a within-participants and within-items factor. The analyses showed a significant effect of Prime Type on the production of passive sentences [ $F_1(2, 31) = 46.46$ ,  $MSE = 3.72$ ,  $p < .001$ ;  $F_2(2, 34) = 24.15$ ,  $MSE = 3.95$ ,  $p < .001$ ]. Paired  $t$ -tests (two-tailed) on the proportions of passives showed that the proportion of passives was higher in the passive conditions (58.4%, averaged over both passive conditions) than in the active condition (33.8%), yielding a 24.6% priming effect for passives [ $t_1(1, 32) = 7.67$ ,  $MSE = .03$ ,  $p < .001$ ;  $t_2(1, 35) = 6.72$ ,  $MSE = .08$ ,  $p < .001$ ]. The proportion of passives was higher after PP-final passives (63.1%) than after PP-medial passives (53.3%). This 9.8% difference was significant in the analysis by-participants, and marginally significant by-items [ $t_1(1, 32) = 3.78$ ,  $MSE = .05$ ,  $p < .005$ ;  $t_2(1, 35) = 1.87$ ,  $MSE = .10$ ,  $p < .1$ ]. Importantly, the proportion of passives in the PP-medial passive condition (53.3%) differed significantly from the percentage of passives in the active condition (33.8%), resulting in a 19.5% passive priming effect [ $t_1(1, 32) = 6.38$ ,  $MSE = .07$ ,  $p < .001$ ;  $t_2(1, 35) = 4.74$ ,  $MSE = .10$ ,  $p < .001$ ].

### 4.3. Discussion

This experiment showed a clear structural priming effect between actives and passives in Dutch and English. The participants produced more passives after passive primes than after active primes; the proportion of passives in the PP-medial condition was significantly higher than in the active condition, but lower than in the PP-final passive condition. This data pattern is difficult to reconcile with an account in which constituent structure is the only locus of priming: Despite the difference in constituent structure, Dutch PP-medial passive primes elicit English PP-final passives.

These data are compatible with an account according to which there are one or more further loci to priming, such as information structure, functional structure, morphology, or thematic role order. Thus, according to the information structure account, PP-medial passive primes in Dutch elicited (PP-final) passives in English, because PP-final passives and PP-medial passives have patterns of emphasis that are almost identical. The finding that English PP-final passives were slightly more common after Dutch PP-final passives than PP-medial passives most probably results from a component of constituent structure priming (see discussion of Experiment 2).

However, we first need to rule out an alternative account. It is possible that PP-medial passive did not cause any priming and that the percentage of passives in this condition was in fact at baseline level. This possibility is perhaps not very likely given that the percentage of English passives in this experiment (50.1%) was quite high (in Experiment 2, the percentage of Dutch passives was 10% lower), but it could be that the baseline percentage of passives in English as a second language is higher than it is in Dutch. We therefore repeated Experiment 3 while adding a neutral baseline condition. In this condition, no verbs were used in the primes (because any verb has voice). Instead of formulating a full sentence, the confederate simply named the two persons or objects that appeared on the screen (e.g., *the nun and the hippo*). This allowed us to measure the percentage of passives produced in unprimed conditions. Thus, strong evidence for an additional level of priming (such as information structure priming), independent of constituent structure priming, would be obtained if the percentage of passives in the PP-medial condition is higher than in the baseline condition. Such an experiment would also test whether the difference between the effect of PP-medial and PP-final passives was reliable.

## 5. Experiment 4: priming between Dutch (L1) and English (L2) transitives (with baseline)

### 5.1. Method

#### 5.1.1. Participants

Forty-four further students from Ghent University (35 females and 9 males) were paid to take part. They all reported having at least 6 years of experience with English as their second language (mean of 11 years). A female undergraduate student with Dutch as L1 and English as L2 acted as confederate.

### 5.1.2. Materials

The materials were identical to the materials of Experiment 3, except that we added 12 Dutch baseline prime sentences consisting of two conjoined noun phrases (e.g., *de gorilla en de piraat*, meaning “the gorilla and the pirate”); see [Appendices A and B](#). Consequently, we selected 12 additional transitive target pictures (4 animate–animate, 4 inanimate–animate and 4 inanimate–inanimate). We also added 24 target pictures to the description and the verification set of the naïve participant and the description set of the confederate. These pictures were similar to the ones that were used in Experiments 2 and 3, except that no verb was printed. These pictures were added in order to justify the use of conjoined noun phrases in the baseline condition: Both the confederate and the participant used conjoined noun phrases on 24 of the 132 trials.

In sum, there were 132 prime–target pairs in this experiment: 48 experimental prime–target pairs (12 in the baseline condition, 12 in the active condition, 12 in the verb–medial passive condition, and 12 in the verb–final passive condition), and 84 filler pairs. Four counterbalanced pseudo-random lists were constructed so that each target picture occurred once in each condition across the four different lists. In each list 4 baseline primes were combined with a target picture with an animate agent and an animate patient, 4 baseline primes were combined with a target picture with an inanimate agent and an inanimate patient, and 4 baseline primes were combined with a target picture with an animate agent and an inanimate patient.

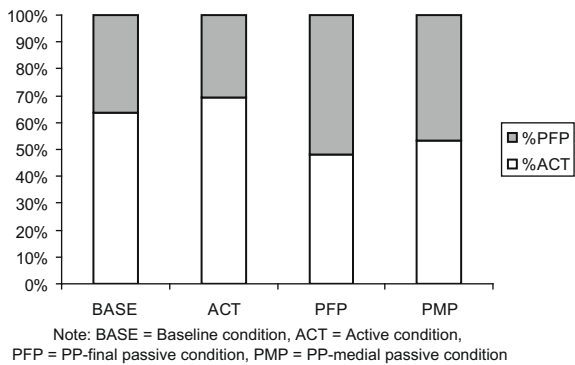
### 5.1.3. Procedure and design

The procedure was identical to that of Experiment 3, except that the participants and the confederate were told that target pictures without a verb had to be described by just naming the persons or the objects in the picture.

### 5.2. Results

One hundred and eighty-nine of the 2112 target responses were coded as ‘Other’ (9.5%). None of these ‘Other’ responses were PP-medial or PP-initial passives. The remaining 1923 target responses were classified either as actives (1125, 53.3%) or as PP-final passives (798, 37.8%). The proportion of passives out of all allowable responses was calculated for each participant and item (see [Fig. 6](#)) and subsequently arcsine-transformed.

ANOVAs were run on these proportions with Prime Type (baseline/active/PP-final passive/PP-medial passive) as a within-participants and within-items factor. The analyses showed an effect of Prime Type on the production of passives [ $F_1(3, 41) = 25.58$ ,  $MSE = 1.98$ ,  $p < .001$ ;  $F_2(3, 45) = 20.70$ ,  $MSE = 2.31$ ,  $p < .001$ ]. Paired  $t$ -tests on the proportions of passive sentences showed that the proportion of passives was lower in the active condition (30.8%) than in the baseline condition (36.2%). This 5.4% difference was significant in the analysis by participants, though not significant in the analysis by items [ $t_1(1, 43) = 2.05$ ,  $MSE = .06$ ,  $p < .05$ ;  $t_2(1, 47) = 1.32$ ,  $MSE = .08$ ,  $p > .1$ ]. The proportion of passives in the PP-final condition (51.9%) was significantly higher than after baseline primes



**Fig. 6.** Percentages of actives (ACT) and PP-final passives (PFP) in each condition of Experiment 4.

(36.2%), yielding a 15.7% effect of syntactic priming [ $t_1$  (1, 43) = 5.78,  $MSE = .06$ ,  $p < .001$ ;  $t_2$  (1, 47) = 6.45,  $MSE = .07$ ,  $p < .001$ ]. Likewise, the proportion of passives after PP-medial passive primes (46.8%) differed significantly from the baseline level, resulting in 10.6% passive priming [ $t_1$  (1, 43) = 4.37,  $MSE = .05$ ,  $p < .001$ ;  $t_2$  (1, 47) = 3.95,  $MSE = .06$ ,  $p < .001$ ]. The difference in the magnitude of cross-linguistic priming caused by PP-final passives (15.7%) and PP-medial passives (10.6%) was very close to significance [ $t_1$  (1, 43) = 1.95,  $MSE = .06$ ,  $p = .058$ ;  $t_2$  (1, 47) = 2.01,  $MSE = .06$ ,  $p = .051$ ].

### 5.3. Discussion

In this experiment, the active prime sentences only caused a marginally significant priming effect. This is not very surprising, because the percentage of passives in the active condition is now compared with the baseline percentage of passives and not with the percentage of passives in conditions where a passive prime is presented. Relative to a neutral baseline, more preferred structures (e.g., actives) exhibit weaker structural priming than less preferred structures (e.g., passives; Bock & Griffin, 2000; see Ferreira & Bock, 2006). Our passive primes, on the other hand, did cause priming: The percentage of passives in the PP-final passive condition was higher than in the baseline condition. Most importantly, the percentage of passives in the PP-medial condition was also higher than in the baseline condition, indicating that PP-medial passives increase the preference for passive target descriptions. As in Experiments 2 and 3, the proportion of passives was higher in the PP-final condition than in the PP-medial condition. Indeed, when the results of Experiments 3 and 4 are combined the difference between the proportions of passives in both conditions is highly significant [ $t_1$  (1, 76) = 3.78,  $MSE = .04$ ,  $p < .001$ ;  $t_2$  (1, 83) = 2.73,  $MSE = .05$ ,  $p < .01$ ].

The results of Experiments 2, 3, and 4 show a consistent pattern: More passives after passive primes than after active primes and more passives after PP-final passives than after PP-medial passives. These data argue for a further locus of priming, in addition to constituent structure, but they do not prove that this further locus is concerned with

the assignment of emphasis to thematic roles: As already noted, this further locus could also be functional structure, morphology, or order of thematic roles.

Our final experiment therefore used Dutch PP-initial passives as primes (*Door de bliksem wordt de kerk getroffen*, 1b). Although the PP-initial passive is less common than the PP-final and the PP-medial passive (Cornelis, 1997, counted 11 PP-initial passives out of over 3000 passives in the Eindhoven Corpus; Uit den Boogaart, 1975), it is natural and fully acceptable to speakers of Dutch (Cornelis, 1997, p. 26). The results of our norming study indicated that perceived emphasis on the agent of the transitive action is stronger in the PP-initial passive than in the PP-medial passive, because it takes the first position in the sentence. On the other hand, the emphasis on the agent is significantly weaker than in active transitives, with which the PP-initial passive shares its order of thematic roles. On the basis of the percentage of passives produced after PP-initial passives, we can determine which additional representation can be primed: Information structure, thematic role order, or functional assignment. If, apart from constituent structure, thematic role order persists between messages, the percentage of English passives in the PP-initial passive condition should lie somewhere between the percentages produced in the active condition and the baseline condition: Neither construction shares constituent structure with the active, but the PP-initial passive and the active have the same order of thematic roles. If functional assignment persists, PP-initial and PP-medial passives should elicit the same number of English passives: They share the same grammatical functions and bindings between thematic roles and grammatical functions, and neither of them can be used in English. Finally, if the assignment of emphasis to thematic roles persists, the percentage of passives in the PP-initial condition should fall midway between the percentages produced in the active and the PP-medial passive condition (cf. Experiment 1).

## 6. Experiment 5: priming between Dutch (L1) and English (L2) transitives

### 6.1. Method

#### 6.1.1. Participants

Forty-four further students from Ghent University (37 females and 7 males) were paid to take part. They all reported having at least 6 years of experience with English as their second language (mean of 13 years). Two males and one female undergraduate student with Dutch as L1 and English as L2 acted as confederates.

#### 6.1.2. Materials

The materials were identical to the materials of Experiment 4, except that in this experiment all PP-final passive primes (1d) were replaced by PP-initial passives (1b), in which the agent, expressed in the prepositional phrase, precedes the patient of the sentence (see Appendices A and B).

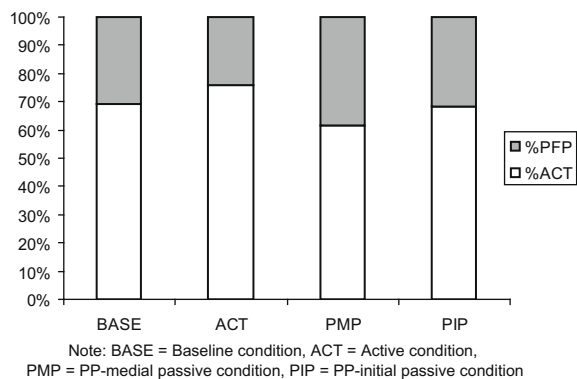


Fig. 7. Percentages of actives (ACT) and PP-final passives (PPF) in each condition of Experiment 5.

### 6.1.3. Procedure and design

The procedure was identical to that of Experiment 4.

## 6.2. Results

Two hundred and eight of the 2112 target responses were coded as 'Other' (9.8%). Three of the 'Other' responses were PP-initial passives (all of which were produced by one participant in the PP-initial passive condition); no PP-medial passives were produced. The remaining 1904 target responses were coded either as actives (1239, 65.1%) or as PP-final passives (665, 34.9%). The proportion of passives out of all allowable responses was calculated for each participant and item and subsequently arcsine-transformed (see Fig. 7). Three items were left out of the analyses: two items were presented in the wrong prime condition in one of the lists and one item (a bug being killed by a flyswatter) elicited 60% 'Other' responses (mainly short passives).

ANOVAs were run on these proportions with Prime Type (baseline/active/PP-initial passive/PP-medial passive) as a within-participants and within-items factor. The analyses showed a main effect of Prime Type on the production of passives [ $F_1(3, 41) = 8.51, MSE = .09, p < .001$ ;  $F_2(3, 42) = 8.66, MSE = .10, p < .001$ ]. Paired  $t$ -tests on the proportion of passive sentences showed that the proportion of passives was lower in the active condition (23.9%) than in the baseline condition (30.9%), resulting in 7% priming for actives [ $t_1(1, 43) = 2.82, MSE = .06, p < .01$ ;  $t_2(1, 44) = 2.69, MSE = .06, p < .05$ ]. The proportion of passives in the PP-medial condition (38.5%) was higher than after baseline primes, yielding a 7.6% effect of syntactic priming [ $t_1(1, 43) = 2.63, MSE = .06, p < .05$ ;  $t_2(1, 44) = 2.04, MSE = .08, p < .05$ ]. However, the proportion of passives after PP-initial passive primes (31.9%) did not differ from the baseline level [ $t_s < 1$ ], so no priming was observed for PP-initial passives. As the percentage of passives in the PP-initial condition was very close to the baseline level, this percentage was lower than in the PP-medial condition [ $t_1(1, 43) = 2.43, MSE = .06, p < .05$ ;  $t_2(1, 44) = 2.04, MSE = .07, p < .05$ ] and higher than in the active condition [ $t_1(1, 43) = 2.79, MSE = .06, p < .01$ ;  $t_2(1, 44) = 3.09, MSE = .06, p < .01$ ].

## 6.3. Discussion

Experiment 5 showed a significant difference between the proportions of passives in the passive conditions: PP-initial passives elicited fewer passives than PP-medial passives did. Additionally, the proportion of passives in the PP-initial passive condition was significantly higher than in the active condition. In fact, the results of this priming experiment perfectly mirror the results of our norming study, which showed significant differences in the perceived information structure of actives, PP-initial passives, and PP-medial passives. The results thus suggest that, apart from constituent structure, the binding between emphasis and thematic roles persists between messages. Because the constituent structure of PP-initial passives matches neither of both constituent structures that can be used in English, the percentage of passives in this condition does not differ from the baseline level. The results cannot be explained by assuming that thematic role order or functional assignment can be primed. In the first case, the proportion of passives in the PP-initial condition should have been significantly lower than in the baseline condition, in the latter case the proportion should have been similar in both passive conditions.

## 7. General discussion

This study investigated whether the binding between emphasis and thematic roles persists across messages. In a first experiment (Experiment 1), we visually presented Dutch transitives in four different structural variants, in order to determine whether and how these structures differ in degree to which they emphasize the agent and the patient of the transitive action. Subsequently, these structures were used as primes in a within-language priming experiment (Experiment 2) and three cross-linguistic priming experiments with Dutch primes and English targets (Experiments 3–5). In Dutch, four different transitive alternatives are available for the formulation of a transitive sentence: actives, PP-initial passives, PP-medial passives, and PP-final passives. The Dutch active and the PP-final passive are structurally equivalent to the English active and the English passive. The PP-medial passive and the PP-initial passive are identical to the English passive in terms of functional assignment (patient = subject, agent = oblique object), but they have a different constituent structure. On the other hand, the PP-initial passive shares its order of thematic roles with the English active. The results of Experiment 1 indicated that the information structure of the PP-initial passive differs from that of the other passives and that of the active transitive: Because the agent expressed in the by-phrase takes the first sentence position, it receives more emphasis than the agents in the other passives, but because it takes the function of oblique object, it receives less emphasis than the agent of the active. Thus, by investigating cross-linguistic priming between Dutch and English transitives we established (a) whether priming occurs between passives with different constituent structures, (b) whether these priming effects are due to information structure persistence.

First, we investigated whether structural priming can be obtained for Dutch transitives (Experiment 2). In this within-language priming experiment with Dutch primes and Dutch targets we showed persistence effects for actives, PP-medial passives, and PP-final passives: All three structures were more frequently produced in primed than in unprimed conditions. No passive priming was obtained between Dutch PP-medial and PP-final passives, suggesting that, apart from constituent structure priming, no higher-order priming effects occur.

However, in our first cross-linguistic experiment (Experiment 3), we showed that structural priming does occur between passives with different constituent structures: The percentage of English PP-final passives increased after Dutch PP-final passives, but also after Dutch PP-medial passives. Experiment 4 replicated these results and showed that the number of English passives after Dutch PP-medial passives is significantly higher than in a baseline condition in which complex noun phrases had to be produced. In both cross-linguistic experiments, more English passives were produced after PP-final passives than after PP-medial passives. Finally, Experiment 5 used PP-medial passive and PP-initial passive primes. Here, we again obtained significant passive priming for PP-medial passives. Importantly, the percentage of English passives after PP-initial passives – which have the same functional assignment as PP-medial passives and the same thematic role order as actives – significantly differed from the percentages observed in the PP-medial passive and the active condition.

The results of our experiments can only be explained by a model according to which there are two loci of structural persistence: constituent structure and information structure. To see this, consider the alternatives. First, the most parsimonious model is of course one in which constituent structure is the *only* level at which priming occurs. This account predicts no priming between passives that have different constituent structures (such as the Dutch PP-medial passive and the English passive). Although the results of Experiment 2 are consistent with that prediction, Experiments 3, 4, and 5 disconfirmed it, because they showed priming between passives with different constituent structures. Second, it is possible that in addition to constituent structure, there is priming at the functional level. This account predicts that PP-initial and PP-medial passives should exert comparable cross-linguistic priming effects, as both have a different constituent structure but the same functional structure as the passive in English. This prediction was ruled out in Experiment 5. Third, it is possible that the additional locus of priming is passive morphology, although as already noted, such an account does not appear consistent with Bock (1989) and Pickering and Branigan (1998). Similar to the functional level account, this predicts comparable effects of the PP-initial and PP-medial passives (which have the same morphology), and this was ruled out in Experiment 5. Fourth, an additional locus of priming could be the order of thematic roles (Chang et al., 2003), although this is difficult to reconcile with Bock and Loebell (1990). This account correctly predicts that PP-initial passives elicit fewer English passives than PP-medial passives do, because PP-medial passives and English pas-

sives share the order Patient–Agent, whereas the PP-initial passive has the order Agent–Patient. However, this account incorrectly predicts that the proportion of passives in the PP-initial condition should be *below* the intransitive baseline. The reason is that neither the baseline nor the PP-initial passive has the same constituent structure as either the active or passive in English, but the PP-initial condition has the same order of thematic roles as the active, and so should elicit more actives than the baseline does.

In contrast, a model according to which information structure persists correctly predicts that there is cross-linguistic priming between the Dutch PP-medial passive and the English passive, despite the difference in constituent structure (Experiments 3, 4, and 5). This is because the information structure of the PP-medial passive (i.e., with emphasis on the patient) does not differ from that of the English passive. The observation from Experiments 2, 3, and 4 that the PP-final passive in Dutch elicited somewhat more passives than the PP-medial passive is most likely due to further priming at the level of constituent structure. Finally, the information structure account correctly predicts that the PP-initial passive elicits fewer passives than the PP-medial passive and more passives than the active (Experiment 5), because the perceived emphasis on the agent of the transitive action differs significantly among these three structures.

As already noted, our findings plead for a re-interpretation of some earlier studies on structural persistence. Chang et al.'s (2003) finding that speakers persisted in the order of “load the truck with boxes” or “load boxes onto the truck” was interpreted as persistence of order of thematic roles; but given the present findings, and the findings of Bock and Loebell (1990), a more likely interpretation is that the information structure of the prime persisted (emphasis on theme or on goal). Likewise, data from Hartsuiker et al. (1999) could reflect information structure priming: These authors showed persistence of the placement of a locative phrase in sentences such as “a bike is in the garden” vs. “in the garden is a bike”. These data might be interpreted in terms of information structure too, with locative-initial sentences placing more emphasis on the location and locative-final sentences emphasizing the theme. As the difference in information structure coincides with a difference in constituent structure, it is, however, impossible to adjudicate between this alternative interpretation of the data and an interpretation in terms of word-order persistence.

An account in terms of information structure priming also offers a straightforward explanation for several other results in the literature. In Hartsuiker, Pickering, and Veltkamp's (2004) cross-linguistic priming experiment between Spanish and English, there was one condition with dislocated actives, which emphasize the patient (“*al camion lo persigue un taxi*”, “to the truck [patient/object] it chases a taxi [agent/subject]”). The data were consistent with an information structure account, with the number of passives after dislocated actives falling in between the baseline and passive conditions (although not significantly different from either). Similarly, Heydel and Murray (2000) found that German topicalizations (e.g., *Den Manager berät ein PR-Mann*, the manager [patient/object]

advice a PR-man [agent/subject]) increased the number of English passive responses in a syntactic priming experiment. In a translation task, however, the same German topicalizations were sometimes translated as actives, and sometimes as passives. Because the agent in the topicalization takes the function of subject and, hence, receives emphasis, this structure might cause weaker passive priming than its passive counterpart (in this case, the PP-medial passive).

Our results show that the binding between emphasis and particular thematic roles is one aspect of information structure that persists across messages. These results extend the findings of Prat-Sala and Branigan (2000) and Ferreira and Yoshita (2003). Prat-Sala and Branigan (2000) showed that speakers produce syntactic structures that allow entities that are emphasized to occur before non-emphasized entities. Ferreira and Yoshita (2003) showed that this ordering effect extends to entities that are conceptually similar to the sentence argument that was emphasized. We showed that such effects extend even further, namely to entities with the same thematic role.

An important issue that our findings raise is which bindings persevere across successive utterances. Our experiments provide evidence in favor of bindings between information structure and thematic roles, but not of functional level bindings (PP-initial, PP-medial and PP-final passive primes with the same functional structure elicited a different number of PP-final passives). But why is this the case? A radical account would have it that speakers do not have a separate level of representation for functional relations (in contrast to theories such as Bock & Levelt, 1994 and Garrett, 1980). On such an account, speakers would begin building a constituent structure for a sentence on the basis of message-level (and/or lexical-level) information, and determine subjecthood as they go along. However, it is also possible that the extent to which a binding is preserved across sentences depends on the scope of this binding. Whether a sentence has a subject and a direct object, or a subject and an oblique object is the internal affair of the mechanisms in charge of producing that one particular sentence; but the degree of emphasis to particular elements in a sentence is part of considerations about the structure of the discourse, because emphasis typically plays a role in the larger discourse. Thus, because emphasis has a supra-sentential scope, bindings involving emphasis tend to be preserved across sentences. More in general, one might argue that in discourse, successive messages are not independent (unless there is a change of topic in a conversation). Because of this, bindings involving aspects of the message (such as conceptual features, Bock et al., 1992) tend to be preserved across sentences.

Finally, our study contributes to a growing body of research that shows structural persistence across languages (see Hartsuiker & Pickering, 2008). Importantly, it is not necessarily straightforward to relate priming effects within and between languages. It was only by studying cross-linguistic priming between Dutch and English transitives that we were able to show that information structure priming can occur in the absence of constituent structure priming, because the use of English as a target language allowed us

to eliminate these priming effects for Dutch PP-medial and PP-initial passives. Thus, cross-linguistic syntactic priming is not only a useful tool to study syntactic and lexical representations in the bilingual memory (Hartsuiker & Pickering, 2008); it can also be used to investigate aspects of syntactic processing in general.

## Acknowledgements

This research was supported by grants from the Fund for Scientific Research Flanders (Belgium) (G.0427.04) and the ESRC (RES-062-23-0376).

## Appendix A

Prime-target pairs in Experiments 2–4 (the primes listed in Appendices A and B were used as stimuli in Experiment 1). On the first line, the target pictures are described in words (e.g., Item 2 corresponds to Fig. 1). For each target the Dutch prime is given for the active condition (a); the passive conditions (b); and the baseline condition (c), for Experiments 3 and 4. The passive form mentioned under (b) has a PP-medial word order. The PP-final word order can be constructed by reversing the order of the second and the last expression between brackets. By reversing the order of the first and the second expression between brackets the PP-initial word order can be obtained. English translations are provided in parentheses. Some baseline items were used for more than one target picture, but never in the same list.

Animate–animate prime-target pairs:

1. sailor chasing boxer
  - a. de politieagent achtervolgt de monnik (the policeman chases the monk)
  - b. [de monnik] wordt [door de politieagent] [achtervolgd](the monk is chased by the policeman)
  - c. boer en matroos (farmer and sailor)
2. pirate chasing boxer
  - a. de politieagent achtervolgt de zwemmer (the policeman chases the swimmer)
  - b. [de zwemmer] wordt [door de politieagent] [achtervolgd](the swimmer is chased by the policeman)
  - c. clown en bal (clown and ball)
3. clown weighing skier
  - a. de dokter weegt de acrobaat (the doctor weighs the acrobat)
  - b. [de acrobaat] wordt [door de dokter] [gewogen](the acrobat is weighed by the doctor)
  - c. dokter en heks (doctor and witch)
4. clown weighing acrobat
  - a. de heks weegt de non (the witch weighs the nun)
  - b. [de non] wordt [door de heks] [gewogen](the nun is weighed by the witch)
  - c. jongen en meisje (boy and girl)

5. pirate chasing skier
    - a. de non achtervolgt de bokser (the nun chases the boxer)
    - b. [de bokser] wordt [door de non] [achtervolgd](the boxer is chased by the nun)
    - c. gorilla en piraat (gorilla and pirate)
  6. judge weighing acrobat
    - a. de duiker weegt de matroos (the diver weighs the sailor)
    - b. [de matroos] wordt [door de duiker] [gewogen](the sailor is weighed by the diver)
    - c. clown en bal (clown and ball)
  7. witch weighing skier
    - a. de non weegt de acrobaat (the nun weighs the acrobat)
    - b. [de acrobaat] wordt [door de non] [gewogen](the acrobat is weighed by the nun)
    - c. dokter en heks (doctor and witch)
  8. judge weighing skier
    - a. de politieagent weegt de monnik (the policeman weighs the monk)
    - b. [de monnik] wordt [door de politieagent] [gewogen](the monk is weighed by the policeman)
    - c. rechter en vleermuis (judge and bat)
  9. Eskimo lifting cricket player
    - a. de piraat tilt de duiker op (the pirate lifts the diver)
    - b. [de duiker] wordt [door de piraat] [opgetild](the diver is lifted by the pirate)
    - c. clown en bal (clown and ball)
  10. diver pulling judge
    - a. de cowboy sleept de clown (the cowboy pulls the clown)
    - b. [de clown] wordt [door de cowboy] [gesleept](the clown is pulled by the cowboy)
    - c. bus en trein (bus and train)
  11. sailor chasing angel
    - a. de politieagent achtervolgt de inbreker (the policeman chases the burglar)
    - b. [de inbreker] wordt [door de politieagent] [achtervolgd](the burglar is chased by the policeman)
    - c. inbreker en draaimolen (burglar and merry-go-round)
  12. sailor chasing skier
    - a. de non achtervolgt de matroos (the nun chases the sailor)
    - b. [de matroos] wordt [door de non] [achtervolgd](the sailor is chased by the nun)
    - c. vogel en matroos (bird and sailor)
- Inanimate–animate prime–target pairs:
1. bicycle running over man
    - a. de taxi rijdt de kleuter aan (the taxi runs over the toddler)
    - b. [de kleuter] wordt [door de taxi] [aangere-den](the toddler is run over by the taxi)
    - c. monnik en inbreker (monk and burglar)
  2. avalanche killing skiers
    - a. de rook doodt de man (the smoke kills the man)
    - b. [de man] wordt [door de rook] [gedood](the man is killed by the smoke)
    - c. dokter en kat (doctor and cat)
  3. truck transporting elephant
    - a. het schip vervoert de passagiers (the ship transports the passengers)
    - b. [de passagiers] worden [door het schip] [vervoerd](the passengers are transported by the ship)
    - c. boot en hond (boat and dog)
  4. arrow hitting bird
    - a. de riek raakt de boer (the fork hits the farmer)
    - b. [de boer] wordt [door de riek] [geraakt](the farmer is hit by the fork)
    - c. boer en matroos (farmer and sailor)
  5. rock hitting boy
    - a. de kogel raakt de inbreker (the bullet hits the burglar)
    - b. [de inbreker] wordt [door de kogel] [geraakt](the burglar is hit by the bullet)
    - c. monnik en inbreker (monk and burglar)
  6. wave hitting swimmer
    - a. het water overspoelt de brandweerman (the water hits the fireman)
    - b. [de brandweerman] wordt [door het water] [overspoeld](the fireman is hit by the water)
    - c. raket en ufo (rocket and UFO)
  7. alarm clock waking boy
    - a. de trompet wekt de soldaat (the trumpet wakes up the soldier)
    - b. [de soldaat] wordt [door de trompet] [gewekt](the soldier is woken by the trumpet)
    - c. jongen en meisje (boy and girl)
  8. ambulance hitting man
    - a. de bus rijdt de fietser aan (the bus runs over the cyclist)
    - b. [de fietser] wordt [door de bus] [aangere-den](the cyclist is run over by the bus)
    - c. bus en trein (bus and train)
  9. tank running over soldier
    - a. de auto overrijdt de hond (the car runs over the dog)
    - b. [de hond] wordt [door de auto] [overreden](the dog is run over by the car)
    - c. bus en trein (bus and train)

10. ball hitting boy
  - a. de pijl raakt de danseres (the arrow hits the dancer)
  - b. [de danseres] wordt [door de pijl] [geraakt](the dancer is hit by the arrow)
  - c. danseres en pijl (dancer and arrow)
11. lightning hitting golf player
  - a. de pijl treft de monnik (the arrow hits the monk)
  - b. [de monnik] wordt [door de pijl] [getroffen](the monk is hit by the arrow)
  - c. dokter en heks (doctor and witch)
12. hurricane lifting girl
  - a. de piraat tilt de cricketspeler op (the pirate lifts the cricket player)
  - b. [de cricketspeler] wordt [door de piraat] [opgetild](the cricket player is lifted by the pirate)
  - c. piraat en zeppelin (pirate and blimp)
7. arrow hitting apple
  - a. de bliksem treft de schuur (lightning strikes the barn)
  - b. [de schuur] wordt [door de bliksem] [getroffen](the barn is struck by lightning)
  - c. jongen en meisje (boy and girl)
8. avalanche destroying house
  - a. de brand vernietigt het flatgebouw (the fire destroys the building)
  - b. [het flatgebouw] wordt [door de brand] [vernietigd](the building is destroyed by the fire)
  - c. piraat en zeppelin (pirate and blimp)
9. magnet attracting coin
  - a. het zwarte gat trekt het ruimteschip aan (the black hole attracts the spaceship)
  - b. [het ruimteschip] wordt [door het zwarte gat] [aangetrokken](the spaceship is attracted by the black hole)
  - c. rechter en vleermuis (judge and bat)

#### Inanimate–inanimate prime-target pairs:

1. tank hitting car
  - a. de raket raakt de ufo (the missile hits the UFO)
  - b. [de ufo] wordt [door de raket] [geraakt](the UFO is hit by the missile)
  - c. de ufo en de raket (the UFO and the missile)
2. torpedo destroying ship
  - a. de kraan vernietigt het gebouw (the crane destroys the building)
  - b. [het gebouw] wordt [door de kraan] [vernietigd](the building is destroyed by the crane)
  - c. monnik en inbreker (monk and burglar)
3. train running over bus
  - a. de vrachtwagen rijdt de auto aan (the truck runs over the car)
  - b. [de auto] wordt [door de vrachtwagen] [aangereiden](the car is run over by the truck)
  - c. gorilla en piraat (gorilla and pirate)
4. truck pulling car
  - a. de boot sleept de vrachtwagen (the boat pulls the truck)
  - b. [de vrachtwagen] wordt [door de boot] [gesleept](the truck is pulled by the boat)
  - c. rechter en vleermuis (judge and bat)
5. missile destroying plane
  - a. de kanonskogel vernietigt het schip (the cannonball destroys the ship)
  - b. [het schip] wordt [door de kanonskogel] [vernietigd](the ship is destroyed by the cannonball)
  - c. postbode en danseres (mailman and dancer)
6. lightning striking church
  - a. de kogel treft het kopje (the bullet hits the cup)
  - b. [het kopje] wordt [door de kogel] [getroffen](the cup is hit by the bullet)
  - c. gorilla en piraat (gorilla and pirate)
10. hurricane demolishing barn
  - a. de brand verwoest het graan (the fire destroys the corn)
  - b. [het graan] wordt [door de brand] [verwoest](the corn is destroyed by the fire)
  - c. postbode en danseres (mailman and dancer)
11. bullet breaking bottle
  - a. het geluid breekt het kopje (the sound breaks the cup)
  - b. [het kopje] wordt [door het geluid] [gebroken](the cup is broken by the sound)
  - c. piraat en zeppelin (pirate and blimp)
12. ball knocking over cans
  - a. de bowlingbal stoot de kegels omver (the bowling ball knocks over the pins)
  - b. [de kegels] worden [door de bowlingbal] [omvergestoten](the pins are knocked over by the bowling ball)
  - c. dokter en kat (doctor and cat)

#### Appendix B

Extra targets Experiments 4 and 5:  
Animate–animate prime-target pairs:

1. cowboy pulling judge
  - a. de takelwagen sleept de bus (the towing car pulls the bus)
  - b. [de bus] wordt [door de takelwagen] [gesleept](the bus is pulled by the towing car)
  - c. postbode en wolf (mailman and wolf)
2. diver pulling clown
  - a. de rechter sleept de olifant (the judge pulls the elephant)
  - b. [de olifant] wordt [door de rechter] [gesleept](the elephant is pulled by the judge)
  - c. rechter en olifant (judge and elephant)

3. clown killing sailor
  - a. het meisje doodt de monnik (the girl kills the monk)
  - b. [de monnik] wordt [door het meisje] [gedood](the monk is killed by the girl)
  - c. monnik en meisje (monk and girl)
4. diver killing doctor
  - a. de boer doodt de ballerina (the farmer kills the dancer)
  - b. [de ballerina] wordt [door de boer] [gedood](the dancer is killed by the farmer)
  - c. ballerina en boer (dancer and farmer)
3. bat hitting ball
  - a. de bom raakt de soldaat (the bomb hits the soldier)
  - b. [de soldaat] wordt [door de bom] [geraakt](the soldier is hit by the bomb)
  - c. bokser en clown (boxer and clown)
4. fire destroying house
  - a. de storm vernietigt het beeld (the storm destroys the statue)
  - b. [het beeld] wordt [door de storm] [vernietigd](the statue is destroyed by the storm)
  - c. vogel en gorilla (bird and gorilla)

#### Inanimate–animate prime–target pairs:

1. shoe hitting bird
  - a. de schoen raakt de vogel (the shoe hits the bird)
  - b. [de vogel] wordt [door de schoen] [geraakt](the bird is hit by the shoe)
  - c. hond en acrobaat (dog and acrobat)
2. arrow hitting knight
  - a. de harpoen raakt de duiker (the harpoon hits the diver)
  - b. [de duiker] wordt [door de harpoen] [geraakt](the diver is hit by the harpoon)
  - c. dokter en duiker (doctor and diver)
3. flyswatter killing fly
  - a. de bom doodt de jongen (the bomb kills the boy)
  - b. [de jongen] wordt [door de bom] [gedood](the boy is killed by the bomb)
  - c. jongen en soldaat (boy and soldier)
4. lightning striking gorilla
  - a. de baseballbat raakt de politieagent (the baseball bat hits the policeman)
  - b. [de politieagent] wordt [door de baseballbat] [geraakt](the policeman is hit by the baseball bat)
  - c. politieagent en verpleegster (policeman and nurse)

#### Inanimate–inanimate prime–target pairs:

1. bicycle pulling chart
  - a. de takelwagen sleept de bus (the towing car pulls the bus)
  - b. [de bus] wordt [door de vrachtwagen] [gesleept](the bus is pulled by the towing car)
  - c. draak en matroos (dragon and sailor)
2. rock breaking window
  - a. de bal breekt de vaas (the ball breaks the vase)
  - b. [de vaas] wordt [door de bal] [gebroken](the vase is broken by the ball)
  - c. zeppelin en spook (blimp and ghost)

#### References

- Bernolet, S., Hartsuiker, R. J., & Pickering, M. J. (2007). Shared syntactic representations in bilinguals: Evidence for the role of word-order repetition. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, 33, 931–949.
- Bock, J. K. (1977). The effect of a pragmatic presupposition on syntactic structure in question answering. *Journal of Verbal Learning and Verbal Behavior*, 16, 723–734.
- Bock, J. K. (1986). Syntactic persistence in language production. *Cognitive Psychology*, 18, 355–387.
- Bock, J. K. (1989). Closed-class immanence in sentence production. *Cognition*, 31, 163–186.
- Bock, K., & Griffin, Z. M. (2000). The persistence of structural priming: Transient activation or implicit learning? *Journal of Experimental Psychology: General*, 129, 177–192.
- Bock, K., & Levelt, W. J. (1994). Language production. Grammatical encoding. In M. A. Gernsbacher (Ed.), *Handbook of psycholinguistics* (pp. 945–984). San Diego: Academic Press.
- Bock, K., & Loebell, H. (1990). Framing sentences. *Cognition*, 35, 1–39.
- Bock, K., Loebell, H., & Morey, R. (1992). From conceptual roles to structural relations: Bridging the syntactic cleft. *Psychological Review*, 99, 150–171.
- Branigan, H. P., Pickering, M. J., & Cleland, A. A. (2000). Syntactic co-ordination in dialogue. *Cognition*, 75, B13–B25.
- Brennan, S. E., & Clark, H. H. (1996). Conceptual pacts and lexical choice in conversation. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, 22, 1482–1493.
- Büring, D. (2007). Intonation, semantics and information structure. In G. Ramchand & C. Reiss (Eds.), *The Oxford handbook of linguistic interfaces*. Oxford: Oxford University Press.
- Chang, F., Bock, K., & Goldberg, A. E. (2003). Can thematic roles leave traces of their places? *Cognition*, 90, 29–49.
- Christianson, K., & Ferreira, F. (2005). Conceptual accessibility and sentence production in a free word order language (Odawa). *Cognition*, 98, 105–135.
- Cleland, A. A., & Pickering, M. J. (2003). The use of lexical and syntactic information in language production: Evidence from the priming of noun–phrase structure. *Journal of Memory and Language*, 49, 214–230.
- Cornelis, L. H. (1997). *Passive and perspective*. Utrecht: Utrecht Studies in Language and Communication.
- Cowles, H. W., Kluender, R., Kutas, M., & Polinsky, M. (2007). Violations of information structure: An electrophysiological study of answers to wh-questions. *Brain and Language*, 102, 228–242.
- Ferreira, V. S. (2003). The persistence of optional complementizer production: Why saying “that” is not saying “that” at all. *Journal of Memory and Language*, 48, 379–398.
- Ferreira, V. S., & Bock, K. (2006). The functions of structural priming. *Language and Cognitive Processes*, 21, 1011–1029.
- Ferreira, V. S., & Yoshita, H. (2003). Given–new ordering effects on the production of scrambled sentences in Chinese. *Journal of Psycholinguistic Research*, 32, 669–692.
- Féry, C. (2008). Information structural notions and the fallacy of invariant correlates. *Acta Linguistica Hungarica*, 55, 361–379.
- Fillmore, C. J. (1977). The case for case reopened. In P. Cole & J. M. Sadock (Eds.), *Syntax and semantics. Grammatical relations* (Vol. 8, pp. 59–81). New York: Academic Press.
- Garrett, M. F. (1980). Levels of processing in sentence production. In B. Butterworth (Ed.), *Language Production* (Vol. 1). Orlando, FL: Academic Press.

- Griffin, Z. M., & Weinstein-Tull, J. (2003). Conceptual structure modulates structural priming in the production of complex sentences. *Journal of Memory and Language*, 49, 537–555.
- Hartsuiker, R. J., Bernolet, S., Schoonbaert, S., Speybroeck, S., & Vanderelst, D. (2008). Syntactic priming persists while the lexical boost decays: Evidence from written and spoken dialogue. *Journal of Memory and Language*, 58, 214–238.
- Hartsuiker, R. J., & Kolk, H. H. J. (1998). Syntactic persistence in Dutch. *Language and Speech*, 41, 143–184.
- Hartsuiker, R. J., Kolk, H. H. J., & Huiskamp, P. (1999). Priming word order in sentence production. *Quarterly Journal of Experimental Psychology*, 52A, 129–147.
- Hartsuiker, R. J., & Pickering, M. J. (2008). Language integration in bilingual sentence production. *Acta Psychologica*, 128, 479–489.
- Hartsuiker, R. J., Pickering, M. J., & Veltkamp, E. (2004). Is syntax separate or shared between languages? Cross-linguistic syntactic priming in Spanish–English bilinguals. *Psychological Science*, 15, 409–414.
- Hartsuiker, R. J., & Westenberg, C. (2000). Word order priming in written and spoken sentence production. *Cognition*, 75, B27–B39.
- Heydel, M., & Murray, W. S. (2000). Conceptual effects in sentence priming: A crosslinguistic perspective. In M. de Vincenzi & V. Lombardo (Eds.), *Cross-linguistic perspectives on language processing* (pp. 227–254). Dordrecht: Kluwer.
- Levelt, W. J. M. (1989). *Speaking: From intention to articulation*. Cambridge, MA: MIT Press.
- MacWhinney, B. (1977). Starting points. *Language*, 53, 152–168.
- Osgood, C. E. (1971). Where do sentences come from? In D. Steinberg & L. Jakobovits (Eds.), *Semantics: An interdisciplinary reader in philosophy, linguistics and psychology*. Cambridge: Cambridge University Press.
- Pardo, J. S. (2006). On phonetic convergence during conversational interaction. *Journal of the Acoustical Society of America*, 119, 2382–2393.
- Pickering, M. J., & Branigan, H. P. (1998). The representation of verbs: Evidence from syntactic priming in language production. *Journal of Memory and Language*, 39, 633–651.
- Pickering, M. J., Branigan, H. P., & McLean, J. F. (2002). Constituent structure is formulated in one stage. *Journal of Memory and Language*, 46, 586–605.
- Pickering, M. J., & Ferreira, V. S. (2008). Structural priming: A critical review. *Psychological Bulletin*, 134, 427–459.
- Pickering, M. J., & Garrod, S. (2004). Toward a mechanistic psychology of dialogue. *Behavioral and Brain Sciences*, 27, 169–225.
- Potter, M. C., & Lombardi, L. (1998). Syntactic priming in immediate recall of sentences. *Journal of Memory and Language*, 38, 265–282.
- Prat-Sala, M., & Branigan, H. (2000). Discourse constraints on syntactic processing in language production: A cross-linguistic study in English and Spanish. *Journal of Memory and Language*, 42, 168–182.
- Reinhart, T. (1982). Pragmatics and linguistics: An analysis of sentence topic. *Philosophica*, 27, 53–94.
- Salamoura, A., & Williams, J. N. (2007). Processing verb argument structure across languages: Evidence for shared representations in the bilingual lexicon. *Applied Psycholinguistics*, 28, 627–660.
- Schoonbaert, S., Hartsuiker, R. J., & Pickering, M. J. (2007). The representation of lexical and syntactic information in bilinguals: Evidence from syntactic priming. *Journal of Memory and Language*, 56, 153–171.
- Tannenbaum, P. H., & Williams, F. (1968). Generation of active and passive sentences as a function of subject and object focus. *Journal of Verbal Learning and Verbal Behavior*, 7, 246–250.
- Uit den Boogaart, P. C. (1975). *Woordfrequenties in geschreven en gesproken Nederlands*. Utrecht: Oosthoek, Scheltema & Holkema.
- Vallduví, E. (1992). *The information component*. New York: Garland.
- Watson, M., Pickering, M. J., & Branigan, H. P. (2004). Alignment of reference frames in dialogue. In *Proceedings of the 26th annual conference of the cognitive science society*. Mahwah, NJ: Erlbaum.