What is coming next?
Anticipatory processing in verb-second and verb-final sentences in Dutch

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ABSTRACT

While monitoring eye movements during visual world paradigm studies, earlier research showed that the appropriate second noun phrase (NP2) is anticipated as upcoming referent before this NP is auditorily encountered, when enough information is available to guide the anticipation process. Anticipatory effects are determined in both SVO-languages (e.g. English) and verb-final languages using case-markers (e.g. Japanese). Dutch lacks case-marking but allows verb-second SVO and verb-final SOV sentences. The aim of this study was to determine whether participants anticipate an upcoming NP2 object in Dutch SVO and SOV sentences. As SOV sentences are embedded clauses that cannot occur on their own, they were preceded by a main clause. Since we wanted to compare sentence constructions that were contentwise as equal as possible we did the same for the main SVO clauses. While linguistically encountering the two preceding main clauses, the different structure and prosody indicated already the word order of the upcoming critical sentence, i.e. SVO or SOV. For the SVO sentences, the preceding main clause, the subject NP1 and the verb provided information for object NP2 anticipation. In the SOV case, the information provided by the subject NP1 becomes extra important, as it was the only linguistic element that could be used as a guider of what element was coming next. To investigate whether the NP1 can lead NP2 anticipation, concrete and abstract NP1s preceded the NP2, such as the abstract NP1 'girl' and the concrete NP1 'pilot'. It was hypothesized that if the NP2 was concrete, the lexical semantics of the NP provided enough information to come up with an upcoming NP2 object in SOV sentences, without the need of a verb. Overall, results showed that participants primarily preferred to look at the NP1 image during the spoken sentence. After sentence offset, a wrap-up effect of fixations to the NP2 was determined in all conditions, possibly indicating a late interpretation and integration of the NP2 with the previous constituents. Across all conditions, the NP2 image received proportionally as much fixations as the distractor images until sentence offset. This demonstrates that in both SVO and SOV sentences, upcoming NP2s were not anticipated. A possible explanation is that Dutch listeners are less pro-active anticipators because of the flexibility of Dutch word orders. The anticipatory process becomes too costly as the risk of anticipating upcoming constituents incorrectly is too high.

Keywords: anticipatory processing, eye tracking, word order, eye movements, association

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1. INTRODUCTION

During language comprehension, people do not only process the past and present incoming linguistic material, but also generate predictions about what forthcoming material is likely to come next. The question raises how and when anticipation takes place. To answer this question, research has been devoted to what and how much information should be available in order to make people anticipate upcoming linguistic elements. For these purposes, some relatively new research methods emerged in the field of studying anticipatory language processing, such as event-related potentials (ERP) (e.g. Federmeier, Kutas & Schul, 2010; DeLong, Groppe, Urbach and Kutas, 2012) and eye tracking techniques. These techniques are very precise on the temporal level and could provide us with information about the incremental comprehension process.

One of the eye tracking paradigms that is insightful for the investigation of anticipatory processing during sentence comprehension is the visual world paradigm (VWP), a paradigm that enables us to determine how visual and linguistic input integrate. Tanenhaus and his colleagues (1995) were the first who adapted this visual world paradigm that was earlier introduced by Cooper (1974). They presented participants a visual display with isolated images on a screen and presented auditorily an accompanying sentence. Some of the objects mentioned in the spoken sentence did overlap with the depicted images, some did not. Tanenhaus et al. (1995) monitored eye movements of listeners to the images while they were auditorily instructed where to look at. The findings showed that listeners processed the linguistic input incrementally as the eyes moved immediately to the images that were just heard. In other words, while listening, what is heard is related to what is depicted and this can influence how listeners look at different depicted images on the visual display over time (Altmann, 2011). But while encountering incoming linguistic material, listeners can also generate predictions about upcoming material. In that case, eyes move to the image of the item that is generated as the one likely to come next.

Visual world paradigm experiments are especially suitable for studying anticipatory processing if the anticipatory referent is an object that is easy to depict, such as noun phrases (NPs). On that account, anticipatory processing of upcoming second noun phrases (NP2) was started to be investigated, in an SVO sentence with a preceding first noun phrase (NP1) and a verb.[1] In this case of NP2 anticipation in an SVO sentence, while hearing the verb and before the second noun phrase is heard, one expects more fixations on the image of the NP2 than on other distractor images. These anticipatory fixations on the NP2 image show that as the spoken sentence unfolds,

[1] I refer to NP1 as the first noun phrase and to NP2 as the second noun phrase in a sentence. For SVO and SOV sentences, the NP1 is the subject and the NP2 the object.

this item is most plausible to come as the upcoming NP2 object and receives most fixations. If none of the depicted noun phrases is an evident potential upcoming NP2, the fixations on the various images remain more or less equally distributed and no NP2 is anticipated.

One of the first visual world paradigm studies on NP2 anticipation was conducted by Altmann and Kamide (1999). They auditorily presented participants English SVO sentences with an animate subject noun phrase (NP1), a monotransitive verb, such as ‘eat’ and ‘move’ preceded by the future tense verb ‘will’, and an inanimate object noun phrase (NP2), as sentences (1) and (2). The future tense forms ‘will eat’ and ‘will move’ indicated that the event had yet to happen and that the current input could provide information about future input. Presumably, these future tense verbs were also included to prolong the duration of the verb, which was the constituent where the anticipatory NP2 fixations were expected to found. While hearing sentences (1) and (2), participants were simultaneously presented with a visual display with images of a ‘boy’, a ‘cake’, a ‘toy car’, a ‘toy train’ and a ‘ball’. This visual display created a semi-realistic scene where the objects were not presented in isolation but occurred as different objects in one workspace (See **Figure 1)**.

(1)	The boy	will eat	the cake	
	Subject	Verb	Object	
	NP1	Verb	NP2	

(2)	The boy	will move	the cake	
	Subject	Verb	Object	
	NP1	Verb	NP2	(Altmann & Kamide, 1999)

In SVO sentences (1) and (2), both the NP1 and the verb are positioned in front of the NP2 and could guide the NP2 anticipation. The aim of Altmann and Kamide (1999) was to examine whether the information provided by the verb could make people anticipate the upcoming NP2. The grammatical functions of the verb, such as the transitivity, what thematic roles can come along with it and how many arguments it can have, can restrict what object is likely to follow.

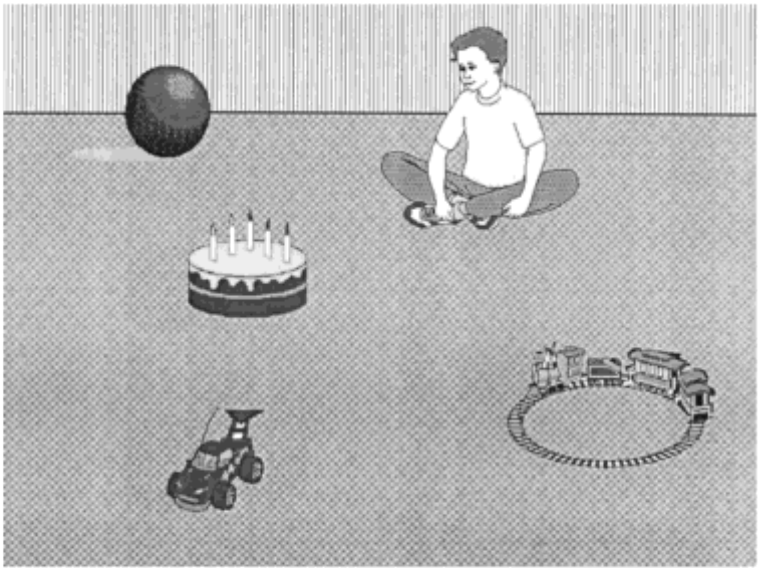

Figure 1. *Example of a semi-realistic scene used by Altmann and Kamide (1999) when participants heard the sentences 'The boy will eat the cake' or 'The boy will move the cake'.*

In this case of Altmann and Kamide (1999), all experimental sentences contained monotransitive verbs, therefore, listeners always expected a post-verbal argument. The verb information that was auditorily present prior to the onset of the NP2 object, made people generate ideas about what NP2 objects were potential arguments of the verb before the argument was actually heard. The grammatical head 'eat' in sentence (1) 'The boy will eat …' made listeners assume that an argument would follow and that this argument would be an edible object. Since only one edible object was depicted on the scene, namely 'the cake', this was the object that fulfilled the specific requirements of the verb. In essence, it was the subcategorization of the grammatical head 'eat' that made listeners expect an upcoming NP2, but eventually it was the plausibility of 'the cake' as an argument of 'eat' that made listeners decide to fixate on the image of 'the cake' as being the best upcoming NP2 candidate. In contrast, the verb 'move' in sentence (2) is not that specific. Again the subcategorization of the verb makes a post-verbal argument expected, however, as multiple depicted objects could undergo a moving event, 'the cake' was not necessarily the most plausible argument of 'move'. The verb 'eat' evokes certain characteristics or properties that are intrinsic to the verb and is therefore more specified than a broader verb as 'move'. As it reduces the amount of upcoming NP2s that are plausible to co-occur with those preceding elements, a more specified preceding verb as 'eat' selects a smaller selection of potential following NP2s than a less specified verb as 'move'. Eventually, on the basis of plausibility, listeners pick the best NP2 candidate that is depicted on the visual scene. Thus, while hearing the verb, the English listeners anticipatorily fixated on the image of 'the cake' during a sentence as (1), but not when presented with a sentence as (2). The results of Altmann and Kamide (1999) demonstrated that the combination of the NP1 and the verb only drove anticipatory fixations on the upcoming NP2 image if the verb was specific and restricted the selection of potential NP2 candidates.

On that account, the question arose whether other information, besides the semantic and syntactic information of the verb, could provide a basis for the processor to anticipate upcoming input. To investigate this, Kamide and colleagues (2003) conducted two studies on case-markers as possible guiders in the NP anticipation process. Monitoring anticipatory NP fixations while hearing verb-final sentences was one of the ways to do this, as then the verb was precluded as a guider of anticipation. Kamide, Altmann and Haywood (2003) investigated the strict verb-final language Japanese, where every argument appears prior to the verb and where the arguments assign post-nominal case-markers on the noun phrases. They presented their participants exclusively canonical SOV sentences, although OSV sentences are also allowed in Japanese. Those experimental sentences were either in dative or accusative condition. Dative sentences as (3) included sentences with ditransitive verbs that required three NP arguments, such as ‘bring’, leading to a sentence with the sequence ‘NP1-nom, NP2-dat, adverb, NP3-acc, verb’. Accusative sentences as (4) included monotransitive verbs with two NP arguments, such as ‘tease’, resulting in a sentence with a ‘NP1-nom, NP2-acc, adverb, verb’ sequence. Foil sentences as (5) were included to contrast with experimental accusative sentences as (4). These foil sentences also had ditransitive verbs with three arguments, but occurred in the sequence ‘NP-nom, NP-acc, adverb, NP-dat, verb’, with the accusative and dative marked noun phrases reversed from the dative sentences. In all cases, the NP1 was an animate NP, such as ‘the waitress’, whereas the NP2s was in half of the cases an animate noun and in the other half an inanimate noun (e.g. ‘the costumer’ in (3) and (4), and ‘soft toy’ in (5)). The NP3s in the dative sentences were all inanimate objects (e.g. ‘hamburger’ in (3)), but in the foil sentences the NP3s could be animate objects as well (e.g. ‘child’ in (5)).

(3) **Dative condition**

weitoresu-ga	kyaku-ni	tanosigeni	hanbaagaa-o	ha-kobu.
waitress-nom	customer-dat	merrily	hamburger-acc	bring
Subject	Indirect Object	Adverb	Direct Object	Verb
NP1	NP2	Adverb	NP3	Verb

‘The waitress will merrily bring the hamburger to the customer.’

(4) **Accusative condition**

weitoresu-ga	kyaku-o	tanosigeni	karakau
waitress-nom	customer-acc	merrily	tease
Subject	Direct Object	Adverb	Verb
NP1	NP2	Adverb	Verb

'The waitress will merrily tease the customer.'

(5) **Foil sentence**

isya-ga	nuigurumi-o	yasasiku	kodomo-ni	ataeru.
doctor-nom	soft toy-acc	gently	child-dat	give
Subject	Direct Object	Adverb	Indirect Object	Verb
NP1	NP2	Adverb	NP3	Verb

'The doctor will gently give the soft toy to the child'

(Kamide, Altmann, & Haywood, 2003)

Since in Japanese it is not grammatically correct to have a nominal subject NP1 and a dative indirect object NP2 without an accusative direct object NP3, an accusative third noun phrase is expected after the dative NP2 in sentence (3). Contrarily, in sentence (4), the accusative direct object occurs as the NP2, and a dative indirect object NP3 is optional. When being presented with a sentence as (4) in Japanese, there are two possible ways for this sentence to continue after the accusative marked NP2 'the customer': either as a monotransitive construction without a dative NP as (4), or as part of a construction with three noun phrases where a dative NP3 follows the accusative NP2. This construction with three noun phrases would lead to a construction as (5). Essentially, in the dative condition in (3) a subsequent accusative noun was required and so expected to be anticipated, whereas in the accusative condition in (4) a dative noun is optional and thus less expected.

Consider that sentences (3) and (4) differ in content, but that for both sentences participants saw a semi-realistic visual scene with images of a 'waitress', a 'hamburger', a 'costumer' and a 'dustbin'. In the dative condition in (3), the NP3 image of 'the hamburger' received significantly more fixations prior to its onset – during the adverb region 'merrily' – than the other images. The nominative marked NP1 'the waitress' and the dative marked NP2 'the costumer' made listeners anticipatorily fixate on the accusative marked NP3 'the hamburger' during the subsequent adverb ‘merrily’. In the accusative sentence in (4) with the nominative marked NP1 ‘the waitress’ and the accusative marked NP2 ‘waitress’, a plausible dative direct object was not depicted. Therefore, no upcoming NP3 was expected and anticipated.

These results of pre-head anticipation in Japanese indicated that the syntactic case-markers on the noun phrases informed listeners about the probability of an upcoming NP3. Thus, not only the verb can guide anticipation, but also syntactic information of case-markers made listeners anticipate upcoming arguments. That is to say, it is the case array that provides information about how many arguments are expected to come up. In the end, it is the likelihood of a ‘hamburger’ co-occurring with arguments such as ‘waitress’ and ‘costumer’ that led the listener’s decision to fixate on the image of the ‘hamburger’ as it was presumed to be the best upcoming NP3 candidate.

Moreover, Kamide, Scheepers and Altmann (2003) investigated German, a language that is flexible in its word order possibilities and has a rich case-marking system that assigns grammatical roles to noun phrases. In contrast with Japanese, it allows verb-final sentences but it is not a strict verb-final language. In declarative main clauses, the verb is moved to the verb-second position (Bader & Lasser, 1994). Because verb-second sentences are allowed in German, it could be investigated whether syntactic information extracted from the case of one NP and a verb, combined with semantic information of the NP1 and the verb could lead to NP2 anticipation. To determine this, participants were presented with declarative main clauses in SVO order as in (6) and passive sentences in OVS order as in (7). At the same time, participants saw a semi-realistic visual scene portraying two animate and two inanimate objects, for these particular sentences images of an animate ‘hare’, an animate ‘fox’, an inanimate ‘cabbage’ and an inanimate ‘tree’. Although the visual display that was presented for these sentences was identical, the sentences differ in terms of content due to case-marking. The thematic role of the NP1 ‘hare’ was reversed from agent to patient from the SVO to the OVS sentence. Thereby the anticipatory NP2 referent differed among the two sentences. In sentence (6), it was the inanimate object the ‘cabbage’ that should be anticipated, in sentence (7), it was the animate object the ‘fox’.

The results of Kamide, Scheepers and Altmann (2003) demonstrated that in both the SVO and OVS sentences, the NP2 was anticipated. Firstly, this showed that anticipation is not restricted to canonical word orders, but also takes place while being presented with sentences in less prominent word orders. Secondly, it demonstrated that indeed the syntactic information extracted from the case of the NP1 ‘hare’ and the verb ‘eats’, in combination with the lexico-semantic information of those preceding elements, guided the anticipation of the NP2. Recall that the content of the SVO and OVS sentences differed and that these results did not prove that NP2 anticipation in an OVS sentence happens if the content was identical to the content of the counter SVO sentence. Now, content and lexico-semantic differences might still have guided the anticipation process.

(6) **SVO**

Der Hase	frißt	gleich	den Kohl.
The hare-nom	eats	shortly	the cabbage-acc.
Subject	Verb	Adverb	Object
NP1	Verb	Adverb	NP2

'The hare will shortly eat the cabbage.'

(7) **OVS**

Den Hases	frißt	gleich	der Fuchs.
The hare-acc	eats	shortly	the fox-nom.
Object	Verb	Adverb	Subject
NP1	Verb	Adverb	NP2

'The hare will be eaten by the fox' (Kamide, Scheepers, & Altmann, 2003)

Those NP2 anticipation effects that Kamide, Altmann and Haywood (2003) obtained with their German study, initiated at verb onset and continued during the adverb region. Earlier, while hearing the NP1, the NP2 was not anticipated yet. Since the critical target sentences were main clauses without any preceding prior context, it was uncertain for the listeners whether an SVO or OVS clause would follow until the case of the NP1 was given. A preceding discourse or clause could have given the participant some time to indicate the upcoming word order and the order in which the upcoming constituents would appear. If this word order was – due to preceding discourse – known beforehand, more information about the upcoming sentence would have been available by the time the NP1 was auditorily received.

Taken together, previous research demonstrated that both syntactic (e.g. Altmann & Kamide, 1999, 2007; Kamide, Altmann & Haywood, 2003; Kamide, Scheepers & Altmann, 2003; Knoeferle, Crocker, Scheepers, & Pickering, 2005; Boland, 2005) and semantic information seem to play an important role in the anticipation process. As a follow-up, Sauppe (2016) focused on the use of semantic information for anticipation during a visual world paradigm study. To do so, he investigated the verb-initial language Tagalog[2], a language where the affixes on the verb provide listeners with information about the order in which the agent and patient will follow the sentence-initial verb. He focused on both NP1 and NP2 anticipation.

The affixes on the verb show the semantic role of the pivot argument (i.e. the topic of the clause). The non-pivot argument follows the verb, and if there is an adverb it occurs after the verb and prior to the non-pivot argument. The pivot argument occurs by default in sentence-final position. If the verb in sentence-initial position carries the affix of the agent as in (8), this agent is the pivot NP2 argument that occurs in sentence-final position (VOS). However, if the verb carries the patient affix as in (9), the patient is the pivot NP2 argument and occurs sentence-finally (VSO). By looking into anticipatory fixations in these two constructions, it could be investigated whether the voice marker on the verb was used to indicate what was the order of the upcoming NP1 and NP2. Although the affixes on the constituents differed, the content of the sentences was similar among the different word orders. In each sentence the 'frog' was the agent and the 'fly' the patient.

Supplementary to the agent pivot (VOS) and patient pivot constructions (VSO), the author included a third sentence construction with the verb being unmarked for voice but carrying an invariant aspect marker. In this recent perfective sentence as (10), there is no pivot argument and the canonical argument order is retained, with after the verb, the agent subject followed by the patient object (VSO). During this visual world paradigm study, participants were presented with visual displays with three isolated depicted images, being an NP1, an NP2 and a distractor image. For the example sentences in (8) – (10), participants saw a display with images of a 'frog', a 'fly' and a 'printer', with for all sentences 'the printer' as the distractor image. In sentence (8), the 'fly' was the non-pivot NP1, but in sentences (9) and (10) the pivot NP2. On the contrary, the 'frog' was the non-pivot NP1 in sentences (9) and (10), but the pivot NP2 in sentence (8).

Altogether, anticipation of upcoming linguistic input in these three sentence configurations could gain insight into what kind of information Tagalog listeners use to anticipate the forthcoming NPs after having heard the sentence-initial verb. While hearing the verb 'eat', listeners could pick 'frog' as a plausible agent and 'fly' as a plausible patient of the verb. If the verb was assigned with an agent pivot marker (8), anticipatory fixations on the patient NP1 'fly' were expected because the patient was the non-pivot NP1, and the agent the pivot NP2 that occurs sentence-final. If the verb had a patient pivot marker (9) or a recent perfective marker (10), it was expected that listeners would anticipatorily started to fixate on the agent NP1 image of the 'frog' during the adverb, as this was the non-pivot argument and thus the first upcoming noun phrase. This non-pivot 'frog' was followed by the

[2] Tagalog is an Austronesian language that is primarily spoken in the Philippines by around 80 million speakers.

patient NP2 'fly', occurring in sentence-final position. In both sentences (9) and (10), the patient 'fly' occurs sentence finally, in (9) because this NP2 is the pivot argument, in (10) because both arguments are non-pivot and hence the common word order VSO is followed.

(8) **Agent pivot**

Kakain sa umaga		ng=langaw	ang=palaka
eat:AV	in the morning	NPVT=fly (**P**)	PVT=frog (**A**)[3]
Verb	Adverb	Object	Verb
Verb	Adverb	NP1	NP2

'The frog will eat a fly in the morning'

(9) **Patient pivot**

Kakainin sa umaga		ng=palaka	ang=langaw
eat:PV	in the morning	NPVT=frog (**A**)	PVT=fly (**P**)
Verb	Adverb	Subject	Object
Verb	Adverb	NP1	NP2

'A/the frog will eat the fly in the morning'

(10) **Recent perfective**

Kakakain pa lang ng=palaka			sa=langaw
eat:RP	just	NPVT=frog (**A**)	NPVT=fly (**P**)
Verb	Adverb	Subject	Object
Verb	Adverb	NP1	NP2

'A/the frog just ate the fly'

[3] The abbreviations are labelled as following, AV = AGENT PIVOT, PV = PATIENT PIVOT, NPVT = NON-PIVOT, PVT = PIVOT, P = PATIENT, A = AGENT.

For NP1 anticipation in the three sentence conditions (i.e. patient pivot, agent pivot and recent perfective), results showed that while hearing the verb and the adverb, listeners were most likely to start fixating on the image of the agent 'frog', as the NP1. These fixations on the image of the agent NP1 'frog' were irrespective of whether this agent was the non-pivot NP1 argument or the pivot NP1 argument that occurs in sentence-final position. For the patient-pivot and recent perfective sentences the anticipation was correct, as indeed the 'frog' was the first mentioned noun phrase. However, for the agent-pivot sentence (8), this anticipation was incorrect as the patient was the NP1 'fly' and the agent the pivot NP2. So, even when the verb marker indicated that the patient would be the NP1 'fly', there were still more anticipatory fixations on the agent image of the 'frog' that was the NP2.

Considering NP2 anticipation, while hearing the adverb, Sauppe expected to find anticipatory NP2 fixations on the image that was a plausible second argument of the verb and the NP1, either the 'frog' in (8) or the 'fly' in (9) and (10). What he found was that listeners did predict the corresponding referent towards the end of the encountering of the NP1, either the agent NP2 in agent-pivot sentences or the patient NP2 in patient-pivot sentences. For this NP2 anticipation, the information of the earlier retrieved verb and NP1 was used. This means that during the entire agent-pivot VOS sentence the eyes fixates on the agent image of the 'frog'.

Sauppe's findings (2016) showed that listeners did not use the syntactic information of the verb affixes but were more prone to use the lexical semantics of the verb to anticipate the upcoming NP1. This lexical verb information made them pick the agent of the verb and made them fixate on this agent image, even when the agent was not the NP1. For NP2 anticipation, anticipatory fixations were on the image that was most plausible to occur as the theme of the previous heard verb and NP1.

The main aim of the present study is to further investigate the anticipation of upcoming NP2s in SVO and SOV sentences. In an SVO sentence, the NP1 and verb appears prior to the NP2, as in sentence (11). In an SOV sentence as (12), the verb is not available yet and thus cannot be used during the anticipation process. Investigating verb-final sentences in Dutch is worthwhile, because the NP1 precedes the NP2 and the verb cannot help in the NP2 anticipation process. Moreover, also due to the lack of case marking, not much useful syntactic information is provided by the noun phrases of SOV sentences (Koster, 1975, 2000) to guide NP2 anticipation.

(11) **SVO**

De jongen	eet	de taart
Subject	Verb	Object
NP1	Verb	NP2
'The boy	*eats*	*the cake'*

(12) **SOV**

Ik denk	[dat	de jongen	de taart	eet]
		Subject	Object	Verb
		NP1	NP2	Verb
'I think	*that*	*the boy*	*the cake*	*eats'*

As noticeable in (12), the SOV sentence is preceded by a main clause, since a Dutch SOV sentence is only grammatical as an embedded clause and is always preceded by a main clause with a subordinated conjunction *dat* 'that', *of* 'or' or *omdat* 'because' in SpecCP-position[4] (Bennis, 2000). Without a preceding main clause or subordinating conjunction ungrammatical sentences, such as (13) and (14), are generated. In contrast, a Dutch SVO sentence is itself a main clause, but can be preceded by another main clause, resulting in a quotative sentence paradigm as in (15). Even though sentence (15) consists of two main clauses and sentence (12) of a main clause [*Ik denk*] '[I think]' and an embedded clause [*dat de jongen de taart* eet] '[that the boy the cake eats]', the two grammatical constructions can be closely compared in terms of semantic information they provide and the thematic roles of the constituents.

(13)

*dat	de jongen	de taart	eet
	Subject	Object	Verb
	NP1	NP2	Verb
'That	*the boy*	*the cake*	*eats'*

[4] See more on required complementizers in SpecCP-positions in embedded clauses in Bennis (2000: 84-86)

(14)	*[De zin is	[de jongen	de taart	eet]]
	Carrier sentence	Subject	Object	Verb
	Carrier sentence	NP1	NP2	Verb
	'The sentence is	*the boy*	*the cake*	*eats'*

(15)	**SVO**			
	Ik denk:	de jongen	eet	de taart
	Main clause	Main clause		
		Subject	Verb	Object
		NP1	Verb	NP2
	'I think	*the boy*	*eats*	*the cake'*

Henceforth, I will use the term 'critical sentence' to refer to the second clause for both the embedded clause of the SOV sentence *de jongen de taart eet* 'the boy the cake eats' and the second main clause of the SVO sentence *de jongen eet de taart* 'the boy eats the cake'. Because the critical SVO sentence and the critical SOV sentence are preceded by two different main clauses, listeners can determine whether an SVO or and SOV sentence comes next, while hearing this preceding main clause.

In our study, both the structure of the preceding main clause and the intonation of these main clauses differ and have a disambiguating effect. This intonation and prosody can be powerful auditory cues to use for anticipation of the upcoming word order. Earlier it is shown that suprasegmental prosodic information is processed immediately and in parallel with segmental information during language processing (Ito & Speer, 2008; Mulders & Szendröi, 2016). Therefore, it is not only the segmental information of the preceding main clause but also the suprasegmental information of the clause that provides information for the anticipation process. Thereby, the critical SVO and SOV sentences also have their own prosodic properties that are distinguishable. This means that also when an SVO and SOV sentence have the same NP1, the intonation of this NP1 differs. The intonation of the subject NP1 could provide information about whether the following order of the constituents is VO as in (15) or OV as in (12).

The asymmetry made by the structure and prosody of the preceding main clauses enables participants to predict what word order the upcoming critical sentence will have. If the preceding main clause did not reveal the word order of the upcoming critical sentence and the prosody of the NP1 was identical among the two sentence configurations, listeners should only be able to distinguish the two word orders at the point of the second constituent (i.e. the verb in SVO or the NP2 in SOV).

When investigating NP2 anticipation in SOV sentences, the anticipatory fixations on the object NP2 should occur while hearing the subject NP1. Finding these NP2 anticipation effects while hearing the NP1 in SOV sentences would be very unlikely if no preceding main clause was present. Immediately presenting listeners to isolated SOV sentences would not give them time to both process the NP1 itself and anticipate the NP2. In our study with Dutch, the subject NP1 can already be identified and processed anticipatorily during the encounter of the preceding clause. This was particularly easy because the NP1 was the only depicted animate object in all sentences. Subsequently, the information of the early identified NP1 can be used for the anticipation of the upcoming NP2. In essence, in our study, NP2 anticipation can start already at the time the NP1 is heard.

In these Dutch SOV sentences, the information provided by the NP1 becomes increasingly relevant for the NP2 anticipation process because there is no guiding verb. It is the NP1 that should select plausible co-arguments, and not the verb. An NP1 that is not sufficiently concrete does not lead to anticipation because there is no sufficient specific information available about what depicted object is most likely to follow as an argument. Statistical information about the co-occurrence of certain arguments may drive anticipatory processing (Altmann & Kamide, 2007). For this to happen, discourse or real-world knowledge is necessary to explore whether a certain NP2 is a plausible candidate to follow the NP1 that is heard (e.g. Altmann & Kamide, 1999; Kamide, Altmann & Haywood, 2003; Kamide, Scheepers & Altmann, 2003). The best NP2 candidate that is depicted receives most fixations.

If it is the case that indeed plausibility information of one element is enough for the anticipation of a second forthcoming element, it would mean that additional morphosyntactic information, or lexico-semantic and syntactic verb information is not always mandatory for anticipation to take place. In that case, the structure and prosody information provided by the preceding clause, and the lexical semantics and prosody of the NP1 is sufficient to enable the anticipation of the immediately following NP2. On the basis of plausibility, such as a semantic relationship among the NP1 and NP2, the NP1 selects a potential NP2 candidate.

In fact, in Altmann and Kamide (1999) it was for a great part the lexical semantic meaning of the verb that guided the NP2 anticipation. Both ‘eat’ and ‘move’ were monotransitive verbs where a post-verbal argument was expected, but eventually it was the lexical meaning of ‘eat’ that led to NP2 anticipation and not ‘move’. Kamide, Scheepers and Altmann (2003) concluded that the verb, the case-markers associated with the NP1 and real-world knowledge enabled the NP2 anticipation of German speakers. Kamide, Altmann and Haywood (2003) asserted that in the case of Japanese, it was the case array of the noun phrases in combination with the plausibility of the noun phrases that allowed them to anticipate an upcoming noun phrase.

To determine whether information provided by the NP1 was used for the anticipation process, Kamide, Altmann and Haywood (2003) conducted two more experiments with English native speakers in their study. In one of the experiments with English listeners, participants saw a semi-realistic visual scene with images of a 'man', a 'young girl', a 'motorbike', a 'carousel' and a 'glass of lemonade'. Simultaneously, they heard either the sentence 'The man will ride the motorbike' or 'The girl will ride the carousel'. In these sentences, it was specifically the subject NP1'the man' or 'the girl' that restricted the plausible theme of the verb 'ride', since it is more plausible for a girl to ride a carousel, than a motorbike. While hearing the verb 'ride', anticipatory fixations on the image of 'the motorbike' were found when the NP1 was 'the man', and on the NP2 image of 'the carousel' when the NP1 was 'the girl'. It was the lexical semantic meanings of the NP1 together with the verb that made people anticipate the upcoming NP2. On its own, the NP1 was not specific enough to know the upcoming NP2 without the verb. Namely, if the NP1 was combined with another verb such as 'kiss', this would have led to anticipatory fixations to the 'man' rather than 'the carousel', as it is more plausible to kiss a man than any of the other objects in the visual scene (i.e., a carousel, a motorbike or a glass of lemonade)

It has been shown that eyes are likely to fixate on objects that relate semantically with what is heard. This is the case – among others - on the basis of thematic compatibility (Altmann & Kamide, 1999; Kukona. Fang, Aicher, Chen, & Magnuson, 2011; Kamide, Altmann & Haywood, 2003; Kamide, Scheepers & Altmann, 2003), category (Huettig & Altmann, 2005) or function (Yee & Sevidy, 2006); (Kukona et al., 2011: 15). For instance, when hearing 'the piano' listeners are more likely to fixate on an image within the same category, such as trumpet, than on other unrelated distractor images from a 'goat, a 'carrot' and a 'hammer' (Huettig & Altmann, 2005). But also when hearing a sentence such as 'Toby arrests the crook', while hearing the verb 'arrests', an image of a 'policeman' received almost as much fixations as the image of the actual upcoming NP2 object 'the crook'. This shows that even when listeners know that the crook is the patient NP2 who is arrested, the thematic compatibility of an argument as 'policeman' co-occurring with an argument as 'crook', make people fixate on a possible agent that was not mentioned.

Lexical semantic meanings of preceding elements can yield information about the lexical semantics of an upcoming element. Those processes of semantic priming can drive anticipation of upcoming referents (Kukona et al., 2011). Prospectively, anticipatory fixations to an NP2 image 'the cake', while hearing 'eat', will be more prominent in a sentence as 'The birthday kid will eat…' than in a sentence as 'The boy will eat...'. In this first sentence, the NP1 ‘birthday kid’ and the NP2 ‘cake’ are semantically associated and therefore both restrict what arguments are plausible continuations. The fact that the NP1 ‘birthday kid’ is more specific about what is likely to come up as a co-argument might lead to early NP2 anticipation, during the auditory encounter of the NP1’the birthday kid’ or during the future tense verb ‘will’.

In SOV sentences, only the NP1 is available, meaning that this NP1 should provide enough information in order to be informative to guide NP2 anticipation. As Dutch noun phrases do not contain case-markers, it is the lexical semantics of these NP1s that should provide this guiding information. Therefore, it is assumed that the concreteness of the NP1s is of great importance, meaning that it should be clearly defined what essential attributes of objects, events, and relations, are associated with the noun. This system of relations that characterizes the semantics of a lexical item, is called the qualia structure, and is part of the Generative Lexicon Theory[5] that is initiated by Pustejovsky (1991; see also Pustejovsky & Boguraev, 1993).

Nouns differ in how adequate and specified the roles in the qualia structure can be realized (Bouillon & Busa, 2001). From a noun as ‘pilot’ the representational framework is much richer than that of a noun as ‘man’ due to the abstractive and broader dimension of ‘man’ compared to ‘pilot’. This noun ‘pilot’ is a more specific noun (hyponym) of the broader noun ‘man’ (hypernym). The lower the noun is posited in the hierarchical taxonomy, the more specified the semantic field of that noun is (e.g. Gao & Xu, 2013). In other words, the semantic field of the hyponym ‘pilot’ is much more specific than the semantic field of the hypernym ‘man’, which is broader. In the remainder of the thesis, the more specific noun phrases are labelled ‘concrete noun phrases’ (e.g. ‘pilot’) and the broader nouns ‘abstract noun phrases’ (e.g. ‘boy’).[6]

When hearing a noun like ‘pilot’, various attributes of objects, events and relations that are associated with the noun, as in the qualia structure, will be activated. This could be semantically related concepts as ‘fly’, ‘airplane’, ‘stewardess’ and ‘uniform’, which are rather specified. In contrast, when hearing a noun like ‘man’, less specific attributes will be activated because less concrete nouns are semantically associative with the abstract NP1. In essence, the co-occurring arguments that are activated when hearing an abstract NP1 like ‘man’ are less

[5] In short, the Generative Lexicon Theory (Pustejovsky, 1991) introduces a knowledge representation framework which offers a rich and expressive vocabulary for lexical information. The computational lexical semantics of words need to make reference to four levels of representation: argument structure, event structure, qualia structure and lexical inheritance structure. The qualia structure that specifies the systems of relations of nouns, identifies four aspects of a word’s meaning:
- constitutive role (the relation between a word and its constituent parts);
- formal role (that which distinguishes it within a larger domain);
- telic role (its purpose and function);
- agentive role (factors involved in its origin or “bringing about”).

[6] Remember that in this context, I do not refer to the concrete words as these words being better imageable than the abstract words (Fliessbach et al., 2006). A term as ‘less-concrete noun phrase’ might have been chosen as well, however, it might also have caused confusion.

specific than the concepts that are activated when hearing a concrete NP1 like ‘pilot’. In the case of the concrete noun ‘man’, a concept as ‘letter’ will not be activated because the two concepts are not semantically associated.

Based on real-world knowledge, the NP1 activates potential NP2s that are semantically associable with this NP1. Hence, the NP2 arguments that are likely to co-occur with the NP1, are potential NP2 candidates. Visual world paradigm studies depict only a selection of objects (e.g. four or five objects at most), from which one is in many instances the NP1, one the NP2 and the others are distractors. From the depicted objects that are not the NP1, only one object is semantically associable and thematic compatible with the NP1: the NP2 referent. This NP2 is the most plausible upcoming element and the image of this NP2 is the one that should receive anticipatory fixations while hearing the NP1. On the contrary, if an NP1 is abstract there is not enough information provided to select one of the depicted images as the best NP2 candidate.

1.1. THE CURRENT STUDY

In this thesis, I aim to answer the following research question: Do Dutch native speakers anticipate an upcoming object NP2 in SOV and SVO sentences before this NP2 is heard? By means of a visual world paradigm study, I examine this question by looking into the anticipatory processing of two different word orders in Dutch: verb-final SOV constructions and verb-second SVO constructions.

The main interest lies in the investigation of NP2 anticipation in the verb-final SOV sentences. The examination of the processing of verb-final Dutch sentences could show us whether the four available information sources are enough for NP2 anticipation to occur, these being 1) the structure of the preceding clause, 2) the intonation of the preceding clause, 3) the intonation of the NP1 and 4) the lexico-semantic information of the NP1.

Before the critical sentence is initiated, the preceding clause makes listeners start thinking ahead of the order in which the arguments of the upcoming critical sentence will appear. Additionally, the intonation of the NP1 provides information about the order of the following constituents. But the NP1 also carries lexico-semantic information that can be used to select potential NP2 candidates on the basis of real-world contingencies between the NP1 and NP2. If, while listening to SOV sentences, it turns out that Dutch speakers do not anticipatorily fixate on the NP2, this would mean that the information provided by the preceding clause and the NP1 are not enough and additional syntactic information might be necessary for the NP2 anticipation process.

On the other hand, the reason for investigating NP2 anticipation in SVO sentences is threefold. Firstly, investigating Dutch verb-second sentences allows us to test whether NP2 anticipation occurs in a sentence with more information available than in the SOV sentence, in this case verb information. This condition would allow us to replicate the earlier obtained findings of NP2 anticipation cross-linguistically. Dutch differs from the earlier investigated languages English, German and Japanese, such as that it lacks case-marking and/or differs in word order possibilities.

Moreover, findings of this study can contribute to the ongoing debate on whether SVO or SOV sentences are processed fastest and most easily by Dutch speakers. On the one hand, one can assume that SOV sentences are processed faster because this word order is the default and canonical word order, and no syntactic transformations needs to be implemented.[7] In that case, because of greater processing complexity due to transformation, processing SVO sentences would be harder than processing SOV sentences (den Ouden, Hoogduin, Stowe & Bastiaanse, 2008). On the other hand, one would expect the most frequent SVO word order to be processed the fastest (den Ouden et al., 2008). Based on both the Corpus Gesproken Nederlands (CGN) on spoken language and the Twente Nieuws Corpus (TwNC) on written language, den Ouden etl al. (2008) showed that in general Dutch verb-second sentences are highly frequent compared to Dutch verb-final sentences. Furthermore, Weyerts and colleagues (2002) argued that SVO sentences are possibly easier to process because people prefer a minimized distance between the subject and the finite verb as in SVO sentences.

To answer my research question, two variables are considered for the stimuli in this study: word order (SVO and SOV) and association (associated and unassociated). All stimuli sentences consisted of a preceding main clause (i.e. the carrier sentence) and a critical sentence. The critical sentences contained an NP1-NP2-verb sequence (SVO) or an NP1-verb-NP2 sequence (SVO). Each critical sentence included either associated or unassociated NPs. In the associated condition, the NP1 and NP2 were semantically associated, such as ‘pilot’ and ‘airplane’, where NP1 ‘pilot’ semantically primes NP2 ‘airplane’. It is assumed that these two NPs are likely to co-occur as arguments in a sentence. In the unassociated condition, the NP1 and NP2 were semantically unassociated, such as NP1 ‘girl’ and NP2 ‘letter’. It was therefore assumed that when hearing NP1 ‘girl’, an object as ‘letter’ will not directly be selected as a plausible upcoming theme without a mediating verb. In those unassociated sentences, it is primarily the verb that connects the two NPs.

Sentences (16) and (17) exemplify associated sentences and sentences (18) and (19) unassociated sentences, in the SVO and SOV word order, respectively. While hearing the audio stimuli, participants are presented to a

[7] In addition to that, based on Kayne (1994), Zwart (1994) argued that all OV languages are ultimately derived from an underlying SVO word order, because sentences always start with a VP and noun phrases move. See Zwart (1994) for an extensive report on this claim of Dutch being an underlying SVO language.

visual display with four isolated images: the NP1, the NP2 and two distractor images[8]. In the following paragraphs I state the hypothesis per sentence condition.

(16) **SVO-Associated**

De zin luidt:	De piloot	bestuurt	het vliegtuig	
Carrier sentence	Subject	Verb	Object	
Carrier sentence	NP1	Verb	NP2	
The sentence states:	*The pilot*		*drives*	*the airplane*

(17) **SOV-Associated**

De zin luidt dat	de piloot	het vliegtuig	bestuurt
Carrier sentence	Subject	Object	Verb
Carrier sentence	NP1	NP2	Verb
The sentence states that	*the pilot*	*the airplane*	*drives*

(18) **SVO-Unassociated**

De zin luidt:	Het meisje	schrijft	de brief
Carrier sentence	Subject	Verb	Object
Carrier sentence	NP1	Verb	NP2
The sentence states:	*The girl*	*writes*	*the letter*

(19) **SOV-Unassociated**

De zin luidt dat	het meisje	de brief	schrijft
Carrier sentence	Subject	Object	Verb
Carrier sentence	NP1	NP2	Verb
The sentence states:	*The girl*	*the letter*	*writes*

[8] As mentioned earlier, some studies presented their participants semi-realistic visual scenes (e.g. Altmann & Kamide, 1999; Kamide, Altmann & Haywood, 2003; Kamide, Scheepers & Altmann, 2003) rather than isolated pictures to create more contextual real-world situations. It might simplify the creation of a mental representation. Nevertheless, it is not assumed this affects people's ability to anticipate (Huettig et al., 2011).

SVO-Unassociated

In the SVO-Unassociated sentence in (16), the abstract NP1 'girl' and the verb 'writes' are available prior to the NP2 and can be used to anticipate the upcoming NP2. Anticipatory fixations on the NP2 image of the 'letter' are expected to be found at the time of the encounter of the verb, as this is the first point in time where there is enough information provided to select the right upcoming NP2.

SVO-Associated

In the SVO-Associated sentence in (17), both the concrete NP1 'pilot' and the verb 'drives' contain information that can guide the NP2 anticipation process. Based on the preceding clause, listeners know that the upcoming sentence is not an SOV sentence and know that the NP2 will not immediately follow the NP1. Therefore, the anticipatory fixations on the NP2 image 'airplane' does not have to start while hearing the NP1, but are expected to start during the encounter of the verb.

SOV-Unassociated

In the SVO-Unassociated sentence in (18), early identification and processing of the NP1 'girl' is expected, while hearing the preceding main clause. However, no anticipatory fixations on the NP2 'letter' are expected to found while hearing the NP1. The NP1 'girl' is too abstract to provide enough semantic referential information to anticipate on 'letter' as the upcoming NP2. At this point, the distractor objects are still as likely to be the upcoming NP2 as the right upcoming NP2 referent. It is expected that the first point in time where the NP2 will receive more fixations than the distractor images is during the encounter of the NP2 constituent, where what is heard is integrated with what is depicted.

SOV-Associated

In the SOV-Associated sentence in (19), the preceding main clause makes participants anticipate that an SOV sentence is upcoming. Therefore, while hearing this preceding clause, anticipatory NP1 fixations are expected. Accordingly, the concrete NP1 'pilot' primes potential NP2s on the basis of semantic relatedness. Participants select the depicted NP2 object that is most likely to co-occur as an argument in a sentence with 'pilot', in this case NP2 'airplane'. That is to say, the anticipatory fixations on the upcoming NP2 image are expected to find while hearing the NP1.

Overall, we hypothesize that Dutch speakers do anticipate the NP2 in both SVO and SOV sentences, before this NP2 constituent is linguistically encountered. In SOV sentences, we only expect these anticipatory NP2 fixations if the NP1 is concrete and selects specific NP2 candidates that are potential to come up (i.e. SOV-Associated condition). If it is indeed the case that we found anticipatory NP2 fixations in SVO sentences and SOV-Associated sentences, this shows that also with a minimal amount of available information, NP2 anticipation occurs. Following, comparisons can be made about the specific points in time where anticipation was initiated and whether anticipation is more prominent in one of the sentence constructions. On the contrary, no NP2 anticipation effects in both SVO and SOV sentences would mean that the preceding semantic and syntactic information is not sufficient for people to anticipate the NP2. Finally, if in SVO sentences NP2 anticipation effects are found, but not in SOV sentences, this could indicate that the lack of verb information in the SOV sentences is crucial.

During the encounter of the preceding clause, we expect anticipatory fixations towards the NP1 image. It is the only depicted animate object, and thus easy to identify as the agent NP1. Moreover, it is visually the most salient and attractive image. This anticipatory processing of the NP1 during the preceding main clause, made it possible to anticipatorily process the NP2 – in SOV sentences – while hearing the NP1. However, this anticipation is only expected when the NP1 is semantically associated with the NP2. Listeners know that a verb will come first after the NP1 in SVO sentences, therefore they might retain their fixations on the NP1 image and only start the anticipation process during the encounter of the verb. While hearing the verb in SVO and the NP2 in SOV sentences, NP2 fixations were expected, either anticipatorily in SVO sentences and confirmatory in SOV sentences. Then, while hearing the last constituent – the NP2 in SVO sentences and the verb in SOV sentences – we presumed to find primarily fixations on the NP2 image for final sentence integration and sentence interpretation.

To this end, I proceed as follows. The following chapter describes the methodology of the study in detail. The third chapter presents the results of the study. This is followed by the discussion in the fourth chapter. A short conclusion is given in the fifth chapter.

2. METHODOLOGY

2.1. PARTICIPANTS

Forty monolingual native speakers of Dutch (female = 22, M_{age} = 23, range = 17-26) participated in the experiment. All participants were highly educated, having either a higher professional education background (i.e. HBO in Dutch) or a university education background. None of the participants reported any hearing or language problems and all of them had normal or corrected-to-normal vision. Each participant signed an informed consent form to indicate that they agree to voluntarily participate in the experiment (See Appendix I). The participants were acquaintances of the author and accepted to take part in the experiment without reimbursement of money or credits.

2.2. MATERIALS

In this visual world experiment, participants received simultaneously audio stimuli which were prerecorded sentences and visual stimuli which were four images depicted on a visual display. The stimuli were brought together into an experiment in Experiment Builder (2011).

The experiment had a two × two within-subject design with two variables: word order (SVO, SOV) and association (associated, unassociated). These two variables resulted in four sentence conditions: i) SVO-Unassociated, ii) SVO-Associated, iii) SOV-Unassociated and iv) SOV-Associated.

Audio stimuli

The prerecorded sentences contained a carrier sentence (i.e. the preceding main clause) followed by a critical sentence with three constituents: an NP1, an NP2 and a verb. For each critical sentence the NP1 was an animate subject, the NP2 an inanimate direct object and the verb was in present tense. The NPs and verbs were controlled and balanced on their frequency. The NP1s were di- or tri-syllabic words and the verbs and NP2s mono-, di-, or tri-syllabic. The reason for presenting longer NP1s was to prolong the participants' time to anticipate the upcoming NP2.

For each of the sentence conditions, 16 exemplars were created, with a total of 64 target stimuli sentences. Half of them were SVO sentences (32 items) and the other half were SOV sentences (32 items). The content of the SVO and SOV sentences was identical, but the order in which the constituents occurred differed. This means that there were 32 unique NP1-NP2 combinations, with each unique combination occurring in both SVO and SOV order. In the critical SVO sentences, the subject NP1 occurred first, followed by the verb and then the object NP2, such as in *Het meisje schrijft de brief* 'The girl writes the letter'. The order of the verb and the object NP2 was reversed for SOV sentences, with a NP1-NP2-verb sequence, as in *het meisje de brief schrijft* 'the girl writes the letter' that occurs after the preceding main clause with the subordinating conjunction *dat* 'that'.

The SVO and SOV sentences included half unassociated (i.e. 16 SVO-Unassociated, 16 SOV-Unassociated) and half associated (i.e. 16 SVO-Associated, 16 SOV-Associated) sentences. The unassociated sentences included NPs that were semantically unassociated, such as NP1 *het meisje* 'the girl' and NP2 *de brief* 'the letter'. The associated sentences included semantically associable NPs, such as *de piloot* 'the pilot' and *het vliegtuig* 'the airplane' (See **Table 1** for example sentences and Appendix II for the complete list of audio stimuli of the target items).

Table 1. *Examples of experimental SVO and SOV sentences in the unassociated and associated condition.*

Target stimuli	Carrier sentence	Critical sentence
SVO-Unassociated	De zin is: *The sentence is:*	Het meisje schrijft de brief *The girl writes the letter* subject verb object
SVO-Associated	De zin luidt: *The sentence states:*	De piloot bestuurt het vliegtuig *The pilot drives the airplane* subject verb object
SOV-Unassociated	De zin luidt dat *The sentences states that*	het meisje de brief schrijft *the girl the letter writes* subject object verb
SOV-Associated	De zin is dat *The sentence is that*	de piloot het vliegtuig bestuurt *the pilot the airplane drives* subject object verb

Six meaningless introductory sentences were chosen as carrier sentences that occur preliminary to the critical sentence. Those same six carrier sentences were used for all experimental trials (See **Table 1** for examples of carrier sentences). Three carrier sentences with 'that' were used for the SOV sentences and three without 'that' for the SVO sentences. In terms of content, the carrier sentences for the SVO and SOV sentences matched except from the *dat* 'that', that was added to the preceding main clause of the SOV sentences. During the recording of the audio stimuli, each sentence included a carrier and a critical sentence. Later, from all recorded carrier sentences, the six most unremarkable ones were picked and added to the critical sentences by the use of a PRAAT script (Boersma & Weenink, 2006). Within the word order type, what carrier sentence was attached to what critical sentence was assigned arbitrarily. The total amount of times a carrier sentence was added to a critical sentence was equally distributed.

Acoustical properties of the audio stimuli

The audio stimuli were recorded in a radio sound booth in Hilversum by a female native speaker of Dutch (age = 22 years) and sampled at 44.1kHz with a 16-bit sampling resolution. The sentences were recorded with a normal speech rate and a neutral intonation contour, such that parts of the sentence were not highlighted and sounded natural. The original prosody in the recordings was maintained. The first reason for this is that monotonous audio stimuli could have resulted in unnatural sounded speech. The second reason is that the prosodic information provided by the carrier sentence was important, as it could be used to reveal whether a critical SVO or SOV sentence would come afterwards (See Appendix III for the differences in pitch between the two word orders).

Every prerecorded sentence was inspected in order to detect any slip of the tongues, hesitations or unnatural pausing. If any of these instances occur, the sentence was rerecorded. After the check of the audio stimuli, some suprasegmental properties of the two word orders were compared by the use of PRAAT to indicate differences between the two sentence configurations. First, a PRAAT script was ran to obtain duration measurements of the three constituents in the SVO and SOV sentences. As can be observed in **Figure 2**, for both word orders, the first constituent was the longest and the second constituent the shortest. This means that the NP2 in the SOV sentences was shorter than the NP2 in the SVO sentences, and that the verb was longer in the SOV than in the SVO sentences

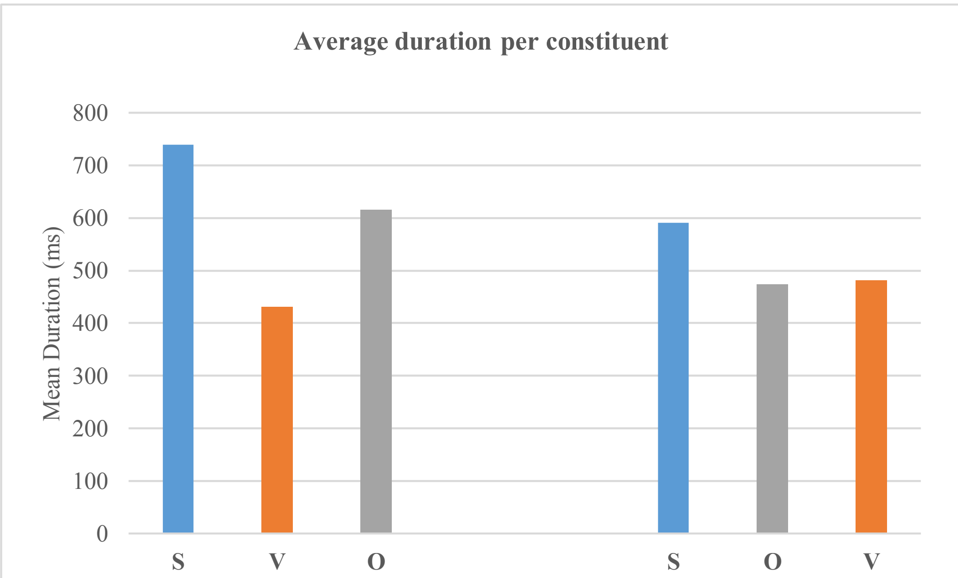

Figure 2. *Average durations of the constituents in the SVO and SOV word order in milliseconds (ms).*

Although the NP1 was in both sentences the longest constituent, it was longer in the SVO than in the SOV sentences. One of the reasons for this is a pause between the NP1 and the verb in the SVO configuration. This pause prosodically belongs to the NP1 and thus is part of the NP1 constituent. Together, this gives two prosodic phrases, one of the NP1 and one of the verb plus the NP2. In the SOV sentences, hardly any pause between constituents was examined, indicating one prosodic phrase including the NP1, NP2 and verb. If there was a short pause after a constituent, it was part of this previous constituent (See also Appendix IV for more detailed information about the durations of the constituents per sentence condition).

Second, the mean pitch of the constituents in the SVO and SOV word order was measured by the use of PRAAT. **Figure 3** shows that the average F0 of the NP1 in the SVO and SOV sentences was almost identical. In the SVO sentences, there was almost no difference between average F0 of the verb and the average F0 of the NP1, and the sentence-final NP2 has the lowest mean pitch. Contrarily, in the SOV sentences, the NP2 has a higher mean pitch than the NP1. Also for this SOV configuration, the sentence-final constituent has the lowest mean pitch, i.e. the verb. The sentence-final constituent in the SOV sentences was lower than the sentence-final NP2 in the SVO sentences (See Appendix V for F0 values per constituent and per sentence condition).

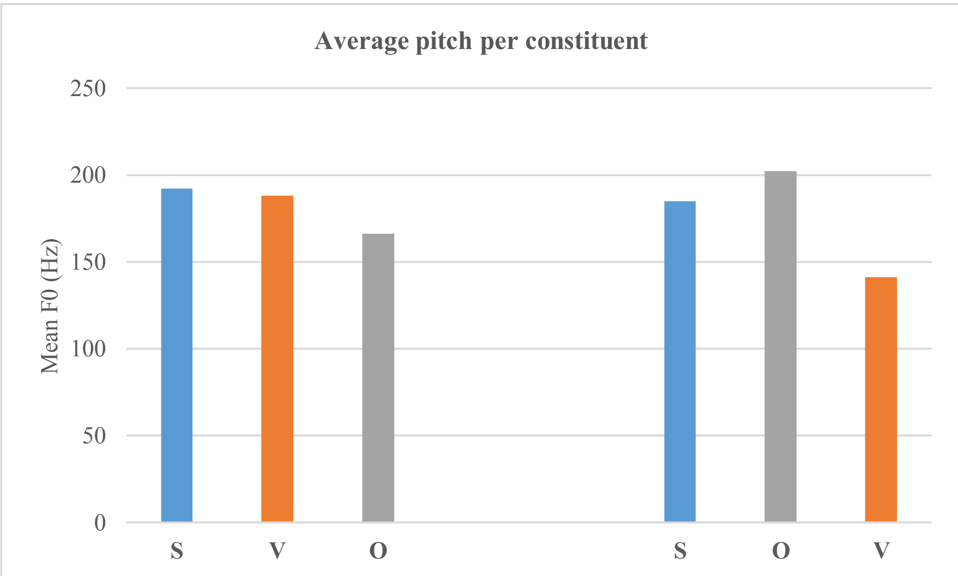

Figure 3. *Average F0 of the constituents in the SVO and SOV word order in Hertz (Hz).*

Visual stimuli

In addition to the audio stimuli, participants were also presented with visual stimuli. The visual stimuli consisted of visual displays presenting four different isolated images per auditory sentence: i) an NP1 image, that was always a visual representation of the grammatical animate subject of the sentence, ii) an NP2 image, being a visual representation of the inanimate grammatical object that was the anticipatory referent, and so the target, iii) an inanimate distractor image that matched the article of the anticipatory NP2 referent but did not match the input of the critical sentence, iv) an inanimate article distractor image that mismatched the NP2 article and the input of the critical sentence. Thus, for each visual display two of the four images conformed the NP1 and NP2 of the trial's audio stimulus, whereas the other two were distractors that did not match the audio input. In no case, the distractors phonologically or semantically overlapped with the target NP2. The distinction between the distractor and article distractor is made because it might occur that the distractor is more a competitor of the NP2 referent, as it matches the article of the upcoming NP2, whereas the article distractor mismatches. If NP2 anticipation effects will be determined, it would be interesting to investigate further whether the article of the upcoming referent was used in the anticipation process.

Figure 4 shows an example of a visual display constructed for an unassociated sentence, such as *De zin is dat het meisje de brief schrijft* 'The sentence is that the girl writes the letter' (or the counter SVO version), where the NP1 is *het meisje* 'the girl', the NP2 *de brief* 'the letter', the distractor *de lasso* 'the lasso' and the article distractor is *het ijsje* 'the ice cream'. **Figure 5** illustrates an example of a visual displays created for an associated sentence, such as *De zin is dat de piloot het vliegtuig bestuurt* 'The sentence is that the pilot the airplane drives' with *de piloot* 'the pilot' as NP1, *het vliegtuig* 'the airplane' as NP2, *het boek* 'the book' as the distractor and *de taart* 'the cake' as the article distractor.

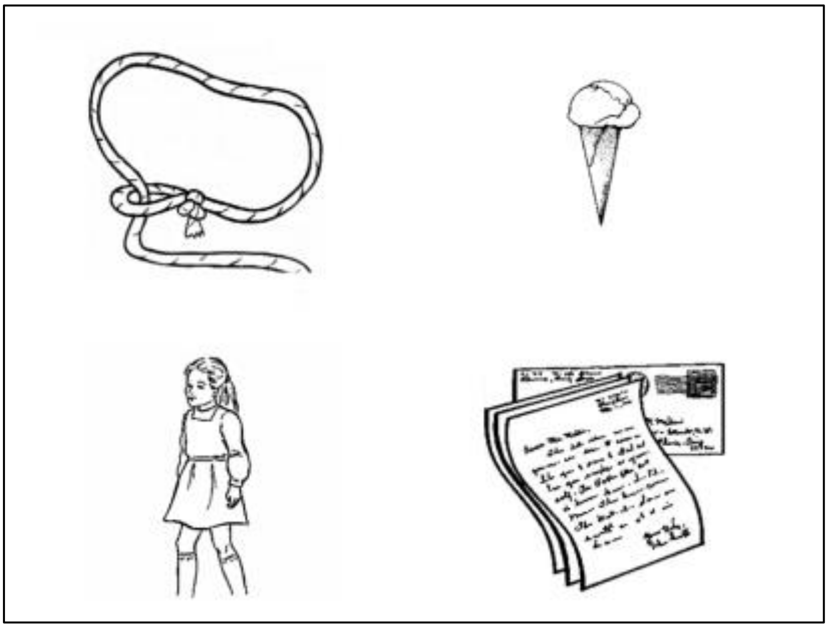

Figure 4. *Example of a visual display of an unassociated sentence with NP2, NP1), distractor and article distractor.*

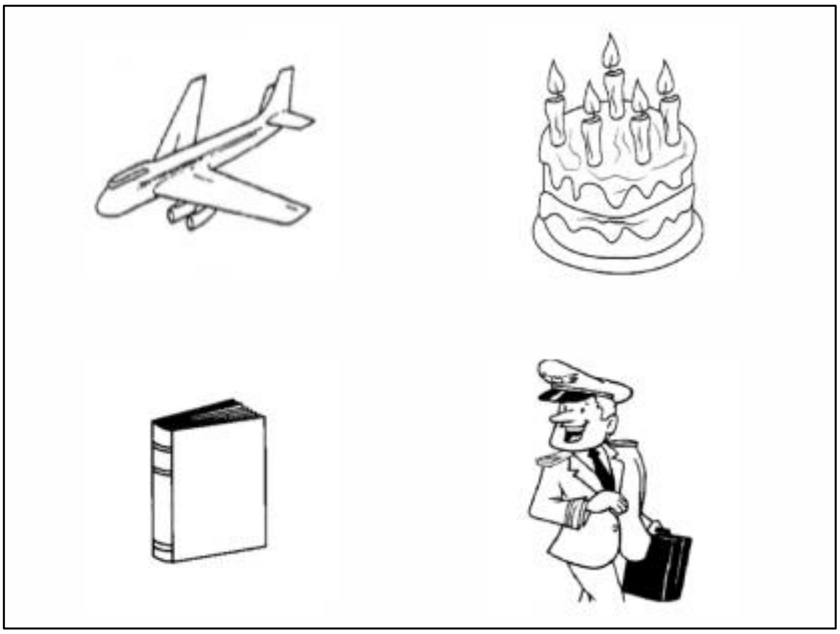

Figure 5. *Example of a visual display of an associated sentence with NP2, NP1, distractor and article distractor.*

The NP1s in the associated condition were concrete noun phrases and occurred twice as a referent on the visual display, once as NP1 of the SVO sentence and once as NP1 of the SOV sentence in a sentence with the same content. For the unassociated conditions, the same four abstract NP1s were used for all sentences, i.e. *het meisje* ‘the girl’, *de jongen* ‘the boy’, *de moeder* ‘the mother’ and *de vader* ‘the father’. This resulted in more repetition of these images across sentences. Also the NP2 images occurred multiple times in different visual displays, with a maximum of eight times divided over two blocks. Target NP2s were used as distractors and article distractors in other trials.

Taken together, there was a total of 102 different images. The images were selected from the MPI database and the standardized set of images of Snodgrass and Vanderwart (1980) and Bonin et al. (2003). Another 28 images in the same style were obtained from the Internet. The images were black and white line drawings presented two by two with a width and height of 300x300 pixels. The rotation of the images on the computer screen were fully randomized.

Filler items

To create filler items, sentences with two other possible Dutch word orders were used. These were VSO and OVS sentences, also including associated or unassociated NPs. Similar as the SVO and SOV sentences, the content of the VSO and OVS sentences corresponded, but was different from the content of the target stimuli sentences. To make the VSO sentences grammatical, a simple adverbial was added in front of the NP1s (i.e. *snel* ‘quickly’, *soms* 'sometimes' and *nu* 'now). Because of this sentence-initial adverbial, the rest of the sentence was forced to inverse its order to VSO. The OVS fillers were passive sentences with the carrier sentence followed by the object, then the auxiliary verb, the subject and the past participle at the end. In Dutch, the NP1 in a passive sentence causes ambiguity, as without case-marker it is unknown whether the NP1 is a subject in an SVO sentence or an object in an OVS sentence. More linguistic input should be retrieved to determine whether a sentence is in active or passive tense.

Table 2 shows some examples of filler items (See Appendix VI for the complete stimuli list of the filler items). The same carrier sentences were used for the VSO and OVS as for the SVO sentences, being the preceding main clauses without 'that'.

Table 2. *Examples of experimental VSO and OVS sentences in the unassociated and associated condition.*

Filler stimuli	Carrier sentence	Adverbial	Critical sentence
VSO-Unassociated	Je hoort *You hear*	soms *sometimes*	scheert de vader de baard *shaves the father the beard* verb subject object
VSO-Associated	De zin luidt *The sentence states*	nu now	laadt de soldaat het geweer *loads the soldier the revolver* verb subject object
OVS-Unassociated	Je hoort *You hear*		de baard wordt door de vader geschoren *the beard is by the father shaven* object aux. subject past part.
OVS-Associated	De zin luidt *The sentence states*		het geweer wordt door de soldaat geladen *the revolver is by the soldier loaded* object aux. subject verb

Altogether, 128 trials were presented to each participant, from which 64 were target and 64 were filler items. The target sentences contained 32 SVO sentences and 32 SOV sentences and the filler sentences 32 VSO and 32 OVS sentences. Each sentence type had 16 associated and 16 unassociated sentences.

Comprehension questions

Furthermore, thirty-two comprehension questions were constructed, four for each sentence type of both the target and filler sentences. An example of a comprehension question after an SVO sentence as *Je hoort: de jongen rookt de sigaret* 'You hear: the boy smokes the cigarette' was *Rookt de jongen de pijp?* 'Does the boy smoke the pipe?'. In this particular exemplar, the correct answer was 'no'. All incorrect comprehension questions were manipulated either on the NP1 or the NP2 (See Appendix VII for the complete list of comprehension questions).

2.3. PROCEDURE

Participants were seated in front of a computer screen at a comfortable distance from the screen in a soundproofed room in the eye tracking lab at Leiden University. This distance was approximately 60-65cm. Eye movements were monitored with an Eyelink 1000 eye tracking system (SR Research, Ltd.), at a 500 Hz sampling rate. The participants' dominant eye was tracked by the use of a target sticker above the dominant eye. Spoken sentences were presented to the participants through headphones (Beyerdynamics).

The participants' task was a simple 'look and listen' task. The participants were asked to look at the screen and listen carefully to the prerecorded sentences. After one fourth of the trials, a simple yes/no questions should be answered about the sentence that was just heard. This experimental procedure was instructed by the experimenter but could also be read on the screen, if the participants wanted. After the instructions, the calibration and validation phase started, followed by the experimental phase. During the experimental phase, there was a drift correction after every third trial, where participants had to fixate on a cross at the center of the screen. Eye tracking settings could be adapted during this drift correction.

As mentioned before, every trial consisted of a carrier sentence followed by a critical sentence. The carrier sentence offset was at 1000ms and the critical sentence started after these 1000ms. During these first 1000ms, a visual display and a carrier sentence were presented to participants. The present study differed from previous studies, where nothing else than the visual display was presented before critical sentence offset initiating from 1000ms onwards (e.g. Altmann & Kamide, 1999; Kamide, Altmann & Haywood, 2003; Knoeferle et al., 2005). In these studies, the participants had 1000ms to process the visual stimuli only. In our study, the time of the presentation of visual stimuli only was shorter, dependent on the duration of the carrier sentence. When the carrier sentence duration was 821ms (i.e. *De zin is* 'The sentence is'), it was auditorily presented to the participants from 179ms until 1000ms, so that the carrier sentence and the critical sentence fluently followed each other. The visual display without audio stimuli was presented to the participants from trial onset to carrier sentence onset. In this exemplar case of *De zin is* 'The sentence is', the participants saw the visual display without audio input from trial onset (0ms) to carrier sentence onset (179ms). Then, from carrier sentence onset (179ms) until critical sentence onset (1000ms) they saw the visual display and heard the carrier sentence. In short, how long the visual display was presented by itself (range visual stimuli only 59-336ms) depended on the duration of the carrier sentence (range carrier sentence 664-941ms) (See Appendix VIII for the durations of the carrier sentence and the visual stimuli only per carrier sentence). Since the range of the duration of the experimental critical sentences varied between 1471 and 2288ms and the carrier sentence took 1000ms, the experimental trials lasted in total between 2471 and 3288 milliseconds.

Thousand milliseconds after critical sentence offset either a comprehension question was presented on the screen or the next trial was initiated. Only after 25% of the trials, a comprehension question followed, which the participants had to answer by pressing on [x] 'no' or [m] 'yes' on the keyboard. The participants received feedback on their responses, either *goed* 'correct' or *fout* 'incorrect', which was presented on the screen. For half of the questions the correct answer was 'yes', for the other half 'no' was the correct answer. After a comprehension question was answered, the next trial commenced.

The experiment contained two blocks of 64 trials each. Each unique NP1-NP2 combination occurred only once per block. This resulted in two stimuli lists which were randomly assigned to participants. For instance, if in the first block a participant was presented to the SVO sentence *De zin is: het meisje schrijft de brief* 'The sentence is: the girl writes the letter', this person received the SOV sentence *Je hoort dat het meisje de brief schrijft* 'You hear that the girl the letter writes' in the second block. After the two blocks, the experiment was completed. Approximately, the entire experiment lasted 30 minutes.

2.4. Data analysis

The eye movement data was generated by the EyeLink system and this data was displayed and visualized in DataViewer (Version 2.6.). Each data point specified a time bin of 50ms. The decision to use time bins of 50ms was made, as it is assumed that a saccade takes at least 200ms to program (Matin, Shao, & Boff, 1993). As a result, fixations are not expected to change within 50ms. In that sense, smaller time bins would have extended the data set without giving any additional information.

For each data point it was reported on which of the four images there was a fixation, whether the fixation was somewhere else on the screen or whether the participant blinked. When a fixation was not on one of the four images, this data point was not included in the analysis. In 13% of the data point cases, no fixation on one of the four images was measured.

Areas of Interest

During our visual world eye tracking experiment, the fixations on the four clearly separable images were measured. Therefore, per visual display four Areas of Interest (AoI) were identified: the NP2, the NP1 and two distractors. The Areas of Interest appeared in a grid that was invisible for the participants. These grids tightly enclosed the boundaries of the images. As soon as a participant fixated in the grid of one of the four images, it was counted as one fixation on that particular image. Hence, the duration of this fixation was measured.

Time windows

In order to see how the auditory constituents affected the looking behavior over time, five time windows were created which separated the constituents of the auditory stimuli. The first time window encompassed the time that only the visual stimuli was presented and the time that the carrier sentence was heard, i.e. the first 1000ms. The second time window spanned the period of the NP1, including the potential pause between the NP1 and the following constituent (See *Acoustical properties of the audio stimuli*, p. 28-29). The third time window covered the presentation of the verb in the SVO sentences and the NP2 in the SOV sentences. The fourth time window comprised the NP2 for the SVO and the verb for the SOV sentences. The last and fifth time window measured the fixations immediately after critical sentence offset to 1000ms ahead. This fifth time window is called the post-critical sentence region and is included to observe possible late integrative wrap-up effects. Wrap-up effects are found at sentence-final or clause-final position, where encountered input needs to be integrated (Just & Carpenter, 1980). Particularly in SOV sentences, late sentence integrative and interpretative processes can be found because the verb occurs after its arguments (Vasishth, 2011). See **Table 3** and **Table 4** for the segmentation of the time windows in the SVO and SOV sentences.

Table 3. *Time windows of the SVO sentences with an example sentence.*

Visual stimuli only	Carrier sentence	Subject	Verb	Object	Post-critical sentence
	De zin is	het meisje	schrijft	de brief	
	The sentence is	*the girl*	*writes*	*the letter*	
	Carrier sentence	NP1	Verb	NP2	
Time window 1		**Time window 2**	**Time window 3**	**Time window 4**	**Time window 5**
Trial onset (0ms)- carrier sentence onset	Carrier sentence onset – Carrier sentence offset (1000ms)	NP1 onset – verb onset	Verb onset – NP2 onset	NP2 onset – NP2 offset	NP2 offset + 1000ms

Table 4. *Time windows of the SOV sentences with an example sentence.*

Visual stimuli only	Carrier sentence	Subject	Object	Verb	Post-critical sentence
	De zin is	het meisje	de brief	schrijft	
	The sentence is	*the girl*	*the letter*	*writes*	
	Carrier sentence	NP1	NP2	Verb	
Time window 1		**Time window 2**	**Time window 3**	**Time window 4**	**Time window 5**
Trial onset (0ms)- carrier sentence onset	Carrier sentence onset – Carrier sentence offset (1000ms)	NP1 onset – verb onset	NP2 onset – verb onset	verb onset – verb offset	NP2 offset + 1000ms

The duration of each time window was defined by the average duration of the constituents in that specific time window over the four conditions. Although the constituents and the durations of the constituents in time windows two, three and four were not fully identical across the SVO and SOV sentences, the same time windows were adopted as the durations were highly similar. Before this final decision was made, the fixation patterns were visually inspected. Only marginal differences in durations were identified across the four conditions and so it is not assumed this to affect the analysis.

Important to note is that all time windows were shifted forward 200ms because eye movements approximately require 200ms to program (Matin et al., 1993) and there is a lag between eye movements and linguistic input of about 200ms (Allopenna, Magnuson, & Tanenhaus, 1998). This means that the measurement of fixations in the time windows started 200ms later than that the participants actually started to hear the audio input of that time window. For instance, the NP1 originally initiated after 1000ms, but the fixations were measured from 1200ms onwards, until the onset of the next constituent plus 200ms. If the NP1 ended auditorily after 1670ms the end of this time window was set at 1870ms (See Appendix IX for the durations of the five time windows).

Statistical analysis

The obtained data were analyzed with the statistics software R, version 3.3.2. (R Core Team, 2016). The dataset preparation for the analysis followed the instructions given by the eyetrackingR Package (Dink & Ferguson, 2015). This package was especially useful for visualizing the data. To further examine statistical differences, linear mixed effects models were run by the use of the R package *lme4* (Bates, Maechler, Bolker, & Walker, 2015). These models had the fixations to the four images as the dependent variable. The variables word order and association and the interaction of word order and association were entered into the model as fixed effects. Also the continuous variable time was added as a fixed effect, which can show whether participants' fixations changed over time.

Interactions with time were included, as well as the three-way interaction with time, word order and association. The random effect structure in the models included subjects (38 participants) and items (16 sentences per condition) (Baayen, Davidson, & Bates, 2008). Separate analyses were conducted for each time window. This allows us to zoom in on time-course processing of constituents in different sentence conditions. P-values were obtained by likelihood ratio tests of the baseline models against models with different predictors added to the model.

3. RESULTS

The data from thirty-eight participants of the forty participants was included for the analysis. The data of these two participants (5%) was discarded because they answered less than 80% of the comprehension questions correctly. From the remaining participants the average accuracy level of the comprehension questions was 97%.

In the following paragraphs, I report the results of the linear mixed effect models ran with fixations to all four images and with the fixed effects time, word order and association and the interactions thereof. First, I discuss the findings of the models when the entire sentence was considered, meaning from the start of the first time window until the end of the fifth time window. This shows us how the variables overall affected fixation behavior.

Following, I report the models per predefined time window in separate subparagraphs. **Table 5** gives an overview of the obtained *t*- and *p* values from the linear mixed effect models. The models in which the fixed effects predicted fixation behavior were printed bolded. The full models converged in R can be found in Appendix X, where it is possible to retrieve the precise numbers and the model fit, by checking the Akaike's Information Criterion (AIC), Bayesian Information Criterion (BIC) and the log-Likehood (log-Lik).

To answer our research questions, we were not specifically interested in fixations to the NP1, as it does not give us a direct indication of effects of NP2 anticipation. Therefore, we ran two separate analyses: analyses including fixations to all images and analyses without fixations to the NP1 image. By comparing only the three other images the focus is more on NP2 anticipation. The results of the models ran without NP1 fixations are concisely described in the section 3.2. of this chapter. A short summary of the results is presented in section 3.3.

Linear mixed effect models

In the linear mixed effect models, participants and items were included as random effects. In all time windows, the random effect participants had more variability than the random effect items. Nevertheless, the random intercepts of both participants and items approached 0 – in each separate time window analysis lower than 0.1 – which shows that items and participants did not vary consistently across conditions. The residual number was higher in all time window models – approximately around 1.3 – meaning that there was more variance that was not explained by participants and items.

3.1. ANALYSES WITH NP1 FIXATIONS

Entire sentence

Considering the total time from the onset of time window one until the offset of time window five, time, χ^2 (5) = 1417.7, p < .00001, and association, χ^2 (7) = 12.37, p= .0004, were good predictors of what images participants looked at. This means that fixations to the areas of interest significantly changed over time and that there was a significant relationship between the AoI participants looked at and whether presented sentences included associated or unassociated NPs. In general, fixation behavior was not affected by word order, χ^2 (6) = 0.012, p = .73. This implies that whether a sentence was presented in an SVO or SOV order did not affect how participants looked at the four images, and that the fixation patterns among the two were near to identical. In **Figure 6** (see also Appendix XI for the proportion numbers), it can also be observed that the fixation patterns between the SVO-Unassociated and the SOV-Unassociated condition and between the SVO-Associated and the SOV-Associated condition are close to similar over the entire sentence. When comparing - irrespective of word order - the fixations patterns in the associated condition with fixation pattern in the unassociated condition, some differences can be noticed. This effect of association explains why the model with association predicts fixation behavior, and the model with word order does not. It seems that the analyses show differences in the NP1 and NP2 fixation behavior, especially considering association, but this does not seem to be the case for the two distractors images. Therefore, the distractors and article distractors are from now on taken as one, and are discussed under the umbrella term 'distractors'.

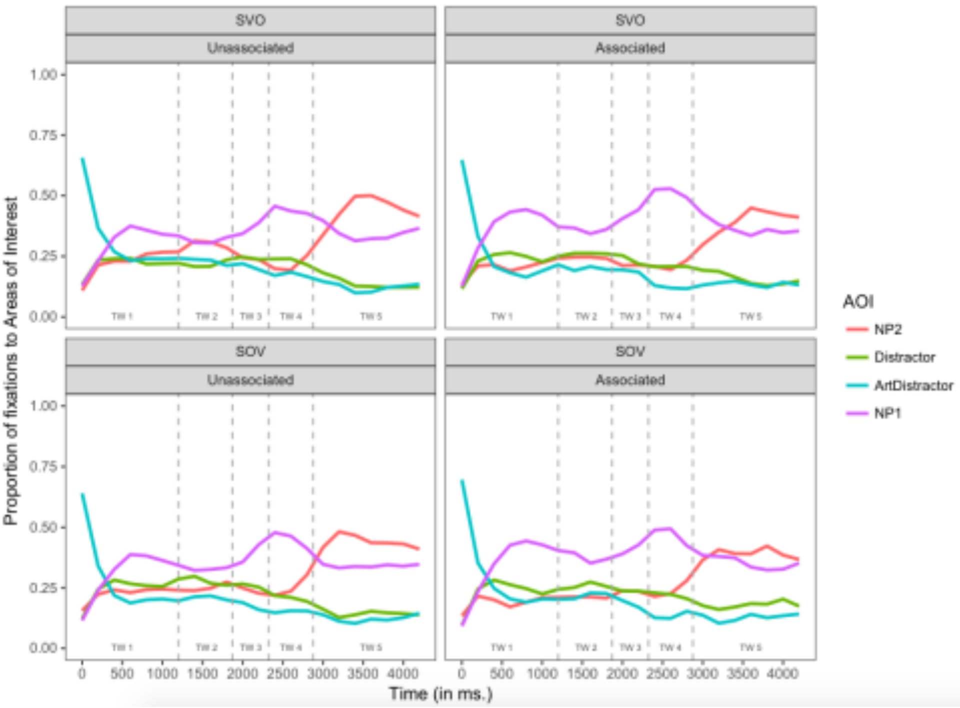

Figure 6. *The mean proportions of fixations to the NP2, NP1 and distractor images per condition in the five time windows.*

Time window 1

When the participants did not yet encounter auditorily the critical sentence, but saw the visual stimuli and heard the preceding main clause, there was a peak of fixations to the NP1 image (See **Figure 6)**. Association predicted AoI, χ^2 (6) = 8.68, p <.003), showing that there was a relation between the NPs being associated or unassociated and the images participants looked at in this first time window. Observing **Figure 6** makes us assume that primarily NP1 fixations were predicted by association, since the proportion of fixations to the other three images was almost identical among the conditions. In the associated condition, the NP1 fixations were higher than in the unassociated condition.

Whether the sentence was in SVO or SOV word order did not determine the fixation behavior of the participants, χ^2 (7) = 0, p = .99. Also time did not predict at which AoI participants looked during the first time window, χ^2 (5) = 0.0034, p = .95. This means that over time, within the time window, there was no significant change of the images participants looked at.

The models with interactions of time and word order, χ^2 (8) = 8.30, p = .004, and time and association, χ^2 (9) = 23.78, p <.0001, were good models, with the model with the interaction of time and association as the best fitting model. This means that how participants looked at the images was best predicted by time and association of the NPs.

Time window 2

In the second time window, for both SVO and SOV sentences, the NP1 was heard. As expected, most fixations were on the NP1 image, and a comparable number of fixations were on the NP2 and the distractor images. When looking into **Figure 6**, the fixations to the NP1 image were higher in the associated than in the unassociated conditions. This also explains why association affected the AoI participants looked, χ^2 (7) = 7.21, p = .007, with this model resulting in the best model. For this time window, also time was a good predictor, χ^2 (5) = 11.7, p = .0006, whereas word order was not, χ^2 (6) = 2.02, p = .16.

Time window 3

Although the constituent the participants heard in the SVO and SOV sentences differed (i.e. verb in SVO and NP2 in SOV), word order did not affect where participants looked at, χ^2 (6) = 2.02, p = .16. The models with association, χ^2 (7) = 4.11, p = .04, time, χ^2 (5) = 24.86, p < .0001, the interaction of time and association, χ^2 (9) = 6.39, p = .01, and the three-way interaction of time, word order and association, $\chi^2(11)=6.14$, $p=.01$, were predicting models. The full model with the three-way interaction was the model with the most explanatory power.

Time window 4

During this fourth time window, the participants were hearing the NP2 (SVO) or just heard the NP2 (SOV). Nevertheless, what seems it that the NP1 image still receives most fixations (See **Figure 6**), with even a peak of NP1 fixations.

Both word order, χ^2 (6) = 2.12, p = .14, and association, χ^2 (7) = 2.47, p = .12, did not predict the AoI participants looked at, but time did, χ^2 (5) = 8.34, p = .004. The interaction effect of time and word order did affect fixation behavior to the four images, χ^2 (8) = 4.76, p = .03. This indicates that as the time within a time window continues, there were differences in how participants looked at images in the SVO and SOV sentences. In **Figure 6**, it is noticeable that an increase of NP2 fixations initiates in the SOV sentences, whereas this increase initiates somewhat later in the SVO sentences. This model with the interaction of time and word order was the model that fitted best.

Time window 5

In the fifth time window – from critical sentence offset until 1000ms after this offset – there is a shift from a preference to look at the NP1 image to a preference to look at the NP2 image (See **Figure 6**). The NP2 fixations reach its peak in this last time window, whereas this was the case for the NP1 fixations in the fourth time window.

In this fifth and last time window, word order did not affect AoI, χ^2 (6) = 0.97, p = .32. but the interaction of time and word order did, χ^2 (8) = 68.0, $p < .0001$, with this as the best fitting model. Also, models with association, χ^2 (7) = 10.99, p = .0009, and time, χ^2 (5) = 327.11, $p < .0001$, predicted on what image participants fixated. The fact that association is a good predictor of fixation behavior in this window makes us assume that association predicts primarily fixations to the NP1 and NP2 images.

Table 5. *T- and p-values from the linear mixed effect models including the fixed effects and the interactions per time window.*

Time window		**Df**	**t-value**	**p-value**
Time window 1	Time	5	0.0034	.95
Visual stimuli only + carrier sentence	Word order	6	0.0000	.99
	Association	7	8.68	**.003****
	Time x Word order	8	8.298	**.004****
	Time x Association	9	23.78	**< .0001*****
	Word order x Association	10	0.0002	.99
	Time x Word order x Association	11	0.0597	.81
Time window 2	**Time**	5	1.170	**.0006*****
NP1	Word order	6	2.02	.16
	Association	7	7.22	**.007****
	Time x Word order	8	0.0026	.96
	Time x Association	9	0.0016	.97
	Word order x Association	10	0.1734	.68
	Time x Word order x Association	11	0.7845	.38
Time window 3	**Time**	5	24.86	**< .0001*****
Verb/NP2	Word order	6	0.1905	.66
	Association	7	4.11	**0.04***
	Time x Word order	8	0.6268	.43
	Time x Association	9	6.399	**.011***
	Word order x Association	10	0.0733	.79
	Time x Word order x Association	11	6.139	**.013***
Time window 4	**Time**	5	8.345	**.004****
NP2/Verb	Word order	6	2.186	.14
	Association	7	2.571	.11
	Time x Word order	8	4.76	**.03***
	Time x Association	9	0.067	.80
	Word order x Association	10	0.95	.33
	Time x Word order x Association	11	0.1313	.72
Time window 5	**Time**	5	327.108	**< .0001*****
Post-critical sentence	Word order	6	0.9744	0.324
	Association	7	109.884	**0.0009*****
	Time x Word order	8	678.940	**< .0001*****
	Time x Association	9	0.4537	0.501
	Word order x Association	10	0.1777	0.673
	Time x Word order x Association	11	15.485	0.213

$^{*}p < 0.05$, $^{**}p < 0.01$, *and* $^{***}p < 0.001$.

3.2. ANALYSES WITHOUT NP1 FIXATIONS

For the analyses without NP1 fixations, full models were again ran for each time window, as well as over the time from the onset of time window one until the offset of time window five, with fixed effects of time, word order and association, and random effects of participants and items. The full models excluding the NP1 fixations can be found in Appendix XII.

When all time windows were considered together, three models predicted AoI: the one with time, χ^2 (5) = 6766.57, p < .0001, the one with the interaction of time and word order, χ^2 (8) = 17.24, p < .0001, and the best model being the one with the three-way interaction of time, word order and association, χ^2 (11) = 13.82, p = .0002.

For the models without NP1 fixations, the best models where the models that included only the fixed effect time, or time interacting with either word order or association, except from time window two (i.e. NP1) and time window four (i.e. NP2 for SVO and verb for SOV). In the second time window, the baseline model without any fixed effects was the best model. In the fourth time window, the model with association predicted best on what AoI participants fixated, meaning that participants looked different to the NP2 and distractor images when hearing unassociated sentences than when hearing associated sentences.

Nevertheless, in all time windows the models with interactions – all with at least time as a predictor – led to the best fitting models. Overall, the models with the interaction of time and association predicted fixation behavior better than models with time and word order interaction. Since in the analyses without NP1 fixations fewer models with fixed effects were significant predicting models, it can be stated that primarily NP1 fixations affected the models in the analyses with NP1 fixations.

3.3. SUMMARY OF THE RESULTS

To summarize our results including NP1 fixations, we can report that in all time windows, the models including time predicted at what image participants fixated, except from the first time window where the preceding main clause was heard. This shows that while the time continued within a time window the fixation behavior to the images changed significantly. However, this fixed effect of time does not provide us with much information to answer our research questions, and so will not be discussed further.

Models with association often predicted on what images participants fixated (i.e. except from time window four). Especially the NP1 fixations were predicted by the association effect. In the associated conditions, the NP1s in time window one, two and three received more fixations than in the unassociated condition. The NP2 in the fifth time window received more fixations in the unassociated than in the associated conditions. However, since association was not a good predictor in the fifth time window in the analyses without NP1 fixations, NP2 fixations in this last time window are not predicted by association, despite of the differences we see between the NP2 fixations in associated and unassociated sentences. Especially in the models with NP1 fixations, association was a good predictor. This suggests that fixations to the NP1 image were mostly affected by association, and not the fixations to the other three images.

In none of the time windows, a model with only word order was a good predictor, since fixation patterns among SVO and SOV sentences were almost identical. Nevertheless, some models with an interaction of time and word order (time window 4 and time window 5) and a three-way interaction of time, word order and association (time window 3) affected the participants' fixation behavior. This implies that if the time and/or association variables were taken into account, there were some differences in fixation behavior between the SVO and SOV sentences.

4. DISCUSSION

The main focus of this study was to see whether an objects NP2 is anticipated in a Dutch SOV sentence where no verb and case-markers can guide the anticipation process. Other preceding information could guide NP2 anticipation in such a sentence. SOV sentences in Dutch are only grammatical as an embedded clause and therefore, should be preceded by a main clause. It is the structure and prosody information provided by this preceding main clause combined with the subject NP1 that should lead the anticipation of an upcoming NP2 in an SOV sentence. In Dutch SVO sentences, verb information is available in addition to the information of the preceding main clause and the NP1. In the current study, both sentence types were preceded by a main clause and had the same content to create a pair that was as similar as possible.

Altogether, the word order (SVO, SOV) and association (Unassociated, Associated) variables created four conditions. While hearing prerecorded sentences, eye movements were measured by means of a visual world eye tracking study, where participants received a visual display with four images; an animate NP1 subject, an inanimate NP2 object and two inanimate distractor images, which were added as potential competitors of the NP2 referent. To examine NP2 anticipation, anticipatory fixations to the NP2 image were compared to the fixations to the NP1 and the two distractor images prior to the auditory encounter of this NP2, i.e. while hearing the verb (SVO) or while hearing the NP1 (SOV). Analyses with and without NP1 fixations were carried out, as the NP1 fixations might not provide insights into anticipatory NP2 processing.

Three direct main conclusions can be drawn when considering the overall fixation behavior over the four conditions. Firstly, there was an overall preference to fixate on the subject NP1 image. This NP1 preference was present during the entire time the sentence was heard and this was consistent over the four conditions. Secondly, the preference to fixate on the object NP2 initiated after the offset of the critical sentence, when no sentence was heard anymore. Up until the moment that the last auditory constituent was heard, the proportion of fixations to the NP2 and the distractor image was compatible and earlier prominent NP2 fixations were not found. The points in time where we would have expected an NP2 preference – right before hearing the NP2 and while hearing the NP2 – did not match with the emerged fixation patterns in the conditions. Thirdly, whether the NPs of the sentences were associable or not, affected how participants looked at NP1 and NP2 images respectively. The NP1 fixations were greater in the associated condition, such as where the subject NP1 was ‘pilot’ and the object NP2 ‘airplane’, whereas the fixations to the NP2 image were greater in the unassociated condition, such as where the subject NP1 was ‘girl’ and the object NP2 ‘letter’.

In the following paragraphs, I first discuss how the obtained findings could be interpreted. Then, I continue with some speculations of why we might have lacked to find NP2 anticipation effects in Dutch. I end the discussion with some ideas for future methodological considerations and further research.

Over the entire time the sentence was heard, the NP1 received most fixations, with two peaks. The first peak emerged when the participants saw the visual stimuli and heard the carrier sentence. This peak is best interpretable as a combination of agenthood and visual attraction of the subject NP1. This NP1 was the only image on the visual display that contained an animate object and this presumably makes it the most salient depicted image (Cohn and Paczynski, 2013). Listeners are more favorable to look at animate than inanimate images (Cohn & Paczynski, 2013).

During this first time window, the preceding main clause could be used to identify the agent of the sentence, as it was in each sentence the only animate depicted object. This identification made general processing of the sentence easier, as agents are often the topic of sentences and the initiators of events. Consequently, they have the most prominent role that gets the attention (Engelen, 2014). Agents form the basis for mental representations and are subsequently used to form expectations about the remainder of the sentence (Cohn & Paczynski, 2013; Sauppe, 2016). Therefore, agents are often processed as quickly and soon as possible. Since 70% of the Dutch sentences start with the agent in sentence-initial position (Bouma & Hendriks, 2012), one can assume that participants in an eye tracking study will always start to fixate on the agent while processing a sentence (Ganushchak, Konopka, & Chen, 2014).

These early NP1 fixations during the encounter of the preceding main clause might indicate NP1 anticipation and early processing of this agent NP1 before the constituent itself is heard. Then, the NP2 anticipation could have started while hearing the NP1. But surprisingly, in this study, we found that as the sentence unfolded, the fixations remained primarily on the NP1 image until sentence offset.

The second peak of NP1 fixations emerged during the fourth time window, while hearing the last constituent before sentence offset (i.e. object NP2 for SVO and verb for SOV sentences). At this point in time, fixations to the NP2 image were expected because the participants were either hearing the NP2 (SVO) or have just heard the NP2 and were hearing the verb (SOV). The reason to have this second peak of NP1 fixations at sentence offset could have to do with the fact that at that point in time, the NP1 was integrated with the earlier heard constituents. Finally, what was linguistically perceived was interpreted and linked with what was visually presented. Nevertheless, considering our expectations, this integration process takes place relatively late.

Moreover, this late integration of visual and linguistic input accords with the late increase of fixations to the NP2 image after the offset of the critical sentence. As soon as the auditory input reached its end, the fixations to the NP2 started to increase substantially and fixations to the NP1 decreased. This effect of NP2 fixations, points to a late integration of the NP2 with the other constituents, and seems a wrap-up effect (Just & Carpenter, 1980; Warren, White, & Reichle, 2009). Even if this is contrary to what we expected in that there is no anticipation, these NP2 fixations in the post-critical region show that the sentence is being interpreted, albeit rather late. Since both the NP1 and NP2 seem to be integrated relatively late, we assume that the integration of what is heard with what is seen did not go hand-in-hand and it seems that more processing time was needed to integrate both types of information.

The late NP2 integration suggests that this object noun phrase was not processed earlier, or at least not while hearing the NP2 auditorily, let alone anticipatorily. In other words, no effects of NP2 anticipation were found. Earlier, Huettig and Mani (2016) noted that finding anticipatory processing effects is not evidently, and that the effects can disappear altogether as soon as there are some minor context changes. The prospect is that our lack of established anticipatory NP2 effects is not caused by an overall disability of Dutch speakers to anticipate upcoming material, as earlier visual world paradigm studies with Dutch speakers did show such anticipation effects[9] (e.g. Huettig & Janse, 2016; Mulders & Szendröi, 2016). However, none of the anticipation studies on Dutch focused on anticipation of upcoming NPs in different word orders.

Dutch is no strict head-final language and allows many different word orders. As a result, Dutch listeners could be more hesitant about what is upcoming as there are often various sentence continuations. Therefore, they may be less pro-active in anticipating upcoming sentence elements. The probability of anticipating an upcoming constituent incorrectly is higher when different upcoming word orders are optional and when it is less predefined what word category is likely to follow. Moreover, the filler items of the present study extended the amount of available word orders for participants. Although, it represents all possible word orders in Dutch, it also reinforces the word order possibilities. This means that because listeners knew that many different word orders could follow the preceding main clause, listeners might have been more restrained to anticipate what is coming next.

Still, anticipation is a costly process, and listeners are only likely to anticipate forthcoming linguistic material if the benefits are higher than the costs (Kamide, 2008). Perhaps in our case, the chance of coming up with a wrong

[9] Earlier within this thesis, these anticipation studies with Dutch speakers were not mentioned. Although, these studies were visual world paradigm studies, the focus and the experimental paradigm differed too much from our study for it to be from added value to be discussed in terms of the research question of the current study.

prediction was too high and therefore, listeners did not dare to take the risk of initiating the anticipation process. It might have been the case that a somewhat slower but correct comprehension process was preferred above a repair process that would have been needed if the prediction turned out to be incorrect. It seems that in our study, while hearing the sentence, the received input was processed, but not anticipatorily. What seems clear is that at a later stage, the interpretation of the arguments and the verb is verified and completed.

One could argue that more information should have been available in order to make Dutch listeners certain enough to initiate the anticipation process. Earlier studies included always at least two direct preceding constituents, namely an NP1 and a verb (i.e. English in Altmann & Kamide, 1999), two NPs with case-markers (i.e. Japanese in Kamide, Altmann & Haywood, 2003), a case-marked NP1 and a verb (i.e. German in Kamide, Scheeprs & Altmann, 2003b) and an affix-marked verb and an NP1 (i.e. Tagalog in Sauppe, 2006). In none of these earlier studies, such little information sources were available prior to the NP2 referent. Recall that in this study, no case-marker or affix was available in any condition, and in the SOV conditions no verb. In our SOV sentences, it was only one subject noun phrase (NP1) that could directly provide information about the upcoming object NP2 referent, and this noun phrase lacked a case-marker. Therefore, it seems that, although various information sources were available in the process, this information was not enough for Dutch listeners to anticipate an upcoming NP2.

The listeners had a lot input to process in a relative short amount of time. Because of the visual stimuli, the difference in presented word orders, the association and the preceding main clauses, the memory load might have become too heavy for participants to process anticipatorily upcoming input. In this case, it seems that participants processed what was fundamentally necessary for sentence interpretation, but that in addition to that, no secondary processes of anticipation took place. Perhaps, anticipation only starts as a secondary process as soon as the basics of fundamental processing are covered.

The fact that association was in most models a good predictor indicates that primarily association guided the process of what image the participants looked, especially to the NP1 and NP2 images. However, how association affected the processing of the NP1 and NP2, differed. For the NP1, there were more fixations in the associated than in the unassociated condition, in both the first and second peak of fixations. One of the possible explanations is that because the NP1s in the associated condition were more specified, their depiction was also more specific and visually complex. These concrete NP1s were often depicted with some other attributes as these were intrinsic to the meaning of these noun phrases. Contrarily, the abstract NP1s were less complex and more repetitive, and therefore, might have been less interesting to look at compared to the concrete NP1s. On that account, the longer fixations on concrete NP1s can be better explained in terms of visual processing than of linguistic processing. That is to say, it does not correspond with the concreteness effect phenomenon, that argues that concrete words are processed more quickly and accurately, as they are more easy to put into a semantic context than abstract words (Fliessbach, Weis, Klaver, Elger, & Weber, 2006; Xiao, Zhao, Zhang, & Guo, 2012).

In contrast, NP2 fixations in the post-critical region were greater in the unassociated sentences than in the associated sentences. This means that in the unassociated condition the number of fixations to the NP2 image was higher than the number of fixations in the associated condition. However, since the analyses without NP1 fixations did not show that association was a good predictor in time window five, it shows that this association variable did not significantly affected NP2 fixations.

The fact that the NP2 received more fixations in the unassociated condition could mean that more fixations were on the NP2 image in this condition, because more processing was required in order to integrate the visual and linguistic input. It is assumed that the more difficult the integration, the longer the integration process takes (Warren et al., 2009). One of the reasons could be that integrating unassociable NPs is more difficult because the two arguments are not semantically associated and therefore less predictable as co-occurring arguments. In essence, the concept of the unassociated NP2 was not activated yet and needed high activation processing in order to integrate it with the previous constituents. On the contrary, because of the semantic association with the NP1, the concept of the NP2 in the associated condition was easier to activate, and therefore, integrated faster and more easily.

Future work

Future studies should provide further insights into the presence of anticipatory processing of upcoming noun phrases in Dutch sentences in different word order configurations. In the following paragraphs, I discuss some methodological considerations and refinements of the current paradigm, as well as ideas for future research that could approach the research question by means of visual world paradigm studies but with a somewhat different research paradigm.

One of the ways to deal with the prominent NP1 fixations that seem to overrule the other fixations, is to discard this NP1 image from the visual display when investigating language mediated eye movements to the NP2. For instance, Borovosky and colleagues (2012) decided not to depict the agent image on their visual display with the reason that their aim was to compare relative activation and anticipation of potential targets as a response to the agent noun phrase. However, in most visual world studies, the main reason to depict the agent noun phrase on the visual display is that its function is to act as a control, shows whether the paradigm holds and whether participants do integrate the visual and linguistic input. A second alternative would be to preclude the NP1 fixations from the final analysis. Altmann and Kamide (1999) included, similar as in our study, one animate object (i.e. the agent NP1) and three inanimate objects in their visual display, from which one was the NP2 referent. Eventually, the fixations on the NP1 image were not taken into account in their analysis. No reason for the decision of excluding those NP1 fixations was reported in their analysis. Perhaps, the fixations to the agent image impeded the anticipatory NP2 fixations and therefore, they were not taken into account. As Altmann and Kamide (1999) decided to do the analyses without NP1 fixations, we also decided to look at the fixation behavior without consideration of the NP1 fixations, which did not provide us with much more insightful findings. Another alternative would be to depict another animate object on the visual display, to make the animate NP1 less salient. In our case, a visual display with various animate objects was not a plausible alternative because it could have changed listeners' expectations about the number of following arguments. It could have indicated that an animate indirect object would follow the inanimate direct object NP2. This would have led to more sentence continuation possibilities. Furthermore, if prior to hearing the NP1, it was unknown which of the two animate objects to pick as the agent, it would become clear which of the two potential agents was the NP1 during the encounter of the NP1. However, in an SOV sentence, this would be too late to initiate the anticipation process of the NP2 during the encounter of the NP1. If then both animate images would receive fixations, it could also indicate that two processes overlap, which could be hard to differentiate. On the side, it could the identification and processing of the potential agent NP1, on the other side anticipatory processing of a potential animate NP2. Eventually, this was why the decision was made to depict only one animate noun phrase on the visual display.

To further enhance the knowledge of the established late integrative wrap-up effects, it would be interesting to look into the fixation patterns of the filler VSO and OVS sentences. As it seems in our findings, the NPs are integrated relatively late with the earlier constituent(s) and with what is depicted. Especially in the OVS sentences, the order of the mentioned NPs is reversed from SVO and SOV sentences, with the inanimate object as the NP1 and the subject as the animate NP2. In these OVS sentences, it might be the case that the subject NP2 receives the late fixations after the offset of the critical sentence, and not the early fixations as in the SVO and SOV sentences.

Moreover, it should be considered that the predefined time windows in the present study were relatively short. This means that the time to fixate on potential appropriate NP2s beforehand might not have been fully adequate. Potentially, the speed of our incoming input was heavy for participants to process and integrate simultaneously with the visual input (Huettig & Mani, 2016). As a reaction, participants could have held their eye gaze on the NP1 image, up until the moment where the sentence could be integrated and interpreted as a whole, which was after the offset of the spoken sentence. In that sense, it could be hypothesized that participants were too slow to show anticipatory effects (Huettig & Mani, 2016; Huettig & Guerra, 2015).

To elaborate more on the relation between finding anticipation effects and experimental circumstances, Huettig and Guerra (2015) performed a visual world eye tracking study with Dutch native speakers where the context of the experiment was manipulated in two ways: the preview of the visual display before the start of the spoken sentence, and the speech rate in which the spoken sentence was presented. Participants were presented with spoken sentences as *Kijk naar de afgebeelde piano* 'Look at the display piano' and visual displays with images of a target and three unrelated distractors (e.g. target 'piano', distractors 'plate', 'pig' and 'paper'). In the first experiment, the preview of the visual display was four seconds, and findings revealed that participants anticipatorily fixated on the image of the target NP 'piano', while hearing the determiner *de* 'the'. In the second experiment, the visual display was previewed only one second before the onset of the spoken sentence. As a result, the target NP 'piano' was only anticipated in the condition where the spoken sentence was slow in its speech rate. In the normal speech rate condition, the target 'piano' did not receive anticipatory fixations. These results emphasize that whether upcoming linguistic elements are anticipated, is not evident, but is strongly dependent on the (experimental) context. However, in terms of experimental set-up, some previous studies that provided evidence for NP2 anticipation did not present their participants spoken sentence that were notably slow in their speech rate, or had longer visual display previews than 1000ms. Since our experimental circumstances did not differ significantly from these earlier studies that did obtain these anticipatory effects, it is assumed this not the main reason for our lack of NP2 anticipation findings.

Nevertheless, our experimental set-up differed from that in previous studies in that it did not include a neutral time window, such as an adverb time region, before the NP2. In earlier studies, such time regions were included to prolong the time in which the participants could show anticipation effects (e.g. Knoeferle et al., 2005; Kamide, Scheepers, & Altmann, 2003; Sauppe, 2016). In our case, the NP1 and NP2 followed each other shortly. However, since our aim was to compare as identical constructions as possible, including an adverb was not ideal, as they could occur in different positions in the main and embedded clause. On the one hand, the adverb could have occurred at the position preceding to the NP2, as in the main clause *De zin is het meisje schrijft* *morgen* *de brief* 'The sentence is the girl writes tomorrow the letter' and the embedded clause *De zin is dat het meisje* *morgen* *de brief schrijft* 'The sentence is that the girl tomorrow the letter writes'. In this case, the time before the NP2 to show anticipation effects was extended by this adverb *morgen* 'tomorrow'. On the other hand, it would again have led to more asymmetry between the two sentence constructions and it would have enhanced the possibilities of the order of the upcoming constituents. That is to say, also other main constructions as *De zin is het meisje schrijft de brief morgen* 'The sentence is the girl writes the letter tomorrow' and embedded constructions as *De zin is dat het meisje de brief morgen schrijft* 'The sentence is that the girl the letter tomorrow writes' are possible (Gerritsen, 1978; Koster, 2002; Barbiers, 2008).

Another modification in the study that could be implemented and might influence the processing is adapting the participants' task. The current look and listen task was a very passive task and the participants were not actively triggered to look at all images. If they were triggered to gazes at different images, other processing strategies may have been adopted. In that case, all the images in the visual display might have been processed at an earlier point in time. Then, the integrative processing, especially of the visual with the linguistic input, would possibly have occurred earlier. An idea would be to include comprehension questions about the visual input as well as about the linguistic input. In this way, participants are kept alert and are pushed to pay attention to both types of input. Now, the comprehension questions specifically focused on the spoken sentences and therefore did not force the participants to direct towards all different images in order to answer the question correctly. Nevertheless, recall that it was decided to choose the look and listen task for our study because this task was also employed in the earlier studies on NP2 anticipation, where those anticipatory NP2 fixation effects were found.

Future work should further investigate the minimal amount of information that is needed to enhance NP2 anticipation effects. As our present study did not provide evidence for NP2 anticipation in sentences where such little information was available, it would be insightful to carry out a study like ours in a comparable language situation but where some more information is available. An interesting idea would be to construct a study like ours but then test it with German speakers. German has similar SVO and SOV constructions as Dutch, with embedded SOV constructions, but then with additional information of the case-marker on the subject NP1 and the object NP2. If NP2 anticipation effects are found with this extra piece of information, the importance of case-markers in the anticipation process is emphasized and partially explains our lack of NP2 anticipation effects. Another possible study would be to test again German listeners, but then use ambiguous NP1s. In that case, the available information in our and the German study comes closer. As it turns out that NP2 anticipation effects are found in the German study with ambiguous case-marking on the NP1, this provides information about cross-linguistic differences between German and Dutch. In that case, it would not essentially be the lack of available information, as there is as much information available in the German and Dutch case, but it would be something language-specific.

Experimentally more complex follow-up studies with bilingual speakers can gather insights into how a word order preference of the first language can affect the anticipatory processing in the second language – under the conditions that the second language is mastered well enough (Martin, Thierry, Kuipers, Boutonnet, Foucart, & Costa, 2013). Native speakers of Dutch are used to the Dutch word order flexibility. Therefore, they might not be directly prone to one specific word order. But if you would present bilinguals who speak Dutch as a second language (L2) but have a first language (L1) that is purely head-final, such as Japanese or Basque, listeners would presumably have a head-final preference, also in the second language, due to a word order transfer from the L1 to the L2 (Isurin, 2005; Zobl, 1986). For them, the object NP2 occurs by default before the verb and therefore, anticipating an object NP2 that directly follow a subject NP1 is more common. Similar studies can be performed for NP2 anticipation in languages that have canonically the verb prior to the object NP2, such as English. NP2 anticipation effects, while hearing the verb in Dutch SVO constructions, can be expected to found more in English-Dutch bilinguals, since they are used to those verb-second constructions in their native language.

Future research should provide us with more information about anticipation of upcoming linguistic material by Dutch speakers. Yet, not much research has been conducted on anticipatory processing with different word orders and it is not straightforward to interpret earlier findings cross-linguistically. As a result, it is difficult to draw any clear conclusions about the minimal amount of information that is necessary for anticipation, let alone for a language-specific case, such as Dutch. As still many questions remain unanswered in the domain of linguistic anticipation, it is highly recommended to conduct more research to clarify the mechanisms that underlie anticipatory processing.

5. CONCLUSION

The present study wanted to determine whether Dutch speakers anticipated an upcoming object NP2 in Dutch SVO and SOV sentences. The two sentence constructions were preceded by main clauses and these preceding main clauses differed in structure and prosody. Therefore, at an early stage the upcoming word order could be anticipated and the NP1 could be processed anticipatorily, as it was in all sentences the only depicted animate object. This early NP1 processing enabled listeners to start anticipating the NP2, while hearing the NP1. However, the NP1 was only expected to be informative as guider of NP2 anticipation if it was a concrete NP1 that selected a repertoire of potential NP2s. Consequently, only one of the potential NP2s was depicted on the visual display and could be picked as the best NP2 candidate. However, during the entire sentence, the fixations remained on the NP1 image during the entire sentence. Reasons given for this are: visual attraction and agenthood. A second observation we did was that participants started to fixate more on the NP2 image than on the other images after the offset of the critical sentence. This late NP2 preference implies a late wrap-up effect, where the NP2 was integrated in a late stage. Taken together, the information that was available in the SVO and SOV sentences was not sufficient enough to guide NP2 anticipation. Also when a grammatical head was available in the SVO sentences, the same fixation patterns emerged. Perhaps the flexibility of Dutch word orders makes Dutch listeners less pro-active as anticipators as the risk of anticipating upcoming elements incorrectly is too high. As a result, the anticipatory process becomes too costly and fundamental sentence processing and interpretation gets priority. This would provide evidence for the idea that anticipatory processing is a secondary process that occurs only if the primary process of sentence interpretation is covered. Hopefully, future studies can shed more light on the anticipatory processing abilities of listeners in different Dutch word orders constructions.

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APPENDICES

APPENDIX I

DUTCH INFORMED CONSENT FORM.

Beste deelnemer,

Welkom! Heel fijn dat je deel wilt nemen aan dit onderzoek.

Met dit onderzoek probeer ik meer te weten te komen over hoe mensen taal verwerken. Om dit te onderzoeken gebruiken we in dit onderzoek een eye-tracker. Een eye-tracker volgt de oogbewegingen die een persoon maakt. Deze bewegingen kunnen veel zeggen over de manier waarop mensen taal verwerken.

Het experimentele gedeelte van het experiment zal ongeveer 30 minuten duren, inclusief de tijd om de eye-tracker goed af te stellen.

Er zijn geen risico's verbonden aan deelname aan dit onderzoek. De data wordt anoniem verzameld en zijn dus nooit naar jou terug te herleiden. Andere personen dan de onderzoekers zullen geen toegang hebben tot de data. Verder is jouw deelname aan dit onderzoek geheel vrijwillig. Je mag je deelname te allen tijde beëindigen zonder opgave van reden. Je gegevens worden in dat geval buiten beschouwing gelaten in de analyses.

Voor deelname aan dit onderzoek zul je geen credits of geld ontvangen. Wel krijg je als dank voor je deelname mijn eeuwige dank en een koekje.

Voor vragen of opmerkingen over dit onderzoek kun je contact opnemen met onderzoeker Tess van der Zanden (t.van.der.zanden@umail.leidenuniv.nl of 06-42508550) of begeleider Dr. Leticia Pablos Robles (l.pablos.robles@hum.leidenuniv.nl of 071-5272106)

Ik heb het bovenstaande gelezen en begrepen en neem vrijwillig deel aan dit onderzoek.

Naam:

Datum:

Handtekening:

APPENDIX II

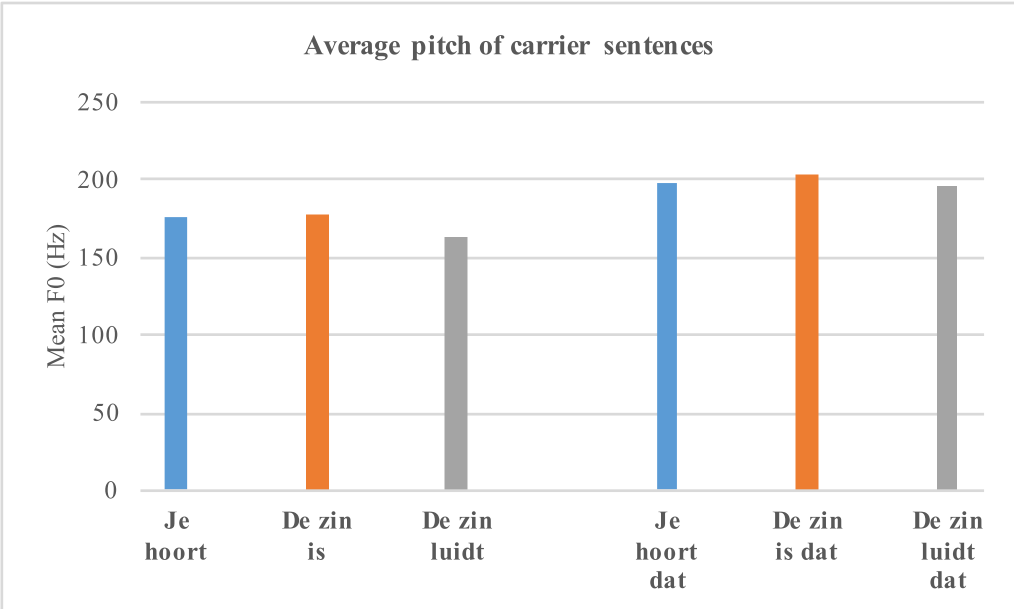
TARGET STIMULI LIST.

Trial	Carrier sentence	Critical sentence	NP2	NP1	Distractor	ArtDistractor	Word Order	Association
1	De zin is	het meisje schrijft de brief	brief	meisje	lasso	ijsje	SVO	Unassociated
2	Je hoort	de moeder verft de muur	muur	moeder	sok	bier	SVO	Unassociated
3	De zin luidt	de vader parkeert de auto	auto	vader	pijp	vuur	SVO	Unassociated
4	De zin is	de moeder dweilt de vloer	vloer	moeder	struik	haar	SVO	Unassociated
5	Je hoort	de oma breit de sjaal	sjaal	oma	bank	tentamen	SVO	Unassociated
6	De zin luidt	de jongen strikt de veter	veter	jongen	postzegel	boek	SVO	Unassociated
7	De zin is	het meisje likt het ijsje	ijsje	meisje	geweer	schat	SVO	Unassociated
8	Je hoort	de vader drinkt het bier	bier	vader	gebak	kies	SVO	Unassociated
9	De zin luidt	de student leert het tentamen	tentamen	student	gras	kerk	SVO	Associated
10	De zin is	de schrijver presenteert het boek	boek	schrijver	raam	koffer	SVO	Associated
11	Je hoort	de piraat vindt de schat	schat	piraat	sigaret	brood	SVO	Associated
12	De zin luidt	de slager snijdt het vlees	vlees	slager	papier	baard	SVO	Associated
13	De zin is	de jarige opent het cadeau	cadeau	jarige	glas	chocola	SVO	Associated
14	Je hoort	de tandarts trekt de kies	kies	tandarts	auto	gras	SVO	Associated
15	De zin luidt	de postbode bezorgt het pakket	pakket	postbode	slot	aardappels	SVO	Associated
16	De zin is	de piloot bestuurt het vliegtuig	vliegtuig	piloot	boek	taart	SVO	Associated
17	Je hoort dat	de vader het vuur blust	vuur	vader	hart	boot	SOV	Unassociated
18	De zin luidt dat	de jongen de bal schiet	bal	jongen	gitaar	vlees	SOV	Unassociated
19	De zin is dat	de moeder de lippen stift	lippen	moeder	trein	cadeau	SOV	Unassociated
20	Je hoort dat	de moeder het haar knipt	haar	moeder	boeket	tractor	SOV	Unassociated
21	De zin luidt dat	de vader de krant leest	krant	vader	schaats	vliegtuig	SOV	Unassociated
22	De zin is dat	de jongen de sigaret rookt	sigaret	jongen	friet	pakket	SOV	Unassociated
23	Je hoort dat	het meisje de beker wint	beker	meisje	raket	medicijn	SOV	Unassociated
24	De zin luidt dat	de moeder de nagels lakt	nagels	moeder	medaille	eten	SOV	Unassociated
25	De zin is dat	de dokter het medicijn geeft	medicijn	dokter	vloer	raam	SOV	Associated
26	Je hoort dat	de opa de pijp rookt	pijp	opa	vlees	radio	SOV	Associated
27	De zin luidt dat	de ober het eten serveert	eten	ober	struik	haar	SOV	Associated
28	De zin is dat	de bakker het brood verkoopt	brood	bakker	pakket	computer	SOV	Associated
29	Je hoort dat	de boerin de tractor rijdt	tractor	boerin	vliegtuig	bel	SOV	Associated
30	De zin luidt dat	de priester de kerk versiert	kerk	priester	sjaal	papier	SOV	Associated
31	De zin is dat	de toerist de koffer tilt	koffer	toerist	veter	ijsje	SOV	Associated
32	Je hoort dat	de matroos de boot vaart	boot	matroos	lippen	slot	SOV	Associated
65	De zin luidt	de vader blust het vuur	vuur	vader	cadeau	postzegel	SVO	Unassociated
66	De zin is	de jongen schiet de bal	bal	jongen	kies	boeket	SVO	Unassociated
67	Je hoort	de moeder stift de lippen	lippen	moeder	schaats	tentamen	SVO	Unassociated
68	De zin luidt	de moeder knipt het haar	haar	moeder	vliegtuig	bank	SVO	Unassociated
69	De zin is	de vader leest de krant	krant	vader	friet	baard	SVO	Unassociated
70	Je hoort	de jongen rookt de sigaret	sigaret	jongen	raket	papier	SVO	Unassociated
71	De zin luidt	het meisje wint de beker	beker	meisje	bal	vuur	SVO	Unassociated

72	De zin is	de moeder lakt de nagels	nagels	moeder	brief	medicijn	SVO	Unassociated
73	Je hoort	de matroos vaart de boot	boot	matroos	lippen	klooster	SVO	Associated
74	De zin luidt	de dokter geeft het medicijn	medicijn	dokter	medaille	muur	SVO	Associated
75	De zin is	de opa rookt de pijp	pijp	opa	taart	glas	SVO	Associated
76	Je hoort	de ober serveert het eten	eten	ober	haar	veter	SVO	Associated
77	De zin luidt	de bakker verkoopt het brood	brood	bakker	gras	sok	SVO	Associated
78	De zin is	de boerin rijdt de tractor	tractor	boerin	vloer	bier	SVO	Associated
79	Je hoort	de priester versiert de kerk	kerk	priester	parfum	eten	SVO	Associated
80	De zin luidt	de toerist tilt de koffer	koffer	toerist	bel	gras	SVO	Associated
81	Je hoort dat	het meisje de brief schrijft	brief	meisje	boot	brood	SOV	Unassociated
82	De zin is dat	de moeder de muur verft	muur	moeder	auto	hart	SOV	Unassociated
83	Je hoort dat	de vader de auto parkeert	auto	vader	handen	boek	SOV	Unassociated
84	De zin luidt dat	de moeder de vloer dweilt	vloer	moeder	radio	glas	SOV	Unassociated
85	De zin is dat	de oma de sjaal breit	sjaal	oma	pijp	vlees	SOV	Unassociated
86	Je hoort dat	de jongen de veter strikt	veter	jongen	boeket	slot	SOV	Unassociated
87	De zin luidt dat	het meisje het ijsje likt	ijsje	meisje	tentamen	koffer	SOV	Unassociated
88	De zin is dat	de vader het bier drinkt	bier	vader	vuur	struik	SOV	Unassociated
89	Je hoort dat	de student het tentamen leert	tentamen	student	boeket	lasso	SOV	Associated
90	De zin luidt dat	de schrijver het boek promoot	boek	schrijver	raam	vloer	SOV	Associated
91	De zin is dat	de piraat de schat vindt	schat	piraat	trein	vliegtuig	SOV	Associated
92	Je hoort dat	de slager het vlees snijdt	vlees	slager	papier	parfum	SOV	Associated
93	De zin luidt dat	de jarige het cadeau opent	cadeau	jarige	medicijn	kerk	SOV	Associated
94	De zin is dat	de tandarts de kies trekt	kies	tandarts	muur	geweer	SOV	Associated
95	Je hoort dat	de postbode het pakket bezorgt	pakket	postbode	klooster	boter	SOV	Associated
96	De zin luidt dat	de piloot het vliegtuig bestuurt	vliegtuig	piloot	eten	krant	SOV	Associated

APPENDIX III

AVERAGE F0 OF CARRIER SENTENCES.



APPENDIX IV

TABLE WITH CONSTITUENT DURATION PER CONDITION.

Condition	**Subject NP1**	**Verb**	**Object NP2**	***Total***
SVO-Unassociated	734	418	608	1760
SVO-Associated	745	444	623	1812
Average	739	431	615	
	Subject NP1	**Object NP2**	**Verb**	
SOV-Unassociated	554	446	467	1464
SOV-Associated	627	504	495	1627
Average	591	474	481	

APPENDIX V

TABLE WITH AVERAGE F0 PER CONSTITUENT PER CONDITION.

Condition	Subject NP1	Verb	Object NP2
SVO-Unassociated	195	184	167
SVO-Associated	190	191	165
Average	192	188	166
	Subject NP1	**Object NP2**	**Verb**
SOV-Unassociated	186	202	142
SOV-Associated	183	202	141
Average	185	202	141

TABLE WITH AVERAGE MINIMUM F0 PER CONSTITUENT PER CONDITION.

Condition	Subject NP1	Verb	Object NP2
SVO-Unassociated	137	147	123
SVO-Associated	134	154	1221
	Subject NP1	**Object NP2**	**Verb**
SOV-Unassociated	134	144	120
SOV-Associated	127	138	115

TABLE WITH AVERAGE MAXIMUM F0 PER CONSTITUENT PER CONDITION.

Condition	Subject NP1	Verb	Object NP2
SVO-Unassociated	256	222	232
SVO-Associated	271	233	234
	Subject NP1	**Object NP2**	**Verb**
SOV-Unassociated	258	252	168
SOV-Associated	250	249	167

APPENDIX VI

FILLER STIMULI LIST.

Trial	Carrier sentence	Adv.	Critical sentence	NP2	NP1	Distractor	Article distractor	Word order	Association
33	De zin is	soms	scheert de vader de baard	baard	vader	krant	gebak	VSO	Unassociated
34	Je hoort	soms	eet het meisje de chocola	chocola	meisje	sigaret	geweer	VSO	Unassociated
35	De zin luidt	soms	bakt de moeder de taart	taart	moeder	beker	raam	VSO	Unassociated
36	De zin is	soms	kookt de vader de aardappels	aardappels	vader	nagels	gras	VSO	Unassociated
37	Je hoort	soms	luistert de jongen de radio	radio	jongen	brief	brood	VSO	Unassociated
38	De zin luidt	snel	wast het meisje de handen	handen	meisje	schat	eten	VSO	Unassociated
39	De zin is	snel	hackt de jongen de computer	computer	jongen	kies	klooster	VSO	Unassociated
40	Je hoort	snel	rinkelt de moeder de bel	bel	moeder	boot	cadeau	VSO	Unassociated
41	De zin luidt	soms	gooit de cowboy de lasso	lasso	cowboy	baard	geweer	VSO	Associated
42	De zin is	soms	eet de jarige de taart	taart	jarige	vuur	sok	VSO	Associated
43	Je hoort	nu	vult de kerstman de sok	sok	kerstman	chocola	slot	VSO	Associated
44	De zin luidt	nu	bewoont de monnik het klooster	klooster	monnik	pakket	sjaal	VSO	Associated
45	De zin is	nu	snoeit de tuinman de struik	struik	tuinman	aardappels	papier	VSO	Associated
46	Je hoort	nu	laadt de soldaat het geweer	geweer	soldaat	ijsje	pijp	VSO	Associated
47	De zin luidt	nu	opereert de dokter het hart	hart	dokter	bier	struik	VSO	Associated
48	De zin is	nu	overvalt de dief de bank	bank	dief	radio	tentamen	VSO	Associated
49	Je hoort		het gras wordt door de vader gemaaid	gras	vader	medicijn	parfum	OVS	Unassociated
50	De zin luidt		het raam wordt door de moeder gezeemd	raam	moeder	vliegtuig	deur	OVS	Unassociated
51	De zin is		de parfum wordt door het meisje gespoten	parfum	meisje	tractor	vlees	OVS	Unassociated
52	Je hoort		het papier wordt door de moeder gescheurd	papier	moeder	klooster	deur	OVS	Unassociated
53	De zin luidt		de deur wordt door de jongen gesloten	deur	jongen	kerk	vuur	OVS	Unassociated
54	De zin is		het glas wordt door de jongen gebroken	glas	jongen	eten	boter	OVS	Unassociated
55	Je hoort		het slot wordt door de vader geopend	slot	vader	brood	lasso	OVS	Unassociated
56	De zin luidt		de boter wordt door de moeder gesmeerd	boter	moeder	koffer	hart	OVS	Unassociated
57	De zin is		de postzegel wordt door de opa gespaard	postzegel	opa	handen	bier	OVS	Associated
58	Je hoort		de gitaar wordt door de zanger bespeeld	gitaar	zanger	computer	tentamen	OVS	Associated
59	De zin luidt		de trein wordt door de machinist gestopt	trein	machinist	bel	haar	OVS	Associated
60	De zin is		de schaats wordt door de trainer geslepen	schaats	trainer	parfum	boek	OVS	Associated
61	Je hoort		de friet wordt door de marktkoopman gefrituurd	friet	marktkoo pman	deur	cadeau	OVS	Associated
62	De zin luidt		de raket wordt door de astronaut bestuurd	raket	astronaut	boter	medicijn	OVS	Associated
63	De zin is		de medaille wordt door de sporter ontvangen	medaille	sporter	brief	vliegtuig	OVS	Associated
64	Je hoort		het boeket wordt door de bloemist geschikt	boeket	bloemist	haar	bank	OVS	Associated
97	De zin luidt	snel	maait de vader het gras	gras	vader	bier	tractor	VSO	Unassociated
98	De zin is	snel	zeemt de moeder het raam	raam	moeder	geweer	aardappels	VSO	Unassociated
99	Je hoort	nu	spuit het meisje de parfum	parfum	meisje	computer	ijsje	VSO	Unassociated
100	De zin luidt	nu	scheurt de moeder het papier	papier	moeder	ijsje	schat	VSO	Unassociated

101	De zin is	nu	sluit de jongen de deur	deur	jongen	tractor	raam	VSO	Unassociated
102	Je hoort	nu	breekt de jongen het glas	glas	jongen	brood	chocola	VSO	Unassociated
103	De zin luidt	nu	opent de vader het slot	slot	vader	hart	taart	VSO	Unassociated
104	De zin is	nu	smeert de moeder de boter	boter	moeder	koffer	pakket	VSO	Unassociated
105	Je hoort	nu	spaart de opa de postzegel	postzegel	opa	cadeau	handen	VSO	Associated
106	De zin luidt	snel	bespeelt de zanger de gitaar	gitaar	zanger	lasso	cadeau	VSO	Associated
107	De zin is	snel	stopt de machinist de trein	trein	machinist	postzegel	boeket	VSO	Associated
108	Je hoort	snel	slijpt de trainer de schaats	schaats	trainer	bank	pakket	VSO	Associated
109	De zin luidt	nu	frituurt de marktkoopman de friet	friet	marktkoo pman	baard	medicijn	VSO	Associated
110	De zin is	nu	bestuurt de astronaut de raket	raket	astronaut	chocola	gebak	VSO	Associated
111	Je hoort	nu	ontvangt de sporter de medaille	medaille	sporter	taart	ijsje	VSO	Associated
112	De luidt	nu	schikt de bloemist het boeket	boeket	bloemist	vlees	bal	VSO	Associated
113	Je hoort		de baard wordt door de vader geschoren	baard	vader	sjaal	glas	OVS	Unassociated
114	De zin luidt		de chocola wordt door het meisje gegeten	chocola	meisje	veter	pakket	OVS	Unassociated
115	De zin is		de taart wordt door de moeder gebakken	taart	moeder	sok	boeket	OVS	Unassociated
116	Je hoort		de aardappels worden door de vader gekookt	aardappels	vader	gitaar	haar	OVS	Unassociated
117	De zin luidt		de radio wordt door de jongen geluisterd	radio	jongen	deur	klooster	OVS	Unassociated
118	De zin is		de handen worden door het meisje gewassen	handen	meisje	sigaret	slot	OVS	Unassociated
119	Je hoort		de computer wordt door de jongen gehackt	computer	jongen	kerk	brood	OVS	Unassociated
120	De zin luidt		de bel wordt door de moeder gerinkeld	bel	moeder	boter	klooster	OVS	Unassociated
121	De zin is		de lasso wordt door de cowboy gegooid	lasso	cowboy	krant	boeket	OVS	Associated
122	Je hoort		het gebak wordt door de jarige gegeten	gebak	jarige	slot	brief	OVS	Associated
123	De zin luidt		de sok wordt door de kerstman gevuld	sok	kerstman	beker	vlees	OVS	Associated
124	De zin is		het klooster wordt door de monnik bewoond	klooster	monnik	nagels	tentamen	OVS	Associated
125	Je hoort		de struikt wordt door de tuinman gesnoeid	struik	tuinman	aardappels	glas	OVS	Associated
126	De zin luidt		het geweer wordt door de soldaat geladen	geweer	soldaat	boek	lippen	OVS	Associated
127	De zin is		het hart wordt door de dokter geopereerd	hart	dokter	glas	beker	OVS	Associated
128	Je hoort		de bank wordt door de dief overvallen	bank	dief	schat	bier	OVS	Associated

APPENDIX VII

COMPREHENSION QUESTIONS LIST.

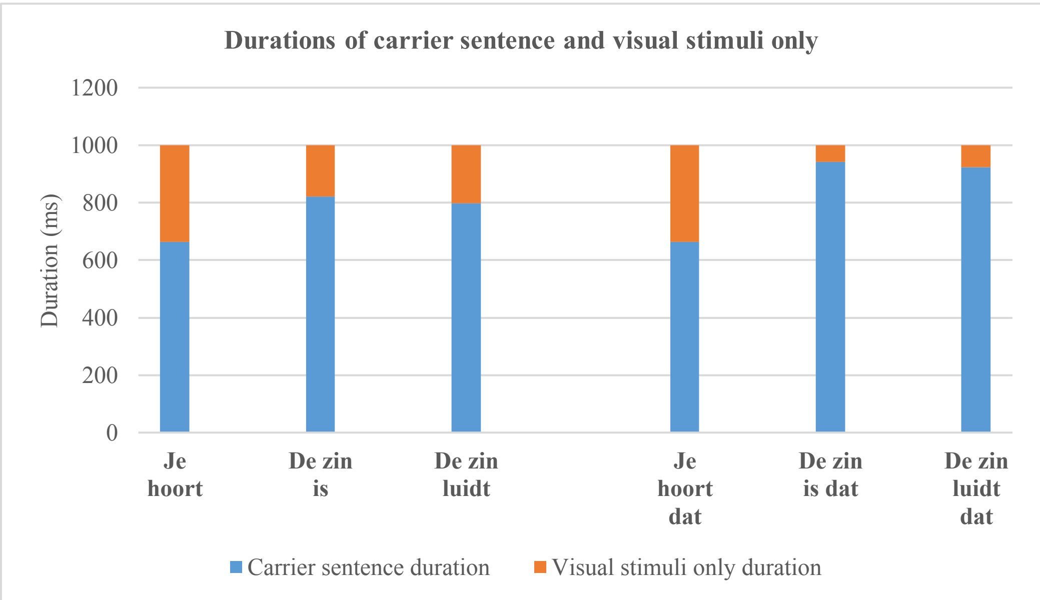
Comprehension question	**Correct response**
schrijft het meisje de brief?	Correct
breit de moeder de sjaal?	Incorrect
vindt de piraat de schat?	Correct
bezorgt de postbode het cadeau?	Incorrect
knipt de moeder het haar?	Correct
rookt de jongen de pijp?	Incorrect
geeft de ober het medicijn?	Incorrect
bestuurt de matroos de boot?	Correct
scheert de vader soms de baard?	Correct
bakt de moeder soms het brood?	Incorrect
vult de kerstman nu de sok?	Correct
snoeit de tuinman nu de struik?	Correct
overvalt de dief nu het hart?	Incorrect
zeemt de man het raam?	Incorrect
breekt de jongen het glas?	Correct
slijpt de zanger de schaats?	Incorrect
wint de jongen de beker?	Incorrect
lakt de moeder de nagels?	Correct
verkoopt de bakker het eten?	Incorrect
rijdt de boerin de tractor?	Correct
parkeert de vader de auto?	Correct
drinkt de moeder het bier?	Incorrect
opent de jarige het cadeau?	Correct
trekt de slager de kies?	Incorrect
maait de moeder snel het gras?	Incorrect
ruikt het meisje nu de parfum?	Correct
sluit de vader nu het slot?	Correct
smeert de moeder nu de boter?	Correct
ontvangt de sporter nu de medaille?	Correct
hackt de jongen het slot?	Incorrect
gooit de cowboy de sok?	Incorrect
laadt de dokter het geweer?	Incorrect

APPENDIX VIII

TABLE WITH CARRIER SENTENCE DURATIONS.

Carrier sentence Dutch	Carrier sentence English	Duration carrier sentence	Duration visual stimuli only
Je hoort	*You hear*	664	336
De zin is	*The sentence is*	821	179
De zin luidt	*The sentence states*	799	201
Je hoort dat	*You hear that*	663	337
De zin is dat	*The sentence is that*	941	59
De zin luidt dat	*The sentence states that*	923	77

FIGURE WITH DURATIONS OF CARRIER SENTENCES AND VISUAL STIMULI ONLY



APPENDIX IX

TABLE WITH TIME WINDOW DURATIONS PLUS 200 MS.

Time window	Onset (ms)	Offset (ms)
Time window 1	0	1200
Time window 2	1200	1870
Time window 3	1870	2324
Time window 4	2324	2876
Time window 5	2876	3876

APPENDIX X

LINEAR MIXED EFFECT MODELS WITH FOUR AREAS OF INTERESTS.

Entire sentence

```
Data: response_window_clean
Models:
baselineM: AOI ~ (1 | SUBJECT) + (1 | ITEM)
timeM: AOI ~ (1 | SUBJECT) + (1 | ITEM) + TIMESTAMP
wordorderM: AOI ~ (1 | SUBJECT) + (1 | ITEM) + TIMESTAMP + WORDORDER
associationM: AOI ~ (1 | SUBJECT) + (1 | ITEM) + TIMESTAMP + WORDORDER + ASSOCIATION
timewordorderM: AOI ~ (1 | SUBJECT) + (1 | ITEM) + TIMESTAMP + WORDORDER + ASSOCIATION +
timewordorderM:     TIMESTAMP:WORDORDER
timeassociationM: AOI ~ (1 | SUBJECT) + (1 | ITEM) + TIMESTAMP + WORDORDER + ASSOCIATION +
timeassociationM:     TIMESTAMP:WORDORDER + TIMESTAMP:ASSOCIATION
wordorderassociationM: AOI ~ (1 | SUBJECT) + (1 | ITEM) + TIMESTAMP + WORDORDER + ASSOCIATION +
wordorderassociationM:     TIMESTAMP:WORDORDER + TIMESTAMP:ASSOCIATION + WORDORDER:ASSOCIATION
fixationM: AOI ~ (1 | SUBJECT) + (1 | ITEM) + TIMESTAMP + WORDORDER + ASSOCIATION +
fixationM:     TIMESTAMP:WORDORDER + TIMESTAMP:ASSOCIATION + WORDORDER:ASSOCIATION +
fixationM:     TIMESTAMP:WORDORDER:ASSOCIATION
                      Df    AIC    BIC  logLik deviance     Chisq Chi Df Pr(>Chisq)
baselineM              4 600134 600175 -300063   600126
timeM                  5 598719 598769 -299354   598709 1417.6645      1  < 2.2e-16
wordorderM             6 598720 598781 -299354   598708    0.1198      1  0.7292527
associationM           7 598710 598781 -299348   598696   12.3663      1  0.0004372
timewordorderM         8 598710 598791 -299347   598694    1.8985      1  0.1682423
timeassociationM       9 598710 598801 -299346   598692    2.4996      1  0.1138764
wordorderassociationM 10 598712 598813 -299346   598692    0.1149      1  0.7346505
fixationM             11 598711 598822 -299344   598689    2.8398      1  0.0919553

baselineM
timeM                 ***
wordorderM
associationM          ***
timewordorderM
timeassociationM
wordorderassociationM
fixationM             .
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1
```

Time window 1

```
Data: response_window_clean1
Models:
baselineM1: AOI ~ (1 | SUBJECT) + (1 | ITEM)
timeM1: AOI ~ (1 | SUBJECT) + (1 | ITEM) + TIMESTAMP
wordorderM1: AOI ~ (1 | SUBJECT) + (1 | ITEM) + TIMESTAMP + WORDORDER
associationM1: AOI ~ (1 | SUBJECT) + (1 | ITEM) + TIMESTAMP + WORDORDER + ASSOCIATION
timewordorderM1: AOI ~ (1 | SUBJECT) + (1 | ITEM) + TIMESTAMP + WORDORDER + ASSOCIATION +
timewordorderM1:     TIMESTAMP:WORDORDER
timeassociationM1: AOI ~ (1 | SUBJECT) + (1 | ITEM) + TIMESTAMP + WORDORDER + ASSOCIATION +
timeassociationM1:     TIMESTAMP:WORDORDER + TIMESTAMP:ASSOCIATION
wordorderassociationM1: AOI ~ (1 | SUBJECT) + (1 | ITEM) + TIMESTAMP + WORDORDER + ASSOCIATION +
wordorderassociationM1:     TIMESTAMP:WORDORDER + TIMESTAMP:ASSOCIATION + WORDORDER:ASSOCIATION
fixationM1: AOI ~ (1 | SUBJECT) + (1 | ITEM) + TIMESTAMP + WORDORDER + ASSOCIATION +
fixationM1:     TIMESTAMP:WORDORDER + TIMESTAMP:ASSOCIATION + WORDORDER:ASSOCIATION +
fixationM1:     TIMESTAMP:WORDORDER:ASSOCIATION
                       Df    AIC    BIC  logLik deviance   Chisq Chi Df Pr(>Chisq)
baselineM1              4 136781 136816 -68387   136773
timeM1                  5 136783 136827 -68387   136773  0.0034      1   0.953445
wordorderM1             6 136785 136837 -68387   136773  0.0000      1   0.997582
associationM1           7 136778 136839 -68382   136764  8.6809      1   0.003216
timewordorderM1         8 136772 136842 -68378   136756  8.2973      1   0.003970
timeassociationM1       9 136750 136829 -68366   136732 23.7822      1  1.079e-06
wordorderassociationM1 10 136752 136839 -68366   136732  0.0002      1   0.989104
fixationM1             11 136754 136850 -68366   136732  0.0597      1   0.806901

baselineM1
timeM1
wordorderM1
associationM1          **
timewordorderM1        **
timeassociationM1      ***
wordorderassociationM1
fixationM1
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1
```

Time window 2

```
Data: response_window_clean2
Models:
baselineM2: AOI ~ (1 | SUBJECT) + (1 | ITEM)
timeM2: AOI ~ (1 | SUBJECT) + (1 | ITEM) + TIMESTAMP
wordorderM2: AOI ~ (1 | SUBJECT) + (1 | ITEM) + TIMESTAMP + WORDORDER
associationM2: AOI ~ (1 | SUBJECT) + (1 | ITEM) + TIMESTAMP + WORDORDER + ASSOCIATION
timewordorderM2: AOI ~ (1 | SUBJECT) + (1 | ITEM) + TIMESTAMP + WORDORDER + ASSOCIATION +
timewordorderM2:     TIMESTAMP:WORDORDER
timeassociationM2: AOI ~ (1 | SUBJECT) + (1 | ITEM) + TIMESTAMP + WORDORDER + ASSOCIATION +
timeassociationM2:     TIMESTAMP:WORDORDER + TIMESTAMP:ASSOCIATION
wordorderassociationM2: AOI ~ (1 | SUBJECT) + (1 | ITEM) + TIMESTAMP + WORDORDER + ASSOCIATION +
wordorderassociationM2:     TIMESTAMP:WORDORDER + TIMESTAMP:ASSOCIATION + WORDORDER:ASSOCIATION
fixationM2: AOI ~ (1 | SUBJECT) + (1 | ITEM) + TIMESTAMP + WORDORDER + ASSOCIATION +
fixationM2:     TIMESTAMP:WORDORDER + TIMESTAMP:ASSOCIATION + WORDORDER:ASSOCIATION +
fixationM2:     TIMESTAMP:WORDORDER:ASSOCIATION
                       Df   AIC   BIC logLik deviance   Chisq Chi Df Pr(>Chisq)
baselineM2              4 93682 93715 -46837    93674
timeM2                  5 93672 93714 -46831    93662 11.7005      1  0.0006248 ***
wordorderM2             6 93672 93722 -46830    93660  2.0207      1  0.1551716
associationM2           7 93667 93725 -46827    93653  7.2195      1  0.0072117 **
timewordorderM2         8 93669 93736 -46827    93653  0.0026      1  0.9597068
timeassociationM2       9 93671 93746 -46827    93653  0.0016      1  0.9679899
wordorderassociationM2 10 93673 93756 -46826    93653  0.1734      1  0.6771165
fixationM2             11 93674 93766 -46826    93652  0.7845      1  0.3757665
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

Time window 3

```
Data: response_window_clean3
Models:
baselineM3: AOI ~ (1 | SUBJECT) + (1 | ITEM)
timeM3: AOI ~ (1 | SUBJECT) + (1 | ITEM) + TIMESTAMP
wordorderM3: AOI ~ (1 | SUBJECT) + (1 | ITEM) + TIMESTAMP + WORDORDER
associationM3: AOI ~ (1 | SUBJECT) + (1 | ITEM) + TIMESTAMP + WORDORDER + ASSOCIATION
timewordorderM3: AOI ~ (1 | SUBJECT) + (1 | ITEM) + TIMESTAMP + WORDORDER + ASSOCIATION +
timewordorderM3:     TIMESTAMP:WORDORDER
timeassociationM3: AOI ~ (1 | SUBJECT) + (1 | ITEM) + TIMESTAMP + WORDORDER + ASSOCIATION +
timeassociationM3:     TIMESTAMP:WORDORDER + TIMESTAMP:ASSOCIATION
wordorderassociationM3: AOI ~ (1 | SUBJECT) + (1 | ITEM) + TIMESTAMP + WORDORDER + ASSOCIATION +
wordorderassociationM3:     TIMESTAMP:WORDORDER + TIMESTAMP:ASSOCIATION + WORDORDER:ASSOCIATION
fixationM3: AOI ~ (1 | SUBJECT) + (1 | ITEM) + TIMESTAMP + WORDORDER + ASSOCIATION +
fixationM3:     TIMESTAMP:WORDORDER + TIMESTAMP:ASSOCIATION + WORDORDER:ASSOCIATION +
fixationM3:     TIMESTAMP:WORDORDER:ASSOCIATION
                       Df   AIC   BIC logLik deviance   Chisq Chi Df Pr(>Chisq)
baselineM3              4 61245 61277 -30619    61237
timeM3                  5 61222 61262 -30606    61212 24.8630      1  6.155e-07 ***
wordorderM3             6 61224 61272 -30606    61212  0.1905      1    0.66247
associationM3           7 61222 61277 -30604    61208  4.1115      1    0.04259 *
timewordorderM3         8 61224 61287 -30604    61208  0.6268      1    0.42854
timeassociationM3       9 61219 61290 -30601    61201  6.3989      1    0.01142 *
wordorderassociationM3 10 61221 61300 -30600    61201  0.0733      1    0.78654
fixationM3             11 61217 61304 -30598    61195  6.1390      1    0.01322 *
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

Time window 4

```
Data: response_window_clean4
Models:
baselineM4: AOI ~ (1 | SUBJECT) + (1 | ITEM)
timeM4: AOI ~ (1 | SUBJECT) + (1 | ITEM) + TIMESTAMP
wordorderM4: AOI ~ (1 | SUBJECT) + (1 | ITEM) + TIMESTAMP + WORDORDER
associationM4: AOI ~ (1 | SUBJECT) + (1 | ITEM) + TIMESTAMP + WORDORDER + ASSOCIATION
timewordorderM4: AOI ~ (1 | SUBJECT) + (1 | ITEM) + TIMESTAMP + WORDORDER + ASSOCIATION +
timewordorderM4:     TIMESTAMP:WORDORDER
timeassociationM4: AOI ~ (1 | SUBJECT) + (1 | ITEM) + TIMESTAMP + WORDORDER + ASSOCIATION +
timeassociationM4:     TIMESTAMP:WORDORDER + TIMESTAMP:ASSOCIATION
wordorderassociationM4: AOI ~ (1 | SUBJECT) + (1 | ITEM) + TIMESTAMP + WORDORDER + ASSOCIATION +
wordorderassociationM4:     TIMESTAMP:WORDORDER + TIMESTAMP:ASSOCIATION + WORDORDER:ASSOCIATION
fixationM4: AOI ~ (1 | SUBJECT) + (1 | ITEM) + TIMESTAMP + WORDORDER + ASSOCIATION +
fixationM4:     TIMESTAMP:WORDORDER + TIMESTAMP:ASSOCIATION + WORDORDER:ASSOCIATION +
fixationM4:     TIMESTAMP:WORDORDER:ASSOCIATION
                       Df   AIC   BIC logLik deviance  Chisq Chi Df Pr(>Chisq)
baselineM4              4 77184 77217 -38588    77176
timeM4                  5 77178 77219 -38584    77168 8.3449      1   0.003868 **
wordorderM4             6 77178 77227 -38583    77166 2.1857      1   0.139294
associationM4           7 77177 77234 -38582    77163 2.5707      1   0.108858
timewordorderM4         8 77175 77240 -38579    77159 4.7579      1   0.029163 *
timeassociationM4       9 77177 77250 -38579    77159 0.0668      1   0.796045
wordorderassociationM4 10 77178 77259 -38579    77158 0.9512      1   0.329411
fixationM4             11 77179 77269 -38579    77157 0.1313      1   0.717113
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

Time window 5

```
Data: response_window_clean5
Models:
baselineM5: AOI ~ (1 | SUBJECT) + (1 | ITEM)
timeM5: AOI ~ (1 | SUBJECT) + (1 | ITEM) + TIMESTAMP
wordorderM5: AOI ~ (1 | SUBJECT) + (1 | ITEM) + TIMESTAMP + WORDORDER
associationM5: AOI ~ (1 | SUBJECT) + (1 | ITEM) + TIMESTAMP + WORDORDER + ASSOCIATION
wordorderassociationM5: AOI ~ (1 | SUBJECT) + (1 | ITEM) + TIMESTAMP + WORDORDER + ASSOCIATION +
wordorderassociationM5:     WORDORDER:ASSOCIATION
timeassociationM5: AOI ~ (1 | SUBJECT) + (1 | ITEM) + TIMESTAMP + WORDORDER + ASSOCIATION +
timeassociationM5:     WORDORDER:ASSOCIATION + TIMESTAMP:ASSOCIATION
timewordorderM5: AOI ~ (1 | SUBJECT) + (1 | ITEM) + TIMESTAMP + WORDORDER + ASSOCIATION +
timewordorderM5:     WORDORDER:ASSOCIATION + TIMESTAMP:ASSOCIATION + TIMESTAMP:WORDORDER
fixationM5: AOI ~ (1 | SUBJECT) + (1 | ITEM) + TIMESTAMP + WORDORDER + ASSOCIATION +
fixationM5:     WORDORDER:ASSOCIATION + TIMESTAMP:ASSOCIATION + TIMESTAMP:WORDORDER +
fixationM5:     TIMESTAMP:WORDORDER:ASSOCIATION
                       Df    AIC    BIC logLik deviance    Chisq Chi Df Pr(>Chisq)
baselineM5              4 151966 152001 -75979   151958
timeM5                  5 151641 151685 -75816   151631 327.1082      1  < 2.2e-16 ***
wordorderM5             6 151642 151695 -75815   151630   0.9744      1  0.3235770
associationM5           7 151633 151695 -75810   151619  10.9884      1  0.0009169 ***
wordorderassociationM5  8 151635 151705 -75810   151619   0.1839      1  0.6680588
timeassociationM5       9 151637 151715 -75809   151619   0.3427      1  0.5582563
timewordorderM5        10 151571 151658 -75775   151551  67.9988      1  < 2.2e-16 ***
fixationM5             11 151571 151667 -75775   151549   1.5485      1  0.2133569
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

APPENDIX XI

PROPORTION AND STANDARD DEVIATIONS OF FIXATIONS IN FIVE TIME WINDOWS PER CONDITION.

Time window	AOI	SVO-Unass	SVO-Ass	SOV-Unass	SOV-Ass	Mean
Time window 1	NP2	0,23 (0,42)	0,20 (0,40)	0,23 (0,42)	0,19 (0,39)	0,21
Carrier sentence	Distractor	0,22 (0,42)	0,24 (0,42)	0,25 (0,43)	0,24 (0,43)	0,24
	ArtDistractor	0,30 (0,46)	0,25 (0,43)	0,26 (0,44)	0,27 (0,44)	0,27
	NP1	0,31 (0,46)	0,38 (0,48)	0,32 (0,47)	0,36 (0,48)	0,34
Time window 2	NP2	0,30 (0,46)	0,25 (0,43)	0,25 (0,43)	0,21 (0,41)	0,25
NP1	Distractor	0,21 (0,41)	0,26 (0,44)	0,28 (0,45)	0,26 (0,44)	0,25
	ArtDistractor	0,24 (0,42)	0,20 (0,40)	0,21 (0,41)	0,21 (0,41)	0,22
	NP1	0,32 (0,47)	0,36 (0,48)	0,33 (0,47)	0,38 (0,48)	0,35
Time window 3	NP2	0,25 (0,43)	0,22 (0,41)	0,25 (0,43)	0,23 (0,42)	0,24
Verb/NP2	Distractor	0,25 (0,43)	0,25 (0,43)	0,26 (0,44)	0,24 (0,43)	0,25
	ArtDistractor	0,21 (0,41)	0,19 (0,39)	0,18 (0,39)	0,20 (0,40)	0,20
	NP1	0,35 (0,48)	0,41 (0,49)	0,37 (0,48)	0,40 (0,49)	0,38
Time window 4	NP2	0,21 (0,41)	0,21 (0,40)	0,24 (0,43)	0,23 (0,42)	0,22
NP2/Verb	Distractor	0,24 (0,42)	0,21 (0,40)	0,22 (0,41)	0,22 (0,42)	0,22
	ArtDistractor	0,18 (0,38)	0,13 (0,33)	0,15 (0,36)	0,13 (0,34)	0,15
	NP1	0,44 (0,50)	0,52 (0,50)	0,46 (0,50)	0,48 (0,50)	0,48
Time window 5	NP2	0,43 (0,49)	0,37 (0,48)	0,44 (0,50)	0,38 (0,49)	0,41
Post-critical	Distractor	0,15 (0,36)	0,17 (0,38)	0,15 (0,36)	0,18 (0,38)	0,16
	ArtDistractor	0,12 (0,33)	0,13(0,34)	0,12 (0,33)	0,13 (0,33)	0,13
	NP1	0,35 (0,48)	0,38 (0,49)	0,35 (0,48)	0,37 (0,48)	0,36

APPENDIX XII

LINEAR MIXED EFFECT MODELS WITHOUT NP1 FIXATIONS.

Entire sentence

```
Data: response_window_clean_noNP1
Models:
baselineM_noNP1: AOI ~ (1 | SUBJECT) + (1 | ITEM)
timeM_noNP1: AOI ~ (1 | SUBJECT) + (1 | ITEM) + TIMESTAMP
wordorderM_noNP1: AOI ~ (1 | SUBJECT) + (1 | ITEM) + TIMESTAMP + WORDORDER
associationM_noNP1: AOI ~ (1 | SUBJECT) + (1 | ITEM) + TIMESTAMP + WORDORDER + ASSOCIATION
timewordorderM_noNP1: AOI ~ (1 | SUBJECT) + (1 | ITEM) + TIMESTAMP + WORDORDER + ASSOCIATION +
timewordorderM_noNP1:     TIMESTAMP:WORDORDER
timeassociationM_noNP1: AOI ~ (1 | SUBJECT) + (1 | ITEM) + TIMESTAMP + WORDORDER + ASSOCIATION +
timeassociationM_noNP1:     TIMESTAMP:WORDORDER + TIMESTAMP:ASSOCIATION
wordorderassociationM_noNP1: AOI ~ (1 | SUBJECT) + (1 | ITEM) + TIMESTAMP + WORDORDER + ASSOCIATION +
wordorderassociationM_noNP1:     TIMESTAMP:WORDORDER + TIMESTAMP:ASSOCIATION + WORDORDER:ASSOCIATION
fixationM_noNP1: AOI ~ (1 | SUBJECT) + (1 | ITEM) + TIMESTAMP + WORDORDER + ASSOCIATION +
fixationM_noNP1:     TIMESTAMP:WORDORDER + TIMESTAMP:ASSOCIATION + WORDORDER:ASSOCIATION +
fixationM_noNP1:     TIMESTAMP:WORDORDER:ASSOCIATION
                            Df    AIC    BIC  logLik deviance     Chisq Chi Df Pr(>Chisq)    
baselineM_noNP1              4 283154 283193 -141573   283146                              
timeM_noNP1                  5 276389 276438 -138190   276379 6766.5663      1  < 2.2e-16 ***
wordorderM_noNP1             6 276391 276449 -138190   276379    0.0001      1  0.9927091    
associationM_noNP1           7 276392 276460 -138189   276378    1.3465      1  0.2458929    
timewordorderM_noNP1         8 276394 276471 -138189   276378    0.1834      1  0.6684736    
timeassociationM_noNP1       9 276378 276466 -138180   276360   17.2444      1  3.287e-05 ***
wordorderassociationM_noNP1 10 276379 276476 -138179   276359    1.7928      1  0.1805810    
fixationM_noNP1             11 276367 276473 -138172   276345   13.8226      1  0.0002009 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1
```

Time window 1

```
Data: response_window_clean1_noNP1
Models:
baselineM1_noNP1: AOI ~ (1 | SUBJECT) + (1 | ITEM)
timeM1_noNP1: AOI ~ (1 | SUBJECT) + (1 | ITEM) + TIMESTAMP
wordorderM1_noNP1: AOI ~ (1 | SUBJECT) + (1 | ITEM) + TIMESTAMP + WORDORDER
associationM1_noNP1: AOI ~ (1 | SUBJECT) + (1 | ITEM) + TIMESTAMP + WORDORDER + ASSOCIATION
timewordorderM1_noNP1: AOI ~ (1 | SUBJECT) + (1 | ITEM) + TIMESTAMP + WORDORDER + ASSOCIATION +
timewordorderM1_noNP1:     TIMESTAMP:WORDORDER
timeassociationM1_noNP1: AOI ~ (1 | SUBJECT) + (1 | ITEM) + TIMESTAMP + WORDORDER + ASSOCIATION +
timeassociationM1_noNP1:     TIMESTAMP:WORDORDER + TIMESTAMP:ASSOCIATION
wordorderassociationM1_noNP1: AOI ~ (1 | SUBJECT) + (1 | ITEM) + TIMESTAMP + WORDORDER + ASSOCIATION +
wordorderassociationM1_noNP1:     TIMESTAMP:WORDORDER + TIMESTAMP:ASSOCIATION + WORDORDER:ASSOCIATION
fixationM1_noNP1: AOI ~ (1 | SUBJECT) + (1 | ITEM) + TIMESTAMP + WORDORDER + ASSOCIATION +
fixationM1_noNP1:     TIMESTAMP:WORDORDER + TIMESTAMP:ASSOCIATION + WORDORDER:ASSOCIATION +
fixationM1_noNP1:     TIMESTAMP:WORDORDER:ASSOCIATION
                             Df   AIC   BIC logLik deviance     Chisq Chi Df Pr(>Chisq)    
baselineM1_noNP1              4 72359 72392 -36175    72351                              
timeM1_noNP1                  5 71242 71284 -35616    71232 1118.7644      1     < 2e-16 ***
wordorderM1_noNP1             6 71244 71294 -35616    71232    0.0013      1     0.97076    
associationM1_noNP1           7 71246 71304 -35616    71232    0.1347      1     0.71363    
timewordorderM1_noNP1         8 71245 71311 -35614    71229    3.0242      1     0.08203 .  
timeassociationM1_noNP1       9 71247 71322 -35614    71229    0.2090      1     0.64752    
wordorderassociationM1_noNP1 10 71246 71329 -35613    71226    2.5997      1     0.10688    
fixationM1_noNP1             11 71247 71339 -35613    71225    0.6045      1     0.43687    
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1
```

Time window 2

```
Data: response_window_clean2_noNP1
Models:
baselineM2_noNP1: AOI ~ (1 | SUBJECT) + (1 | ITEM)
timeM2_noNP1: AOI ~ (1 | SUBJECT) + (1 | ITEM) + TIMESTAMP
wordorderM2_noNP1: AOI ~ (1 | SUBJECT) + (1 | ITEM) + TIMESTAMP + WORDORDER
associationM2_noNP1: AOI ~ (1 | SUBJECT) + (1 | ITEM) + TIMESTAMP + WORDORDER + ASSOCIATION
timewordorderM2_noNP1: AOI ~ (1 | SUBJECT) + (1 | ITEM) + TIMESTAMP + WORDORDER + ASSOCIATION +
timewordorderM2_noNP1:     TIMESTAMP:WORDORDER
timeassociationM2_noNP1: AOI ~ (1 | SUBJECT) + (1 | ITEM) + TIMESTAMP + WORDORDER + ASSOCIATION +
timeassociationM2_noNP1:     TIMESTAMP:WORDORDER + TIMESTAMP:ASSOCIATION
wordorderassociationM2_noNP1: AOI ~ (1 | SUBJECT) + (1 | ITEM) + TIMESTAMP + WORDORDER + ASSOCIATION +
wordorderassociationM2_noNP1:     TIMESTAMP:WORDORDER + TIMESTAMP:ASSOCIATION + WORDORDER:ASSOCIATION
fixationM2_noNP1: AOI ~ (1 | SUBJECT) + (1 | ITEM) + TIMESTAMP + WORDORDER + ASSOCIATION +
fixationM2_noNP1:     TIMESTAMP:WORDORDER + TIMESTAMP:ASSOCIATION + WORDORDER:ASSOCIATION +
fixationM2_noNP1:     TIMESTAMP:WORDORDER:ASSOCIATION
                             Df   AIC   BIC logLik deviance  Chisq Chi Df Pr(>Chisq)
baselineM2_noNP1              4 47443 47475 -23718    47435
timeM2_noNP1                  5 47445 47485 -23718    47435 0.1752      1     0.6755
wordorderM2_noNP1             6 47446 47493 -23717    47434 1.4574      1     0.2273
associationM2_noNP1           7 47447 47502 -23716    47433 0.7877      1     0.3748
timewordorderM2_noNP1         8 47447 47510 -23715    47431 2.2836      1     0.1307
timeassociationM2_noNP1       9 47446 47517 -23714    47428 2.4622      1     0.1166
wordorderassociationM2_noNP1 10 47448 47527 -23714    47428 0.4897      1     0.4841
fixationM2_noNP1             11 47449 47536 -23714    47427 0.3865      1     0.5341
```

Time window 3

```
Data: response_window_clean3_noNP1
Models:
baselineM3_noNP1: AOI ~ (1 | SUBJECT) + (1 | ITEM)
timeM3_noNP1: AOI ~ (1 | SUBJECT) + (1 | ITEM) + TIMESTAMP
wordorderM3_noNP1: AOI ~ (1 | SUBJECT) + (1 | ITEM) + TIMESTAMP + WORDORDER
associationM3_noNP1: AOI ~ (1 | SUBJECT) + (1 | ITEM) + TIMESTAMP + WORDORDER + ASSOCIATION
timewordorderM3_noNP1: AOI ~ (1 | SUBJECT) + (1 | ITEM) + TIMESTAMP + WORDORDER + ASSOCIATION +
timewordorderM3_noNP1:     TIMESTAMP:WORDORDER
timeassociationM3_noNP1: AOI ~ (1 | SUBJECT) + (1 | ITEM) + TIMESTAMP + WORDORDER + ASSOCIATION +
timeassociationM3_noNP1:     TIMESTAMP:WORDORDER + TIMESTAMP:ASSOCIATION
wordorderassociationM3_noNP1: AOI ~ (1 | SUBJECT) + (1 | ITEM) + TIMESTAMP + WORDORDER + ASSOCIATION +
wordorderassociationM3_noNP1:     TIMESTAMP:WORDORDER + TIMESTAMP:ASSOCIATION + WORDORDER:ASSOCIATION
fixationM3_noNP1: AOI ~ (1 | SUBJECT) + (1 | ITEM) + TIMESTAMP + WORDORDER + ASSOCIATION +
fixationM3_noNP1:     TIMESTAMP:WORDORDER + TIMESTAMP:ASSOCIATION + WORDORDER:ASSOCIATION +
fixationM3_noNP1:     TIMESTAMP:WORDORDER:ASSOCIATION
                             Df   AIC   BIC logLik deviance  Chisq Chi Df Pr(>Chisq)
baselineM3_noNP1              4 28896 28925 -14444    28888
timeM3_noNP1                  5 28897 28934 -14443    28887 1.0290      1    0.31040
wordorderM3_noNP1             6 28898 28942 -14443    28886 1.1463      1    0.28433
associationM3_noNP1           7 28899 28951 -14442    28885 0.6046      1    0.43681
timewordorderM3_noNP1         8 28894 28954 -14439    28878 6.6233      1    0.01007 *
timeassociationM3_noNP1       9 28890 28957 -14436    28872 6.0314      1    0.01405 *
wordorderassociationM3_noNP1 10 28891 28966 -14436    28871 0.8355      1    0.36070
fixationM3_noNP1             11 28892 28973 -14435    28870 1.8576      1    0.17290
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1
```

Time window 4

```
Data: response_window_clean4_noNP1
Models:
baselineM4_noNP1: AOI ~ (1 | SUBJECT) + (1 | ITEM)
timeM4_noNP1: AOI ~ (1 | SUBJECT) + (1 | ITEM) + TIMESTAMP
wordorderM4_noNP1: AOI ~ (1 | SUBJECT) + (1 | ITEM) + TIMESTAMP + WORDORDER
associationM4_noNP1: AOI ~ (1 | SUBJECT) + (1 | ITEM) + TIMESTAMP + WORDORDER + ASSOCIATION
timewordorderM4_noNP1: AOI ~ (1 | SUBJECT) + (1 | ITEM) + TIMESTAMP + WORDORDER + ASSOCIATION +
timewordorderM4_noNP1:     TIMESTAMP:WORDORDER
timeassociationM4_noNP1: AOI ~ (1 | SUBJECT) + (1 | ITEM) + TIMESTAMP + WORDORDER + ASSOCIATION +
timeassociationM4_noNP1:     TIMESTAMP:WORDORDER + TIMESTAMP:ASSOCIATION
wordorderassociationM4_noNP1: AOI ~ (1 | SUBJECT) + (1 | ITEM) + TIMESTAMP + WORDORDER + ASSOCIATION
+
wordorderassociationM4_noNP1:     TIMESTAMP:WORDORDER + TIMESTAMP:ASSOCIATION + WORDORDER:ASSOCIATION
fixationM4_noNP1: AOI ~ (1 | SUBJECT) + (1 | ITEM) + TIMESTAMP + WORDORDER + ASSOCIATION +
fixationM4_noNP1:     TIMESTAMP:WORDORDER + TIMESTAMP:ASSOCIATION + WORDORDER:ASSOCIATION +
fixationM4_noNP1:     TIMESTAMP:WORDORDER:ASSOCIATION
                             Df   AIC   BIC logLik deviance  Chisq Chi Df Pr(>Chisq)
baselineM4_noNP1              4 30787 30818 -15390    30779
timeM4_noNP1                  5 30786 30824 -15388    30776 3.2099      1    0.07320 .
wordorderM4_noNP1             6 30786 30831 -15387    30774 2.0129      1    0.15597
associationM4_noNP1           7 30784 30836 -15385    30770 4.4304      1    0.03531 *
timewordorderM4_noNP1         8 30785 30845 -15384    30769 0.9279      1    0.33542
timeassociationM4_noNP1       9 30787 30854 -15384    30769 0.1851      1    0.66706
wordorderassociationM4_noNP1 10 30787 30862 -15384    30767 1.5254      1    0.21680
fixationM4_noNP1             11 30788 30871 -15383    30766 0.7217      1    0.39559
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1
```

Time window 5

```
Data: response_window_clean5_noNP1
Models:
baselineM5_noNP1: AOI ~ (1 | SUBJECT) + (1 | ITEM)
timeM5_noNP1: AOI ~ (1 | SUBJECT) + (1 | ITEM) + TIMESTAMP
wordorderM5_noNP1: AOI ~ (1 | SUBJECT) + (1 | ITEM) + TIMESTAMP + WORDORDER
associationM5_noNP1: AOI ~ (1 | SUBJECT) + (1 | ITEM) + TIMESTAMP + WORDORDER + ASSOCIATION
timewordorderM5_noNP1: AOI ~ (1 | SUBJECT) + (1 | ITEM) + TIMESTAMP + WORDORDER + ASSOCIATION +
timewordorderM5_noNP1:     TIMESTAMP:WORDORDER
timeassociationM5_noNP1: AOI ~ (1 | SUBJECT) + (1 | ITEM) + TIMESTAMP + WORDORDER + ASSOCIATION +
timeassociationM5_noNP1:     TIMESTAMP:WORDORDER + TIMESTAMP:ASSOCIATION
wordorderassociationM5_noNP1: AOI ~ (1 | SUBJECT) + (1 | ITEM) + TIMESTAMP + WORDORDER + ASSOCIATION
+
wordorderassociationM5_noNP1:     TIMESTAMP:WORDORDER + TIMESTAMP:ASSOCIATION + WORDORDER:ASSOCIATION
fixationM5_noNP1: AOI ~ (1 | SUBJECT) + (1 | ITEM) + TIMESTAMP + WORDORDER + ASSOCIATION +
fixationM5_noNP1:     TIMESTAMP:WORDORDER + TIMESTAMP:ASSOCIATION + WORDORDER:ASSOCIATION +
fixationM5_noNP1:     TIMESTAMP:WORDORDER:ASSOCIATION
                             Df   AIC   BIC logLik deviance   Chisq Chi Df Pr(>Chisq)
baselineM5_noNP1              4 64489 64522 -32240    64481
timeM5_noNP1                  5 64418 64460 -32204    64408 72.9572      1    < 2e-16 ***
wordorderM5_noNP1             6 64420 64470 -32204    64408  0.0005      1    0.98206
associationM5_noNP1           7 64416 64474 -32201    64402  6.0819      1    0.01366 *
timewordorderM5_noNP1         8 64388 64455 -32186    64372 29.4291      1    5.8e-08 ***
timeassociationM5_noNP1       9 64385 64460 -32184    64367  5.0910      1    0.02405 *
wordorderassociationM5_noNP1 10 64387 64471 -32184    64367  0.1571      1    0.69186
fixationM5_noNP1             11 64389 64480 -32183    64367  0.4896      1    0.48409
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1
```