

# **Auxiliary influences on argument- verb integration in Dutch**

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## I. Abstract

Passive sentences are structurally different from active sentences. In Dutch, passives are expressed with the auxiliaries *zijn* (to be) and *worden* (to be[come]), whereas transitive active sentences most often use *hebben* (to have) in the perfect. In this thesis, I seek to find out what the influence is of these auxiliaries on sentence processing, and more specifically, argument-verb integration. The subject of transitive active sentences is an external argument, whereas the subject of passives is an internal argument. How does this influence the integration of the subject with the verb? Audio test sentences were created for a visual world paradigm experiment in which only the auxiliary altered. For every argument, four visual objects were collected of which one (the target) was semantically related to the sentence argument, and three others (the distracters) were not related. These four visual objects were all shown in one display. In a visual world experiment participants were presented with spoken sentences while they sat in front of a desktop that showed the display with four visual objects. I tracked participant's eyes to measure eye movements to the target image. I analyzed the data using growth curve analyses on the difference in looks to the target between test and control conditions. The results show that in all conditions there is simultaneous reactivation of the argument right after the verb. However, for *worden*, there is a late second reactivation of the argument 1300 ms after verb offset. I attribute this second reactivation to the eventivity of *worden*, which reflects an agent position in the semantic structure that is not present in the stative passive *was*.

## *II. Acknowledgements*

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## 1. Introduction

### 1.1 Actives and passives

Actives and passives differ structurally. In transitive active sentences, the argument that appears in subject position is an external argument, whereas in passive sentences the argument that appears in subject position is an internal argument. In this thesis my starting point is the analysis of passivization in Chomsky (1981). Informally passive sentences (2) can be formed from active sentences (1). Passive sentences have a corresponding active counterpart. This active counterpart reflects the underlying structure from which you can derive the passive sentence (Wekker & Haegeman, 1985). To form a passive, the object in an active sentence is promoted to the subject position. To illustrate, in (1) the NP *het meisje* (the girl) is the object, but in the passive counterpart in (2) it is the subject.

Active voice:

1. *De jongen knuffelt het meisje.*

The boy hugs the girl.

Passive voice:

2. *Het meisje is geknuffeld (door de jongen).*

The girl is hugged (by the boy).

Interestingly, the thematic relations assigned to the arguments by the verb stay the same. In (1), *knuffelt* assigns the AGENT relation to *de jongen*, and the PATIENT relation to *het meisje*. In (2), *geknuffeld* does exactly the same, even though the two arguments have swapped syntactic positions. We can conclude there is a semantic parallelism between the two sentences, yet in a passive there is no obligation to express the AGENT. Concomitantly with the promotion of the object to the subject position, the AGENT (and original subject) can no longer be expressed in a NP in an A-position. For example, in (2), the original verb's agent is no longer expressed and expression of the AGENT is optional in an adjunct PP, or *by*-phrase. Furthermore, the passive requires an auxiliary, whereas the verb is realized in participial form.

In their passive form verbs do not assign an external theta role to the argument in the subject position, nor accusative Case to their object. In order to receive Case, the object is moved to the subject position. The underlying structure of the active (3) and passive (4) sentences in (1) and (2) is portrayed below.

3. [<sub>IP</sub> [<sub>NP</sub> De jongen] [<sub>I'</sub> knuffelt [<sub>NP</sub> het meisje]]]

4. [<sub>IP</sub> [<sub>NP</sub> Het meisje<sub>i</sub>] [<sub>I'</sub> is [<sub>VP</sub> geknuffeld [<sub>e<sub>i</sub></sub>] door de jongen]]]

The effect of this structural shift on processing has been studied extensively. Olson and Filby (1972) showed that when judging truthfulness of statements that were either put in active or passive voice, it took participants longer to verify passive sentences. They used picture verification and cross-combined four types of events (a car hitting a truck going left or right, and a truck hitting a car going left or right) with four types of sentences (“The truck hit the car” and vice versa, and “The car was hit by the truck” and vice versa). Either a picture of the car or the truck preceded the picture, thereby creating a point of view for the participants. This way, half of the conditions were false and half were true, and half of the conditions were perceived from the agent’s point of view, and half from the patient’s point of view. Regardless of whether the condition was true, participants always took longer verifying passive sentences. Generally, participants also took longer verifying false sentences. However, Olson and Filby showed that in the set of agent-point of view passives, false items took *less* time to verify than true items. This means that passive sentences are not firstly recoded into an active word order and judged subsequently, otherwise the true item should be judged more quickly, as in the active condition. This leaves the question, why then do passives take longer to process, if it is not the process of recoding to the underlying active structure.

I suspect it is the process of integrating the argument with the verb that is more difficult in passives and therefore causes a processing delay for readers/listeners. This integration represents the assigning of thematic relations, the semantic incorporation, and in a sense a test that indicates the fit of the verb in the given semantic context. After every word a listener has more information that has to be incorporated with the previously given information, thereby reducing the amount of possible meanings of the utterance. Certain points in the sentence involve crucial

information, such as the arguments and the (main) verb. Returning to (2), repeated below, I will explain the active integration that takes place when a reader/listener processes a passive<sup>1</sup>, following Pritchett's (1988, 1991) projection principle. This principle states that a node is not projected until the reader/listener has arrived at its head. The reason for this is that the relevant semantic information that determines the node's type, i.e. whether it is a VP or an IP, is not yet available to the reader/listener. At the start of a sentence, The CP node is projected into which each newly occurring element is integrated. I will illustrate this process with a step-by-step analysis of (2) repeated below.

2. *Het meisje is geknuffeld (door de jongen).*

The girl is hugged (by the boy).

Firstly, *het meisje* is encountered in the input string, and identified as a noun (N) as its head. That is to say, the subject is identified as an argument, and at this point it is most likely that this argument will be the external argument, but it is not implausible that this assumption will be refuted. The N head projects an NP/DP node, [NP[N'[N *het meisje*]]]. At this point, no theta-roles can be assigned since no theta-role assigned has been encountered. Subsequently, the first verb, *is*, adds to the likelihood that *het meisje* is the external argument. At this point the reader/listener does not know that *is* is actually the auxiliary. All that is known is that an inflectional element has occurred, that projects an IP node. The syntactic structure that incorporates *is* will look like this: [IP[NP[N'[N *het meisje*]]][I'[I *is*]]. We can observe that *het meisje* has taken the SPEC-IP position to satisfy the NP *het meisje*, which requires Case and the tensed Inflection on the IP node, which can give (external) Case. However, immediately at *geknuffeld*, the readers/listener will know that because of the passive participle form this sentence is a passive, and that *is* was an auxiliary. *Geknuffeld*, being a passive participle, assigns an internal theta-role but no Case. The reader/listener needs to re-assign the verbal-head position to *geknuffeld*, and fit *is* into an auxiliary position. The position of the verb *zijn* ('to be') in I licences *geknuffeld* to project a VP, resulting in a syntactic structure that looks like this: [N'[NP[N'[N *het meisje*]]]I[,I *is*][VP[V'[V *geknuffeld*][NP *e<sub>i</sub>*]]]]. The internal theta-role is

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<sup>1</sup> The production process of a speaker/writer is different from the deduction process of a reader/listener. I will only address the deduction process, since this is what I will be testing in my experiment.

re-assigned to *het meisje*. Case is now satisfied as well as the theta-criterion. At this point, the verb needs to assign its thematic relations. *Knuffelen* ('to hug') has an AGENT and PATIENT relation to assign, and given that the reader/listener knows that the sentence is passive, he/she will have to assign the PATIENT relation to *het meisje*. Furthermore, the reader/listener can now semantically check the situation described by the utterance against the real world: a girl is being hugged. He/she checks the plausibility and the truth of the utterance and integrates it with his/her additional knowledge.

As you can see, the position at which argument-verb integration takes place here is right after the main verb. However, before the main verb is uttered, the reader/listener has assigned external Case to the subject, which needs to be reassigned, or reanalyzed, to receive internal Case (Pritchett, 1991). At this point, the reader/listener is likely to mistake the subject for the AGENT, and therefore requires some type of reanalysis of the syntactic structure at the main verb. This could cause processing delays.

It has been shown that the process of argument-verb integration is not straightforward in passives. Osterhout and Swinney (1993) found significant differences in response times between prime words that were related to the argument of the passive verb (associate) and prime words that were not related to the argument of the passive verb (control). Sentences such as (5), which are active, and (6), passive, were presented to participants aurally, whilst at particular points after verb offset, participants were presented with a prime visually. In this case, the prime was a related or non-related word that shortly appeared on the screen.

5. The dentist from the new medical centre in town invited the actress to go to the party.
6. The dentist from the new medical centre in town was invited (t)<sup>2</sup> by the actress to go to the party.

In these examples, the related prime would have been 'tooth'. Participants were asked to judge the existence of the target word as rapidly as possible after exposure by pressing either a *word* or *nonword* button. Response times were measured for

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<sup>2</sup> NP-trace



both associated prime words, such as dentist-tooth, and control prime-words such as dentist-flood. They found a significant difference between reactions to the associate and control primes at 1000 ms after verb offset in passive sentences; associate primes were judged 46 ms faster than control primes. However, they found no significant effect at earlier primes at 500 ms after verb offset and immediately after verb offset. Osterhout and Swinney conclude that these findings suggest that argument-verb integration in passives is a more complicated process than they would predict based on Government and Binding theory (Chomsky, 1981), since these theories would predict that reactivation immediately follows the verb due to the trace in the canonical position of the object. That is to say, in the underlying structure of a passive the internal argument originates from the object position, and Osterhout and Sinney's theory would predict reactivation of the argument in its origin. Since the reactivation is located late after verb offset, Osterhout and Swinney conclude that it must be a process more complicated than underlying-argument origin reactivation. The object in active sentences followed the verb, and was not primed for. However, they found no significant difference between associate or control primes with the subject in the active sentences. This finding suggests that the passive is not processed as a modified active, but that argument-verb integration in actives and passives is a different process altogether.

Previous experiments that research language processing confirm or reject theories on the syntactic structure of the differences between actives and passives. When processing a sentence, there are certain points in the sentence where new information, posited by new words, is integrated with the already present information, enabling the reader/listener to construct a part of the sentence structure. Since I am interested in differences in argument-verb integration in active and passive sentences, it is important to know where exactly this takes place. It appears that in English passives, argument-verb integration occurs during the second after verb-offset. Dutch passives are not a direct translation; hence it is possible, although not likely that the timing of the argument-verb integration is different. I can base my hypothesis on the previous research regarding English, once I have confirmed the structural similarities between the two.

## 1.2 Worden and zijn

In Dutch, there are two main auxiliaries available to form a passive<sup>3</sup>. There is an important difference in use and meaning between the auxiliaries *worden* and *zijn*. However, there is unfortunately no clear parallel with English auxiliaries to show the difference in meaning between the two. Partly because in English both can be translated using the auxiliary *be* (7, 8), but both can also, in combination with different verbs, be translated using the paraphrase *have been* (9, 10).

7. De vloer wordt elke morgen gepoetst.  
The floor is [+INCH] polished every morning.
8. *De vloer is elke morgen gepoetst.*  
The floor is [+PERF] polished every morning.
9. *De oude liederen werden allemaal gezongen.*  
The old hymns have all been [+INCH] sung.
10. *De oude liederen waren allemaal gezongen.*  
The old hymns had all been [+PERF] sung.

In order to describe detailed differences between these two types of passives, I need to deviate from the basic Government and Binding framework (Chomsky, 1981) of passives. Embick (2004) uses Distributed Morphology, a framework that investigates the syntax-morphology interface, to identify syntactic structures that represent the differences between *worden* and *zijn*, among others. Although it is somewhat

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<sup>3</sup> Multiple other verbs, in their auxiliary form, are associated with the passive: *krijgen* ('to get'), which forms indirect object passives (i), or with the semi-passive: *staan* ('to stand'), which roughly translates as 'it says' in this use (ii).

- i. *Ze kreeg een leuke baan aangeboden.*  
She got a nice job offered.  
"She got offered a nice job."
- ii. *Het stond niet op de voorpagina vermeld.*  
It stood not on the front page mentioned.  
"It was not mentioned on the front page."

I will not discuss *krijgen* in this thesis, as it is uncommon in the form of an auxiliary; only 1% of all auxiliaries used in the Eindhoven Corpus were a form of *krijgen* (Verhagen, 1992). I will also not discuss any semi-passive, as its behavior is too restricted for the purpose of my experiment. I will, however, include both *worden* and *zijn* in my experiment, because although *was* has multiple uses and could therefore be said to be less of a passive, I want to find out the exact differences between the two. (Bron: den Boogaart, P.C. (Ed). (1975) *Woordfrequenties in geschreven en gesproken Nederlands*. Utrecht, Scheltema & Holkema.)

removed from the GB framework, it has very accurate predictions on the behavior of eventive and stative passives – which is what I am interested in in this paper.

There are two ways to look at the difference between *worden* and *zijn*: semantically and syntactically. Firstly, there is a semantic difference in point of view. *Worden* (11) creates a point of view where the reference time (point in time from which the event is described) and the event time (time at which the event described takes place) are the same, making it an eventive passive (Embick, 2004). On the other hand, *zijn* (12) creates a point of view where the reference time is placed after the event has occurred, therefore creating a gap between the reference time and the event time, making it a stative passive (Embick, 2004).

11. *We werden ingesloten.* (Eventive)

We were surrounded / ?We became surrounded.

12. *We waren ingesloten.* (Stative)

We had been surrounded.

Interestingly, Embick (2004) noted a subtle distinction within the English passive auxiliary *be*. (13) can be interpreted in two ways, as an eventive passive (13a) and a resultative (13b).

13. The door was opened.

a. *Someone* opened the door. (Eventive)

b. The door was in a state of having become open. (Resultative)

(requires state resulting from an event)

14. The door was open. (Stative)

Embick's resultative passive is slightly different from the stative passive (14). The resultative is marked by a verbalizing v head, meaning the '-ed' inflection on 'open', whereas the stative does not. This inflection creates a referent to a previous event, which adds the additional reading of the door being opened. Now, we can see why these passives are difficult to translate to Dutch. In Dutch, our eventive passive is expressed solely by the auxiliary *worden* (15). The auxiliary *zijn* is able to formulate both the resultative (16a) and the stative passive (16b).

15. *De deur werd geopend.*

The door was being opened.

- a. **Someone** opened the door. (Eventive)

16. *De deur was geopend.*

The door was open(ed).

- a. The door was in a state of having become open. (Resultative)  
b. The door was open. (Stative)

Embick claims that the resultative cannot be combined with a by-phrase as it erases the 'in a state of having become'-reading. By adding the by-phrase, he claims the reading shifts from resultative (17) to eventive (18).

17. The metal is hammered.

The metal was in a state of being flat. (Resultative)

18. The metal is hammered by John.

The metal is being hammered flat by John. (Eventive)

19. *Het metaal wordt platgeslagen.*

The metal is being hammered. (Eventive)

20. *Het metaal is platgeslagen.*

The metal has been flattened. (Stative) (?Resultative)

21. *Het metaal wordt platgeslagen door Jan.*

The metal is being hammered flat by John. (Eventive)

22. *Het platgeslagen metaal...*

A metal in a state of being hammered flat. (Resultative)

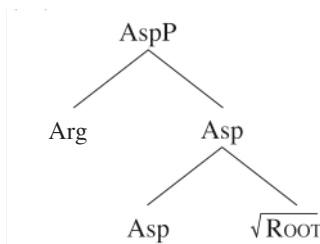
As you can see, this is also the case in Dutch, but we use a different auxiliary to express one type of passive. The auxiliary *worden* is used to express the eventive (19), and another auxiliary is used to express the stative passive (20). Adding a by-phrase (21) to the *worden* sentence is grammatical and does not influence the eventivity. Although it is possible to interpret *zijn* sentences as resultative, it is more common to use the deadjectival form (22) to express resultativity.

The semantic difference between *worden* and *zijn* resides in the clear sense of the presence of an external causer (Cornelis, 1996; Verhagen, 1992) when the auxiliary *worden* is used, but not when *zijn* is used. When using *worden* (21), the sentence

“implies that the producer of the resultant state described by the participle is external” (Verhagen, 1992: p. 316), creating a process interpretation. On the other hand, *zijn* (22) creates a state reading, and the sentence is just a description of the state of the sentence’s subject.

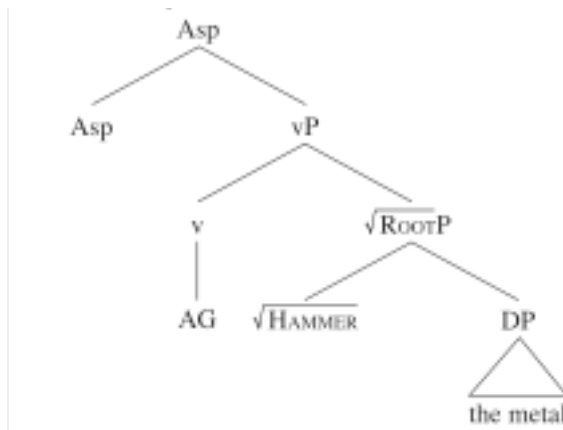
This has to be represented in the syntactic structure. I can draw a straight parallel between the syntactic structures Embick proposes for English passives and the ones that I seek for Dutch. According to Embick (2004), we must take into account the following: syntactically, identical surface forms result from underspecification. That is to say, for resultative, eventive, stative passives and the perfect, each structure includes an Asp head into which the phonological inflection is expressed (-ed etc.). The most important observation from Embick in the Distributed Morphology framework is that in passives, the head of a VP (*v*) denotes agentivity and eventivity. Depending on where the Asp head is attached (above or below) to the rest of the sentence, or ROOTP (Embick, 2004), *v* is expressed or not, respectively. Without *v*, it is impossible for the sentence to express agentivity or eventivity. In (23), we can observe that here, the Asp-head is attached to the ROOTP, which in this case means non-inflected main verb (‘open’).

### 23. Stative passive



For the eventive passive, Embick proposes a structure where the external causer interpretation, such as in (18), is reflected in *v* by the feature AG (24). This is interesting because often in passives, the AGENT is not overtly expressed, and when expressed it only appears in a *by* phrase. The fact that it is expressed in the structure means that there is an agentive interpretation associated with the eventive (Embick, 2004). The same interpretive effect is captured by the existential closure of the agent role of the lexical entry (Reinhart, 2002).

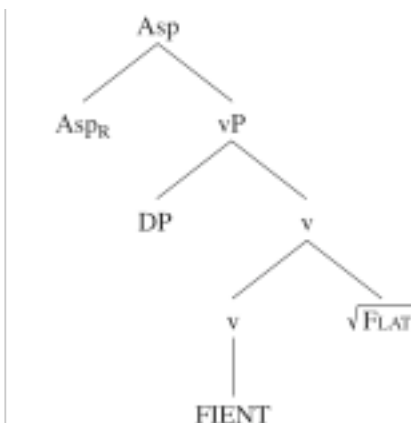
## 24. Eventive passive



Following Embick, in Dutch we can conclude that distinguishing stative passives from eventive passives is done by the AG feature in *v*, an element that indicates a difference in prominence of the AGENT. In English, this is a minor distinction made by the inflection on the verb, whereas in Dutch it is expressed by a separate auxiliary.

Evidently, the resultative should sit somewhere in between these two structures. Embick argues that the required element to distinguish resultatives from statives is the feature ‘fientive’, [FIENT], a feature that expresses “a becoming – or perhaps better, transition event – that moves toward a state” (Embick, 2004: p. 366). It is similar to inchoative aspect or a BECOME-operator, but according to Embick it is not intended to define this feature in terms of telicity – that is to say, he does not want to constrain the verb’s interpretation to the start or end of the action. This feature is expressed in *vP* (25) instead of AG.

## 25. Resultative passive



Interestingly, the absence of the AGENT relation with the verb is reflected in the impossibility for a *by*-phrase to be expressed in a resultative.

*Zijn* is compatible with more verbs than *worden*, due to the lacking of an external causer. In short, *worden* in a sense creates the coming into a state through actions of an external causer, whereas *zijn* combined with a past participle describes the resultant state, from the subject's point of view. Syntactically, this is represented by the element AG in *v*, indicating the 'agentive interpretation' characteristic of *worden* sentences.

The question remains how this is reflected in the sentence processing of a reader/listener. From the syntactic structure alone I cannot with certainty know when the assigning of the thematic roles begins. The reader/listener could already create an AGENT position after the utterance of the auxiliary *worden*, but perhaps this does not take place until the main verb. I need an experimental method with which I can search for the point of argument-verb integration.

### **1.3 Psycholinguistic research**

In order to establish when integration of the verb and the argument takes place, I must find evidence of this process in on-line<sup>4</sup> sentence computation. I will now discuss methods used in similar studies to evaluate which is most fitting for my experiment.

#### **1.3.1 Priming**

Previous literature has indicated that the active/passive distinction leads to differences in argument-verb integration (Osterhout & Swinney, 1993). It is yet to be established that the structural difference between stative and eventive passives also leads to a processing difference. Ideally, there would be a unifying account that explains differences between actives and passives, as well as the likely differences taking place between *worden* and *zijn*. However, it could also be the case that two different processes occur altogether. To detect subject reactivation in the region following the verb, Osterhout and Swinney (1993) used priming, a method where

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<sup>4</sup> On-line measurements are taken in an experiment if the data is subtracted whilst the participants are actively computing language. On the contrary, off-line data is collected by means of taking measurements or asking questions following the relevant language use.

related (associate) and unrelated (control) prime words appear visually during aurally presented sentences. The participants were asked to judge whether these primes were real words or non-words.

Similarly, Friedmann et al. (2008) used this method to investigate reaction times to lexical primes in unaccusative (26) and unergative (27) sentences. It is interesting for me to look at studies about unaccusatives, because like passives, the syntactic subject is the semantic *THEME*, originating in an internal argument position. For example, *breken* (to break) is an unaccusative verb, taking the semantic *THEME* as its subject. On the other hand, *rennen* (to run) is an unergative verb: 'the man' is the *AGENT* of the verb 'ran'.

26. *De vaas was gebroken.*

The vase was broken.

27. *De man had gerend.*

The man ran.

Unaccusatives are lexically intransitive verbs without a (semantically or syntactically) active *AGENT* whereas in the case of canonical passives at least semantically the *AGENT* role is active (Reinhart 2002). Still, the similarity between passives and unaccusatives could stretch as far as verb-argument integration, because in unaccusatives it is also the internal argument that has to be integrated with the verb.

Friedmann et al. (2008) studied the difference in subject reactivation in unergative and unaccusative sentences. Unergative sentences such as (28) and unaccusative sentences such as (29) were presented to participants over headphones whilst they were looking at a screen.

28. The surgeon<sub>p1</sub> with a brown felt fedora hat and matching coat eagerly smiled<sub>p2</sub> when the beautiful<sub>p3</sub> actress walked down the corridor to exam room three.

29. The runner<sub>p1</sub> with the funny accent and humble attitude unfortunately disappeared<sub>p2</sub> when the important<sub>p3</sub> scout arrived at the gymnasium.

At the indicated probe points, a letter string appeared on the screen, which the participants were asked to judge as being a *word* or *nonword*. Friedmann et al.



(2008) found no reactivation at point two and three for unergative verbs, however, for unaccusative verbs they found reactivation of the argument at point 3. This indicates that the integration process triggered by the verb does not take place immediately at verb offset, but about 750ms later. This is an indication that integration of the internal argument with the verb is a demanding process; otherwise the argument would have been reactivated faster after verb offset.

As we can see, similar results are achieved within this method for unaccusative and passive sentences. Like Osterhout and Swinney (1993), Friedmann et al. (2008) found reactivation of the argument some time after verb offset for passive sentences and unaccusative sentences respectively. Nevertheless, it is worth noting that priming methodology creates an indirect measure, i.e. due to the interference of the judgement (the lexical decision) that has to be made by the participants, priming experiments represent the online processing less precisely. When we take away the overt lexical decision task, and replace this with implicit eye-movement measures, we minimize the extra processing required for overt decision-making. This is made possible in the Visual World Paradigm.

### **1.3.2 Visual World Paradigm**

In this experimental paradigm, eye movements are continuously measured whilst participants can be presented with all kinds of visual stimuli. Participants are presented with these stimuli whilst listening to spoken language, possibly related to some of the visual input. It has been frequently demonstrated that humans instinctively look at relevant and related things, which is not only taught to us in school but is also how we express ourselves when we relate to things in our present surroundings (Huettig, Rommers & Meyer, 2011). On top of that, people are constantly linking sound and picture, inferring underlying causal relations and subconsciously making a semantic web of related words, sounds and visual stimuli. It has been shown that upon hearing a phonetically or semantically related word, people look at the related image on a display (Tanenhaus & Trueswell, 2006; Tanenhaus, 2007).

Interestingly, eye movements that are measured in the visual world paradigm represent not only the processing of the unfolding visual or audible input; they

represent “the mental representation the listeners construct while processing the stimuli over time” (Huettig and Altmann, 2005; Huettig, Rommers & Meyer, 2011: p. 156). It has been proven in experiments that eye-movements can be anticipatory, caused by visual and audible input that suggests certain events are about to happen (Altmann and Kamide, 2009). It is therefore possible to say that eye movements reflect cognitive processes extremely well, since they reveal the mental process of sentence structure building while it takes place.

What is more, it has been shown that only phonological and semantic cues trigger visual-audio assimilation. Language specific properties, such as syntactic structures, do not shape the mental representation overtly. That is to say, they cannot be used to directly stimulate eye movement, since listeners are not consciously aware of the differences. Therefore, syntactic structures can be studied by means of the visual world paradigm (Huettig & Altmann, 2005). In the case of auxiliary effects in passive structures, we are looking at syntactic properties of the Dutch language, which do not include specific phonological or semantic cues. Therefore, when we use lexical-semantic cues to establish argument-picture relations, we can be sure there will be no interference of the possible syntactic cues in the sentence. I can conclude that this method is highly appropriate for this type of experiment.

However, there are influences that need to be accounted for when using this method. In previous research, it has been shown by looking at anticipatory eye-movements, that participants can predict properties of the spoken input that will appear later on in the sentence (Altmann, 2004). It is crucial that the input does not undermine the relations that are being tested. That is to say, all items should be phonologically, semantically and visually unrelated. On top of that, the visual world paradigm requires participants to look freely, and undetermined. These circumstances can be created by giving the participants a ‘no-task task’ (Altmann, 2004), or a look-and-listen task (Andersson, Ferreira, & Henderson, 2011), where participants are simply told to look and listen attentively.

Now that I have shown that the visual world paradigm is a successful way of testing underlying syntactic structures, I will look at studies more related to my topic of interest to find out how we can implement this method.

### 1.3.3 Eye-tracking

Koring et al. (subm.) performed a study similar to that of Osterhout and Swinney (1993) and Friendmann et al. (2008) with eye-tracking and unaccusatives. They compared the processing of unergative verbs to unaccusative verbs and compared argument-verb integration points. To do so, they used the visual world paradigm, where certain images were semantically related to the sentence subject. By means of continuous measuring of the eye movement, they were able to determine the exact point at which participants reactivated the subject. They were able to determine subject reactivation in both unergative and unaccusative sentences. In unergative sentences, the subject reactivated before verb offset, whereas unaccusative sentences had subject reactivation at 750 ms after verb offset on average. Koring et al. (subm.) conclude that the point at which the argument reactivates depends on the syntactic position. If it is possible to draw a direct parallel between their results and the distinction between actives and passives, this would mean I should find a difference in reactivation timing between the two.

From what I know so far about the structure of passives, it is most likely that the argument-verb integration will take place some time after the verb, but not necessarily directly. This is suggested by findings of Osterhout and Swinney (1993) and Koring et al. (subm.). On top of that, the syntactic structure proposed by Embick (2004) indicates a clear difference between stative and eventive passives. I expect to also find differences between these two, yet I cannot say exactly where I will find these. I therefore would like to use a continuous window of measurement. This is possible by means of the visual world paradigm.

### 1.4 Predictions

Now that we know the possibilities and limitations of the experimental methodology, we can outline our predictions for Dutch passives. By using verbs that are compatible with all three auxiliaries, I can isolate the effects of the auxiliary on argument-verb integration, and create three separate conditions. These three auxiliaries, *hebben*, *worden* and *zijn*, project different structures which influence the processing of sentences. To determine the exact influence the auxiliaries have on the online computation of a sentence, I will construct materials that will differ only in the use of

the auxiliary. For that, I need a specific type of verb, namely bidirectional verbs. These verbs, such as *knuffelen* ('to hug'), are compatible with *hebben*, *worden* and *zijn*. Only a limited amount of verbs are compatible with all three auxiliaries, and these verbs are always transitive for two reasons. Firstly, it has to be possible, when combined with the auxiliary *hebben*, for the verb's action to be performed by the subject, and secondly, combined with the auxiliary *zijn*, it has to be possible for the verb's action to be performed by the (possibly implicit) object. This type of verb causes a bidirectional relationship between the subject and the object, and allows the user to make a reversible passive. Common bidirectional verbs that are compatible with both *hebben* and *zijn* are hugging, kissing, ringing up, and nursing for example. Note that only verbs that describe an action in which the initiator's (or agent) action is no different from the receiver's (or patient) action can serve as a reversible passive. As a result, the reader or listener has to rely on the auxiliary to inform them who the agent is.

In each condition, the processing of the sentence for a specific type of auxiliary follows a different path. Analyzing sentences that possibly employ all three auxiliaries on a word-by-word basis could help determine the differences in the process of structure building, and each individual operation on the syntactic structure by the listener/reader.

With all three auxiliaries, the sentence remains ambiguous after the auxiliary is reached, since all can either be interpreted as an auxiliary or as the main verb. Pritchett's projection principle states that the auxiliary will project an IP in which the argument can be incorporated to satisfy case. (30) is an example for every auxiliary used as a main verb.

30. a. *Volgens Halsema had de jongen gele koorts.*

According to Halsema the boy had yellow fever.

b. *Volgens Halsema werd de jongen kwaad.*

According to Halsema the boy became mad.

c. *Volgens Halsema was de jongen te laat.*

According to Halsema the boy was too late.

In (30), once *de jongen* is reached, it projects a NP that can be attached in the projected SPEC-IP position. The constituent after *de jongen* indicates that *had/werd/was* was the main verb of the sentence. However, there is no way to know beforehand whether the first verb is an auxiliary or not. Once readers know that these verbs are auxiliaries, for *had*, the subject will be the AGENT of the upcoming verb, and for *werd*, the subject will *not* be the AGENT of the verb. Accordingly, once the main verb is reached, the listener can project a syntactic position in which the argument can be licensed by the verb. Still, in the case of *was*, listeners will have to wait until the actual main verb to find out whether the subject that appears right after the auxiliary is an AGENT or a PATIENT. (30c), up to the verb, could just as well have been (31) (*was* turns out to be an auxiliary to a passive), (32) (unaccusative) or (33) (imperfective), whilst only the latter has active voice.

31. *Volgens Halsema was de jongen bedrogen.*

According to Halsema the boy was deceived.

32. *Volgens Halseman was de jongen gevallen.*

According to Halsema the boy had fallen.

33. *Volgens Halsema was de jongen aan het gillen.*

According to Halsema was IMPERFECTIVE screaming.

We can conclude that *was*-sentences, out of all three verbs, are the only type that is ambiguous with regard to voice. That is to say, the listener/reader cannot arrive at the correct syntactic structure until identification of the main verb – up until the main verb, the reader/listener has not parsed a syntactic head that will indicate the correct syntactic structure. In my experiment, I accounted for this possibility by adding sentences such as (33) to the filler group, to prevent participants to be biased towards passive usage of *was*. This means that for my participants, *was* will be ambiguous with regard to voice, just as it is normally.

If we assume that listeners/readers use the projection principle (Pritchett, 1991), thereby parsing each sentence constituent to satisfy the Case and theta criterion as much as possible, the passive structure will always require a small reanalysis. However, whilst going through a sentence, argument-verb integration should be easier in *hebben* and *worden* sentences, since they have the least possible projections

available to the listener/reader. That is to say, whilst listeners/readers process a sentence, the syntactic structure they build will develop with every new input they get. When building a structure for *was*, an auxiliary ambiguous up until the main verb, it is more likely that in the process of structure building they assign a wrong position in the structure to a certain word or phrase. Consequently, reanalysis is required which increases the effort spent on processing. If this directly relates to the time spent processing, we will see that *was* sentences have later argument-verb integration than *hebben* and *worden* sentences.

On the other hand, it is possible that readers/listeners expect the first argument they read/hear to be the semantic AGENT, since this is most frequently the case. If, however, the participants expect the same for *zijn* and *worden*, and continue to think that until the main verb, some kind of reanalysis has to take place in both passive constructions, since only the *hebben* sentences in my experiment start with the subject. In that case I would predict active sentences to have faster argument-verb integration than passive sentences as a whole, since there is no reanalysis of the syntactic structure required there.

From the syntactic structure I would predict that all three auxiliaries have different argument-verb integration. There has to be a difference between active and passive verbs, since the first has an external argument to integrate and the latter an internal argument, which are two different processes. However, within the passive we have two types of structures as well. On the one hand, there is the strictly eventive passive (*worden*), which indicates the existence of an external causer expressed in *v* as the element AG. On the other hand, there is the passive that can express either a stative or a resultative (*zijn*), where depending on the interpretation, the argument is interpreted in AspP or vP respectively. Following Embick (2004), this adds once more to the ambiguity of *zijn* as an auxiliary. However, the explicit foregrounding of the object, which is inherent to the passive, contrasts with the eventivity of *worden*, which draws the reader/listener's attention to the external causer (which is the external argument). This means in my results I could get a difference in reactivation of the subject between *zijn* and *worden*, because in *zijn* the subject is more prominent than in *worden*.

Based on the literature on eye-tracking in the visual world paradigm, I predict that the argument-verb integration process will be reflected by the eye movements. I will interpret increasing gazes at the picture related to the subject as subject activation, and if there are increased looks to the target in a place where the subject is not literally mentioned, I can interpret that as argument integration. Specifically, if the subject is activated shortly after the verb, I can conclude that at that point verb-argument integration takes place.

All in all, I expect deviating results in each condition. Based on the previous experimental research and literature, I have two hypotheses.

Hypothesis 1: Active sentences will have faster verb-integration time than both passive conditions, due to the difference in argument-verb relation. I predict internal argument-verb integration is more difficult than external argument-verb integration, and will therefore take longer, and appear later after the verb. In addition, within the passive, *zijn* will integrate earlier than *worden*, because the additional stress that *worden* puts on its external causer, thereby causing the reader/listener to posit a v with an AGENT feature in the syntactic structure, delays the internal argument-verb integration. This hypothesis is based on the syntactic position of the argument.

Hypothesis 2: *Worden* and *hebben* have quicker argument-verb integration than *zijn*, due to the ambiguity that only takes place with *zijn* auxiliaries. This is caused by the fact that it is more likely that readers/listeners have to reanalyze the *zijn* sentences than the *worden* and *hebben* sentences. This hypothesis is based on the linear order of structure building during processing.

## 2. Method

### 2.1. Participants

Forty students of the University of Utrecht participated in this experiment<sup>5</sup>, their average age was 23;11. They were all native speakers of Dutch, did not suffer from dyslexia and had normal or corrected to normal vision. They were paid in exchange for their participation.

### 2.2. Materials

In total, 48 test items and 48 control items in three conditions were divided between six lists. All conditions tested the same 48 different verbs, which were presented in a within items design. Therefore, for every item there is data from each condition. The test items had matching argument-picture pairs, i.e. one of the visual objects in the display was semantically related to the argument of the spoken sentence, whereas the control items were void of any picture related to the argument. Participants never received the same item twice, thus each list consisted of 96 items and one practice-item.

The arguments that were selected were descriptive characteristics of people, such as jobs (e.g. teacher)<sup>6</sup>. For each item, the argument was semantically related to one of the four objects displayed on the screen. I pretested the relatedness of the argument and its target object with a semantic relatedness judgment test on a different set of participants. For each argument-target object pair, participants were asked to rate, on a scale of 0-5, to what degree the meanings of the two words were related. 78 people<sup>7</sup> (average age 24;11) participated in the pretest. 45 filled out the survey on paper and 33 filled in an online survey. All argument-picture pairs scored over 4, with a mean of 4.6. In Appendix A all arguments and their related target objects are provided.

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<sup>5</sup> 6 male, 34 female

<sup>6</sup> The arguments had to refer to a specific person, but also had to be semantically related to a visual object, hence it could not be a proper name. I opted for typical classifications of humans such as *grandma*, as well as jobs such as *doctor*.

<sup>7</sup> , 22 male, 56 female



On the contrary, for the control sentences, none of the objects on the display could be related to the argument of the sentence, or to any other word in the sentence. I therefore tested these pairs in the same survey. All pairs scored below 2, with a mean of 0.7. I can now use the looks to the control item as a baseline for looks to the target object in the test items, since they represent the average amount of looks one-in-four pictures would get in any case. In Appendix B, all control arguments and their unrelated objects are provided.

The test-sentences were constructed so that they would meet the following two requirements. Firstly, there had to be enough time between the argument and the verb to allow looks to deviate from the target object. The results will be based on the increase in looks, so there had to be enough time for looks to deviate completely. At verb onset, looks to the target need to be as low as possible for the increase to indicate reactivation. That is to say, if the subject is still active in participant's processing, due to the subject clause at the start of the sentences, I would not be able to measure reactivation, as this is a measure of growth. Secondly, there had to be unrelated material following the verb in order to be able to measure the increase of looks to the target objects after the verb. The best option was a subordinate clause embedded in a speaker-construction (SP), followed by the auxiliary (AUX), the subject argument (ARG), a descriptive adjectival phrase (DSC), an adverb (ADV), the verb (V) and finally a temporal adverbial clause (ADC). In (34), taken from the test-sentences in the experiment, the different constituents of the sentence are labelled.

34. [Volgens Rutte ]<sub>SP</sub> [had/werd/was]<sub>AUX</sub> [de kok ]<sub>ARG</sub> [met schele ogen en een lange jas]<sub>DSC</sub>[behoorlijk ]<sub>ADV</sub> [gesard ]<sub>V</sub> [toen het sprookje over de dolfijnen toch nog goed afliep]<sub>ADC</sub>.

*According to Rutte had/was[+INCH]/was the chef with crossed eyes and a long jacket properly nagged when the fairytale about the dolphins eventually ended happily.*

All proper names were prominent political figures in the current or penultimate Dutch cabinet. The descriptive adjectival phrases were 4.7 words on average. The temporal adverbial clauses were 8.2 words on average. The control-sentences were structurally identical to the test-sentences.

The verbs that were used were selected on the basis of four criteria. First, they had to be compatible with all three auxiliaries, *had*, *werd* and *was* in the past perfect tense. Secondly, their meaning had to be consistent across these three auxiliaries. For example, in (35), which was not included in the test materials, when the auxiliary *had* is used, the student is the AGENT, and washed takes the covert direct object 'dishes'. On the other hand, when the auxiliaries *werd* or *was* are used, the student, as the AGENT, is the direct object, and no dishes are involved.

35. Volgens Jan had/werd/was de student afgewassen toen de deur open ging.

*According to John had/became/was the student washed when the door opened.*

This is a different interpretation of the verb depending on the auxiliary, and although these verbs are bi-directional, since the AGENT and the PATIENT can be swapped, the interpretation without an overt direct object gives the sentence a different meaning. Therefore these types of verbs were excluded from the materials. Thirdly, I only used transitive verbs because these allow passivization. In addition, the transitive verbs I used had to be verbs that could do without an overt direct object, because I wanted the sentences to be of the same surface structure. This is not straightforward, since in Dutch the placement of the direct object is different for each type of sentence and would therefore dissimilate the surface structure. Had I made all direct objects overt, the difference in position of the objects would have caused dissimilarity between the surface structures of three conditions, as shown in example 36-38.

36. Volgens Jan had de student Piet aangevallen toen de bal viel.

*According to John had the student Pete attacked when the ball dropped.*

37. Volgens Jan was de student (door Piet) aangevallen (door Piet) toen de bal viel.

*According to John was the student (by Pete) attacked (by Pete) when the ball dropped.*

38. Volgens Jan werd de student (door Piet) aangevallen (door Piet) toen de bal viel.

*According to John became the student (by Pete) attacked (by Pete) when the ball dropped.*

(37) and (38) show that the addition of an AGENT argument in the *zijn* and *worden* conditions requires a prepositional indicator *door*<sup>8</sup> (a *by*-phrase). On top of that, the *by*-phrase can be positioned either before or after the main verb, whereas in the *hebben* condition the sentence object can only be positioned before the main verb and does not require a prepositional indicator. This means that the addition of an (in)direct object would provide the reader with an extra cue regarding the thematic role of the subject, AGENT or PATIENT.

Fourthly and finally, the verbs were pretested for semantic relation in combination with their paired arguments. That is to say, I ensured that the verb did not denote an action that was overly typical for the agent, which would enhance looks to the target object for reasons other than reactivation of the argument. For example, when the verb's action is prototypical for that specific agent, the target object might also be related to that verb and looks to the target will increase due to this relation<sup>9</sup>. In the pretest I included 48 argument-verb pairs and asked the participants to rate them on a scale of 0-5 for relatedness. All pairs were judged below 2, with an average of 0.8. This ensures us that all looks to the target object after the verb indicate reactivation of the subject, since it cannot be anything else in the sentence triggering looks to the target picture. In Appendix C a list of all the verbs is provided.

Additionally, I included 48 fillers. The fillers were used to counterbalance the learning effect that might be caused by the otherwise one-sided passive use of *was*. Therefore, 16 fillers were of type *was*, but with the addition of the active phrase *aan het* (doing), giving them active voice. Counterbalancing was not necessary for *hebben* and *zijn*, because they are not ambiguous with regard to voice. The other fillers were distributed equally among the modal auxiliaries *kon* (could), *wilde* (wanted to), *mocht* (was allowed to), and *moest* (must/was ordered to). The sentence structure of the fillers was very similar to the item-structure.

The sentences were recorded in a soundproof cabin using a TASCAM DA-40 recorder and a Symetrix 302 microphone amplifier at sample rate 48000 Hz. The voice was of

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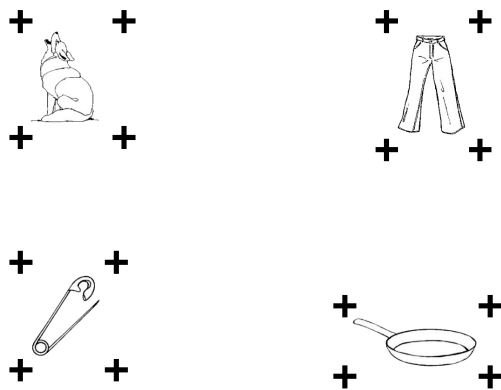
<sup>8</sup> In Dutch, a *by*-phrase is called a 'bepaling met *door*'.

<sup>9</sup> An example of a prototypical agent-verb relation would be 'taking care' (*verzorgen*) and 'doctor' (*dokter*). The argument 'doctor' was portrayed by a stethoscope, which is in close relation with the verb *verzorgen*.

a young female, registered with mono recording. The average recording length of the sentences was 8.5 seconds, and a second of silence was added before and after each sentence making the average sound file length 10.5 seconds.

Each display consisted of four objects that occupied distinct quadrants of the screen (Altmann, 2004; Huettig & Altmann, 2005; Andersson, Ferreira & Henderson, 2011; Huettig, Olivers & Hartsuiker, 2011). The location of the target object was evenly distributed among the quadrants. Some of the objects in the visual display were adopted from Szekely et al. (2004), who created an online database for black-and-white line drawings. Additional visual objects were created in the same style. An example of a visual display is given in Figure 1. The markers around each object indicate the edges of the fixation-areas used in analyses.

Figure 1  
*The visual display of the item in (33). The objects were all evenly sized, and the marked fixation area determines which fixations are ascribed to which object.*



In short, the trial of one item would progress as follows. The visual display appears as in Figure 1; the participant looks freely at all four objects. The audio starts, and after approximately 2 s the argument is played (the chef); the participant's gaze moves towards the related target image (the frying pan). The following 2 s the descriptive adjectival phrase is played, in which the participant's gaze will move away from the target image. On average, the verb (nagged) would start playing at 6269 ms, at which point I predict the participant's gaze will move towards the target image again.

### **2.3. Procedure**

A desktop EyeLink 1000 tracker with 0.5 degrees accuracy and a sample frequency of 500 Hz was used to record data. Participants had binocular vision but only the right eye was measured. Instructions were given both in written and oral form. Participants were given the no-task task, in order to avoid memorization and meta-linguistic interference on the involitional eye movements (Altmann, 2004; Altmann & Kamide, 2009; Altmann, 2010).

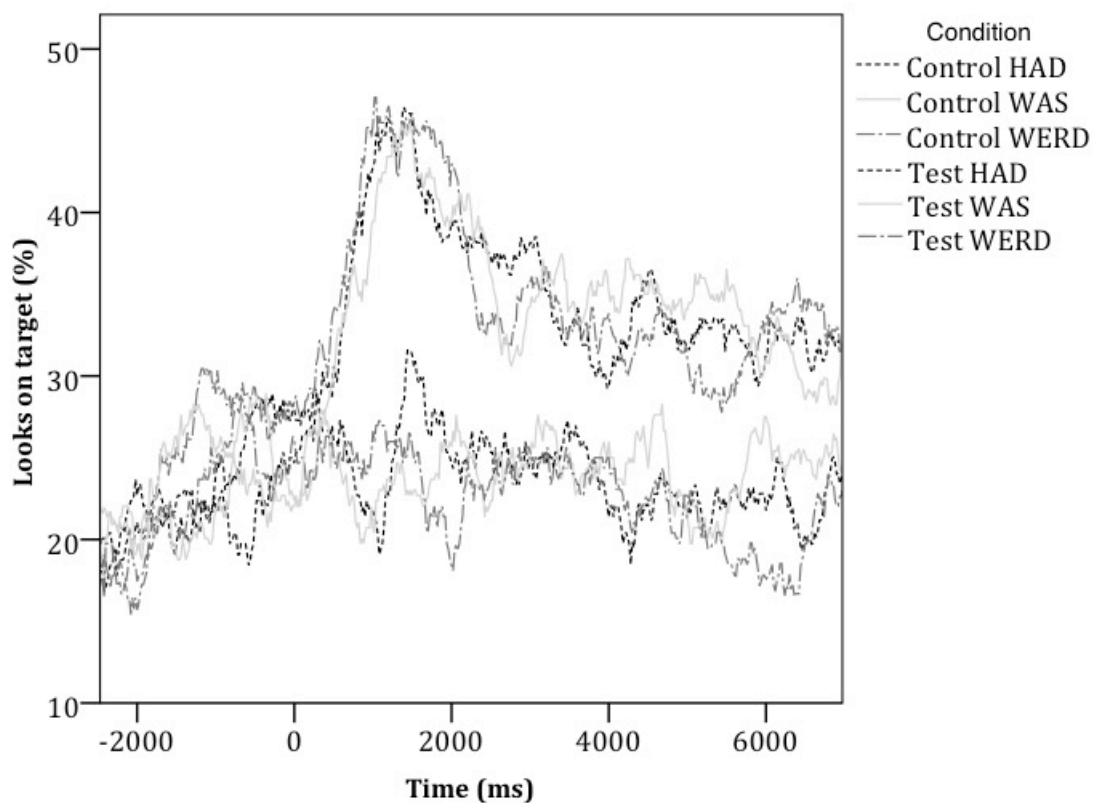
Preceding the test, the eye tracker was calibrated by means of 14 fixation points across the computer screen. After calibration, one practice item was presented. Subsequently, the test phase would start. The visual display presented itself once the participant had fixated on a centre dot. After 1000 ms the audio would start playing, and 1000 ms after audio offset, the visual display would be replaced by the fixation dot. The test consisted of two blocks and two calibration opportunities, one at the start and one in the middle. The test lasted approximately 25 minutes.

### 3. Results

The fixations were assigned manually to the four possible areas, of which one was the target area. These were determined for each object individually. All areas had a rectangular shape, and were determined by taking a 30-pixel margin from the outer corners, as indicated in Figure 1. Fixations that fell outside any area were labelled 'outside', and were treated differently from target or non-target fixations during the analyses.

In all audio files, the four points of interest were marked. I used these points to synchronize the data on different points in time and marked the argument onset and offset in order to be able to compare the effects of sentence type. By synchronizing on argument onset, for example, it was clearly visible that in the test condition there was an increase in looks to the target, which was not visible in the control condition. Additionally, I marked the verb onset and offset so it was possible to zoom in on the specific influence of each auxiliary in the region around the verb.

I investigated the general shape of the data. First, I checked if the argument-object relations were strong enough to increase looks at the target. In Figure 2, it is clear that at argument onset at 0 ms, looks on target increase rapidly in the test condition, but not in the control condition. Secondly, we can observe that the looks on target never drop to the level of the looks on target in the control condition. Lastly, Figure 2 shows that this effect is consistent among all three conditions.



*Figure 2*  
*The percentage of looks on the target out of 100 on a time scale of 0 (argument onset) to average end of sentence, in both the Test and the Control type, in each condition (HAD, WERD and WAS).*

Secondly, I investigated whether there was any reactivation of the argument due to the expression of the verb. To begin with, I calculated the effective additional looks on target by subtracting the looks in the control condition from those in the test condition. This generates the percentage of looks that are supplementary to any looks by chance. In order to confirm if the seemingly different tracks of each condition follow similar patterns, i.e. reactivate at the same time, or behave differently, I tried to fit a modelled curve on the basis of this data. This modelled curve will depict the curve of the data more clearly.

To do so, I defined the regions of interest in the data. Although there are continuous measurements of the looks on target, I needed to specify timeframes in which it is to be expected that reactivation takes place, in order to find the best fitting model. On the basis of previous research, I can separate two regions in the data analyses: the verb frame and the post-verb frame (Koring, Mak & Reuland, *subm.*). Priming experiments have found significant results in unaccusatives at 750ms (Friedmann et al., 2008) after the verb offset, and 1000 ms after the verb offset in passives

(Osterhout and Swinney, 1993). Additionally, the processing system needs 200 ms to initiate and program an eye movement for these kinds of tasks (Altmann and Kamide, 2004; Huettig and Altmann, 2005; Altmann 2010). Therefore, the first frame was centred on the verb offset plus 200ms, with an average verb's length before and after. Given that the average verb length is 836,76 ms, this results in a verb frame of 800 – 1200 ms. In the verb frame, I anticipate to detect early reactivation effects similar to those of Koring et al. (subm.). The post-verb frame is centred at 950 ms after verb offset, as previous findings with passives start to show a reactivation effect at 1000 ms after verb offset (Osterhout and Swinney, 1993) and we add an additional 200 ms of eye movement programming. This second frame starts at 200 ms after verb offset and ends 750 ms after its mid-point. Thus, the post-verb frame consists of all data from 200 – 1700 ms from verb offset. In the post-verb frame, I anticipate to detect late reactivation effects similar to those of Osterhout and Swinney (1993), and Friedmann et al. (2008), at 1000 ms and 750 ms after verb offset respectively.

I analyzed the data using a growth curve model (Mirman, Dixon and Magnuson, 2008). The model is built on the basis of the curves of looks to the target in each condition. Then, these models are compared to find out whether the different conditions show the same curve or not. With this technique, it is possible to investigate whether or not the shape of the curve made by the increase of the looks on target is different in each condition. For each region, I created a simple base model with participants as a random factor and the polynomial time terms as predictors. Secondly, I progressively added the interaction of condition with the terms; first the intercept, then the linear, quadratic, cubic and lastly the quartic term. After adding each term, there is an outcome that shows whether the model fit has improved by adding the effect of condition on the term or not. I then calculated the fit of the model compared to the data for each condition individually, and the differences between the models. I calculated model fits for both the verb region and the post-verb region.



### 3.1 Verb region

Figure 3 illustrates that the three different conditions at verb offset show an increase in the percentage of looks on target. The analyses of the regions of interest show that in both *was* and *werd* the curve shows a decline in looks after the verb region, followed by a rise in looks, whereas *had* remains steady at 10% additional looks on target. It shows the data-points in the verb region for each condition. The dotted, dashed and solid lines represent the model best fitting the data.

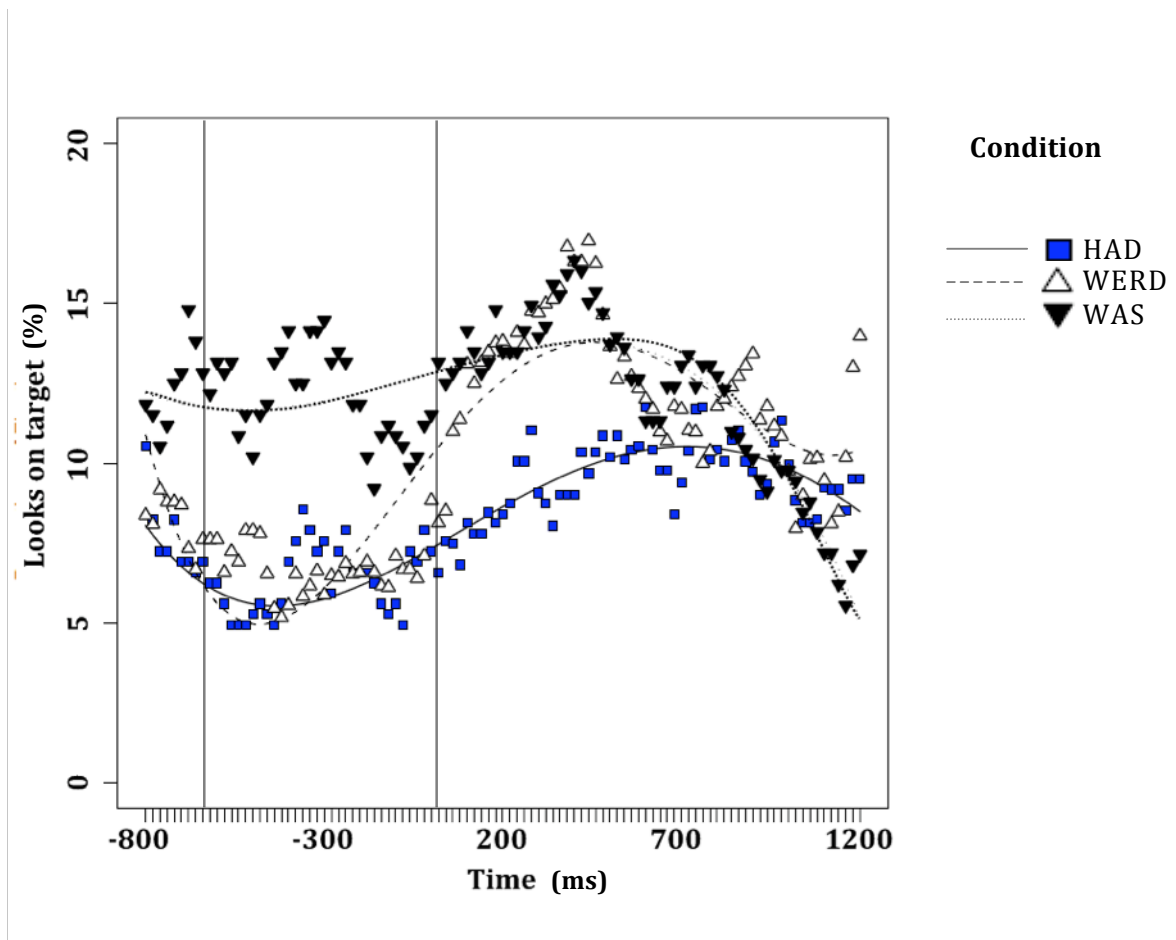


Figure 3  
*Verb frame (verb on- and offset indicated by the vertical lines)*  
*The difference in looks to the target object in the test condition and the control condition, in three conditions, compared to the best fitting curve predicted by the model.*

The  $-2 * \text{the log-likelihood}$  is the deviance statistic, which indicates the goodness of fit of the model (Mirman, Dixon and Magnuson, 2008). This changes in every model due to addition of another term. The difference is indicated by the  $\Delta D$  (a chi-statistic), with degrees of freedom equal to the number of parameters added. Any additional

term is tested for significance, that is to say, whether or not it increases the goodness of fit of the model.

Table 2  
*Verb frame* analyses. The -2LL is a measure of the goodness of fit of the model.  
 $\Delta D$  indicates the change in the fit of the model.

Model parameter	-2LL	$\Delta D$	$p <$
base	144416	-	-
intercept	144414	2	n.s.
linear	144412	2	n.s. <sup>10</sup>
quadratic	144391	21	.001
cubic	144387	4	.05

Table 2 shows that by adding both the effect of condition on the quadratic term and the cubic term significance increases. This means that the fit of the model improves by adding the effect of condition on the quadratic and cubic term. The table also shows that neither the intercept nor the linear term is significant, which means that there is no difference in the intercept or slope between the three conditions. That is to say, the three conditions are consistently similar in their linear term and intercept, but not in the quadratic and cubic terms.

There are significant differences between the conditions indicated by Figure 3 and Table 2. Overall, *had* differs significantly from both *werd* and *was* in the quadratic component, where *had* differs from *werd* ( $b = -.093$ ,  $t = -3.3$ ,  $p < 0.001$ ) and *had* differs from *was* ( $b = -.122$ ,  $t = -4.3$ ,  $p < 0.001$ ) respectively. There are no significant differences between *werd* and *was*.

Table 3 shows a description of each of the individual lines.

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<sup>10</sup> For this term, a converging model could not be computed. This is the outcome of a forced false convergence model, and therefore not reliable.

Table 3

*Verb frame* analyses using five model terms. Conditions are set off against each other. Components in bold are significant.

Condition	Model term	Value	Std. Error	t-value	p
HAD	intercept	.115	.0797	1.4	.1
	linear	-.614	.4663	-1.3	.2
	<b>quadratic</b>	<b>.305</b>	<b>.0731</b>	<b>4.2</b>	<b>&lt;.001</b>
	cubic	.064	.0731	.9	.4
WERD	intercept	.133	.0797	1.7	.09
	linear	-.566	.4663	-1.2	.2
	<b>quadratic</b>	<b>.211</b>	<b>.0731</b>	<b>2.9</b>	<b>.004</b>
	cubic	.013	.0731	.2	.8
WAS	intercept	.152	.0798	1.9	.05
	linear	-.832	.4663	-1.8	.07
	<b>quadratic</b>	<b>.182</b>	<b>.0731</b>	<b>2.5</b>	<b>.01</b>
	cubic	.063	.0731	.9	.4

We can observe that in all three conditions, looks on target increase shortly before verb offset, somewhere in between verb onset and verb offset. Figure 3 suggests that this increase is largest in the *werd* condition; this can be confirmed by a significant quadratic component in Table 3, as well as a significant difference between *werd* and *was/had* in the cubic component, on which I will elaborate below. Nonetheless, both *had* and *was* also show significantly increased looks on target.

All conditions have a positive quadratic effect, meaning they all have a significant fall followed by an increase. Only *was* has a slight linear decrease, because it sets off higher on the y-axis than where it ends; however this is not significant.

By adding the cubic effect, the model has a significantly better fit than with only the quadratic effect. There are only significant differences between *werd* and the other two conditions; *werd* differs from *had* ( $b=.051$ ,  $t=1.8$ ,  $p=.08$ ) and from *was* ( $b=.05$ ,  $t=1.7$ ,  $p=.08$ ). This indicates that the cubic component of *werd* is different from both *was* and *had*. We can see this in the graph, as both the fall and rise of *werd* are more pronounced than that of *had*, and *was* has a big fall but only has a small rise.

From this, we can conclude that all three conditions show reactivation in the verb-frame. However, the amount of reactivation differs significantly between *had* and the other two conditions; the quadratic component in the *had* condition is bigger than in both *was* and *werd*. As a preliminary conclusion, I can claim that reactivation of the argument takes place immediately at verb offset for all three conditions, which

means that argument-verb integration occurs at the same time in active and passive constructions.

### 3.2 Post-verb region

In Figure 4, the data-points in the post-verb region are shown for each condition. Additionally, the best-fitting model is plotted for each condition. When comparing to Figure 3, it is helpful to realize this timeline starts at 0.2 s, which means that it partly overlaps with Figure 3.

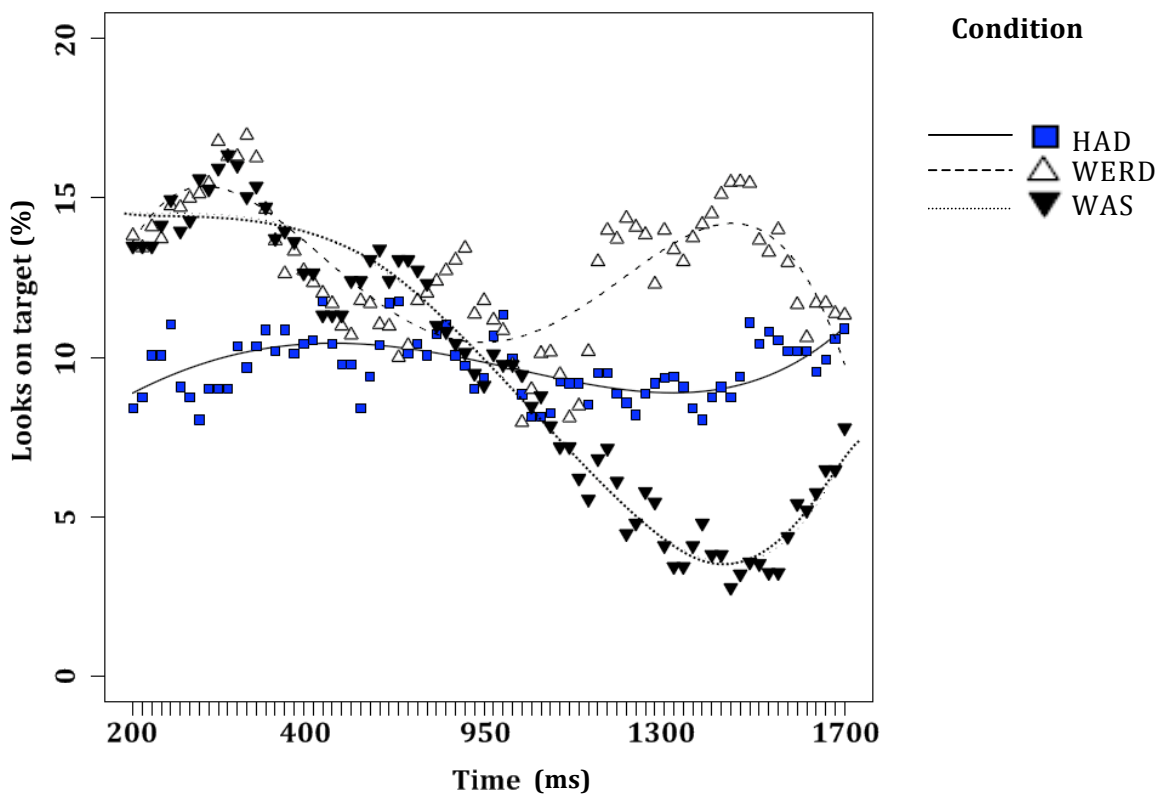


Figure 4  
*Post-verb frame*  
*The difference in looks to the target object in the test condition and the control condition, in three conditions, compared to the best fitting curve predicted by the model.*

To begin with, Figure 4 shows a large decrease in difference in looks on target in the *was* condition, and a seemingly constant difference in looks in the *had* condition. Additionally, it shows a second rise in difference in looks in the *werd* condition.

Table 4  
*Post-verb frame analyses.* The -2LL is a measure of the goodness of fit of the model.  $\Delta D$  indicates the change in the fit of the model.

Model parameter	-2LL	$\Delta D$	$p <$
base	107992	-	-
intercept	107990	2	n.s.
linear	107984	6	.02
quadratic	107974	9	.002
cubic	107933	41	.001
quartic	107899	34	.001

On top of that, Table 4 shows that the difference between the conditions has a significant effect on the quartic term.

Table 5  
*Post-verb frame analyses using five models.* Conditions are set off against each other. Components in bold are significant.

Condition	Model term	Value	Std. Error	t-value	$p$
HAD	intercept	.091	.0751	1.2	.2
	linear	.344	.03639	.9	.3
	<b>quadratic</b>	<b>.161</b>	<b>.0642</b>	<b>2.5</b>	<b>.01</b>
	cubic	.045	.0642	.7	.5
	quartic	-.101	.0642	-1.6	.1
WERD	intercept	.121	.0751	1.6	.1
	linear	.307	.03639	.8	.4
	<b>quadratic</b>	<b>.235</b>	<b>.0642</b>	<b>3.6</b>	<b>&lt; .001</b>
	cubic	-.041	.0642	-.6	.5
	<b>quartic</b>	<b>.203</b>	<b>.0642</b>	<b>-3.1</b>	<b>.001</b>
WAS	intercept	.088	.0751	1.2	.2
	linear	.016	.3639	.04	.9
	<b>quadratic</b>	<b>.182</b>	<b>.0642</b>	<b>2.8</b>	<b>.005</b>
	cubic	.117	.0642	1.8	.07
	quartic	-.064	.0642	-.9	.3

From Table 5 and Figure 4, we can observe that there is a significant difference of increase in looks on target, but in different gradations. The *had* condition has the least increase, whereas *werd* has a significant second increase in difference in looks. I will propose a possible explanation in the discussion.

There were three main differences between conditions. To begin with, *had* differed significantly from *was* in the cubic component, with  $b=.071$ ,  $t=2.9$ ,  $p<0.001$ . This means that the curve of *had* has a significantly smaller dale and a smaller peak, than the curve of *was*.

Secondly, the curve of *had* is significantly different from the curve of *werd* in multiple components. The curve of *werd* shows a second reactivation, whereas the curve of *had* does not. In the data, this is expressed by the following differences: their quadratic component differed, with  $b=.074$ ,  $t=2.9$ ,  $p=0.003$ . *Had* and *werd* also differed in their cubic component, with  $b=-.086$ ,  $t=-3.5$ ,  $p<0.001$ , and in their quartic component, with  $b=-.102$ ,  $t=-4.1$ ,  $p<0.001$ .

Finally, the curves of *werd* and *was* differ significantly in their cubic component  $b=.158$ ,  $t=6.4$ ,  $p<0.001$ , and quartic component  $b=.139$ ,  $t=5.6$ ,  $p<0.001$ , respectively. This means that the curve of *was* reaches more extremes on the y-axis, and deviates significantly from the quartic shape of the curve that *werd* makes. In other words, while *werd* shows significant reactivation and significant second reactivation, *was* shows a significant reactivation and subsequently, a significant decline in activation.

In brief, to draw a preliminary conclusion, it is clear that each condition's argument activation patterns in a different way. Most differences between active and passive sentences occur in the verb frame, immediately subsequent to the verb offset. The main differences between *werd* and *was* occur in the post-verb frame, at around 950 ms after verb offset. This is an initial indication that there are two different processes that separate these three auxiliaries. I will discuss the possible conclusions more in depth in the next section of my thesis.

#### 4. General Discussion

I set out to discover the differences in processing of arguments, between three types of auxiliaries: *hebben* (have), *zijn* (be), and *worden* (become). I compared the argument-verb integration in active and passive constructions, as well as eventive and stative passives. More specifically, I compared the singular past tense auxiliary *had* (active) with *was* (stative or resultative passive) and *werd* (eventive passive).

Previous research has shown that for unaccusative verbs (Friedmann, Taranto, Shapiro & Swinney, 2008), as well as unergative verbs, reactivation of the subject takes place during and after the verb (Koring, Mak & Reuland, *subm.*). However, in active sentences, reactivation of the subject in unergative verbs occurred during the verb, whereas in unaccusative verbs this occurred 750 ms after verb offset (Koring, Mak & Reuland, *subm.*). On top of that, it has been shown that argument reactivation in passives takes place 1000 ms after verb-offset (Osterhout & Swinney, 1993).

Furthermore, structural variations between the three auxiliaries indicate that argument-verb integration differs consistently between the three conditions. That is to say, the structural element AGENT was only expressed in *v* in the eventive passive, not in the stative passive. On top of that, the active auxiliary *hebben* projected a much simpler syntactic structure.

With the experiment reported in this thesis I set out to further research the argument-verb integration in passives in Dutch. I put forward two hypotheses, one argued that the speed and location of argument-verb integration would be based on the syntactic position of the argument, and the other hypothesized that argument-verb integration would be based on the linear order of structure building during processing. I studied argument-verb integration in transitive verbs in three conditions: active, eventive passive, and stative passive.

I concluded that in all three conditions significant subject reactivation occurs in the verb-frame, with *worden* showing the largest increase and *zijn* the smallest. I also concluded that *worden* causes a second reactivation, which is not the case for either *zijn* or *hebben*. In the post-verb frame, looks to the subject in the *hebben* condition hardly increase at all, and in fact, in the *zijn* condition looks to the subject show

significant decrease. That is to say, compared to the ‘random’ looks on target, subject specifically look away from the subject in this condition.

Hypothesis 1 predicted that active sentences would generally have earlier argument-verb integration than passive sentences. This is not exactly what I found – the increase in looks on target in the active condition is not earlier than in the other two conditions. Hypothesis 2 predicted that both active sentences and eventive passives would generally have earlier and/or faster argument-verb integration than stative passive sentences. This hypothesis is difficult to reject, because the data for *was* are a little messy. The variation in eye movement, especially in the early onset of the verb, is very high and it is therefore difficult to say what is happening exactly. It appears that for some participants, the subject was already reactivated before verb onset, whereas others seem to show the same gaze-behaviour as they do for *worden*.

Furthermore, Hypothesis 1 predicted that the subject reactivation in the *zijn* condition would be earlier after verb offset than in *worden*, because of the external causer expressed in *v* by the AG feature. Again, I cannot with certainty say that one is faster than the other. Even so, there are no significant differences between the two in the verb frame. However, unlike *zijn*, in the *worden* condition there is a second increase in looks to the subject, located in the post-verb frame, indicating a second reactivation of the subject.

I will now explain why *worden* would reactivate twice and *zijn* would not. The main difference between the two, as explained before, is that *worden* is an auxiliary that creates an eventive passive. That is to say, it indicates the start of an activity or action, which is instigated by an external causer. *Zijn*, on the other hand, creates either a stative or resultative passive that simply describes a situation as an entirety. Consider the form of the items I used, repeated in (39) for convenience.

39. *Volgens Bos werd de dokter gekust toen het kindermisje snel verdween.*

According to Bos, the doctor ‘became’ kissed when the nanny quickly disappeared.

The second reactivation I found in the *worden* condition appears very late after the verb. The first reactivation could be the integration of the argument with the verb, but the second reactivation takes place almost 1300 ms after verb offset. Could this



second reactivation be something completely different from argument-verb integration? It is possible that the eventivity of *worden* influences the processing of the sentence, or more specifically, the second clause. Namely, the eventivity causes listeners to interpret the activity of the verb as the start of an action, applicable to the ongoing situation. The second clause in each sentence starts with *toen* (when); this implies that this clause will describe the situation in which the first clause's actions were taking place. To clarify, let me use (39) as an example. The action of *gekust worden* ('getting kissed) is interpreted as ongoing, or as Embick (2004) would say, the doctor is coming into a state of being kissed, yet, is still getting kissed in this situation. Although the clause is wrapped up after the verb *gekust*, *toen* indicates to the listener that more information is coming which is situated in the same temporal frame as the first clause. The listener therefore reactivates the subject of the previous clause, since he is the most prominent backward looking centre<sup>11</sup> from that clause, and thereby increases the looks on the target image, which relates to the subject of the second clause. It is clear that the ongoing action depicted by *worden*, which indicates the start of an activity, applies to the second clause. This could account for the late second reactivation of the argument in the *worden* condition.

Another possible explanation for the second reactivation in the *worden* condition is the fact that out of the two passive auxiliaries, *worden* relies most on its external agent, or causer (Verhagen, 1992; Cornelis, 1996), incorporated in the syntactic structure of Embick (2004) as the feature AG. There is a possibility that the clear implication of an external producer that *worden* makes, delays the integration of the argument with the verb, because the indirect internal argument is implicit and the listener will try to infer the agent from the context. The first reactivation, then, is only the integration of the subject in the first clause.

The unclear results for the *zijn* condition could be caused by the manipulation of the items through the fillers. Beforehand, I decided that if I used *zijn* exclusively as a passive auxiliary, even though its possible usages are more extensive, I might bias the participants into knowing that every *zijn* sentence would be a passive. This would be unrealistic, so in order to solve this, I added fillers in which sentences with

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<sup>11</sup> For more information on Centering Theory, see *Centering theory in discourse* (1998) by Marilyn A. Walker, Aravind Krishna Joshi, and Ellen Friedman Prince

*zijn* auxiliaries were combined with unergative verbs, such as *opstaan* ('to get up') and *beginnen* ('to start'). I did not include 'counterbalancing' fillers for the *hebben* or *worden* conditions, since their interpretations as auxiliaries are exclusively active or eventive passive, respectively. As a result, I had a higher percentage of *was* sentences in each list (33,3%) compared to the percentages of *hebben* and *worden* (16,7%). Instead of solving the ambiguity that *zijn* as an auxiliary has innately, I did not want to blind sight the participants by only including passive uses of *zijn*, thereby inducing this problem.

Data for *zijn* seem to have a larger variance up to verb offset. This is probably caused by the ambiguity caused by *zijn*, but by including all types of possible usages of *zijn*, I did not prevent this variation to occur. Still, the results show that *zijn*, at least after verb offset, behaves like *worden*; there is subject reactivation early in the verb-frame. Hereafter, *zijn* behaves different from *worden*; there is no second reactivation but instead a significant decrease in looks to the target image. This could be caused by the stative nature of the sentence. By interpreting the *zijn* passive as stative, the reader/listener assumes a completed action after the verb has been integrated. Clearly, if we assume that the first reactivation is a reflex of argument-verb integration, there is no difference between the amount of effort it takes to integrate an eventive passive or a stative passive, since the moment the reactivation takes place is shortly after verb offset in both cases. However, the use of the auxiliary *zijn* indicates a set state that can be wrapped up completely after the verb. Readers/listeners will no longer expect the sentence to go on about the subject, hence looks to the target image decline.

In light of this, I can conclude that passives induce early reactivation of the argument, thus early argument-verb integration. Moreover, *worden* introduces a late second reactivation in eventive passives, which is not visible in *zijn* due to its stativity.

In conclusion, this study has given us more insight in the subject-verb integration process of active, eventive and stative passives in Dutch sentences. By examining the processing of complex sentences using the visual world paradigm, I have shown that reactivation takes place in unique patterns for each type of sentence. By using a within-subjects design, I could directly compare the three types, and by using the

visual world paradigm I had a continuous window of measurement. The resulting differences between the three types of sentences indicate that crucial structural differences exist between the use of the passive auxiliaries *zijn* ('to be') and *worden* ('to become'), initiating distinct patterns of argument-verb integration.

## 5. Remaining questions

In order to find out for sure whether the second reactivation in *worden* sentences is caused by the *then*-clause, it is possible to adapt the items in such a way that the second clause should not reactivate the subject. This is possible, for example, by using a *but*-clause (40).

40. *Volgens Thieme, werd de dirigent met drie scheidingen achter de rug eindelijk geknuffeld, maar het toneelstuk over de jungle was al begonnen.*  
According to Thieme, became the conductor with three divorces behind the back finally hugged, but the play on the jungle was already started.

Instead of reactivating the first clause, *but* distances the second clause from itself in order to form a contrastive relation. I would expect to find no second reactivation in sentences such as (40).

Future research is required to investigate the different usages of the auxiliary *zijn*. In this experiment, I only recorded data for the passive use, and it would be interesting to directly compare the subject activation in progressive and perfect sentences such as (41) and (42) respectively.

41. *Volgens Bos was de piraat zonder interessante hobby's onrustig op zijn stoel aan het wippen toen de telefoon ging.*  
According to Bos, was the pirate without interesting hobbies restless on his chair tipping back when the phone rang.  
“The pirate without any interesting hobby’s was restlessly tipping back his chair when the phone rang, according to Bos.”

42. *Volgens Balkenende was de tovenaar uit het koude vakantieoord eindelijk gestopt toen de meisjes dreigden de vijver in te vallen.*  
According to Balkenende, was the wizard from the cold holiday resort finally quit when the girls were in danger the pond to fall in.  
“The wizard from the cold holiday resort finally quit when the girls were in danger to fall into the pond, according to Balkenende”.

In accordance with the results from my study, both these types of sentences should behave like the set of active sentences in the *hebben* condition, because here the

sentence subject is also the verb's acting agent. In a sense, these sentences are active counterparts to the ones used in my experiment.

Additionally, it could be interesting to investigate subject activation in less common auxiliary verbs such as *krijgen* ('to get'), *gaan* ('to go'), *zullen* ('to shall) and *doen* ('to do'), as they only combine with a limited amount of verbs which could lead the listener to process sentences faster (Roland & Jurafsky, 2002). The question is whether these auxiliaries should behave any different from *hebben*, *zijn* and *worden*, if they have the same properties. However, as I mentioned before, *krijgen* is of a different type than all three, as it forms indirect internal argument passives, and thus it would be interesting to see how it behaves and if, in combination with current results, a pattern can be distinguished. For *gaan*, a strictly future tense auxiliary, and possibly also *zullen* ('shall'), it would be interesting to see how its syntactic structure relates to passive auxiliaries, and if it is similar, whether or not it behaves alike in a psycholinguistic test as well. Lastly, for *doen*, and possibly also *laten* ('to let'), which both are causative auxiliaries in combination with an active verb, it would simply be interesting to see if there is a contrast between the two. For example, in (43)<sup>12</sup> there is no sense of an unmentioned external causer. However, in (44) there is a sense of a third person (or thing) that will eventually be responsible for carrying out the verb's action.

43. *Doe jij de auto wassen?*

Do you the car wash?

"Will you wash the car?"

44. *Laat jij de auto wassen?*

Let you the card wash?

"Will you let someone else [IMPL] wash the car?"

However, this person or thing is implicit and will have to be inferred from the context. This distinction could be similar to the effect I found with the external causer in *worden* in the current experiment.

Lastly, all these auxiliaries are restricted to a smaller set of verbs, compared to *hebben*, *zijn* and *worden*. It could be the case that the decreased variety of possible

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<sup>12</sup> The use of 'doen' as an auxiliary is restricted to a number of Dutch dialects, and Flemish.

main verbs also decreases the processing effort of the argument-verb integration. Previously, it has been shown that while processing language, we make use of certain prefixed argument-verb preferences (Roland & Jurafsky, 2002), which might be determined by plain probability. If that is the case, these less common auxiliaries should be easier to process than the main auxiliaries used in this experiment.

## 6. Bibliography

- Altmann, G. T. M. (2004). Language-mediated eye movements in the absence of a visual world: The 'blank screen paradigm'. *Cognition*, 93, 79–87.
- Altmann, G.T.M., & Kamide, Y. (2009). Discourse-mediation of the mapping between language and the visual world: Eye movements and mental representation. *Cognition*, 111, 55-71.
- Altmann, G.T.M. (2011). Language can mediate eye movement control within 100 milliseconds, regardless of whether there is anything to move the eyes to. *Acta Psychologica*, 137(2), 190-200.
- Andersson, R., Ferreira, F., & Henderson, J.M. (2011). I see what you're saying: The integration of complex speech and scenes during language comprehension. *Acta Psychologica*, 137(2), 208-216.
- Aranovich, R. (2007). Split auxiliary selection from a cross-linguistics perspective. In R. Aranovich (Ed.) *Split Auxiliary Systems: A cross-linguistic perspective* (pp 1-24) (1<sup>st</sup> ed.).
- Bock, J. K. (1986). Meaning, Sound, and Syntax: Lexical Priming in Sentence Production. *Learning, Memory, and Cognition*, 12(4), 575-586.
- Chomsky, N. (1981). *Lectures on Government and Binding*. Dordrecht: Foris.
- Cornelis, L. (1996). English and Dutch: The Passive Difference. *Language Sciences*, 18(1-2), 247-264.
- Embick, D. (2004). On the Structure of Resultative Participles in English. *Linguistic Inquiry*. 35,(3), 355-392.
- Friedmann, N., Taranto, G., Shapiro, L.P., & Swinney, D. (2008). The leaf fell (the Leaf): The Online Processing of Unaccusatives. *Linguistic Inquiry*, 39, 355-377.
- Haegeman, L. (1991). *Introduction to Government & Binding Theory*. (2<sup>nd</sup> ed.). Oxford: Blackwell Publishers.
- Hoekstra, T., & Mulder, R. (1990). Unergatives as Copular Verbs; Locational and Existential Predication. *The Linguistic Review*, 7, 1-79.
- Hoekstra, T. (1999). Auxiliary Selection in Dutch. *Natural Language and Linguistic Theory*, 17, 67-84.
- Huettig, F., & Altmann, G.T.M. (2005). Word meaning and the control of eye

- fixation: semantic competitor effects and the visual world paradigm. *Cognition*, 96, 23-32.
- Huettig, F., Olivers, C.N.L., & Hartsuiker, R.J. (2011). Looking, language, and memory: Bridging research from the visual world and visual search paradigms. *Acta Psychologica*, 137(2), 138-150.
- Huettig, F., Rommers, J., & Meyer, A.S. (2011). Using the visual world paradigm to study language processing: A review and critical evaluation. *Acta Psychologica*, 137(2), 151-171.
- Kordoni, V., & van Noord, G. (2009). Passives in Germanic Languages: the case of Dutch and German. *Groninger Arbeiten zur Germanistischen Linguistik*, 49, 77-96.
- Koring, L., Mak, W.M., & Reuland, E.J. (subm.). Verb type determines the time course of argument reactivation: evidence from eye movements.
- Legendre, G. (2007). On the typology of auxiliary selection. *Lingua*, 117, 1522-1540.
- Lieber, R., & Baayen, H. (1997). A Semantic Principle of Auxiliary Selection in Dutch. *Natural Language and Linguistic Theory*, 15, 789-845.
- McFadden, T., & Alexiadou, A. (2010). Perfects, Resultatives, and Auxiliaries in Earlier English. *Linguistic Inquiry*, 41(3), 389-425.
- Mirman, D., Dixon, J.A., & Magnuson, J.S. (2008). Statistical and computational models of the visual world paradigm: Growth curves and individual differences. *Journal of Memory and Language*, 59, 475-494.
- Olson, D.R., & Filby, N. (1972). On the comprehension of active and passive sentences. *Cognitive Psychology*, 3(3), 361-381.
- Osterhout, L., & Swinney, D.A. (1993). On the Temporal Course of Gap-Filling During Comprehension of Verbal Passive. *Journal of Psycholinguistic Research*, 22(2), 273-286.
- Primus, B. (2011). Animacy and telicity: Semantic constraints on impersonal passives. *Lingua*, 121, 80-99.
- Pritchett, B.L. (1988). Garden Path Phenomena and the Grammatical Basis of Language Processing. *Language*, 64(3), 539-576.
- Pritchett, B.L. (1991). Head Position and Parsing Ambiguity. *Journal of Psycholinguistic Research*, 20(3), 251-270.



- Reinhart, T. (2002). The Theta System – An Overview. *Theoretical Linguistics*, 28(3), 229-290.
- Roland, D., Jurafsky, D. (2002). Verb sense and verb subcategorization probabilities. In P. Merlo & S. Stevenson (Eds). *The Lexical Basis of Sentence Processing: Formal, Computational, and Experimental Issues* (pp 325–345) (1<sup>st</sup> ed.).
- Szekely, A., Jacobsen, T., D’Amico, S., Devescovi, A., Andonova, E., Herron, D., Ching Lu, C., Pechmann, T., Pléh, C., Wicha, N., Federmeier, K., Gerdjikova, I., Gutierrez, G., Hung, D., Hsu, J., Iyer, G., Kohnert, K., Mehotcheva, T., Orozco-Figueroa, A., Tzeng, A., Tzeng, O., Arévalo, A., Vargha, A., Butler, A., Buffington, R., & Bates, E. (2004). A new on-line resource for psycholinguistic studies. *Journal of Memory and Language*, 51, 247-250.
- Tanenhaus, M.K., & Trueswell, J.C. (2006). Eye Movements and Spoken Language Comprehension. In M.J. Traxler and M.A. Gernsbacher (Eds.) *Handbook of Psycholinguistics* (pp 863-900) (2<sup>nd</sup> ed.). Academic Press, Elsevier: New York.
- Tanenhaus, M.K. (2007). Eye movements and spoken language processing. *Eye Movements*, In R.P.G. van Gompel, M.H. Fisher, W.S. Murray & R.L. Hill (eds.), *Eye Movements: A Window on Mind and Brain* (pp. 443-469). Amsterdam: Elsevier.
- Verhagen, A. (1992). Praxis of linguistics: Passives in Dutch. *Cognitive Linguistics*, 3(3), 301-342.
- Wekker, H. & Haegeman. (1985). *L. A Modern Course In English Syntax*. Abingdon: Routledge.
- Zaenen, A. (2006). Unaccusativity. In Keith Brown (Ed.) *Encyclopedia of Language and Linguistics* (pp 217-224) (2<sup>nd</sup> ed.). Cambridge University Press: Cambridge.

#### IV. Appendix A

Test arguments, as used in experiment.

De aap	<i>Monkey</i>	De muzikant	<i>Musician</i>
De bakker	<i>Baker</i>	Het meisje	<i>Girl</i>
De bankier	<i>Banker</i>	Het model	<i>Model</i>
De boer	<i>Farmer</i>	De oma	<i>Grandma</i>
De boswachter	<i>Woodward</i>	De orthodontist	<i>Orthodontist</i>
De brandweerman	<i>Firefighter</i>	De papegaai	<i>Parrot</i>
De burgemeester	<i>Mayor</i>	De piloot	<i>Pilot</i>
De chauffeur	<i>Driver</i>	De politieagent	<i>Policeman</i>
De clown	<i>Clown</i>	De presentator	<i>Presenter</i>
De dokter	<i>Doctor</i>	De prins	<i>Prince</i>
De fotograaf	<i>Photographer</i>	De schilder	<i>Painter</i>
De globetrotter	<i>World citizen</i>	De schoenmaker	<i>Shoemaker</i>
De groenteman	<i>Greengrocer</i>	De schoonmaakster	<i>Maid</i>
De houthakker	<i>Lumberjack</i>	De secretaresse	<i>Secretary</i>
De indiaan	<i>Indian</i>	De slager	<i>Butcher</i>
De kabouter	<i>Gnome</i>	Het spook	<i>Ghost</i>
De kapper	<i>Hairdresser</i>	De straatartiest	<i>Street artist</i>
De Kerstman	<i>Santa Claus</i>	De tandarts	<i>Dentist</i>
Het kindermisje	<i>Nanny</i>	De timmerman	<i>Carpenter</i>
De kok	<i>Cook</i>	De topsporter	<i>Athlete</i>
De koningin	<i>Queen</i>	De vis	<i>Fish</i>
De lerares	<i>Teacher (female)</i>	De visser	<i>Fisherman</i>
De maîtresse	<i>Mistress</i>	De zangeres	<i>Singer (female)</i>
De marktkoopman	<i>Market vendor</i>	zwarte Piet	<i>Black Pete</i>

V. *Appendix B*

Control arguments, as used in experiment.

De advocaat	<i>Lawyer</i>	De mondhygiëniste	<i>Dental hygienist</i>
De badmeester	<i>Lifeguard</i>	De Paashaas	<i>Easter bunny</i>
De basketballer	<i>Basketball player</i>	De paus	<i>The Pope</i>
De bloemist	<i>Florist</i>	De prinses	<i>Princes</i>
De boerin	<i>Farmer (female)</i>	De psychologe	<i>Psychologist</i>
De bouwvakker	<i>Constructor</i>	De punker	<i>Punker</i>
De bruid	<i>Bride</i>	De rat	<i>Rat</i>
De chinees	<i>Chinese</i>	De rechter	<i>Judge</i>
De conducteur	<i>Conductor (train)</i>	De reus	<i>Giant</i>
De cowboy	<i>Cowboy</i>	De ridder	<i>Knight</i>
De dief	<i>Thief</i>	De schaapherder	<i>Shepherd</i>
De dikzak	<i>Fatty</i>	De slang	<i>Snake</i>
De directeur	<i>Manager</i>	De snotneus	<i>Whipster</i>
De dirigent	<i>Conductor (music)</i>	De taxichauffeur	<i>Cab driver</i>
De EHBO'er	<i>First aid helper</i>	De techneut	<i>Technician</i>
De fee	<i>Fairy</i>	De telefoniste	<i>Telephonist</i>
De heks	<i>Witch</i>	De tuiman	<i>Gardener</i>
De hippie	<i>Hippy</i>	De tuinier	<i>Gardener</i>
De hockeyer	<i>Hockey player</i>	De verzamelaar	<i>Collector</i>
De ijscoman	<i>Icecream man</i>	De voorzitter	<i>Chief</i>
Het jongetje	<i>Boy</i>	De vuilnisman	<i>Garbage collector</i>
De kattenliefhebber	<i>Catlover</i>	De wees	<i>Orphan</i>
De koorbal	<i>Fratboy</i>	De zuster	<i>Nurse</i>
De melkboer	<i>Dairy farmer</i>	Het jurylid	<i>Jury member</i>

VI. Appendix C

Verbs, as used in experiment.

Aaien	<i>Rub</i>	Roepen	<i>Call</i>
Assisteren	<i>Assist</i>	Saboteren	<i>Sabotage</i>
Bedriegen	<i>Threaten</i>	Sarren	<i>Agitate</i>
Bekeuren	<i>Fine</i>	Schetsen	<i>Sketch</i>
Bekritisieren	<i>Criticize</i>	Schilderen	<i>Paint</i>
Bellen	<i>Call</i>	Schminken	<i>Apply makeup</i>
Beuken	<i>Thrash</i>	Schoppen	<i>Kick</i>
Bijstaan	<i>Stand by</i>	Skypen	<i>Skype</i>
Citeren	<i>Cite</i>	Slaan	<i>Hit</i>
Desinfecteren	<i>Disinfect</i>	Sms'en	<i>Text message</i>
Duwen	<i>Push</i>	Steken	<i>Stab</i>
Helpen	<i>Help</i>	Stompen	<i>Punch</i>
Kietelen	<i>Tickle</i>	Straffen	<i>Punish</i>
Knijpen	<i>Pinch</i>	Strelen	<i>Stroke</i>
Knuffelen	<i>Hug</i>	Tegenhouden	<i>Stop</i>
Krabben	<i>Scratch</i>	Terugbetalen	<i>Pay back</i>
Kussen	<i>Kiss</i>	Trappen	<i>Kick</i>
Mailen	<i>Email</i>	Vastgrijpen	<i>Grab</i>
Meppen	<i>Whack</i>	Veroordelen	<i>Judge</i>
Omhelzen	<i>Embrace</i>	Verplegen	<i>Nurse</i>
Ondersteunen	<i>Support</i>	Verzorgen	<i>Take care</i>
Opgeven	<i>Give up</i>	Volgen	<i>Follow</i>
Pesten	<i>Tease</i>	Zoeken	<i>Seek</i>
Prikken	<i>Prick</i>	Zoenen	<i>Make out</i>