Universiteit Utrecht

The influence of semantic properties on syntactic structures in improvised communication

A study on language evolution using gesturing as a window

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April 29, 2011

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ACKNOWLEDGEMENTS

The research project described in this thesis was by far the most interesting one of my academic career. To recall two highlights, our paper based on this research project is accepted by CogSci 2011 and we went to Istanbul to conduct our experiments with Turkish participants. It was a wonderful experience and I really enjoyed working on this project. Thanks to the team of enthusiastic researchers I worked with, I learned a lot during my participation on this project.

With the enthusiastic approach of Henriëtte I was familiar, because Henriëtte also supervised my first thesis and two internships. Again, she was able to keep me concentrated and critical. I would like to thank Henriëtte very much for her useful input and critical comments on my work. It was a pleasure to work with someone who is as dedicated to the research field as Henriëtte.

Marieke was my second supervisor. Hundreds of e-mails were sent from one to another and meetings were frequently planned to discuss the important decisions and the progress of the project. I would like to thank Marieke very much for her time and enthusiasm to bring this project to a higher level. I would like to wish Marieke the best with finishing her dissertation and I hope that the results of this thesis can contribute to her project.

Interpreting the results of our experiments statistically was difficult. A lot of different factors had to be considered. Marijn helped us with the statistics. Because of her psychological background and her help on the statistical part of our project, we asked Marijn to be the third reviewer of this thesis. I would like to thank Marijn for her help and for reviewing my thesis.

I would like to thank Nicky for our good cooperation during the project and the wonderful time we had in Istanbul. I would like to thank Caglar and Zeynep for their efforts to arrange the experiments with participants in Istanbul and I would like to thank all the Dutch and Turkish participants for their contribution to the experiment.

Last but not least I would like to thank Tjarko and my parents for being there for me every step of the way and for their help with the finishing touch of this thesis.

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1. INTRODUCTION

This thesis describes a graduation project for the Master of Science (MSc.) program Cognitive Artificial Intelligence (CAI). In the first section of this introduction, the contribution of the research project to the field of CAI will be explained. In the second section, the research question and structure of the thesis is presented.

1.1 A CAI RESEARCH PROJECT

Cognitive Artificial Intelligence (CAI) is a multidisciplinary study that focuses on human intelligence from different perspectives like philosophy, linguistics, computer science and psychology. Language is seen as a uniquely human property that distinguishes our intelligence from that of animals. Because of this uniquely human property, the study of language in general (linguistics) is a very important part of the CAI research field that is connected to all other CAI research parts. CAI researchers are very interested in how language works, to learn more about human intelligence. How did this special form of intelligence arise in our evolution? How did it develop and with what purposes?

The multidisciplinary research project of this thesis has a focus on semantics and language evolution and therefore will contribute to the CAI research field by creating a better understanding of the role of semantic structures in the origin of language.

To achieve our goal, we were able to use our multidisciplinary CAI background to fully grasp the research area which requires linguistic insight but also studying philosophical theories on language evolution and applying psychological skills to run experiments and to interpret the results correctly.

The central research question of this thesis will be specified in the next section.

1.2 THE STRUCTURE OF THIS THESIS

As explained in the previous section, this thesis will contribute to a better understanding of the role of semantic structures in the origin of language. The central research question in this thesis is:

Are syntactic structures in improvised communication influenced by the semantic properties of events?

The question above arose after studying the latest developments in the area of language evolution and some interesting studies on improvised communication from which the results were linked to the language evolution debate. These previous studies were about syntactic structures within an improvising gesturing task. Our intuition is that semantic properties influence the syntactic structures in the gesturing task for communicative purposes. Therefore, our study investigates the role of semantic properties within the same kinds of gesturing tasks.

A quick introduction into the previous studies and our concerns can be found below, after which the structure of the research project is illustrated.

Languages like English and Turkish are fully developed languages with different word orders. English is a Subject-Verb-Object (SVO) language which means that in a well constructed sentence the subject precedes the verb and the sentence is concluded with the object like in 'the girl throws the ball'. Turkish on the other hand is a Subject-Object-Verb (SOV) language which means that the sentence is constructed like 'the girl – the ball – throws'. Although different developed languages have different word orders, some researchers believe there exists a cross-linguistically stable order to convey information about events (Goldin-Maedow et al, 2008, Langus and Nespor, 2010). To prove this theory, the researchers used gesturing tasks. Their most important question to prove the mentioned theory was: 'Does word order of the native language influence gesture order in a gesture task?'. To answer this question, events needed to be described by participants of different native languages with different word orders, using gestures and no speech.

Goldin-Meadow et al (2008) and Langus and Nespor (2010) studied gesture order in motion events (like 'throwing a ball' or 'shooting a horse'), using simple pictures illustrating the events. In this experiment which we will call 'production experiment', they found that the events are gestured in SOV order and that this order was independent of the native language of the participants. The studies of Goldin-Meadow et al and Langus and Nespor are described in chapter 3 of this thesis.

Goldin-Meadow et al and Langus and Nespor did not distinguish between motion events and other events, they made statements about 'events' in general. We would like to propose an addition to the work of Goldin-Meadow et al to increase the knowledge of how improvised communication works.

Schouwstra et al (2010) and van Leeuwen (2010) were the first researchers distinguishing different types of events in a gesturing task. They found different gesturing orders for so called motion events (like 'the girl throws a ball') and intensional events (like 'the girl thinks of a ball'). After a production experiment, they also conducted an 'interpretation experiment' in which participants had to interpret gestured events. Again they found an interesting difference; events of which the elements were gestured in different orders tended to be interpreted differently. Chapter 4 of this thesis reflects semantic differences between different kinds of events and explores a way to implement this in an experimental setting by describing the experiments in Schouwstra et al (2010) and Van Leeuwen (2010).

The results of Schouwstra et al and van Leeuwen were promising but not totally convincing. This is the point at which we start. We evaluate the previous experiments, improve them and study the influence of semantic properties on syntactic structures in a cross linguistic improvised communication task. We think that the different orders that were found by previous researchers, serve a communicative purpose. Communication involves the production of strings and their interpretation. Therefore, we conducted a production experiment and an interpretation experiment. Chapter 5 describes the production experiment and chapter 6 the interpretation experiment. Improvements compared to the previous experiments are presented, together with the methods, the results and the conclusions of our experiments. Based on the hypothesis that different orders serve communicative purposes, we expect to find different gesturing orders for different types of events and different interpretations for events presented with different gesturing orders (Schouwstra et al (to appear, 2011).

The results of our experiments are associated with the language evolution debate. The central idea is that the results of our study can be linked to the language evolution debate because the improvised situation we create with the experimental set up is in accordance with the situation in which we think language evolution started. This central idea will be explained in chapter 2 of this thesis. It describes the relevant parts of language evolution theory for this study, including a few important points in the debate and the quality of the gesturing task as a window on language evolution.

The overall discussion in respect to the central research question and the implications of the results for the language evolution debate are presented in chapter 7. Suggestions for further research are discussed in chapter 8.

PART I THEORETICAL FRAMEWORK

2. LANGUAGE EVOLUTION AND GESTURING AS A WINDOW

This chapter gives an overview of the relevant parts of the language evolution debate for this study and it explains why we used the phenomenon 'gesturing' as a window on language evolution.

2.1 LANGUAGE EVOLUTION DEBATE

Language is a uniquely human way to communicate. Our language system is very complex and there are a lot of unsolved questions about the origin and the development of language. The research project described in this thesis, will contribute to a better understanding of the role of semantic structures in the origin of language.

In literature, there seems to be consensus about the importance of three systems for language: the computational system, the conceptual system and the sensory-motor system. Though, in this modular view there is no consensus about the development of the different systems. Did the different systems develop in a specific order or did they develop at the same time? Can we distinguish different intermediate stages in language evolution? Or can we speak of some big revolutions that made language as it is now?

The majority of the literature on this subject is about the importance of syntactic properties in the evolution of language. Hauser, Chomsky and Fitch (2002) for example divide language in two parts. They call the first part 'FLN': a uniquely human part which means Faculty of Language in the Narrow sense. This part is essential for language and uses the computational system. It only includes recursion: *"providing the capacity to generate an infinite range of expressions from a finite set of elements"*. Hauser et al argue that "*FLN may have evolved for reasons other than language, hence comparative studies might look for evidence of such computations outside of the domain of communication".* The second part interacts with FLN but is not uniquely human. It is called 'FLB' which means Faculty of Language in the Broad sense. This part uses other systems like the sensory-motor system and the conceptual-intentional system.

The results of the research project described in this thesis emphasize that there is a lot of interaction between the computational and the conceptual system, especially in sequencing utterances.

Most researchers agree that we can speak of a gradual language evolution process with protolanguages; different intermediate stages in language evolution (Pinker and Bloom (1990), Kirby (2007), Fitch (2010)). Possible protolanguages are not necessarily of verbal nature, a possible intermediate state could be a state with gestural movements only. Possible driving forces behind this gradual evolution process are social grooming, sexual display, communicative purposes and alliance-forming (Kirby, 2007). We think that communicative purposes are an important driving force behind the evolutional process of language and that language developed with a great influence of semantic structures in communication. This is the main point we would like to investigate with our research project.

Research on language evolution is very difficult, because there is a data problem: no direct evidence is left of the first stages of language. One can imagine that in the very beginning, there was no fully developed language system available and people had to improvise a lot to communicate. A new way of collecting indirect evidence, is using restricted linguistic systems: modern limited linguistic systems that do share a lot of properties with language, but not all. By looking at structures of language in situations in which speakers cannot use their native language but have to improvise, a window on language evolution is created (Botha, 2009). An example of a restricted linguistic system that could be a source for indirect evidence is the Basic Variety (Jackendoff, 2002).

> Basic Variety: Second language learning without taking lessons. In basic variety, people learn a language by living in a new environment in which people speak a language they did not hear before.

Examples of organizational principles that were found in Basic Variety are FocusLast (the most important information of the sentence comes last) and AgentFirst (the NP referent with the highest control comes first). These principles seem to be successful for communication and independent of the native language of the users (Jackendoff, 2002). Therefore, studying restricted linguistic systems like Basic Variety could help us to understand more about the structure of evolutionarily early language (Schouwstra, 2010).

Some examples of restricted linguistic systems were shown, but what is a window on language evolution exactly? Botha (2009) explains that *"a window is in essence a device for making inferences about language evolution. To – metaphorically – "see" a property of some aspect of language evolution by – metaphorically – "looking at" a*

property of some other phenomenon is – nonmetaphorically – to infer that first property from data about this second property. As inferential devices, windows on language evolution have a structure that may be roughly portrayed as follows:"

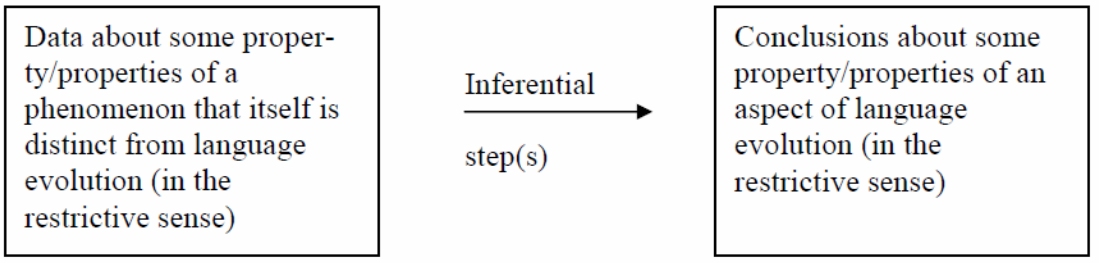


Figure 2.1 A window on language evolution (Botha, 2009)

Botha explains that restricted linguistic systems often develop in uncontrollable settings which provide unreliable data. To collect reliable data, we need a well-understood phenomenon in a controlled setting that can be associated with language development. Previous data collection had a focus on production, but also the collection of data on comprehension would be desirable to approach the important research questions from different angles. In the next section, the relatively new and still developing window phenomenon 'gesturing' that is used in this study will be explained.

2.2 GESTURING AS A WINDOW ON LANGUAGE EVOLUTION

Gesturing is the phenomenon in which people use their limbs and body to convey information. Normal speakers use speech accompanying gestures to strengthen their utterances, even if they speak to blind people (Iverson and Goldin-Meadow, 1998). Iverson and Goldin-Meadow conclude that gesturing "*appears to be integral to the speaking process itself. These findings leave open the possibility that the gestures that accompany speech may reflect, or even facilitate, the thinking that underlies speaking*".

Gestures can also be used instead of speech as in fully developed sign languages. Those sign languages share properties with spoken language. They have advanced grammatical systems and develop through the same stadia (from babbling to a basic vocabulary) as spoken languages.

As stated above, gesturing and speech have a strong connection and sign languages develop through the same stadia as spoken language. It seems that this strong

connection and similarity between gesturing and speech could help the investigation into language evolution by using a certain way of gesturing as a restricted linguistic system.

We believe that at an early stage in language evolution, there was no advanced linguistic system available and people had to improvise a lot to communicate. Therefore, a good window on language evolution needs to be a phenomenon starting without an advanced linguistic system as well. As explained, sign languages have advanced linguistic systems like spoken languages, so studying fully developed sign languages is no solution for studying early stages of language evolution.

Goldin-Meadow et al (2008) and Langus and Nespor (2010) were the first researchers suggesting the use of improvised gesturing tasks to study language evolution. They conducted a gesturing task performed by participants without knowledge of conventional sign language. Gesturing tasks can be performed in controllable situations and can be seen as a restricted linguistic system in which people have to improvise because they are not able to use their fully developed linguistic system. Therefore an improvised gesturing task seems to be an appropriate window on the early stages of language evolution. The advantage of gesturing as a restricted linguistic system for our research project, is that it enables us to investigate the communicative purposes which we think are an important driving force behind the evolutional process of language.

To study the role of semantic structures in communication we conducted a production task (from the perspective of the speaker) and an interpretation task (from the perspective of the hearer). To fully bypass the linguistic systems of the native languages of the participants, we used no written language in the experiment, we used pictures with events only. In the production task, participants had to gesture pictures of different types of events. In the interpretation task, participants had to interpret movies in which someone explained an event by using gestures only.

Previous research of Goldin-Meadow et al (2008) and Langus and Nespor (2010) is explained in chapter 3 of this thesis after which we continue with the specifications of our own experiments.

3. RELEVANT EXPERIMENTS IN LITERATURE

Before we are able to start with the main experiments of this thesis, earlier experiments need to be well understood. This chapter describes the experiments of Goldin-Meadow et al (2008), Langus and Nespor (2010) and Meir (2010) and their conclusions.

3.1 GOLDIN-MEADOW ET AL, 2008

The research area of Goldin-Meadow and colleagues is sign language. With their study in 2008, they wanted to investigate the relation between word order in language and the non-verbal representations of events. They studied this by having participants convey information about events using gestures. Goldin-Meadow et al call this experiment non-verbal and communicative. They used four groups of participants with different native languages: English, Spanish, Turkish and Chinese. None of the participants had previous knowledge about sign language.

The stimuli that were used were pictures of simple events containing an Actor, a Patient and an Act like 'Girl covers box' and 'Boy tilts glass to mouth', shown on a computer screen. Participants first had to write down sentences of the pictures. After writing sentences of the pictures, they had to gesture the pictures one by one. Goldin-Meadow et al compared the word orders of the written sentences to the orders in which the different elements of the pictures (the Actor, the Patient and the Act) were gestured. They found a large variation in the word orders of the written sentences in accordance with the word orders of the native languages of the participants. For the gesturing task they found mainly one order: Actor – Patient – Act (ArPA) which corresponds to the word order Subject – Object – Verb (SOV) (figure 3.1).

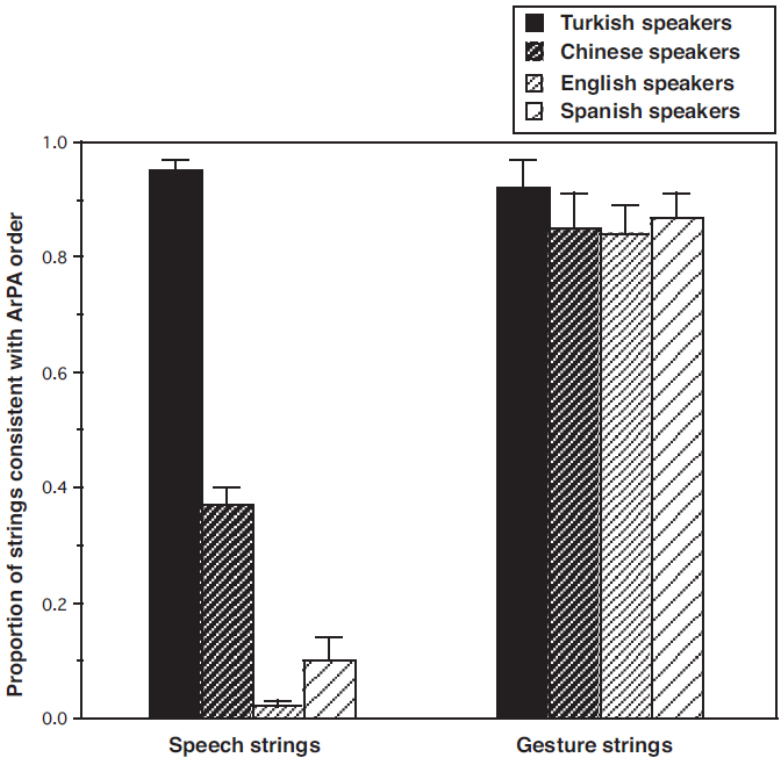


Figure 3.1 Proportion of speech strings and gesture strings consistent with ArPA order (Goldin-Meadow et al, 2008)

Goldin-Meadow et al emphasize that this ArPA order is not found because of communicative pressure. To strengthen this statement, Goldin-Meadow et al carried out another, non-verbal and non-communicative, experiment in which participants had to 'build' an event from transparent vignettes. Participants were shown a picture of an event after which they had to lay three different transparent vignettes on top of each other, a subject an object and a verb, to 'build' the event. Again, the ArPA order was found which weakens the argument that the ArPA order arrives because of communicative pressure.

Goldin-Meadow et al conclude that word order of the native language does not influence non-verbal behavior. Actor – Patient – Act (ArPA) is the natural sequence to represent events. Goldin-Meadow et al think this makes sense because deaf children also start sign language in SOV order.

3.2 LANGUS AND NESPOR, 2010

The researchers Langus and Nespor are concerned with the same kind of experiments, from a different view than Goldin-Meadow and colleagues. In line with Hauser et al

(2002) they think language is modular and every module of language has its own specific linguistic tasks. They distinguish three modules. The conceptual system is the module responsible for semantics and interpretation. The computational system is the module responsible for grammar and a third system makes it possible to speak.

In the experiments described in Langus and Nespor (2010), the emphasis is on the difference between the conceptual system and the computational system. They expect to find different orders for different linguistic tasks, because they state that different modules of language are used. In line with Goldin Meadow et al, they expect to find an SOV order for the conceptual system. For the computation system, Langus and Nespor expect to find an SVO order. One of the examples Langus and Nespor use to ground their expectations, is the difference between the development of pidgin languages and sign languages. Pidgin languages are spoken, fully developed languages which have an SVO word order and sign languages have an SOV order.

Langus and Nespor carried out four experiments of which three are interesting to point out in this thesis. The first experiment was a replication of the experiment of Goldin-Meadow et al (2008) in which participants had to write down sentences of depicted events after which participants had to gesture the depicted events. Langus and Nespor call this task a pre-linguistic communicative task. Langus and Nespor found the same results; an SOV order in the gesture task. They conclude that since the task presented pictures and no syntactic structures like spoken language, there is a direct interaction between the conceptual system and the system that conveys the information.

The second experiment is an interpretation-experiment in which movies with gestured events were shown. The movies were recorded in six different orders (SOV, SVO, OVS, OSV, VOS and VSO). After every movie, participants could choose between two possible pictures that randomly differed from subject, object or verb. For example, if an OVS order was shown with 'ball – throws – girl', the two answer possibilities were pictures of 'a girl throwing a ball' and 'a girl throwing a vase' (in this example the object was differed). The goal of this experiment was to determine which order of gestures leads to the fastest correct interpretation. Langus and Nespor found that SOV order leads to the fastest correct interpretation for all participants. Again, this preference for SOV order is independent of the order in the native language of the participants. Langus and Nespor conclude that participants used the conceptual system to interpret the movies.

Because Langus and Nespor wanted to demonstrate that different word orders belong to different systems which have their own specific linguistic tasks, they carried out a third experiment. In this experiment participants had to listen to speech recordings of three words (subject, object and verb) in six possible orders. After every sentence, participants had to choose between two possible representations (pictures) of what they just heard. The results of this experiment show that people have the fastest responses to sentences in the word order of their native language. This is not in agreement with the hypothesis that the computational system prefers an SVO word order.

To deal with this problem, Langus and Nespor compared the average response times for orders in which the object precedes the verb (SOV, OVS and OSV) with the other three orders (SVO, VSO and VOS). The last group shows a shorter response time from which Langus and Nespor conclude that in general SVO is the most suitable order for the computational system. One can say that this is not a very strong conclusion. For example Greenberg (1963) in Van Leeuwen (2010) claims that sentences in which the object precedes the subject are more complex to interpret. Since this phenomenon can be found twice in group one and once in group two, this could be responsible for the difference they found.

Another question that arises from Langus and Nespor's point of view is why there are so many SOV-languages if SVO is the word order of the computational system. Based on the objections above, one could question a strongly modular view. In the next section, we will describe the study presented in Meir et al (2010), which suggests that semantic properties influence syntactic structures found in the gesturing task. This is not in line with the intuition that the conceptual system and the computational system are strictly separate.

3.3 MEIR ET AL, 2010

Meir et al (2010) conducted a gesture experiment, paying attention to the phenomenon 'animacy'. In their experiment, they used pictures of events with animate subjects and either animate or inanimate objects. Participants were asked to describe events using gesture and again the point of interest in this study was the order in which the elements of the events were gestured.

Meir et al explain that clauses in which both arguments are animate could lead to confusion if the clauses are uttered in SOV order, so SVO would be the preferable order. For example in 'the girl pulled the man', both the girl and the man are able to 'pull'; the subject and the object are reversible. Using an SOV order with the object after the subject could lead to confusion, while using an SVO order in which the subject and the object are separated by the verb would clarify the meaning.

Meir found interesting results in accordance to their intuition; for the inanimate objects the SOV order was dominant, for the animate objects the SVO order was dominant. This experiment shows that the semantics of the object influence the order in which elements are gestured in an improvising gesturing task. Meir et al conclude their paper with the following statement:

"Our study shows that different types of clauses pose different communicative challenges, and different word orders and other devices may emerge to cope with them. It may be, then, that a language begins with more than one word order, and conventionalizes to a particular order later in its development."

Meir et al (2010) varies in the semantics of the objects. Our study varies in the semantics of the verb. In line with Meir and colleagues, we think the gesturing task is a communicative task and different types of clauses pose different communicative challenges which result in different gesturing orders. With our experiments we want to emphasize that semantics and syntaxis work closely together in order to convey a message. The next chapter is about the semantics of different types of events.

4. DIFFERENT TYPES OF EVENTS

To study the influence of semantics on syntactic structure in the gesturing task, different types of events need to be considered. Our intuition is that different events lead to different gesturing orders. To explain this intuition, we look at the order in which the elements of an event are sequenced naturally. Take for example the event 'the girl covers a box'.

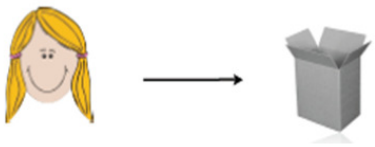


Figure 4.1 Schematic view of the event 'a girl covers a box'.

As shown in figure 4.1, there is a girl and there is a box (Subject, Object). The covering connects the girl and the box. Whether the box is covered or not does not influence its existence, the girl and the box were already present. Our intuition says that the verb comes after the subject and the object (Subject – Object – Verb).

For the sentence 'the elephant dreams about a snake', the same reasoning cannot be applied.

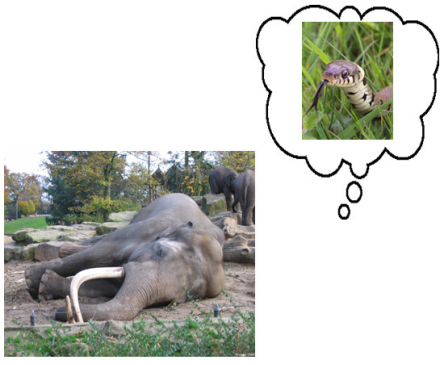


Figure 4.2 Schematic view of the event 'an elephant dreams about a snake'.

As shown in figure 4.2, there is an elephant and the elephant is dreaming (Subject, Verb). The snake (Object) only exists in the dream so it depends on the dreaming. Our intuition says that the snake has to come after the dreaming (Subject – Verb – Object).

Because of this semantic difference in verbs like 'cover' and 'dream about' we think that events of the first type, so called 'motion events' are gestured in Subject-Object-Verb (SOV) order and events of the second type, so called 'intensional events' are gestured in Subject-Verb-Object (SVO) order. The next sections will explain more precisely the difference between those kinds of events.

4.1 EVENTS

Investigating differences between motion events and intensional events requires a classification of those events. One way to do this is by using aspectual classes that state something about the temporal structure of the event. According to Verkuyl (1989), different verbs belong to different aspectual classes. There are three types of aspectual classes each consisting of a predicate (verb) with one or more arguments (a subject and possible objects):

- Stative predicates: the so called 'states'. Examples are 'to stand on the bridge', 'to love Peter', 'to be sad'.
- Dynamic predicates: in this category Verkuyl distinguishes the so called 'processes' and 'events'.
    - Events: the argument of the predicate has a specified quantity (+SQA). For example 'to eat an apple', 'to throw two balls'.
    - Processes: the argument of the predicate has no specified quantity (-SQA). For example 'to walk on the street', 'to throw balls'.

The term 'event' is a little confusing. Verkuyl only calls a special class of dynamic predicates 'events'. In this thesis, we call a predicate with its arguments (like 'Mary kisses peter') an 'event'. We distinguish two main classes; stative events (like 'Mary stands on the bridge') and dynamic events (like 'Mary throws a ball').

This thesis focuses on motion events and intensional events. The motion events we used belong to the dynamic events, occurring in time and space and having a begin and an

end (Zachs and Tversky, 2001). Examples are 'the girl throws a ball' and 'the boy eats an apple'. The intensional verbs we used belong to a subcategory of the stative events. Examples are 'the girl looks for a ball' and 'the boy thinks of an apple'. A special group of events, the so called 'creation events' do not fit in the above dichotomy. The different categories will be explained in detail in the next section.

Because we are interested in word order, we only focus on transitive events. Transitive events contain more than one argument. The events we used contain a verb with a subject and an object (a predicate with two arguments). For example, 'the girl walks (on the bridge)' contains a verb (walks) with one argument (the girl), 'on the bridge' is no argument but a location marker. 'The girl eats an apple' contains a verb (eats) with two arguments (the girl and an apple), which means that 'eat' is a transitive verb.

4.2 EXTENSIONAL AND INTENSIONAL EVENTS

So called extensional verbs like 'pushing', 'throwing' or 'reading' meet three criteria which are indicated below.

1. An argument exists in reality (Moltmann, 1997)
2. An argument is just an object and not a whole sentence (Larson, den Dikken en Ludlow, 1997)
3. The existence of the argument is independent of the subject (Andrews, 1986).

For example, the extensional event 'Mary pushes Peter' meets all three criteria. Other events like 'Mary fears ghosts' or 'Mary bakes a cake' do not meet all three criteria of extensional verbs. We call those verbs intensional verbs. To point out the differences between extensional and intensional events, examples of intensional events that do not meet all three criteria are shown.

1. An argument exists in reality (Moltmann, 1997)

    - Extensional: Mary pushes Peter

      The argument (Peter) exists in reality, because otherwise Mary should not be able to push him.

    - Intensional: Mary fears ghosts

The argument (ghosts) is just a meaning and does not exist in reality. Note that in the sentence 'Mary pushes a ghost', the verb 'pushes' is an extensional verb. It is only possible to push someone who exists. It is possible to fear someone or something that does not exist.

2. An argument is just an object and not a whole sentence (Larson, den Dikken en Ludlow, 1997)

    - Extensional: Mary pushes Peter

    The argument (Peter) is just an object and not a whole sentence. It is not possible to say: *Mary pushes that Peter plays the piano.

    - Intensional: Mary thinks that she flies to school

    The argument (she flies to school) is a whole sentence.

3. The existence of the argument is independent of the subject (Andrews, 1986).

    - Extensional: Mary pushes Peter

    Peter exists whether Mary pushes him or not.

    - Intensional: Mary builds a house

    The argument (the house) is dependent on Mary who has to build it.

The class of intensional events is handled differently by different researchers. Creation verbs are verbs like 'building', 'baking' and 'knitting'. There is a discussion whether creation verbs are intensional or not. Zucchi (1999) claims, based on theories of Parsons (1989) and Landman (1992), that if creation verbs are intensional, they are of a different type of verb than standard intensional verbs like 'look for' in 'Mary looked for a unicorn'.

Parsons (1989) and Landman (1992) claim that intensional events have a reading that does not entail the existence of the object like 'Mary looked for a unicorn'. Creation verbs do not have this property: 'Mary builds a house' means that at some point, the house exists. Parsons claims that if Mary is building a house, then her building event has an object which is a house, and so there is a house that she is building. How to deal with unfinished objects is complicated. How much of a cake needs to be baked before it is correct to call it a cake? Is the intension of baking a cake (tomorrow) enough to hold such a sentence true? Even though the cake is never made?

In this thesis we prefer a basic dichotomy of intensional and extensional transitive events, based on the mentioned three criteria. Because creation verbs seem to be of a special type of intensional verbs, we count them with the intensional verbs. While processing the results, we will also look at the creation verbs apart from the intensional verbs to see if they result in different word orders than standard intensional verbs.

To draw grounded conclusions about the influence of semantic differences in the verb on syntactic structures, the different semantic categories need to be completely represented within the experiments. Seungho Nam (1997) describes a lot of different verb categories which can be distributed among our two different types of events: extensional events and intensional events.

Examples of different kinds of verbs, according to Seungho Nam (1997) that meet our three criteria of extensional events are:

- Motion-causative verbs: draw, drag, pull, push, throw, hit, knock, run, walk, jump
- Verbs of sending/carrying: mail, convey, deliver, pass, return, carry, take, bring
- Verbs of placement: place, arrange, install, position, set, situate, put
- Verbs of hunting: dig, hunt, mine, shop, watch
- Verbs of combining/attaching: mix, whip, tape
- Verbs of housing: house, contain, fit, hold, seat, sleep, store, serve
- Verbs of communication: call, wire, cable
- Verbs of contact: touch, pat
- Verbs of co-movement: escort, accompany, chase, follow, tail, lead, guide
- Verbs of social interaction: meet, date, hug, marry, fight, visit

Examples of different kinds of verbs, according to Seungho Nam (1997) that do not meet all of our three criteria of extensional events, and therefore are intensional events, are:

- Verbs of perception: see, feel, hear, sense, observe, examine, discover, watch
    - John saw Mary from the rooftop: it is not clear whether John actually saw Mary or someone else. Mary is just a meaning.

        - Mary hears that the piano is tuned false: the argument is a whole sentence.
        - Mary hears a violin: it is not a fact that Mary actually hears a violin, it could be another instrument. Mary thinks that she hears a violin, so the violin is just a meaning.
- Psych-verbs: adore, idolize, miss, worship, despise
        - John misses Mary at the meeting: it is possible that Mary does not exist.
        - John misses someone to love: not a specific person, but something John imagines.
        - Mary thinks that she flies to school: the argument is a whole sentence.
        - Mary thinks of a unicorn: the argument is just a meaning.
- Intensional verbs: search, look for, seek, mention
        - John was looking for a knife in the kitchen: it is possible that the knife does not exist.
        - John mentioned Mary at the meeting: it is possible that Mary does not exist.
- Creation verbs (Zucchi, 1999) are also a class of verbs that do not meet all three criteria of extensional verbs:
        - Mary is baking a cake: the existence of the argument depends on the subject.
        - Mary draws an elephant: the existence of the argument depends on the subject.

To make grounded statements about different types of events in our experiments, we aim to use a balanced representation of each event type.

Before applying this knowledge to our experiments, in the next section we discuss the studies of two researchers who use different types of events in an improvised communication task.

4.3 SCHOUWSTRA ET AL (2010) AND VAN LEEUWEN (2010)

As stated earlier, Meir (2010) investigated the influence of animate objects on the syntactic structure in an improvised communication task. Her findings correspond to our intuition that semantic properties influence syntactic structures. Schouwstra et al (2010) and Van Leeuwen (2010) who also share this intuition, performed studies in which the influence of different verb types on the syntactic structure were the point of interest. The different verb types they used were motion events and intensional events, from which the characteristics are explained in the previous section.

The work of Schouwstra et al (2010) consists of a pilot in which participants had to gesture events of different types; motion events and intensional events. Schouwstra found a tendency for SOV order for the motion events and a tendency for SVO order for the intensional events.

Van Leeuwen (2010) continued with the work of Schouwstra et al (2010) and took the main experiment of Goldin-Meadow et al (2008) as a starting point. She added intensional events to the set of events that were used by Goldin-Meadow et al and she made some small adjustments. For example, Van Leeuwen had the participants write down sentences after instead of before the gesturing task to be sure the linguistic system was not triggered during the gesturing task.

The stimuli consisted of 24 pictures of motion and intensional events. The participants were 19 native speakers of Dutch.

The results of the experiment were significant for the intensional events: almost all intensional events were gestured in SVO order. The results of the motion events were not in line with the results of Goldin-Meadow et al (2008) and Langus and Nespor (2010); there was no significant difference between the SOV order and SVO order in the gesturing task (figure 4.3).

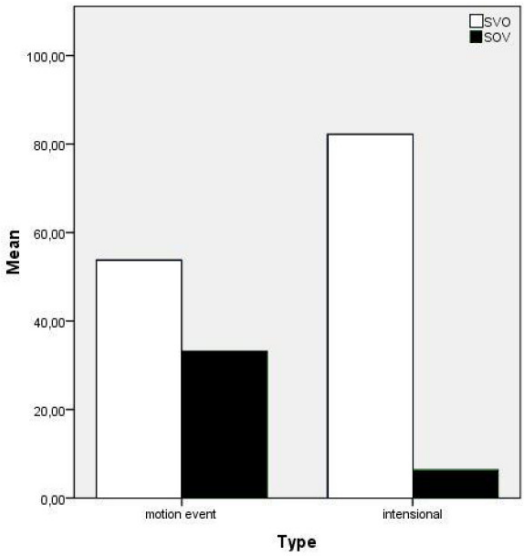


Figure 4.3 Average percentage of gesturing orders for the two types of items (Van Leeuwen, 2010)

Because the SVO order was found for motion events more often than expected, Van Leeuwen (2010) also carried out a control experiment with motion pictures only. The result of this experiment was even more in contrast with the results of Goldin-Meadow et al and Langus and Nespor; 52% was gestured in SVO order and only 2% was gestured in SOV order. Van Leeuwen (2010, p.27) suggests that this preference for SVO is caused by the strategy that was used by the participants: "*some of them said they had 'written' sentences in mind while gesturing*".

Van Leeuwen also performed a pilot of an interpretation experiment in which participants had to interpret movies with gestured events. She used ambiguous verbs that could be interpreted both as a motion event and an intensional event. One of the ambiguous verbs she used was 'paint'. As shown in figure 4.4, 'painting' can be interpreted as a motion event when someone is painting the skin of an elephant. On the other hand, 'painting' can be interpreted as an intensional event when someone is painting (creating) an elephant on a canvas, see figure 4.5.

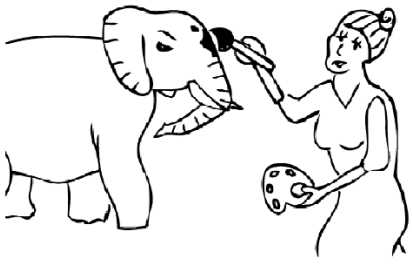


Figure 4.4

The woman paints an elephant (motion)

Figure 4.5

The woman paints an elephant (intensional)

The ambiguous events were presented to different participants in different orders, SOV or SVO:

Figure 4.6

'The woman paints an elephant' (in SOV order)

Figure 4.7

'The woman paints an elephant' (in SVO order)

After each movie, the participant had to choose between two pictures, like figures 4.4 and 4.5. The goal of the pilot was to study the influence of the order of the gestures on the interpretation of the event.

The stimuli consisted of 4 ambiguous movies in SVO and SOV order. The participants were 23 native speakers of Dutch.

The results of the interpretation pilot can be found in figure 4.8. For all of the ambiguous movies (1 to 4), intensional answers were chosen relatively often (the light grey parts), especially for the SVO movies. For the SOV movies, also many motion events were chosen.

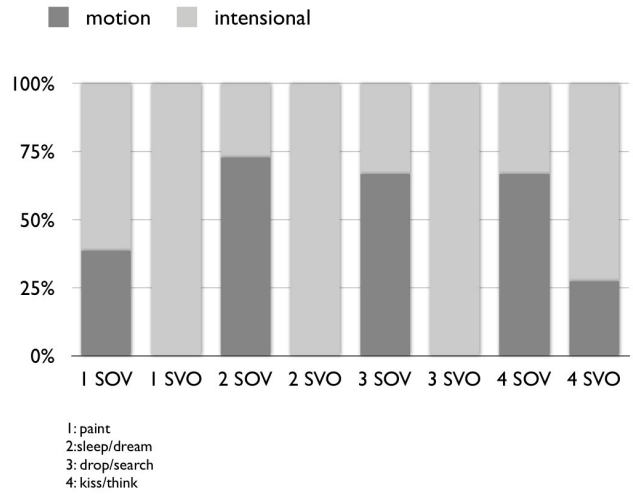


Figure 4.8 Results Van Leeuwen 2010 Interpretation experiment

Van Leeuwen (2010) was not able to replicate the SOV order for motion events, but she was able to confirm the intuition that different types of verbs behave differently in an improvised communication task.

After the promising results of the pilots of Schouwstra et al (2010) and Van Leeuwen (2010) we started our own experiments by:

- Improving the design that was used in the production experiment by Van Leeuwen (2010), so that it would replicate the previous findings of Goldin-Meadow et al (2008) and Langus and Nespor (2010) for motion events.
- Increasing the number of ambiguous movies to conduct a full interpretation experiment.
- Making sure that the events used in the production and interpretation experiment are a balanced representation of the sets of motion and intensional events.

Based on the results of previous studies, the improvements we made to the existing experiments and our intuition about different natural orders to sequence different types of events, we expect to find an SOV order for motion events and an SVO order for intensional events.

A detailed description of our experiments and their results can be found in the next part of this thesis.

PART II EXPERIMENTS

5. THE PRODUCTION EXPERIMENT

In this chapter, our study into the production part of communication is described. Two experiments are conducted. The first experiment is a replication of the production experiment of Van Leeuwen (2010), conducted in The Netherlands and with motion events only. We conducted this replication experiment to investigate the possibility that undesirable factors influenced the results of Van Leeuwen which could explain the difference between the results of Van Leeuwen and previous results. The second experiment is our new production experiment, conducted both in The Netherlands and in Turkey, in which we applied some improvements to eventually answer our central research question:

Are syntactic structures in improvised communication influenced by the semantic properties of events?

For the first experiment, we investigate whether motion events are gestured in one particular order. Our hypothesis is in line with the findings of Goldin-Meadow et al (2008) that motion events are gestured in SOV order.

Because Meir et al (2010) found a significant effect from 'animacy' on gesturing order, we will pay attention to this effect in the replication experiment by investigating whether animacy (animate object or inanimate object) has a significant effect on gesturing order. We expect to find a significant effect, in line with the findings of Meir et al, namely that animate objects are significantly more gestured in SVO order and inanimate objects are significantly more gestured in SOV order. If we are able to confirm those results, this could be a reason to modify the pictures before we use them for the new production experiment to be sure that animacy does not affect the results.

To answer the central research question, in the new production experiment we investigate whether the type of event (motion or intensional) has a significant effect on the gesturing order (SOV or SVO). The first part of the hypothesis of this experiment is similar to the findings of Goldin-Meadow et al (2008) and Langus and Nespor (2010), namely that motion events are gestured in SOV order significantly more often than in SVO order. For intensional events we expect to find a significant preference for SVO order, in line with the findings of Schouwstra et al (2010) and Van Leeuwen (2010). We

expect to find no significant effect from 'native language' (Dutch or Turkish) or 'version' (the different versions of the experiment we used, which will be explained in the method section).

In the new production experiment, we will also pay attention to a special group of intensional events, namely creation events. As explained in chapter 4, there is a discussion whether creation verbs belong to the class of intensional verbs or not. We decided to classify the creation verbs as a special group of verbs within the class of intensional verbs. To investigate whether this was a right decision to make, we investigate whether creation verbs are significantly less gestured in SVO order than other intensional events. As explained in chapter 4, we think that creation verbs behave a little different than other intensional events. We expect that creation verbs are significantly less gestured in SVO order than other intensional verbs, but still more in SVO order than in SOV order.

5.1 REPLICATION OF VAN LEEUWEN (2010)

Goldin-Meadow et al (2008) and Langus and Nespor (2010) found a tendency for the SOV order in their production experiments in which they used motion events as stimuli. Van Leeuwen (2010) was not able to confirm those results; she found no significant difference between SOV and SVO gesturing order for the motion events. Because this production experiment is the basis of our new experiments, we decided to replicate the experiment of Van Leeuwen, to make sure it was performed well the first time and to find possible improvements.

5.1.1 METHOD

Participants

The participants used in this experiment were 18 native Dutch speaking students; 4 male and 14 female. Participants were recruited from first year classes of the Utrecht University and from the vicinity of the university campus. Participants received a financial compensation for their participation. The participants were not familiar with conventional sign languages.

Stimuli

The original stimuli of Van Leeuwen (2010) were reused; twelve motion events (items A and B) as displayed in table 5.1. Furthermore, three events were added (items N) to create a larger set of items from which three practice items could be used. Events were presented to the participants by depicting them on images. The three new items were based on the existing images, with different subjects or objects. Images were presented in random order on a computer screen.

Item code	**Item description**
A1a	Girl throws guitar
A2a	Woman lifts saxophone
A3a	Man catches shoe
A4a	Boy shoots elephant
A5a	Gorilla feeds cat
A6a	Woman pushes horse
B1a	Woman throws saxophone
B2a	Girl lifts guitar
B3a	Gorilla catches ball
B4a	Girl shoots horse
B5a	Man feeds bird
B6a	Boy pushes elephant
N1a	Girl throws ball
N2a	Girl shoots bird
N3a	Gorilla shoots cat

Table 5.1: Items used in the replication production experiment

Two examples of the pictures that were used:

Figure 5.1a

B3a Girl lifts guitar

Figure 5.1b

N2a Girl shoots bird

The complete set of pictures can be found in appendix 1.

Procedure

Before the experiment started, participants signed a consent form that gave their permission to be recorded.

Participants stood in front of the computer screen where the images were shown. The experimenter sat behind the computer screen and was not able to see the screen. Participants had to watch fifteen images in random order and were asked for each picture to convey what was happening on the images by gesturing to an experimenter. The participants were recorded by webcam. During the experiment participants were not allowed to talk, they were allowed to make sound-effects.

The first three (random) images were practice items, during these items participants were motivated by the experimenter to gesture all three elements of the image (the subject, the object and the verb). This was done indirectly. If participants were not gesturing every element, the experimenter told them that it was not totally clear and that every detail could be of importance. In such a case, participants had to gesture the whole image again. Participants could continue to the next image, by pressing the mouse button, if they thought they had conveyed the image correctly. However, if the gestures were not clear to the experimenter participants were asked to gesture the whole image again.

Images were displayed on the screen while the participants gestured the picture. This is the only difference in set up with the experiment of Van Leeuwen (2010) where the images were not presented while gesturing. Van Leeuwen (2010) suggests that people use their linguistic system to 'remember' the picture they have to gesture, by formulating a sentence in their mind. Therefore it is probably more suitable to show the picture during the gesturing task.

After participants had completed the gesturing task they were instructed to write down whole sentences of the images they saw in the experiment by looking at all images again. To be sure they understood the task, two sample sentences were written down by the experimenter.

Analysis

In order to determine whether motion events are gestured mostly in one particular order, we make a qualitative analysis of the gesture orders that were used in the experiment.

In order to determine whether animacy has a significant effect on gesturing order, we conduct a Repeated Measures ANOVA with two within-subjects factors (gesturing order: SOV, SVO and animacy: animate object, inanimate object). If we find a significant effect, we conduct pair-wise comparisons to show which effect animacy has on gesturing order.

5.1.2 RESULTS

Two researchers looked at all written sentences independently to see if participants understood the pictures. Most important was that the participants interpreted a picture as a motion event, and not as a stative or intensional event (see chapter 4 for a characterization of different types of events). Of the 270 sentences, we decided to delete 103 sentences that were not interpreted well, which results in a total of 167 correctly interpreted motion pictures (62%).

After reviewing the sentences, the movies were viewed and the gesturing orders were written down. Two researchers watched the movies independently and this resulted in a 75% agreement on the orders. The items for which there was no consensus were deleted which results in a total of 123 orders (46% of items).

The results can be found in table 5.2.

		Order																		
Item	Sentence	OSOVOV	OSV	OV	OVO	OVOV	OVS	OVSOV	OVSV	SOSV	SOV	SOVO	SOVSO	SVO	SVOOV	SVOV	VO	VOV	VOVO	Total
A1a	Girl-throws-guitar	1		6							3	1		1						12
A2a	Woman-lifts-sax			2							2									4
A3a	Man-catches-shoe			1	1						1			1		2	1			7
A4a	Boy-shoots-elephant		1	1										2						4
A5a	gorilla-feeds-cat.png			1		1					3			3			1		1	10
A6a	Woman-pushes-horse			4			1	1			1			5			2			14
B1a	Woman-throws-sax		1	4	1		1				5			1				1		14
B2a	Girl-lifts-guitar			3							1									4
B3a	Gorilla-catches-ball										2		1	1						4
B4a	Girl-shoots-horse			1										2			1	1		5
B5a	Man-feeds-bird			1	1						2	1		2	1		1			9
B6a	Boy-pushes-elephant		1	4			1		1					2			2			11
N1a	Girl-throws-ball			5			1			1	6			1			2			16
N2a	Girl-shoots-bird										1			3						4
N3a	Gorilla-shoots-cat										2			3						5
Eindtotaal		1	3	33	3	1	4	1	1	1	29	2	1	27	1	2	10	2	1	123

Table 5.2 Orders in the replication production experiment with motion events only

The four largest categories in the table are OV, SOV, SVO and VO. Other orders just had a few occurrences. A pie chart with the proportions can be found in figure 5.2.

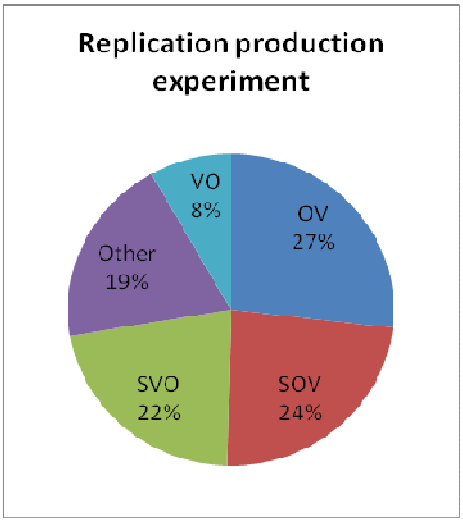


Figure 5.2 Results replication production experiment

Animacy

If we divide the 123 pictures in pictures with animate and pictures with inanimate objects, we find 62 pictures with animate objects and 61 pictures with inanimate objects. The results of those pictures can be found in table 5.3a.

Inanimate objects		**Animate objects**	
Order	**Number**	**Order**	**Number**
OV	21	OV	12
SOV	**20**	SOV	**9**
SVO	**5**	SVO	**22**
VO	3	VO	7
Other	12	Other	12
Total	61	Total	62

Table 5.3a Results divided in two parts: animate objects and inanimate objects

Has animacy a significant effect on the gesturing order?

Inanimate objects		
Subject	**Prop SOV**	**Prop SVO**
1	67%	0%
2	80%	20%
3	40%	0%
4	17%	0%
6	50%	0%
7	20%	0%
9	0%	0%
10	50%	25%
11	50%	50%
12	0%	0%
13	0%	0%
14	71%	14%
15	0%	80%
16	0%	17%
17	0%	0%
18	80%	20%
19	50%	50%
20	0%	0%

Animate objects		
Subject	**Prop SOV**	**Prop SVO**
1	29%	57%
2	0%	100%
3	0%	0%
4	0%	33%
6	33%	33%
7	43%	0%
9	0%	0%
10	0%	100%
11	0%	0%
12	0%	0%
13	20%	0%
14	75%	0%
15	0%	100%
16	0%	20%
17	0%	0%
18	0%	75%
19	0%	67%
20	0%	0%

Table 5.3b Results animacy per participant

In order to determine whether animacy had a significant effect on gesturing order, we carried out a Repeated Measures ANOVA with two within-subjects factors (animacy: animate object, inanimate object and gesturing order: SOV, SVO). We found a significant interaction between animacy and gesturing order ($F(1,17) = 8.019$, $p = .012$).

Pair-wise Bonferroni-corrected comparisons showed that pictures with inanimate objects are significantly more gestured in SOV order ($M = .319$, $SE = .073$) than in SVO order ($M = .153$, $SE = .054$, $p = .067$) and pictures with animate objects are significantly more gestured in SVO order ($M = .325$, $SE = .094$) than in SOV order ($M = .111$, $SE = .050$, $p = .085$).

5.1.3 DISCUSSION

From the original production experiment of Van Leeuwen (2010), all twelve motion pictures were reused and the set was extended with three new pictures. The only difference in methods between the replication and the original experiment, is the presence of the pictures on the screen during the gesturing task.

As can be concluded from the results presented in the previous section, SOV is not the largest category within the results. This is not in line with our hypothesis which says that there is a significant preference for SOV order.

A comparison between the replication production experiment with motion events only and the original experiment of Van Leeuwen (2010) with motion events only can be found in figure 5.2. The four largest categories of our replication experiment are shown (OV, SOV, SVO and VO) along with a category with other orders.

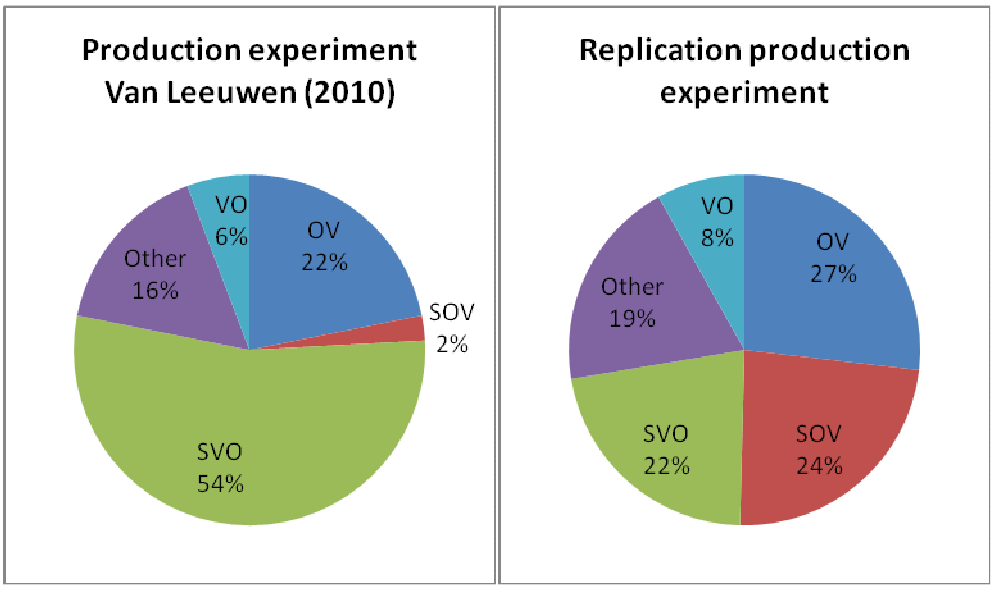


Figure 5.2 Comparison between the original production experiment of Van Leeuwen (2010) and the replication production experiment

As one can see, in the replication experiment SOV gesture order is used more often, at the expense of SVO order. This is more in line with the hypothesis that motion events are gestured in SOV order significantly more often than in SVO order. Still, only 24% is gestured in SOV order. Also many two-gesture strings were performed (VO, OV and part of the category 'other') from which mostly the subject was excluded. To decrease this large set of 2-gesture strings, we have to improve the pictures with more prominent subjects, to make sure participants gesture them.

Another remarkable fact is that 103 out of 270 pictures (38%) were not interpreted right by the participants. They interpreted a motion event as a stative event (holding a ball instead of dropping it) or they interpreted a motion event as an intensional event (trying to push the elephant instead of just pushing it). To decrease this large set of incorrectly interpreted pictures, we have to improve the clarity of the pictures and we

have to test them on some participants to be sure they are clear enough to use them for the actual production experiment.

Another point of interest is the use of animate objects. As explained in section 3.3, Meir et al (2010) found that inanimate objects trigger SOV gesturing order, and animate objects trigger SVO order. We were able to confirm the results of Meir et al (2010).

For our main production experiment, we have to minimize the influence of animacy because this is not our point of interest. We are interested in the influence of different types of verbs on the gesturing order. We think the best way to say something about this research question with minimizing the influence of animacy is to use only one category of images: images with inanimate objects only, to avoid the confusion that the subject and the object can be reversed. In that case, the results cannot be completely compared to the results of previous research because they used both types of pictures.

5.2. THE MAIN PRODUCTION EXPERIMENT

In the replication production experiment described in the previous section, motion events with animate and inanimate objects were used. In our main production experiment we use different types of events; motion events and intensional events, with inanimate objects only.

As described in the previous section, a few points of improvement can be applied to the existing production experiment. The knowledge of section 4.2 in which a characterization of different types of events has been made, can be applied to the experiment. In line with Goldin-Meadow et al (2008), we perform a cross linguistic study, with Dutch and Turkish native speakers. Dutch has an SVO word order and Turkish has an SOV word order and therefore participants of both languages are suitable to prove that the word order in the native language is not of influence on the gesturing order in the improvised communication task.

5.2.1 METHOD

For this main production experiment we conducted four versions of the experiment:

1. A motion experiment: participants are confronted with 20 images displaying motion events.

2. An intensional experiment: participants are confronted with 20 images displaying intensional events.

3. Combination experiment 1: participants are confronted with a combination of 10 motion and 10 intensional events as used in experiments 1 and 2. This experiment contains the first half of all pictures.

4. Combination experiment 2: participants are confronted with a combination of 10 motion and 10 intensional events as used in experiments 1 and 2. This experiment contains the second half of all pictures.

Participants

In the four parts of our main production experiment, Dutch and Turkish native speakers participated. Dutch participants were recruited from the Utrecht theater school and the Utrecht University campus. Turkish participants were recruited from the Boğaziçi University in Istanbul. Because in Turkey multiple languages are spoken, participants were asked for the age at which they started to speak Turkish. By only allowing participants who started speaking Turkish at an age under 6, we made sure they were native speakers of Turkish. Participants received a financial compensation for their participation. The participants were not familiar with sign languages. Table 5.4 shows the amounts of participants per experiment type and the gender (male/female) of the participants.

	Participants	
	Dutch (m/f)	Turkish (m/f)
Motion	7 (4/3)	8 (2/6)
Intensional	16* (9/7)	8 (2/6)
Combination 1	8 (3/5)	9 (3/6)
Combination 2	8 (2/6)	10 (7/3)
Total	39 (18/21)	35 (14/21)

Table 5.4: Participants in the main production experiment

**After studying 16 participants for the intensional experiment, we decided that 8 participants per experiment would be more feasible and we continued the experiments with 8 participants per experiment.*

Stimuli

We improved the existing stimuli according to the findings in the replication production experiment:

- We used more prominent subjects (leprechaun, princess, cook, pirate and witch) to decrease the large set of 2-gesture strings.

  Examples are presented in figure 5.3:

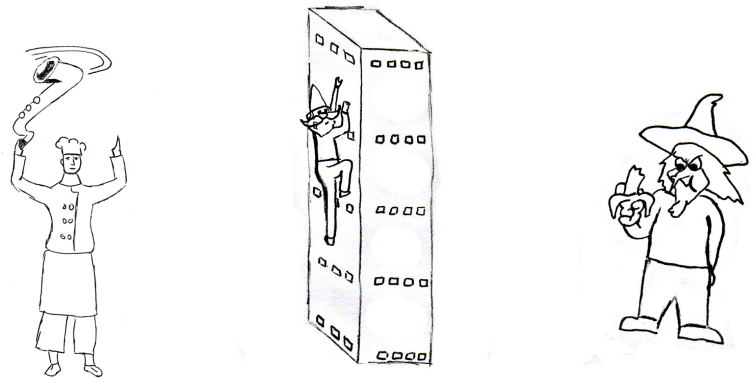


Figure 5.3 Examples of pictures that were used with more prominent subjects

- We improved the clarity of the pictures by changing them when they were not interpreted correctly the first time. A pretest was conducted with a small group of participants to check the clarity of all pictures. Participants were asked to describe each picture using a simple declarative sentence. After some new changes and a new pretest, we came up with a set of correctly interpretable pictures.

- We only used inanimate objects to decrease the influence of animacy on the experiment.

- In section 4.2 we made a characterization of the different types of verbs we use in the experiment: motion events and intensional events with a list of subtypes. We tried to create a set of pictures that forms a complete representation of the sets of motion events and intensional events. Because we are working with pictures and gestures, it was required that the events are depictable and gesturable.

Examples of the verbs that were used are:

Motion

Motion-causative: throw Combining/attaching: hang Sending/carrying: carry

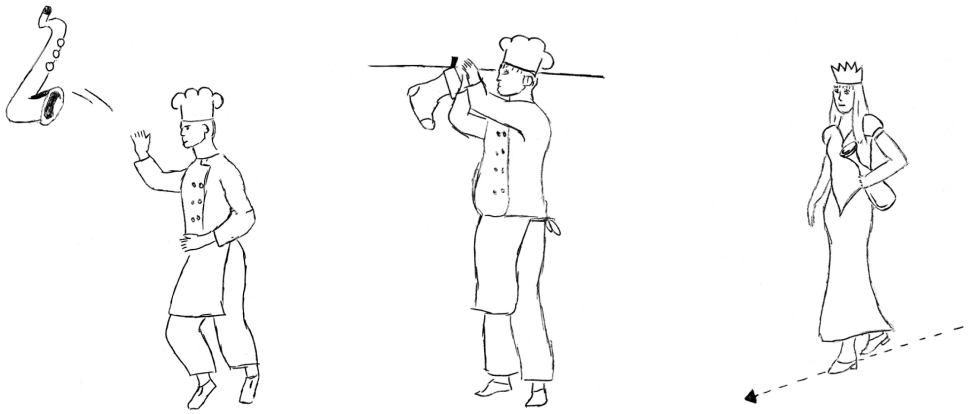
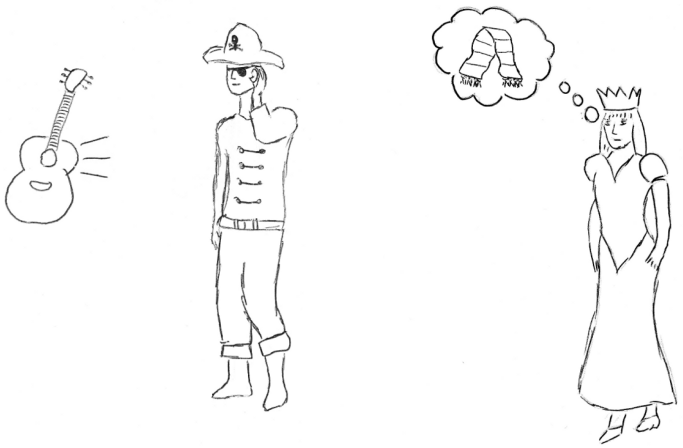


Figure 5.4 Examples of motion pictures

Intensional

Perception: hear Psych: think



Intensional: look for Creation: build

Figure 5.5 Examples of intensional pictures

An overview of all events can be found in table 5.4. Participants were first confronted with practice items:

- Motion experiment: 3 items Tm*
- Intensional experiment: 3 items Ti*
- Combination experiments: two motion and two intensional items, alternating (Tm3 and Ti3 were excluded)

After the practice items, twenty 'real' items were shown. Gray items in table 5.4 were used in the motion experiment, white items in the intensional experiment.

Items			
Set A		Set B	
A1	Cook cuts sock	B1	Princess cuts scarf
A2	Cook knits sock	B2	Princess knits scarf
A3	Cook swings saxophone	B3	Pirate swings guitar
A4	Cook throws saxophone	B4	Pirate throws guitar
A5	Leprechaun builds tower	B5	Witch builds house
A6	Leprechaun climbs tower	B6	Witch climbs house
A7	Leprechaun eats pizza	B7	Witch eats banana
A8	Leprechaun wants pizza	B8	Witch wants banana
A9	Pirate carries ball	B9	Princess carries vase

A10	Pirate looks for ball	B10	Princess looks for vase
A11	Pirate dreams of guitar	B11	Cook dreams of saxophone
A12	Pirate hears guitar	B12	Cook hears saxophone
A13	Princess drops vase	B13	Pirate drops ball
A14	Princess sculpts vase	B14	Pirate sculpts ball
A15	Princess hangs scarf	B15	Cook hangs sock
A16	Princess thinks of scarf	B16	Cook thinks of sock
A17	Witch paints house	B17	Leprechaun paints tower
A18	Witch sees house	B18	Leprechaun sees tower
A19	Witch cuts banana	B19	Leprechaun cuts pizza
A20	Witch draws banana	B20	Leprechaun draws pizza
Practice items			
Motion		Intensional	
Tm1	Leprechaun pushes cart	Ti1	Princess dreams of car
Tm2	Witch pulls car	Ti2	Pirate thinks of cart
Tm3	Princess throws trumpet	Ti3	Gorilla thinks of ball

Table 5.4: Items used in the main production experiment

In the combination experiments the stimuli were divided into two sets; set A and set B, in which a combination of motion and intensional items was given. Both sets contained the same verbs, but different subjects and objects. The items were presented in random order to the participants with the following constraints:

1. Presenting the same subject two times in a row is not allowed
2. Presenting the same object two times in a row is not allowed
3. Presenting the same verb two times in a row is not allowed
4. When a sequence of three consecutive items had been presented in a previous experiment, this sequence was not used again.

To rule out the possible influence of the way a picture is presented, namely the left to right order of the elements in the pictures, we used mirror images like Langus and Nespor (2010) did. Pictures were alternately presented in the original way or mirrored.

The 46 original (not mirrored) pictures that were used for the main production experiments can be found in Appendix 2.

Procedure

Before the experiment started, participants signed a consent form that gave us permission to record them.

Participants stood in front of the computer screen on which the images were shown. The experimenter sat behind the computer screen and was not able to see the screen. As shown in table 5.4, there were three motion and three intensional practice items. For the separate motion and intensional experiments, we used the three relevant practice items. For the combination experiment we used two of the motion and two of the intensional practice items, which results in a total four practice items. Participants had to watch 23 or 24 (depending on the type of experiment) images in random order and were asked to convey what was happening on the images by gesturing to an experimenter. The gesturing was recorded with a webcam. During the experiment participants were not allowed to talk, they were allowed to make sound effects.

The first three images were practice items, during these items participants were motivated by the experimenter to gesture all three elements of the image (the subject, the object and the verb). This was done indirectly. If participants were not gesturing every element, the experimenter told them that it was not totally clear and that every detail could be of importance. In such a case, participants had to gesture the whole image again. Participants could continue to the next image, by pressing the mouse button, if they thought they had conveyed the image correctly. However, if the gestures were not clear to the experimenter participants were asked to gesture the whole image again.

Images were displayed on the screen while the participants gestured, to be sure that people did not use their linguistic system to remember the picture while they were gesturing.

After participants had completed the gesturing task they were instructed to write simple declarative sentences describing the images they saw in the experiment by looking at the images again. To be sure they understood the task, two sample sentences were written down by the experimenter, containing a subject, an object and a verb.

Analysis

In order to determine whether event type has a significant effect on gesturing order, we conduct a Repeated Measures ANOVA with two within-subjects factors (event type: motion, intensional and gesturing order: SOV, SVO) and two between-subjects factors (native language: Dutch, Turkish and version: combination experiment 1, combination experiment 2). If we find a significant effect, we conduct pair-wise comparisons to show which effect event type has on gesturing order.

The same analysis will be conducted for the effect of different intensional event types (creation event or other intensional event) on gesturing order.

5.2.2 RESULTS

Every participant had to gesture 20 pictures; motion, intensional or a combination of motion and intensional events. The three or four test-items that were used are not included in the results of the experiment.

Two researchers watched all written sentences independently to see if participants understood the pictures well. Most important was that the participants interpreted a picture as the right type of event (motion or intensional). Of the 1500 sentences, we decided to delete 123 sentences that were not interpreted well, which resulted in a total of 1377 correctly interpreted pictures (92%).

All recordings were watched by two researchers independently, with more than 80% agreement on the gesture order. All recordings with no consensus about the order were filtered out. There was no consensus about 232 (17%) of the 1377 recordings which results in a total of 1145 useful items (76% of all items).

The following subsections will present the results of the different types of experiments in The Netherlands and in Turkey, after which the overall results of the combination experiments in The Netherlands and Turkey will be presented.

Results of the different experiments in The Netherlands and in Turkey

Experiment 1: Motion events in The Netherlands

Sixteen participants were shown 20 motion pictures.

Results:

	Order															
Picture	SVO	SOV	SVOV	OSV	SV	OSOV	OVS	OV	OVSOV	SVOVS	OVSV	SO	SOVS	SOSV	SOVO	**Total**
lepricon_cuts_pizza		13					1									14
princess_hangs_scarf		12			1	1	1									15
cook_cuts_sok		11		1	1		1						1			15
lepricon_climbes_tower	2	6		3	1			1								13
pirate_drops_ball		7					1					1				9
cook_swings_sax	1	10	1			1	2									15
witch_paints_house	2	8		2	1			1			1					15
princess_cuts_scarf		12	1					1							1	15
witch_climbes_house	2	5		4										1		12
pirate_throws_guitar		10						1			1					12
cook_hangs_sok		12			1		1		1							15
witch_eats_banana		11								1						12
pirate_swings_guitar		11	1													12
lepricon_paints_tower	1	6	2	3	2											14
princess_carries_vase	1	11					1	1								14
lepricon_eats_pizza		11		1									1			13
princess_drops_vase		8			1											9
witch_cuts_banana		12	1					1								14
pirate_carries_ball		10					1							1		12
cook_throws_sax		11	1	1			1									14
Total	**9**	**197**	**7**	**15**	**8**	**2**	**10**	**6**	**1**	**1**	**2**	**1**	**2**	**2**	**1**	**264**

Table 5.5 Results motion experiment in The Netherlands

Of the 320 trials in the motion experiment, 264 trials were useful (82%). Of the 264 useful trials, 197 pictures (75%) were gestured in SOV order and 9 pictures (3%) were gestured in SVO order.

Experiment 1: Motion events in Turkey

Eight participants were shown 20 motion pictures.

Results:

	Order								
Picture	OS	OSV	OVS	OVSV	SO	SOV	SV	SVO	**Total**
cook_cuts_sok			1			6			7
cook_hangs_sok			1			7			8
cook_swings_sax						8			8
cook_throws_sax			1			6			7
lepricon_climbes_tower		1	1			2			4
lepricon_cuts_pizza		1	3			2	1		7
lepricon_eats_pizza			3			3			6
lepricon_paints_tower		3	1			3	1		8
pirate_carries_ball			1			4			5
pirate_drops_ball			1		1	4			6
pirate_swings_guitar						8			8
pirate_throws_guitar	1					6			7
princess_carries_vase						4			4
princess_cuts_scarf			1			6			7
princess_drops_vase			1			6			7
princess_hangs_scarf			2			5			7
witch_climbes_house		2	1	2		1			6
witch_cuts_banana			3			4			7
witch_eats_banana			2		1	5			8
witch_paints_house		1	2			3		1	7
Total	**1**	**8**	**25**	**2**	**2**	**93**	**2**	**1**	**134**

Table 5.6 Results motion experiment in Turkey

Of the 160 trials in the motion experiment, 134 trials were useful (83%). Of the 134 useful results, 93 pictures (69%) were gestured in SOV order and 1 picture (1%) was gestured in SVO order.

Experiment 2: Intensional events in The Netherlands

Seven participants were shown 20 intensional pictures.

Results:

	Order								
Picture	SVO	SOV	SVOV	SV	SO	VO	VSVO	OSVO	**Total**
pirate_sculpts_ball	3	2							5
lepricon_draws_pizza	6		1						7
cook_hears_sax	5	1							6
princess_looks-for_vase	6								6
cook_thinks-of_sok	6								6
cook_dreams-of_sax	4					1	1		6
lepricon_sees_tower	4	1			1				6
witch_wants_banana	6								6
witch_builds_house	4		1	1					6
princess_knits_scarf	1	1	1	2	1				6
cook_knits_sok	4	2		1					7
lepricon_wants_pizza	7								7
pirate_hears_guitar	4	1	1	1					7
witch_draws_banana	3			1	1	1			6
princess_sculpts_vase	3		1						4
princess_thinks-of_scarf	5				1				6
pirate_dreams-of_guitar	7								7
witch_sees_house	5								5
lepricon_builds_tower	3		1	1				1	6
pirate_looks-for_ball	6								6
Total	**92**	**8**	**6**	**7**	**4**	**2**	**1**	**1**	**121**

Table 5.7 Results intensional experiment in The Netherlands

Of the 140 trials in the intensional experiment, 121 trials were useful (86%). Of the 121 useful trials, 92 pictures (76%) were gestured in SVO order and 8 pictures (7%) were gestured in SOV order.

Experiment 2: Intensional events in Turkey

Seven participants were shown 20 intensional pictures.

Results:

	Order											
Picture	OSV	OVS	SO	SOV	SOVOV	SV	SVO	SVOV	SVOVO	VO	VOS	**Total**
cook_dreams-of_sax							3			1		4
cook_hears_sax							5	1	1			7
cook_knits_sok						2	2					4
cook_thinks-of_sok							5	1				6
lepricon_builds_tower				1			4				1	6
lepricon_draws_pizza							4					4
lepricon_sees_tower		1		1			5	1				8
lepricon_wants_pizza							4	2				6
pirate_dreams-of_guitar							5	1	1			7
pirate_hears_guitar			1				4					5
pirate_looks-for_ball				1			6	1				8
pirate_sculpts_ball					1		1	1				3
princess_knits_scarf						1	2	1				4
princess_looks-for_vase							6		1			7
princess_sculpts_vase							4					4
princess_thinks-of_scarf			1				4					5
witch_builds_house						1	5					6
witch_draws_banana						1	4	2				7
witch_sees_house	1						3	2		1		7
witch_wants_banana							5	2				7
Total	**1**	**1**	**2**	**3**	**1**	**5**	**81**	**15**	**3**	**2**	**1**	**115**

Table 5.8 Results intensional experiment in Turkey

Of the 140 trials in the intensional experiment, 115 trials were useful (82%). Of the 115 useful results, 81 pictures (70%) were gestured in SVO order and 3 pictures (3%) were gestured in SOV order.

Experiment 3: Combination experiment in The Netherlands

Sixteen participants were shown 10 motion pictures and 10 intensional pictures.

Results:

	Order										
Picture	SVO	SOV	SVOV	OSV	SV	OVS	OV	OVSV	SO	SOSV	**Total**
lepricon_cuts_pizza	1	5									6
princess_hangs_scarf		5			1						6
cook_cuts_sok	1	5									6
lepricon_climbes_tower		2		1						1	4
pirate_drops_ball		3			1						4
cook_swings_sax		7									7
witch_paints_house	1	2		1			1	1			6
princess_cuts_scarf	1	7									8
witch_climbes_house		4	1	1			1				7
pirate_throws_guitar	3	5									8
cook_hangs_sok	1	4				1					6
witch_eats_banana	1	7									8
pirate_swings_guitar	2	6									8
lepricon_paints_tower	2	3	1		1						7
princess_carries_vase	1	7									8
lepricon_eats_pizza	1	6									7
princess_drops_vase	1	3			1						5
witch_cuts_banana		7			1						8
pirate_carries_ball		7									7
cook_throws_sax	1	3	1						1		6
Total	**17**	**98**	**3**	**3**	**5**	**1**	**2**	**1**	**1**	**1**	**132**

Table 5.9 Results combination experiment - motion part, in The Netherlands

Of the 160 trials in the motion part of the combination experiment, 132 trials were useful (82,5%). Of the 132 useful trials, 98 pictures (74%) were gestured in SOV order and 17 pictures (13%) were gestured in SVO order.

	Order													
Picture	SVO	SOV	SVOV	OSV	SV	VSO	SO	SVOVO	VO	VSVO	SOVOV	SVOVOV	OS	**Total**
pirate_sculpts_ball	3	1												4
lepricon_draws_pizza	6		2											8
cook_hears_sax	6	1												7
princess_looks-for_vase	4		1											5
cook_thinks-of_sok	6						1							7
cook_dreams-of_sax	4		1			1			1	1				8
lepricon_sees_tower	1	2			1			1						5
witch_wants_banana	6	1					1							8
witch_builds_house	4	1			1									6
princess_knits_scarf	6				2									8
cook_knits_sok	3	1	1		1									6
lepricon_wants_pizza	4		1											5
pirate_hears_guitar	2	2	1										1	6
witch_draws_banana	4		1		1									6
princess_sculpts_vase	2													2
princess_thinks-of_scarf	6	1												7
pirate_dreams-of_guitar	7													7
witch_sees_house	3		1	1							1			6
lepricon_builds_tower	2	2			1									5
pirate_looks-for_ball	4		1									1		6
Total	**83**	**12**	**10**	**1**	**7**	**1**	**2**	**1**	**1**	**1**	**1**	**1**	**1**	**122**

Table 5.10 Results combination experiment - intensional part, in The Netherlands

Of the 160 trials in the intensional part of the combination experiment, 122 trials were useful (76,25%). Of the 122 useful trials, 83 pictures (68%) were gestured in SVO order and 12 pictures (10%) were gestured in SOV order.

Experiment 3: Combination experiment in Turkey

Ten participants were shown 10 motion pictures and 10 intensional pictures and nine other participants were shown the remaining 10 motion pictures and 10 intensional pictures.

Results:

	Order												
Picture	OSOV	OSV	OV	OVS	OVSV	SO	SOV	SOVO	SOVS	SV	SVO	SVOV	**Total**
cook_cuts_sok							6			1	2		9
cook_hangs_sok							4				2		6
cook_swings_sax							5						5
cook_throws_sax						1	3						4
lepricon_climbes_tower		2	1				2			2	1		8
lepricon_cuts_pizza							2	1					3
lepricon_eats_pizza							4			3	2		9
lepricon_paints_tower		1					5				1		7
pirate_carries_ball							8						8
pirate_drops_ball						1	2						3
pirate_swings_guitar							5				1	1	7
pirate_throws_guitar							5				1		6
princess_carries_vase							5				1	1	7
princess_cuts_scarf						1	7				1		9
princess_drops_vase	1					1	3						5
princess_hangs_scarf							6						6
witch_climbes_house		3		1	1		3						8
witch_cuts_banana				1			6	1					8
witch_eats_banana						1	7						8
witch_paints_house		2	2				4		1				9
Total	**1**	**8**	**3**	**2**	**1**	**5**	**92**	**2**	**1**	**6**	**12**	**2**	**135**

Table 5.11 Results combination experiment - motion events, in Turkey

Of the 190 trials in the motion part of the combination experiment, 135 trials were useful (71,05%). Of the 135 useful motion pictures in the combination experiments, 92 pictures (68%) were gestured in SOV order and 12 pictures (9%) were gestured in SVO order.

	Order													
Picture	OSV	OSVO	OV	OVSV	SO	SOV	SOVO	SV	SVO	SVOSV	SVOV	SVOVO	VSOV	**Total**
cook_dreams-of_sax									6		1			7
cook_hears_sax	3					1			1		1	1		7
cook_knits_sok						3			3		1			7
cook_thinks-of_sok									6		1			7
lepricon_builds_tower	2						1		2					5
lepricon_draws_pizza						1			1		2			4
lepricon_sees_tower	1	1		1		2			1					6
lepricon_wants_pizza						1			6		2			9
pirate_dreams-of_guitar									7				1	8
pirate_hears_guitar	1				1	2			4			1		9
pirate_looks-for_ball					1				4		4			9
pirate_sculpts_ball											1			1
princess_knits_scarf						2		1	1		1			5
princess_looks-for_vase							1		3		3			7
princess_sculpts_vase						1								1
princess_thinks-of_scarf									4		1			5
witch_builds_house				1		1			1		1			4
witch_draws_banana						1			3		2			6
witch_sees_house			1			1			2	1	1			6
witch_wants_banana									7		2			9
Total	**7**	**1**	**1**	**2**	**2**	**16**	**2**	**1**	**62**	**1**	**24**	**2**	**1**	**122**

Table 5.12 Results combination experiment - intensional events in Turkey

Of the 190 trials in the intensional part of the combination experiment, 122 trials were useful (64,21%). Of the 122 useful intensional pictures in the combination experiments, 62 pictures (51%) were gestured in SVO order and 16 pictures (13%) were gestured in SOV order.

The results of the combination experiments in The Netherlands and Turkey combined

Table 5.13 shows the Dutch and Turkish results of the motion pictures of the combination experiments:

		Order													
Picture	**Type**	**SOV**	**SVO**	**OSV**	**SV**	**SO**	**SVOV**	**OV**	**OVS**	**OVSV**	**SOVO**	**SOSV**	**OSOV**	**SOVS**	**Total**
Cook cuts sock	Motion	11	3		1										**15**
Cook hangs sok	Motion	8	3						1						**12**
Cook swings sax	Motion	12													**12**
Cook throws sax	Motion	6	1			2	1								**10**
Lepricon climbes tower	Motion	4	1	3	2			1				1			**12**
Lepricon cuts pizza	Motion	7	1								1				**9**
Lepricon eats pizza	Motion	10	3		3										**16**
Lepricon paints tower	Motion	8	3	1	1		1								**14**
Pirate carries ball	Motion	15													**15**
Pirate drops ball	Motion	5			1	1									**7**
Pirate swings guitar	Motion	11	3				1								**15**
Pirate throws guitar	Motion	10	4												**14**
Princess carries vase	Motion	12	2				1								**15**
Princess cuts scarf	Motion	14	2			1									**17**
Princess drops vase	Motion	6	1		1	1							1		**10**
Princess hangs scarf	Motion	11			1										**12**
Witch climbes house	Motion	7		4			1	1	1	1					**15**
Witch cuts banana	Motion	13			1				1		1				**16**
Witch eats banana	Motion	14	1			1									**16**
Witch paints house	Motion	6	1	3				3		1				1	**15**
Total		**190**	**29**	**11**	**11**	**6**	**5**	**5**	**3**	**2**	**2**	**1**	**1**	**1**	**267**

Table 5.13 Combination experiment – Motion, Dutch and Turkish data combined

Of the 350 trials in the motion part of the combination experiment, 267 trials were useful (76%). Of the 267 useful intensional pictures in the combination experiments, 190 pictures (71%) were gestured in SOV order and 29 pictures (11%) were gestured in SVO order.

Table 5.14 shows the Dutch and Turkish results of the intensional pictures of the combination experiments:

		Order																				
Picture	Type	SVO	SVOV	SOV	OSV	SV	SO	OVSV	SOVO	SVOVO	OV	VSOV	VSO	SVOVO	VO	VSVO	SOVOV	SVOVOV	OS	OSVO	SVOSV	Total
Cook dreams of sax	Intensional	10	2										1		1	1						15
Cook hears sax	Intensional	7	1	2	3					1												14
Cook knits sok	Intensional	6	2	4		1																13
Cook thinks of sok	Intensional	12	1				1															14
Lepricon builds tower	Intensional	4		2	2	1			1													10
Lepricon draws pizza	Intensional	7	4	1																		12
Lepricon sees tower	Intensional	2		4	1	1		1						1						1		11
Lepricon wants pizza	Intensional	10	3	1																		14
Pirate dreams of guitar	Intensional	14										1										15
Pirate hears guitar	Intensional	6	1	4	1		1			1									1			15
Pirate looks for ball	Intensional	8	5				1											1				15
Pirate sculpts ball	Intensional	3	1	1																		5
Princess knits scarf	Intensional	7	1	2		3																13
Princess looks for vase	Intensional	7	4						1													12
Princess sculpts vase	Intensional	2		1																		3
Princess thinks of scarf	Intensional	10	1	1																		12
Witch builds house	Intensional	5	1	2		1		1														10
Witch draws bnana	Intensional	7	3	1		1																12
Witch sees house	Intensional	5	2	1	1						1						1				1	12
Witch wants banana	Intensional	13	2	1			1															17
Total		**145**	**34**	**28**	**8**	**8**	**4**	**2**	**2**	**2**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**244**

Table 5.14 Combination experiment – Intensional, Dutch and Turkish data combined

Of the 350 trials in the intensional part of the combination experiment, 244 trials were useful (70%). Of the 244 useful intensional pictures in the combination experiments, 145 pictures (59%) were gestured in SVO order and 28 pictures (11%) were gestured in SOV order.

Is there a significant effect from picture type on gesturing order?

In order to determine whether event type had a significant effect on gesturing order, we carried out a Repeated Measures ANOVA with two within-subjects factors (event type: motion, intensional and gesturing order: SOV, SVO) and two between-subjects factors (version: combination experiment 1, combination experiment 2 and native language: Dutch, Turkish). There was a main effect of event type ($F(1,31) = 7.318$, $p = ,011$). The interaction between event type and gesturing order was also significant ($F(1,31) = 270.840$, $p = <.001$). There were no effects of version or native language.

Pair-wise Bonferroni-corrected comparisons showed that motion pictures are significantly more gestured in SOV order ($M = .713$, $SE = .036$) than SVO order ($M = .106$, $SE = .035$, $p < .001$) and intensional pictures are significantly more gestured in SVO order ($M = .576$, $SE = .046$) than SOV order ($M = .118$, $SE = .024$, $p < .001$).

Creation verbs

Eight of the twenty intensional verbs that were used in the experiments are creation verbs. In table 5.15a the category of intensional verbs is divided into two parts: creation verbs and other intensional verbs.

	Dutch			**Turkish**		
	SVO	SOV	Other	SVO	SOV	Other
Creation verbs	62%	11%	27%	52%	15%	33%
Other intensional verbs	78%	7%	15%	64%	5%	31%

Table 5.15a Creation verbs within the main production experiment

Are creation verbs significantly less gestured in SVO order than other intensional verbs?

Participant	Creation	%SVO	%SOV	Country
1	1	29%	29%	T
1	0	43%	21%	T
2	1	40%	0%	T
2	0	19%	0%	T
3	1	64%	27%	T
3	0	82%	0%	T
4	1	70%	20%	T
4	0	69%	0%	T
5	1	20%	0%	T
5	0	86%	0%	T
6	1	57%	14%	T
6	0	67%	0%	T
7	1	56%	0%	T
7	0	80%	13%	T
8	1	36%	27%	T
8	0	63%	0%	T
9	1	100%	0%	T
9	0	80%	0%	T
10	1	0%	100%	T
10	0	67%	17%	T
11	1	100%	0%	T
11	0	100%	0%	T
12	1	25%	50%	T
12	0	40%	0%	T
13	1	0%	50%	T
13	0	75%	0%	T
14	1	33%	33%	T
14	0	0%	67%	T
15	1	33%	0%	T
15	0	17%	0%	T
16	1	0%	0%	T
16	0	33%	0%	T
17	1	0%	100%	T
17	0	80%	20%	T
18	1	0%	50%	T
18	0	83%	0%	T

Participant	Creation	%SVO	%SOV	Country
19	1	33%	33%	T
19	0	80%	20%	T
20	1	91%	9%	NL
20	0	73%	13%	NL
21	1	78%	0%	NL
21	0	87%	7%	NL
22	1	50%	0%	NL
22	0	60%	0%	NL
23	1	67%	0%	NL
23	0	88%	6%	NL
24	1	58%	25%	NL
24	0	86%	14%	NL
25	1	22%	22%	NL
25	0	93%	0%	NL
26	1	60%	10%	NL
26	0	81%	0%	NL
27	1	70%	0%	NL
27	0	63%	6%	NL
28	1	0%	0%	NL
28	0	67%	0%	NL
29	1	33%	67%	NL
29	0	100%	0%	NL
30	1	100%	0%	NL
30	0	75%	0%	NL
31	1	50%	50%	NL
31	0	60%	20%	NL
32	1	75%	0%	NL
32	0	100%	0%	NL
33	1	50%	0%	NL
33	0	0%	67%	NL
34	1	100%	0%	NL
34	0	83%	0%	NL
35	1	0%	0%	NL
35	0	33%	0%	NL

Table 5.15b Results creation verbs and other intensional verbs per participant

In order to determine whether the intensional event type (creation event or other intensional event) has a significant effect on the proportion SVO order that was gestured, we carried out a Repeated Measures ANOVA with one within-subjects factor (event type: creation, other intensional) and two between-subjects factors (native

language: Dutch, Turkish and version: combination experiment 1, combination experiment 2). There was a main effect of event type ($F(1,29) = 4.679$, $p = .039$). There were no effects of version or native language.

Pair-wise Bonferroni-corrected comparisons showed that creation verbs are significantly less gestured in SVO order ($M = .445$, $SE = .064$) than other intensional events ($M = .602$, $SE = .058$, $p = .039$).

5.2.3 DISCUSSION

To improve the design of the replication experiment, we made some changes in the pictures. More prominent subjects were used to achieve less 2-gesture strings. The pictures were also tested before they were used to be sure they were clear and changes were made to make the pictures clearer. The changes resulted in the following:

- In the main production experiment, 8% of the pictures were not interpreted right, against 38% wrongly interpreted pictures in the replication experiment.
- In the main production experiment, 7% of the gestured strings were 2-gesture strings, against 35% 2-gesture strings in the replication experiment.

Before discussing the results of the experiment, we are able to state that we improved the experimental design of the production experiment of Van Leeuwen (2010).

The hypothesis of this experiment was that motion events are gestured in SOV order significantly more than in SVO order and intensional events are gestured in SVO order significantly more than in SOV order. We expected that this difference does not depend on the native language of the participant. With the results of our production experiment, we are able to confirm the hypotheses.

Creation verbs

As explained in section 4.2, creation verbs like 'building' and 'knitting' are a special type of verb which we placed in the category of intensional verbs. Creation verbs are gestured significantly less in SVO order than other intensional events, but still they are mostly gestured in SVO order and just for small percentages in SOV order. We can conclude that creation verbs belong to the intensional verb category, but they behave as a special group of verbs within the category of intensional verbs.

We conclude this chapter by stating that:

- We improved the design of the production experiment of Van Leeuwen (2010) with:
    - more prominent subjects which lead to less 2-gesture strings
    - by clarifying the pictures which leads to more correctly interpreted pictures
- With the results of our experiments, we are able to confirm our hypothesis: **Motion events are gestured in SOV order significantly more than in SVO order and intensional events are gestured in SVO order significantly more than in SOV order. This difference does not depend on the native language of the participant. The preference for a specific order depends on the semantics of the event.**
- Creation verbs are a special group of verbs within the intensional verb category.

From the influence of semantic properties on syntactic structures, we continue to the next chapter in which the influence of syntactic structures on the interpretation of gesture strings will be studied; the interpretation experiment.

6. THE INTERPRETATION EXPERIMENT

For a communicative task, two perspectives are of importance: the perspective of the speaker and the perspective of the hearer. In the production experiment as described in the previous chapter, the emphasis was on the perspective of the speaker (the one who gestures). The emphasis in the interpretation experiment described in this chapter is on the perspective of the hearer (the one who has to interpret the gestures).

This is the research question of the interpretation experiment:

Do syntactic structures in improvised communication influence the interpretation of gesture strings?

We conducted an interpretation experiment based on the pilot interpretation experiment of Van Leeuwen (2010) to investigate whether the gesturing order of the movie has a significant effect on the proportion motion interpretations. We expect to find more motion interpretations if movies are gestured in SOV order than if movies are gestured in SVO order. We extended the pilot with more movies, more pictures and more participants. After analyzing the results and evaluating the methods of our first interpretation experiment, it appeared to be necessary to conduct a second interpretation experiment with some improvements. We conducted the second interpretation experiment with Dutch and Turkish participants. Again, we expect to find more motion interpretations if movies are gestured in SOV order than if movies are gestured in SVO order. We expect to find no significant effect from 'native language' (Dutch or Turkish) or 'version' (combination experiment 1 or combination experiment 2).

6.1 AMBIGUOUS VERBS

For the interpretation experiment we were interested in the influence of gesture order on the interpretation of utterances. To see if the gesture order had any influence we used ambiguously gestured verbs. The notion of ambiguous verbs is briefly discussed in this section.

Definition of 'ambiguous verbs' in this experiment: Verbs that can be interpreted either as a motion or as an intensional verb.

An example is the verb 'paint'. There exist two types of 'painting':

1. Motion verb: Decorating an existing object
2. Intensional verb: Making a painting of the object itself.

Both readings can be gestured by a 'painting' motion with the hand. In figure 6.1 screen shots of the verb 'Decorate – Paint' for the event 'Witch decorates - paints table' are presented. Both readings can be interpreted from the gesture.

Figure 6.1: Example of an ambiguous verb used in the interpretation experiments

6.2 INTERPRETATION EXPERIMENT 1

In this section, our first interpretation experiment with its results is presented. An actor was hired to create the movies we used for this experiment.

6.2.1 METHOD

In this experiment we performed five types of experiments:

1. A pre-experiment with movies of the verbs that are used for the interpretation experiment was conducted to be sure that the ambiguous verbs are really ambiguous.
2. An intensional experiment: Participants were confronted with 10 ambiguous movies in SVO order.
3. A motion experiment: Participants were confronted with 10 ambiguous movies in SOV order.
4. Combination experiment 1: Participants were confronted with 10 ambiguous movies with a combination of SVO and SOV orders.

5. Combination experiment 2: Participants were confronted with 10 movies with a combination of SVO and SOV orders, in exact the opposite order as the orders in combination experiment 1.

Because we wanted to study all 10 ambiguous movies in SOV and SVO order, 20 different movies were created. Because we wanted to study all 20 movies both in a separate experiment (with SOV or SVO movies only) and in a combination experiment (with both SOV and SVO movies) we conducted two combination experiments with the same amounts of movies as in the separate experiments.

Participants

Participants in this experiment were all students and native speakers of Dutch. Participants were recruited from the Utrecht University Library. The participants were not familiar with conventional sign languages. See table 6.1 for the number of participants in each study.

	Participants (m/f)
Pre-experiment	16
Motion	8 (1/7)
Intensional	8 (4/4)
Combination 1	16 (9/7)
Combination 2	16 (5/11)

Table 6.1: Participants in the first interpretation experiment

Stimuli

Pre-experiment:

The stimuli used in the pre-experiment consisted of movies displaying ambiguous verbs by means of gestures. Participants had to watch the movies and interpret the verbs. Before and after watching the movie, two pictures were presented on the screen, corresponding to the motion and the intensional interpretation of the verb, but in context (with a subject and an object). After watching the movie, participants had to choose between the two pictures and were asked which verb was gestured in the movie.

Main experiment:

The stimuli used in the main experiment consisted of movies displaying events by means of gestures. Participants had to watch the movies and interpret the gestures. The movies consisted of ambiguous verbs presented in context, thus in combination with

subjects and objects. For each ambiguous verb two movies were created, one with the SVO and one with the SOV order. The movies were created by taking the individual gestures for the subjects, objects, and verbs and combining them into the correct orders, with a grey 'flash' between the elements. This is the only difference with the experiment of Van Leeuwen (2010) in which movies were recorded from beginning to end without using flashes between the elements.

Before and after watching the movie, two pictures were presented on the screen, corresponding to the motion and the intensional interpretation of the verb. After watching the movie participants had to choose between the two pictures and were asked which picture was gestured in the movie.

There were two practice items, four fillers and ten ambiguous movies. The movies showed events which are shown in table 6.2

For the practice items and the fillers, only the expected order was used; for motion events an SOV movie and for intensional events an SVO movie. The possible answers for the practice items and fillers were two pictures: one depicting the verb in the movie and one depicting an event of the opposite verb type. The orders that were used in the different experiments, can be found in table 6.2.

Items		Order in the experiment			
#	Ambiguous verb	Combination 1	Combination 2	Interpretation	Motion
practice 1 answer L answer R		(SVO) Princess–Knit–Scarf Princes hangs scarf Princess knits scarf	(SOV) Princess–Scarf–Cut Princess cuts scarf Princess thinks of scarf	(SVO) Princess–Knit–Scarf Princes hangs scarf Princess knits scarf	(SOV) Princess–Scarf–Cut Princess cuts scarf Princess thinks of scarf
practice 2 answer L answer R		(SOV) Leprechaun–Table–Push Leprechaun pushes table Leprechaun looks at table	(SVO) Cook–Look at–Ball Cook plays with ball Cook looks at ball	SVO) Cook–Look at–Ball Cook looks at ball Cook plays with ball	(SOV) Leprechaun–Table–Push Leprechaun looks at table Leprechaun pushes table
filler 1 answer 1 answer 2		(SOV) Pirate–Guitar–Lift Pirate lifts guitar Pirate dreams of guitar	(SOV) Cook–Sock–Hang Cook hangs sock Cook knits sock	(SVO) Girl–Miss–Doll Girl carries doll Girl misses doll	(SOV) Pirate–Guitar–Lift Pirate lifts guitar Pirate dreams of guitar
filler 2 answer 1 answer 2		(SOV) Witch–Car–Pull Witch pulls car Witch likes car	(SOV) Princess–Vase–Carrie Princes caries vase Princess sculpts vase	(SVO) leprechaun–Feels–Book Leprechaun cuts book Leprechaun feels book	(SOV) Witch–Car–Pull Witch pulls car Witch likes car
filler 3 answer 1 answer 2		(SVO) Girl–Miss–Doll Girl carries doll Girl misses doll	(SVO) Girl–Fear–Ghost Girl pushes ghost Girl fears ghost	(SVO) Girl–Fear–Ghost Girl pushes ghost Girl fears ghost	(SOV) Cook–Sok–Hang Cook hangs sok Cook knits sok
filler 4 answer 1 answer 2		(SVO) leprechaun–Feels–Book Leprechaun cuts book Leprechaun feels book	(SVO) Pirate–Despise–Insect Pirate sqauches insect Pirate despises insect	(SVO) Pirate–Despise–Insect Pirate sqauches insect Pirate despises insect	(SOV) Princess–Vase–Carrie Princes caries vase Princess sculpts vase
exp 1	"drops-search for"	(SVO) Pirate–Search for–Ball	(SOV) Pirate–Ball–Drop	(SVO) Pirate–Search for–Ball	(SOV) Pirate–Ball–Drop
exp 2	"cuts-draws"	(SVO) Leprechaun–Draw–Pizza	(SOV) Leprechaun–Pizza–Cut	(SVO) Leprechaun–Draw–Pizza	Leprechaun–Pizza–Cut
exp 3	"eats-wants"	(SVO) Witch–Want–Banana	(SOV) Witch–Banana–Eat	(SVO) Witch–Want–Banana	(SOV) Witch–Banana–Eat
exp 4	"decorates-paints"	(SVO) Witch–Paint–Table	(SOV) Witch–Table–Decorate	SVO) Witch–Paint–Table	SOV) Witch–Table–Decorate
exp 5	"sleeps on-dreams of"	(SVO) Girl–Dreams of–Book	(SOV) Girl–Book–Sleeps on	(SVO) Girl–Dreams of–Book	(SOV) Girl–Book–Sleeps on
exp 6	"kisses-thinks of"	(SOV) Girl–Doll–Kiss	(SVO) Girl–Thinks of–Doll	SVO) Girl–Thinks of–Doll	(SOV) Girl–Doll–Kiss
exp 7	"talks to-talks about"	(SOV) Princess–Snowman–Talk to	(SVO) Princess–Talk about–Snowman	(SVO) Princess–Talk about–Snowman	(SOV) Princess–Snowman–Talk to
exp 8	"throws-hears"	(SOV) Pirate–Guitar–Throw	(SVO) Pirate–Hear–Guitar	(SVO) Pirate–Hear–Guitar	SOV) Pirate–Guitar–Throw
exp 9	"stirs-smells"	(SOV) Cook–Soup–Stir	(SVO) Cook–Smell–Soup	(SVO) Cook–Smell–Soup	(SOV) Cook–Soup–Stir
exp 10	"climbs-builds"	(SOV) Witch–House–Climb	(SVO) Witch–Build–House	(SVO) Witch–Build–House	(SOV) Witch–House–Climb

Table 6.2: Items used in the first interpretation experiment

The complete set of pictures can be found in appendix 3.

Procedure

Participants sat in the library in front of a laptop with the program for the interpretation experiment. During the experiment participants saw images and movies. First participants were able to familiarize with the images. After pressing the mouse button, the movie could be watched once, during which the images were not visible. When the participant was ready to answer, he had to push the mouse button to see the images again and press on the image he thought was gestured in the movie. In the main experiment participants were first confronted with two practice items. After that, fillers and experimental items were randomly presented to the participants. The possible answers for the fillers and experimental items were presented randomly on the left or the right position.

Analysis

In order to determine whether the gesturing order of the movie has an effect on the proportion motion interpretations, we perform a qualitative analysis of the interpretations in the experiment.

6.2.2 RESULTS

This section shows the results of the five types of experiments. The test-items and fillers are not included in the results of the experiment.

Pre-experiment:

Sixteen participants were shown 10 ambiguous verb movies.

Results:

		Answer type	
Experiment	Item	Motion	Intensional
Pre experiment	Cook stirrs/smells soup	7	9
	Witch climbs/builds house	10	6
	Pirate drops/looks for ball	11	5
	Leprechaun cuts/draws pizza	14	2
	Witch eats/wants banana	13	3
	Witch draws/decorates table	7	9
	Girl dreams of/sleeps on book	4	12
	Girl kisses/misses doll	5	11
	Princess talks to/talks about teddybear	12	4
	Pirate throws/hears guitar	9	7
Total Pre-experiment		92	68

Table 6.3 Results first interpretation experiment - pre-experiment

Of the 160 ambiguous verb movies, 92 (57,5%) were interpreted as a motion answer, 68 (42,5%) were interpreted as an intensional answer.

Main experiment with SOV movies:

Eight participants were shown 10 ambiguous movies.

Results:

			Answer type	
Experiment	Order movie	Meaning movie	Motion	Intensional
Motion	SOV	Cook stirrs/smells soup	5	3
	SOV	Witch builds/climbs house	6	2
	SOV	Pirate drops/looks for ball	2	6
	SOV	Leprechaun cuts/draws pizza	7	1
	SOV	Witch eats/wants banana	4	4
	SOV	Witch draws/decorates table	3	5
	SOV	Girl sleeps on/dreams of book	4	4
	SOV	Girl kisses/thinks of doll	5	3
	SOV	Princess talks to/talks about teddybear	7	1
	SOV	Pirate throws/hears guitar	5	3
Total motion			**48**	**32**

Table 6.4 Results first interpretation experiment with SOV movies

Of the 80 SOV movies, 48 (60%) were interpreted as a motion event and 32 (40%) were interpreted as an intensional event.

Main experiment with SVO movies:

Eight participants were shown 10 ambiguous movies.

Results:

			Answer type	
Experiment	Order movie	Meaning movie	Motion	Intensional
Intensional	SVO	Cook stirrs/smells soup	6	2
	SVO	Witch builds/climbs house	5	3
	SVO	Pirate drops/looks for ball	3	5
	SVO	Leprechaun cuts/draws pizza	8	0
	SVO	Witch eats/wants banana	6	2
	SVO	Witch draws/decorates table	5	3
	SVO	Girl sleeps on/dreams of book	1	7
	SVO	Girl kisses/thinks of doll	7	1
	SVO	Princess talks to/talks about teddybear	6	2
	SVO	Pirate throws/hears guitar	5	3
Total Intensional			**52**	**28**

Table 6.5 Results first interpretation experiment with SVO movies

Of the 80 SVO movies, 28 (35%) were interpreted as an intensional event and 52 (65%) were interpreted as a motion event.

Combination experiments with SOV and SVO movies:

Sixteen participants were shown 10 ambiguous movies.

Results of the SOV movies:

			Answer type	
Experiment	Order movie	Meaning movie	Motion	Intensional
Com 1 en 2	SOV	Cook stirrs/smells soup	9	7
	SOV	Witch builds/climbs house	9	7
	SOV	Pirate drops/looks for ball	5	11
	SOV	Leprechaun cuts/draws pizza	16	0
	SOV	Witch eats/wants banana	12	4
	SOV	Witch draws/decorates table	10	6
	SOV	Girl sleeps on/dreams of book	8	8
	SOV	Girl kisses/thinks of doll	8	8
	SOV	Princess talks to/talks about teddybear	12	4
	SOV	Pirate throws/hears guitar	9	7
Total SOV			**98**	**62**

Table 6.6 Results combination experiment with SOV movies

Of the 160 SOV movies, 98 (61%) were interpreted as a motion event and 62 (39%) were interpreted as an intensional event.

Results of the SVO movies:

			Answer type	
Experiment	Order movie	Meaning movie	Motion	Intensional
	SVO	Cook stirrs/smells soup	15	1
	SVO	Witch builds/climbs house	12	4
	SVO	Pirate drops/looks for ball	4	12
	SVO	Leprechaun cuts/draws pizza	14	2
	SVO	Witch eats/wants banana	13	3
	SVO	Witch draws/decorates table	10	6
	SVO	Girl sleeps on/dreams of book	3	13
	SVO	Girl kisses/thinks of doll	13	3
	SVO	Princess talks to/talks about teddybear	13	3
	SVO	Pirate throws/hears guitar	7	9
Total SVO			**104**	**56**

Table 6.7 Results combination experiment with SVO movies

Of the 160 SVO movies, 56 (35%) were interpreted as an interpretation event and 104 (65%) were interpreted as a motion event.

6.2.4 DISCUSSION

Pre-experiment:

For some ambiguous verbs participants seemed to have a strong preference for the motion or the intensional answer. For example the ambiguous movie 'cut/draw' is interpreted in 14 of 16 times as 'cut' and just in two times as 'draw'. This could be a reason to label this verb pair as 'not ambiguous' and delete this movie from the experiment. We actually kept all verb pairs in the experiment because we had to conduct a new experiment with new movies which will be explained below.

Main experiment:

In all types of experiments showed in the previous section, there seems to be a preference for the motion answer. Averaged over all four experiments 61% of the SOV movies were interpreted as a motion event and 65% of the SVO movies were interpreted as a motion event.

This is not in line with our hypothesis which says that there are more motion interpretations if movies are gestured in SOV order than if movies are gestured in SVO order.

In table 6.8 a comparison between the pre-experiment, the movies in SOV order and the movies in SVO order is shown. The last two columns are based on all types of experiments in which the particular orders were shown.

It would be in line with our expectations if:

- The percentages in the 'SOV' column increase with respect to the 'PRE' column for the motion answers (the grey parts of the table). In that case, more motion answers are chosen for the SOV orders of the ambiguous movies than in the pre-experiment in which there was no influence of order.
- The percentages in the 'SVO' column increase with respect to the 'PRE' column for the intensional answers (the blue parts of the table). In that case, more intensional answers are chosen for the SVO orders of the ambiguous movies than in the pre-experiment in which there was no influence of order.

	Answer	PRE	SOV	SVO
stirr/smell	stirr	44%	58%	88%
	smell	56%	42%	13%
climb/build	climb	63%	63%	71%
	build	38%	38%	29%
drop/look for	drop	69%	29%	29%
	look for	31%	71%	71%
cut/draw	cut	88%	96%	92%
	draw	13%	4%	8%
eat/want	eat	81%	67%	79%
	want	19%	33%	21%
draw/decorate	decorate	44%	54%	63%
	draw	56%	46%	38%
dream of/sleep on	sleep on	25%	50%	17%
	dream of	75%	50%	83%
kiss/miss	kiss	31%	54%	83%
	miss	69%	46%	17%
talk to/talk about	talk to	75%	79%	79%
	talk about	25%	21%	21%
throw/hear	throw	56%	58%	50%
	hear	44%	42%	50%

Table 6.8 Total results pre-experiment, SOV movies and SVO movies.

As one can see, the results of the experiments are not in line with our expectations. Still, our intuition says that the order of the elements in the movie influences the interpretation of the movie. Possibly, the gesturing in the movies was too elaborate and complex, and the attention of the participants was drawn to the details, so that the order of the elements was not a factor of influence any more. For example in some cases, to gesture an object or a subject, also a verb was used to make the meaning clear. In other cases, objects were used to make a verb clear. For example to gesture a cook, the cook was characterized by gesturing the verb cooking. We think that this was of influence on this task. Recording new movies with less elaborate gesturing could allow the effect of gesture order to be more clearly visible.

Because the results of this first interpretation experiment are not in line with our expectations, we improved the experiment by:

- Creating new movies with less elaborate gesturing
- Adding new ambiguous movies to the experiment because not all movies were as ambiguous as we hoped.

The type of motion experiment (motion or combination-motion) or intensional experiment (intensional or combination-intensional) appeared to have no influence on the answers. Therefore, the experiments with only motion or only intensional events could be deleted from the second interpretation experiment.

The second interpretation experiment will be presented in the next section.

6.3. INTERPRETATION EXPERIMENT 2

As described in the previous section, a few improvements can be applied to the existing interpretation experiment. We perform a cross linguistic study, with Dutch and Turkish native speakers, in line with our main production experiment.

Again, ambiguous verbs are used in this experiment. A definition of ambiguous verbs can be found in section 6.1.

6.3.1 METHOD

In this second interpretation experiment we performed three types of experiments:

1. A pre-experiment with 12 movies of the verbs in order to be sure that the ambiguous verbs are ambiguous.
2. Combination experiment 1: Participants were confronted with 12 movies with a combination of SVO and SOV orders.
3. Combination experiment 2: Participants were confronted with 12 movies with a combination of SVO and SOV orders, in exact the opposite order as the orders in combination experiment 1.

Because we wanted to study all 12 ambiguous movies in SOV and SVO order, 24 different movies were created. To decrease the amount of movies participants had to watch at once, two combination experiments were conducted: one with the first half of the 24 movies, and one with the other half.

Participants

The pre-experiment was performed by eight Dutch participants, recruited from the Utrecht University Library.

Participants in the main experiment were native speaking Dutch and Turkish students. See table 6.9 for the number of participants in each study. Dutch participants were recruited from the Utrecht University Library. Turkish participants were recruited from the library of the Boğaziçi University in Istanbul. Because in Turkey multiple languages are spoken, participants were asked for the age at which they started to speak Turkish. By only allowing participants who started speaking Turkish at an age under 6, we made sure they were native speakers of Turkish. Participants received a financial compensation for their participation. The participants were not familiar with conventional sign languages.

	Participants	
	Dutch (m/f)	Turkish (m/f)
Combination 1	21 (6/15)	20 (8/12)
Combination 2	21 (10/11)	20 (4/16)
Total	42 (16/26)	40 (12/28)

Table 6.9: Participants in the main interpretation experiment

Stimuli

The stimuli for the second interpretation experiment were new movies, with less elaborate gesturing. Two ambiguous events were added to the set of ten ambiguous verbs in the first experiment, which results in twelve ambiguous events.

Pre-experiment:

The stimuli used in the experiment consisted of movies displaying ambiguous verbs by means of gestures. Participants had to watch the movies and interpret the verbs. Before and after watching the movie, two pictures were presented on the screen, corresponding to the motion and the intensional interpretation of the verb, but in context (with a subject and an object). After watching the movie, participants had to choose between the two pictures and decide which verb was gestured in the movie.

Main experiment:

The stimuli used in the experiment consisted of movies displaying events by means of gestures. Participants had to watch the movies and interpret the gestures. The movies

consisted of ambiguous verbs presented in context, thus in combination with subjects and objects. For each ambiguous verb two movies were created, one with the SVO and one with the SOV order. The movies were created by taking the individual gestures for the subjects, objects, and verbs and combining them into the correct orders, with a grey 'flash' between the elements. Before and after watching the movie, two pictures were presented on the screen, corresponding to the motion and the intensional interpretation of the verb. After watching the movie participants had to choose between the two pictures and decide which picture was gestured in the movie.

There were two practice items, four fillers and twelve ambiguous movies. The movies showed events as can be seen in table 6.10. For the practice items and the fillers, only the expected order was used; for motion events an SOV movie and for intensional events an SVO movie. The answer possibilities of the practice items and fillers were one image depicting the verb in the movie and one image of an event of the other category than the verb that was gestured.

Items		Order in the experiment	
#	Sentence	Combination 1	Combination 2
practice 1	Princess knits scarf	(SVO) Princess-Knit-Scarf	(SOV) Leprechaun-Table-Push
answer L		Princes hangs scarf	Leprechaun pushes table
answer R		Princess knits scarf	Leprechaun looks at table
practice 2	Leprechaun pushes table	(SOV) Leprechaun-Table-Push	(SVO) Princess - Knit - Scarf
answer L		Leprechaun pushes table	Princes hangs scarf
answer R		Leprechaun looks at table	Princess knits scarf
filler 1	Pirate despises insect	(SVO) Pirate-Despise-Insect	(SVO) Pirate-Despise-Insect
filler 2	Girl fears ghost	(SVO) Girl-Fear-Ghost	(SVO) Girl-Fear-Ghost
filler 3	Witch pulls car	(SOV) Witch-Car-Pull	(SOV) Witch-Car-Pull
filler 4	Pirate lifts guitar	(SOV) Pirate-Guitar-Lift	(SOV) Pirate-Guitar-Lift
exp 1	Pirate "drops search for" ball	(SVO) Pirate-Search for-Ball	(SOV) Pirate-Ball-Drop
exp 2	Princess "breaks sculpts" vase	(SVO) Princess-Sculpt-Vase	(SOV) Princess-Vase-Break
exp 3	Leprechaun "cuts draws" pizza	(SVO) Leprechaun-Draw-Pizza	(SOV) Leprechaun-Pizza-Cut
exp 4	Witch "eats wants" banana	(SVO) Witch-Want-Banana	(SOV) Witch-Banana-Eat
exp 5	Witch "decorates paints" table	(SVO) Witch-Paint-Table	(SOV) Witch-Table-Decorate
exp 6	Girl "sleeps on dreams of" book	(SVO) Girl-Dreams of-Book	(SVO) Girl-Book-Sleeps on
exp 7	Girl "kisses thinks of" doll	(SOV) Girl-Doll-Kiss	(SVO) Girl-Thinks of-Doll
exp 8	Princess "talks to talks about" snowman	(SOV) Princess-Snowman-Talk to	(SVO) Princess-Talk about-Snowman
exp 9	Pirate "throws hears" guitar	(SOV) Pirate-Guitar-Throw	(SVO) Pirate-Hear-Guitar
exp 10	Cook "stirs smells" soup	(SOV) Cook-Soup-Stir	(SVO) Cook-Smell-Soup
exp 11	Leprechaun "hits feels" book	(SOV) Leprechaun-Book-Hit	(SVO) Leprechaun-Feels-Book
exp 12	Witch "climbs builds" house	(SOV) Witch-House-Climb	(SVO) Witch-Build-House

Table 6.10: Items used in the second interpretation experiment

The complete set of pictures that were used in the second interpretation experiment can be found in appendix 3.

Screen shots of the movie for 'Witch decorates - paints table' are presented in figure 6.2:

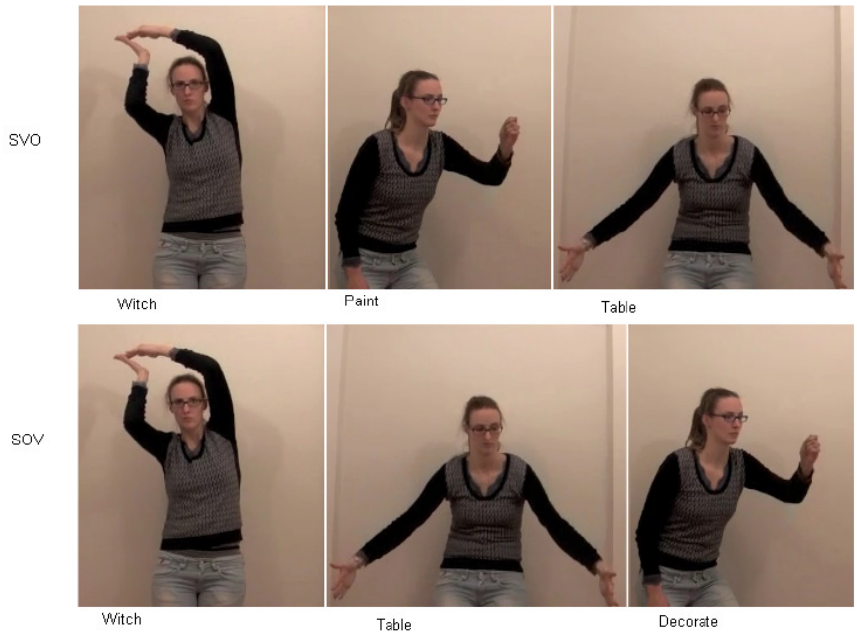


Figure 6.2: Example of a movie with an ambiguous verb used in the second interpretation experiment

Procedure

Participants sat in the library and got a laptop with the program for the interpretation experiment on it. During the experiment participants saw images and movies. First participants were able to familiarize with the images. After pressing the mouse button, the movie could be watched once, during which the images were not visible. When the participant was ready to answer, he had to push the mouse button to see the images again and press on the image he thought was gestured in the movie. In the main experiment participants were first confronted with two practice items. After that, fillers and experimental items were randomly presented to the participants. The possible answers for the fillers and experimental items were presented randomly on the left or the right position.

An example of the program can be found in figure 6.3. First participants were able to familiarize with the images (step 1). After they pressed the mouse button, they could watch the movie once while the images disappeared (step 2). When they were ready to answer they had to push the mouse button to see the images again and press on the image they thought was gestured in the experiment (step 3).

Figure 6.3: Screen shots of interpretation experiment 2

Analysis

In order to determine whether the gesturing order of the movie has a significant effect on the proportion motion interpretations, we carry out a Repeated Measures ANOVA with one within-subjects factor (gesturing order: SOV, SVO) and two between-subjects factors (version: combination experiment 1, combination experiment 2 and native language: Dutch, Turkish). If we find a significant effect, we use pair-wise comparisons to show which effect gesturing order has on the proportion motion answers.

6.3.2 RESULTS

This section shows the results of the interpretation experiments in The Netherlands and in Turkey after which the combined results of the experiments in The Netherlands and Turkey will be presented. The test-items and fillers are not included in the results of the experiment.

Results of the interpretation experiments in The Netherlands and in Turkey

Pre-experiment:

Eight Dutch participants were shown 12 ambiguous verb movies.

Results:

		Answer type	
Experiment	Item	Motion	Intensional
Pre -experiment	Cook stirrs – smells	8	0
	Girl kisses – thinks of doll	2	6
	Girl sleeps on – dreams of book	3	5
	Leprechaun cuts – draws pizza	2	6
	Leprechaun hits – feels book	2	6
	Pirate drops – search ball	5	3
	Pirate throws – hears guitar	7	1
	Princess breaks – sculpts vase	4	4
	Princess talks to – talks about teddybear	5	3
	Witch climbs – builds house	6	2
	Witch decorates – paints table	6	2
	Witch eats – wants banana	4	4
Total Pre experiment		42	54

Table 6.11 Results pre-experiment in second interpretation experiment

Of the 96 ambiguous verb movies, 42 (44%) were interpreted as a motion answer and 54 (56%) were interpreted as an intensional answer.

Interpretation experiment in The Netherlands:

Forty-two Dutch participants were shown 12 ambiguous movies.

Results of the SOV movies:

			Answer type	
Experiment	Order movie	Meaning movie	Motion	Intensional
Com 1 en 2	SOV	Cook stirs – smells	20	1
	SOV	Girl kisses – thinks of doll	11	10
	SOV	Girl sleeps on – dreams of book	10	9
	SOV	Leprechaun cuts – draws pizza	13	6
	SOV	Leprechaun hits – feels book	3	18
	SOV	Pirate drops – search ball	12	7
	SOV	Pirate throws – hears guitar	16	5
	SOV	Princess breaks – sculpts vase	13	6
	SOV	Princess talks to – talks about teddybear	20	1
	SOV	Witch climbs – builds house	20	1
	SOV	Witch decorates – paints table	17	2
	SOV	Witch eats – wants banana	13	6
Total SOV			**168**	**72**

Table 6.12 Results combination experiment – SOV part (The Netherlands)

Of the 240 SOV movies, 168 (70%) were interpreted as a motion event and 72 (30%) were interpreted as an intensional event.

Results of the SVO movies:

			Answer type	
Experiment	Order movie	Meaning movie	Motion	Intensional
Com 1 en 2	SVO	Cook stirs – smells	19	0
	SVO	Girl kisses – thinks of doll	11	8
	SVO	Girl sleeps on – dreams of book	3	18
	SVO	Leprechaun cuts – draws pizza	15	6
	SVO	Leprechaun hits – feels book	2	17
	SVO	Pirate drops – search ball	14	7
	SVO	Pirate throws – hears guitar	9	10
	SVO	Princess breaks – sculpts vase	12	9
	SVO	Princess talks to – talks about teddybear	17	2
	SVO	Witch climbs – builds house	14	5
	SVO	Witch decorates – paints table	16	5
	SVO	Witch eats – wants banana	5	16
Total SVO			**137**	**103**

Table 6.13 Results combination experiment – SVO part (The Netherlands)

Of the 240 SVO movies, 103 (43%) were interpreted as an intensional event and 137 (57%) were interpreted as a motion event.

Interpretation experiment in Turkey:

Forty Turkish participants were shown 12 ambiguous movies.

Results of the SOV movies:

			Answer type	
Experiment	Order movie	Meaning movie	Motion	Intensional
Com 1 en 2	SOV	Cook stirs – smells	17	3
	SOV	Girl kisses – thinks of doll	13	7
	SOV	Girl sleeps on – dreams of book	14	6
	SOV	Leprechaun cuts – draws pizza	14	6
	SOV	Leprechaun hits – feels book	3	17
	SOV	Pirate drops – search ball	12	8
	SOV	Pirate throws – hears guitar	14	6
	SOV	Princess breaks – sculpts vase	14	6
	SOV	Princess talks to – talks about teddybear	18	2
	SOV	Witch climbs – builds house	20	
	SOV	Witch decorates – paints table	19	1
	SOV	Witch eats – wants banana	8	12
Total SOV			**166**	**74**

Table 6.14 Results combination experiment – SOV part (Turkey)

Of the 240 SOV movies, 166 (69%) were interpreted as a motion event and 74 (31%) as an intensional event.

Results of the SVO movies:

			Answer type	
Experiment	Order movie	Meaning movie	Motion	Intensional
	SVO	Cook stirs – smells	16	4
	SVO	Girl kisses – thinks of doll	14	6
	SVO	Girl sleeps on – dreams of book	7	13
	SVO	Leprechaun cuts – draws pizza	12	8
	SVO	Leprechaun hits – feels book	3	17
	SVO	Pirate drops – search ball	13	7
	SVO	Pirate throws – hears guitar	8	12
	SVO	Princess breaks – sculpts vase	12	8
	SVO	Princess talks to – talks about teddybear	19	1
	SVO	Witch climbs – builds house	16	4
	SVO	Witch decorates – paints table	16	4
	SVO	Witch eats – wants banana	6	14
Total SVO			**142**	**98**

Table 6.15 Results combination experiment – SVO part (Turkey)

Of the 240 SVO movies, 98 (41%) were interpreted as an intensional event and 142 (59%) as a motion event.

The results of the Dutch and Turkish data combined

Table 6.16 shows the Dutch and Turkish results of the SOV movies of the combination experiment:

			Answer type	
Experiment	Order movie	Meaning movie	Motion	Intensional
Com 1 en 2	SOV	Cook stirs – smells	37	4
	SOV	Girl kisses – thinks of doll	24	17
	SOV	Girl sleeps on – dreams of book	24	15
	SOV	Leprechaun cuts – draws pizza	27	12
	SOV	Leprechaun hits – feels book	6	35
	SOV	Pirate drops – search ball	24	15
	SOV	Pirate throws – hears guitar	30	11
	SOV	Princess breaks – sculpts vase	27	12
	SOV	Princess talks to – talks about teddybear	38	3
	SOV	Witch climbs – builds house	40	1
	SOV	Witch decorates – paints table	36	3
	SOV	Witch eats – wants banana	21	18
Total SOV			**334**	**146**

Table 6.16 Results combination experiment – Motion

Of the 480 SOV movies, 334 (70%) were interpreted as motion event.

Table 6.17 shows the Dutch and Turkish results of the SVO movies of the combination experiment:

			Answer type	
Experiment	Order movie	Meaning movie	Motion	Intensional
Com 1 en 2	SVO	Cook stirs – smells	35	4
	SVO	Girl kisses – thinks of doll	25	14
	SVO	Girl sleeps on – dreams of book	10	31
	SVO	Leprechaun cuts – draws pizza	27	14
	SVO	Leprechaun hits – feels book	5	34
	SVO	Pirate drops – search ball	27	14
	SVO	Pirate throws – hears guitar	17	22
	SVO	Princess breaks – sculpts vase	24	17
	SVO	Princess talks to – talks about teddybear	36	3
	SVO	Witch climbs – builds house	30	9
	SVO	Witch decorates – paints table	32	9
	SVO	Witch eats – wants banana	11	30
Total SVO			**279**	**201**

Table 6.17 Results combination experiment - Intensional

Of the 480 SVO movies, 279 (58%) were interpreted as motion event.

In order to determine whether gesturing order in the movie had a significant effect on the proportion motion interpretations, we carried out a Repeated Measures ANOVA with one within-subjects factor (gesturing order: SOV, SVO) and two between-subjects factors (version: combination experiment 1, combination experiment 2 and native language: Dutch, Turkish). There was a main effect of gesturing order ($F(1,77) = 17.798$, $p = < .001$). The interaction between gesturing order and version was also significant ($F(1,77) = 6.771$, $p = .011$). There was no effect of native language.

Pair-wise Bonferroni-corrected comparisons showed that movies with gesture order SOV are significantly more interpreted as a motion event ($M = .694$, $SE = .018$) than movies with gesture order SVO ($M = .583$, $SE = .018$, $p = < .001$).

Pair-wise Bonferroni-corrected comparisons also showed that in combination experiment 1, SOV movies were interpreted significantly more as motion event ($M = .711$, $SE = .025$) than the SVO movies ($M = .533$, $SE = .026$, $p < .001$). Such a significant effect could not be found for combination experiment 2.

6.3.4 DISCUSSION

Pre-experiment

Because we recorded new movies, we also had to conduct a second pre-experiment to be sure that the movies were ambiguous. We added two new ambiguous events to the set.

A comparison between the first and the second pre-experiment with Dutch participants can be found in table 6.16:

		First pre- experiment		Second pre-experiment	
Experiment	Item	Motion	Intensional	Motion	Intensional
Pre experiment	Cook stirrs/smells soup	44%	56%	100%	0%
	Witch climbs/builds house	63%	38%	75%	25%
	Pirate drops/looks for ball	69%	31%	63%	38%
	Leprechaun cuts/draws pizza	88%	13%	25%	75%
	Witch eats/wants banana	81%	19%	50%	50%
	Witch draws/decorates table	44%	56%	75%	25%
	Girl dreams of/sleeps on book	25%	75%	38%	63%
	Girl kisses/misses doll	31%	69%	25%	75%
	Princess talks to/talks about teddybear	75%	25%	63%	38%
	Pirate throws/hears guitar	56%	44%	88%	13%
	Leprechaun hits – feels book	x	x	25%	75%
	Princess breaks – sculpts vase	x	x	50%	50%

Table 6.16 Results pre-experiment interpretation experiment 1 and 2 in The Netherlands

The results of the new pre-experiment were similar to the results of the first pre-experiment; two movies were not interpreted ambiguous. Because we added two movies, we end up with more ambiguous movies. As one may have noticed, we did not delete any items from the results because they could behave differently in context with a subject and an object in the gesturing task.

One could say that this pre-experiment does not prove that the movies are ambiguous. What if the movies are just vague, and the answer possibilities are not two competitive options for the movie? Participants had to choose one option, and maybe they chose randomly because the option they had in mind was not among the possible options. Another concern could be that the pre-test is not representative for the interpretation experiment because verbs can be interpreted differently when they are placed in context

(with a subject and a verb). These concerns are important to keep in mind while interpreting the results of the experiments. Our intuition tells us that this pre-experiment is a good basis for the interpretation experiment; movies were not that obvious that all participants chose one particular option. Some participants said to us after they completed the task that a lot movies were very obvious. *"The witch definitely climbed the house"* while others said *"The witch definitely built the house"*. If it follows from the results of the interpretation experiment that the sequence order of the movie influences the chosen option significantly, the exact ambiguousness of the movies is not of great importance anymore, the influence from the sequence order on the interpretation is the point of interest.

Interpretation experiment in The Netherlands:

In the combination experiments, 70% of the SOV movies were interpreted as a motion event and 57% of the SVO movies were interpreted as a motion event.

Interpretation experiment in Turkey:

In the combination experiments, 69% of the SOV movies were interpreted as a motion event and 59% of the SVO movies were interpreted as a motion event.

Combining the Dutch and Turkish results:

Combining the Dutch and Turkish results, 69% of the SOV movies were interpreted as a motion event and 58% of the SVO movies were interpreted as a motion event. Using a Repeated measures ANOVA test and pair-wise Bonferroni-corrected comparisons showed that movies with gesture order SOV are significantly more interpreted as a motion event ($M = .694$, $SE = .018$) than movies with gesture order SVO ($M = .583$, $SE = .018$, $p = < .001$).

The syntactic structures of an event in improvised communication influence the interpretation of the event. Ambiguous movies in SOV order are significantly more interpreted as motion events than movies in SVO order. This effect is not influenced by the native language of the participant.

One remark we have to make, is that the results are not as strong as we expected. Still a lot of SVO movies (about 58%) were interpreted as a motion event. Maybe this effect can be explained by the fact that in the pre-experiment, more motion answers than

intensional answers were chosen (57% motion and 43% intensional) and therefore there were relatively more motion answers.

We also found a significant interaction between 'version' and 'order'. This means that the version (combination experiment 1 or combination experiment 2) influenced the results significantly. For future research, it would be wise to investigate were this influence came from and how it can be resolved. There was no significant interaction between 'native language' and 'gesture order' which means that the results were not significantly different in The Netherlands than in Turkey.

The results of our interpretation experiment differ from the results of Van Leeuwen (2010). She found a significant effect, but with high percentages of intensional interpreted movies. We found a significant effect, but with high percentages of motion interpreted movies.

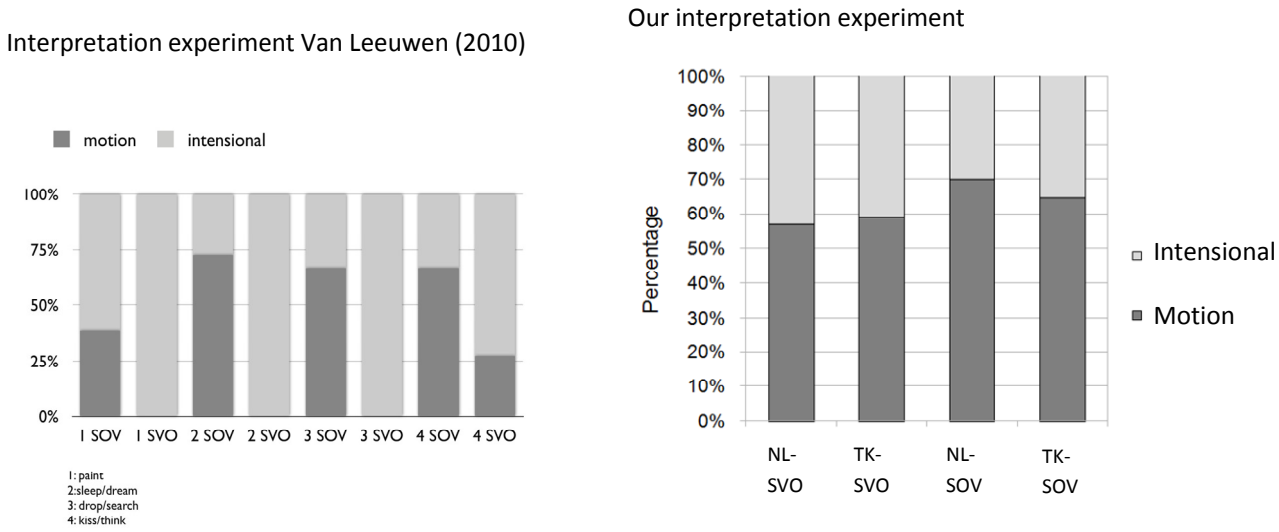


Figure 6.4 The results of Van Leeuwen (2010) and the results of our interpretation experiment

One explanation could be that there were differences in the movies. Van Leeuwen did not conduct a pre-test, so we are not able to compare our results of the pre-test with her results. The only difference in set up between our experiment and the experiment of Van Leeuwen (2010) is that she recorded movies in a particular order from beginning to end without using flashes between the elements. Our movies were created by taking the individual movies for the subjects, objects, and verbs and combining them into the correct orders, with a grey 'flash' between the elements. It could be the case that this difference influenced the results. To be sure, the experiment of Van Leeuwen (2010)

could be replicated, creating one difference: for the elements in an SVO or SOV movie, the same recorded elements were used with between two consecutive elements a gray flash. In a forthcoming study of Marien, this experiment is conducted and the results are presented below:

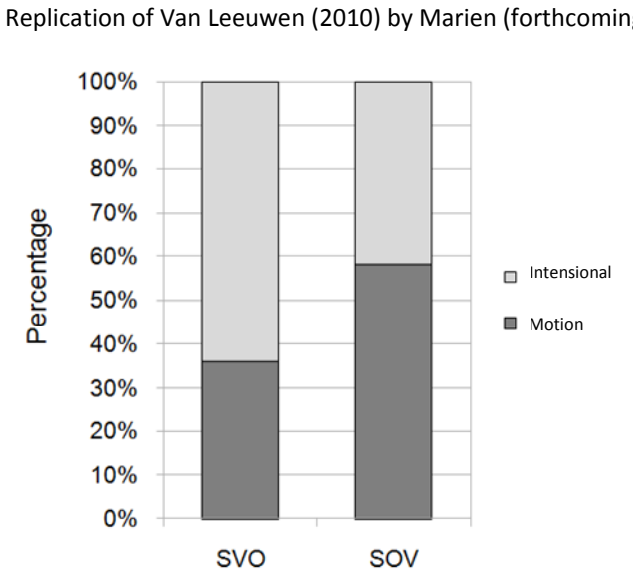


Figure 6.5 Results of a replication of Van Leeuwen (2010) by Marien (forthcoming)

As one can see, the overall results of this replication experiment show a graph that shows more similarities with our results than with the results of Van Leeuwen (2010): relatively more motion answers were given in this replication experiment than in the original experiment conducted by Van Leeuwen (2010). It seems to be the case that the gray flashes and the use of the same movies for the same elements, independent of the order of the movies, caused the difference we found between our results and the results of Van Leeuwen (2010).

We conclude this chapter by stating that:

- We improved the design of the first interpretation experiment by:
    - Creating new movies with less elaborate gesturing
    - Adding new ambiguous movies to the experiment
- With the results of our experiments, we are able to confirm our hypothesis: **The syntactic structures of an event in improvised communication influence the interpretation of the event. Ambiguous movies in SOV**

order are significantly more interpreted as motion events than ambiguous movies in SVO order. This effect is not influenced by the native language of the participant.

- A few remarks have to be made:
    - Our pre-experiment is no proof of the ambiguousness of the movies we used, but a good basis to start from.
    - The results were not as strong as we expected, still a lot of SVO movies were interpreted as a motion event.
    - We found a significant interaction between 'version' and 'order' which asks for further research.

With strong results in our production experiment and less strong but still significant results in our interpretation experiment, we are able to confirm the hypotheses of both experiments. The answers to our central research questions and the implications of those answers for the language evolution debate will be discussed in the next section.

Part III Discussion and further research

8. OVERALL DISCUSSION AND THE IMPLICATIONS FOR THE LANGUAGE EVOLUTION DEBATE

In this chapter, the results of our experiments that were presented in the previous chapters are linked to the language evolution debate. Remember the central research question of this thesis:

Are syntactic structures in improvised communication influenced by the semantic properties of events?

To answer this question, two main experiments were conducted; a production experiment and an interpretation experiment to investigate both ways of communication.

The production experiment was based on the production experiment conducted by Van Leeuwen (2010). After a replication experiment, a few adjustments were made:

- More pictures were added to the set.
- The pictures were presented on the screen during the gesturing task to provide the participants from using their linguistic systems to 'remember' the picture they had to gesture.
- The pictures were improved with more prominent subjects to decrease the amount of 2-gesture strings (this adjustment decreased the percentage of 2-gesture strings from 35% to 7%).
- The clarity of the pictures was improved, using a pre-test to be sure the pictures were clear (this adjustment decreased the percentage of wrong interpreted pictures from 38% to 8%).
- We used no animate objects because of the influence of animacy on the gesturing order (Meir et al (2010) found this effect and the effect can and also be confirmed by the results of our replication production experiment, section 5.1.2).
- In section 4.2 of this thesis, a characterization of the different types of events was made to create complete representations of the sets of motion events

and intensional events. We made sure that both sets of motion and intensional events were fully represented.

The hypothesis of this experiment was that motion events are gestured in SOV order significantly more often than in SVO order and intensional events are gestured in SVO order significantly more often than in SOV order. This difference does not depend on the native language of the participant.

To test the hypothesis, we conducted a production experiment with Dutch and Turkish participants. We could confirm the hypothesis: the preference to use a specific order significantly depends on the semantics of the event.

The interpretation experiment was based on the interpretation experiment conducted by Van Leeuwen (2010). The central research question of this experiment is:

Do syntactic structures in improvised communication influence the interpretation of events?

Compared to Van Leeuwen (2010), a few adjustments were made to the interpretation experiment:

- The movies were created by taking the individual gestures for the subjects, objects, and verbs and combining them into the correct orders, with a grey 'flash' between the elements to be sure that differences in gestured elements could not be of any influence on the task.
- We added new ambiguous verbs.
- We conducted a pre-experiment to make sure that the verbs were ambiguous.

The hypothesis of this experiment was that the syntactic structures of an event in improvised communication influence the interpretation of the event. Ambiguous movies in SOV order are significantly more interpreted as motion events than ambiguous movies in SVO order. This effect is not influenced by the native language of the participant.

To test the hypothesis, we conducted an interpretation experiment with Dutch and Turkish participants. Although the results of the interpretation experiment were less strong than the results of our production experiment, we could confirm the hypothesis:

the interpretation of events significantly depends on the syntactic structures of the events.

Implications for the language evolution debate

As stated in chapter 2, the emphasis in literature about the early stages of spoken language is on the role of syntactic structures and not on the role of semantic structures. Hauser et al (2002) divide language in two separate systems: the computational system that is uniquely human and includes recursion, and the conceptual system that is not uniquely human and uses other systems like the sensory-motor system and the conceptual-intensional system.

With our study we wanted to emphasize that there is a lot of interaction between the computational system (syntax) and the conceptual system (semantics), especially in sequencing utterances.

Because we think that communicative purposes are an important driving force behind the evolutional process of language, we used a communication task to study the interaction between the computational system and the conceptual system. The type of communication we used was an improvised gesturing task. We believe that at an early stage in language evolution, there was no advanced linguistic system available and people had to improvise a lot to communicate. Therefore, a suitable window on language evolution needs to be a phenomenon starting without an advanced linguistic system as well. An improvising gesturing task seems to meet that criterion. We tried to fully bypass the linguistic systems of the native languages of the participants by using no written language in the experiment but pictures with events only.

The results of our study show that the preference to use a specific syntactic order to communicate, significantly depends on the semantics of the event one wants to convey. Similarly, the interpretation of events significantly depends on the syntactic structures in which the events are presented.

With the results of our study we showed that there is a lot of interaction between the computational system and the conceptual system during communication.

9. FURTHER RESEARCH

With our research project, we found significant influences of semantic properties on syntactic structures. We also found significant influences of syntactic structures on the interpretation of events.

The results of our production experiment were stronger than the results of our interpretation experiment. We found a significant interaction between the type of experiment (combination 1 or combination 2) and the interpretation of the movies. This finding could be an explanation for the less strong results in the interpretation experiment and asks for further research.

We studied different semantic properties of verbs. Also other semantic differences could be a point of interest. For example, differences in the semantics of the objects. Meir et al (2010) for example found a significant effect of animacy of the object on the syntactic representation of the event.

During processing the results of our experiments, an interesting finding came up. Within the production experiment, we distinguished ten motion verbs and ten intensional verbs. The results per verb can be found below.

	The Netherlands			**Turkey**		
Motion verb	***SOV***	***SVO***	***Other***	***SOV***	***SVO***	***Other***
Cut	80%	5%	16%	78%	9%	13%
Swing	81%	7%	12%	93%	4%	4%
Drop	78%	4%	19%	71%	0%	29%
Throw	73%	10%	18%	83%	4%	13%
Hang	79%	2%	19%	81%	7%	11%
Carry	85%	5%	10%	88%	4%	8%
Eat	88%	5%	8%	61%	6%	32%
Paint	45%	15%	**40%**	48%	6%	**45%**
Climb	47%	11%	**42%**	31%	4%	**65%**
Slice	88%	2%	10%	56%	0%	**44%**

Table 9.1 Results per motion verb

	The Netherlands			Turkey		
Intensional verb	***SOV***	***SVO***	***Other***	***SOV***	***SVO***	***Other***
Knit	15%	52%	33%	25%	40%	35%
Dream	0%	79%	21%	0%	81%	19%
Look	0%	86%	14%	3%	61%	35%
Hear	20%	64%	16%	11%	50%	39%
Think	4%	88%	8%	0%	83%	17%
Sculpt	20%	73%	7%	0%	100%	0%
Want	4%	88%	8%	3%	71%	26%
Build	14%	59%	27%	10%	57%	33%
See	14%	59%	27%	15%	41%	**44%**
Draw	0%	69%	31%	10%	57%	33%

Table 9.2 Results per intensional verb

As one can see, some verbs like 'paint' and 'climb' have high percentages in the category 'other' which means that they are gestured a lot in different orders than SOV or SVO. From our data, we noted that those events were gestured a lot with the object first. For example the events 'Leprechaun climbs tower' and 'Leprechaun paints house' are gestured a lot in OSV order. We think this is the effect of the prominent objects within the events. It seems that participants tend to gesture big objects first, before going to the subject and the verb. It could be interesting to investigate this specific effect by conducting a production experiment with events containing small versus big objects. Note that this effect could be an organizational principle like organizational principles that were found in other restricted linguistic systems like Basic Variety (for example, FocusLast and AgentFirst as explained in section 2.1).

Of course other semantic influences could be investigated as well. Examples are semantic structures with negation or temporal structures. It could be interesting to rank different semantic properties that are of influence on syntactic structures on dominance; which property dominates other properties in an improvising communication task?

Another interesting finding is the influence of different types of events on each other.

	Percentage SVO in NL	Percentage SVO in TK
Combi-motion	13%	9%
Motion	3%	1%

Table 9.3 The influence of different types of events on each other – motion part

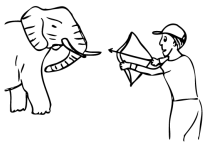
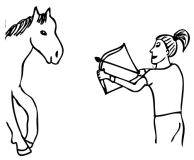
	Percentage SOV in NL	Percentage SOV in TK
Combi- intensional	10%	13%
Intensional	7%	3%

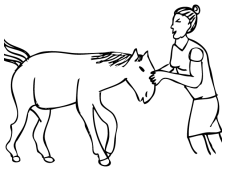
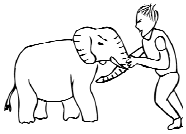
Table 9.4 The influence of different types of events on each other – intensional part

There seems to be a difference in the amount of the not predicted order within the combination experiments and the separate experiments with motion or intensional events only. For the motion events, more SVO orders (the not predicted order) were used within the combination experiment than within the motion experiment. For the intensional events, more SOV orders (the not predicted order) were used within the combination experiment than within the interpretation experiment. It seems to be the case that different types of events within one experiment influence the gesturing order. Since languages from all over the world developed in finally using mainly one order for different types of events (like Turkish mainly uses SOV order and Dutch mainly uses SVO order), it could be interesting to conduct an improvising gesturing task in which participants have to communicate different types of events with each other. Maybe, if participants have to improvise and communicate with each other, finally one order remains.

APPENDICES

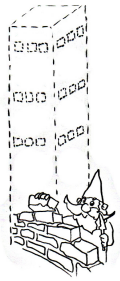
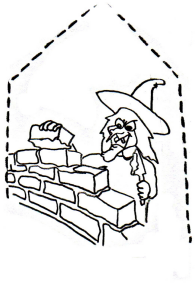
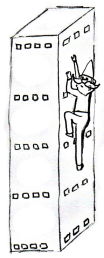
APPENDIX 1 SET PICTURES USED IN THE REPLICATION PRODUCTION EXPERIMENT

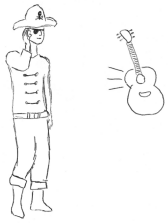
A1a Girl throws guitar 	B1a Woman throws saxophone 
A2a Woman lifts saxophone 	B2a Girl lifts guitar 
A3a Man catches shoe 	B3a Gorilla catches ball 
A4a Boy shoots elephant 	B4a Girl shoots horse 

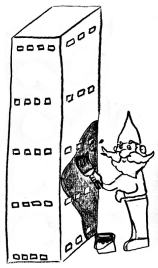
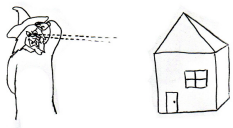
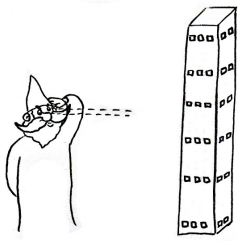
A5a Gorilla feeds cat 	B5a Man feeds bird 
A6a Woman pushes horse 	B6a Boy pushes elephant 
N1a Girl throws ball 	N2a Girl shoots bird 
N3a Gorilla shoots cat 	

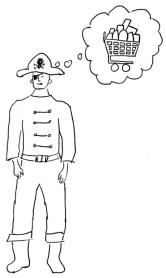
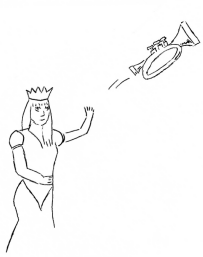
APPENDIX 2 SET PICTURES USED IN THE MAIN PRODUCTION EXPERIMENT

Gray items (motion events) were used in the motion experiment White items (intensional events) were used in the intensional experiment			
Set A: Combination experiment 1		**Set B: Combination experiment 2**	
A1	Cook cuts sock 	B1	Princess cuts scarf 
A2	Cook knits sock 	B2	Princess knits scarf 
A3	Cook swings saxophone 	B3	Pirate swings guitar 
A4	Cook throws saxophone 	B4	Pirate throws guitar 

A5	Leprechaun builds tower 	B5	Witch builds house 
A6	Leprechaun climbs tower 	B6	Witch climbs house 
A7	Leprechaun eats pizza 	B7	Witch eats banana 
A8	Leprechaun wants pizza 	B8	Witch wants banana 
A9	Pirate carries ball 	B9	Princess carries vase 

A10	Pirate looks for ball 	B10	Princess looks for vase 
A11	Pirate dreams of guitar 	B11	Cook dreams of saxophone 
A12	Pirate hears guitar 	B12	Cook hears saxophone 
A13	Princess drops vase 	B13	Pirate drops ball 
A14	Princess sculpts vase 	B14	Pirate sculpts ball 

A15	Princess hangs scarf 	B15	Cook hangs sock 
A16	Princess thinks of scarf 	B16	Cook thinks of sock 
A17	Witch paints house 	B17	Leprechaun paints tower 
A18	Witch sees house 	B18	Leprechaun sees tower 
A19	Witch cuts banana 	B19	Leprechaun cuts pizza 

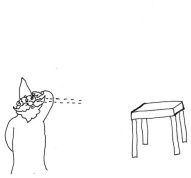
A20	Witch draws banana 	B20	Leprechaun draws pizza 
Practice items			
Motion		Intensional	
Tm1	Leprechaun pushes cart 	Ti1	Princess dreams of car 
Tm2	Witch pulls car 	Ti2	Pirate thinks of cart 
Tm3	Princess throws trumpet 	Ti3	Gorilla thinks of ball 

APPENDIX 3 SET PICTURES USED IN THE INTERPRETATION EXPERIMENT

For interpretation experiment 1, more items were used than for interpretation experiment 2 because of the separate motion and intensional experiments that were conducted in experiment 1.

Interpretation experiment 1: Items with an 'a' were used for the motion experiment, items with a 'b' were used for the interpretation experiment.

Interpretation experiment 1 and 2: All items were used for the combination experiments (one half for com1 and the other half for com2).

Type	**Used in interpretation experiment:**	**Answer option 1 (presented left or right)**	**Answer option 2 (presented left or right)**
Practice 1a	1	Princess cuts scarf 	Princess thinks of scarf 
Practice 1b	1 and 2	Princess knits scarf 	Princess hangs scarf 
Practice 2a	1 and 2	Leprechaun pushes table 	Leprechaun looks at table 
Practice 2b	1	Cook looks at ball 	Cook plays with ball 

Filler 1a	1 and 2	Pirate lifts guitar 	Pirate dreams of guitar 
Filler 1b	1	Girl misses doll 	Girl carries doll 
Filler 2a	1 and 2	Witch pulls car 	Witch likes car 
Filler 2b	1	Leprechaun feels book 	Leprechaun cuts book 
Filler 3a	1	Cook hangs sock 	Cook knits sock 
Filler 3b	1 and 2	Pirate despises insect 	Pirate kills insect 

Filler 4a	1	Princess carries vase 	Princess sculpts vase 
Filler 4b	1 and 2	Girl fears ghost 	Girl pushes ghost 
Experiment	1 and 2	Pirate drops ball 	Pirate searches for ball 
Experiment	1 and 2	Leprechaun cuts pizza 	Leprechaun draws pizza 
Experiment	1 and 2	Witch eats banana 	Witch wants banana 
Experiment	1 and 2	Witch decorates table 	Witch paints table 

Experiment	1 and 2	Girl sleeps on book 	Girl dreams of book 
Experiment	1 and 2	Girl kisses doll 	Girl thinks of doll 
Experiment	1 and 2	Princess talks to snowman 	Princess talks about snowman 
Experiment	1 and 2	Pirate throws guitar 	Pirate hears guitar 
Experiment	1 and 2	Cook stirs soup 	Cook smells soup 
Experiment	1 and 2	Witch climbs house 	Witch builds house 

Experiment	2	Princess breaks vase 	Princess sculpts vase 
Experiment	2	Leprechaun hits book 	Leprechaun feels book 

BIBLIOGRAPHY

Andrews, E. (1986). A Synchronic Semantic Analysis of *De-* and *Un-* in American English. *American Speech*, 61(3), p. 221-232.

Botha, R. (2009). What are windows on language evolution? In: Botha, R. and De Swart, H.E. (eds.), *Language evolution: the view from restricted linguistic system,* p. 1-20. LOT Utrecht.

Fitch, W. T. (2010). *The Evolution of Language*. Cambridge University Press.

Goldin-Meadow, S., So, W.C., Özyürek, A. & Mylander, C. (2008). The natural order of events: how speakers of different languages represent events nonverbally. *Proceedings of the National Academy of Sciences of the USA*, 105(27), p. 9163-9168.

H.J. Verkuyl, (1989). Aspectual Classes and Aspectual Composition. *Linguistics and Philosophy*, 12, p. 39-94.

Hauser, M., Chomsky, N., & Fitch, W.T. (2002). The faculty of language: What is it, who has it, and how did it evolve? *Science*, 298, p. 1569-1579.

Iverson, J. M. & Goldin-Meadow, S. (1998). Why people gesture when they speak. *Nature*, 396, p. 228.

Jackendoff, R. (2002). *Foundations of language: Brain, meaning, grammar, evolution*. Oxford University Press.

Kirby, S. (2007). The evolution of language. In: Dunbar, R. and Barrett, L., (eds.), *Oxford Handbook of Evolutionary Psychology,* p. 669-681. Oxford University Press.

Landman, F. (1992). The progressive. *Natural Language Semantics* 1(1), p. 1–32.

Langus, A., & Nespor, M. (2010). Cognitive systems struggling for word order. *Cognitive Psychology,* 60, p. 291-318.

Larson, R., den Dikken, M. & Ludlow, P. (1997). *Intensional Transitive Verbs and Abstract Clausal Complementation. Ms. Stony Brook University and CUNY. [http://semlab5.sbs.sunysb.edu/~rlarson/]*

Marien, N. (forthcoming). Master's thesis on the role of semantic structures in the origin of language. Utrecht University

Meir, I., Lifshitz, A., Ilkbasaran, D., and Padden, C. (2010). The interaction of animacy and word order in human languages. In A. Smith, M. Schouwstra, B. de Boer, and K. Smith (eds.), *The Evolution of Language*, p. 455–456, Singapore. World Scientific.

Moltmann, F. (1997). Intensional Verbs and Quantifiers. *Natural Language Semantics*, 5(1), p. 1–52.

Parsons, T. (1989). The Progressive in English: Events, States and Processes. *Linguistics and Philosophy,* 12(2), p. 213-241.

Pinker, S., & Bloom, P. (1990). Natural language and natural selection. *Behavioral and Brain Sciences*, 13(4), p. 707-784.

Schouwstra, M., van Leeuwen, A., Smit, M., Marien, N., and de Swart, H. (to appear, 2011). Semantic structure in improvised communication. In L. Carlson, C. Holscher, and T. Shipley (eds.), *Proceedings of the 33rd Annual Conference of the Cognitive Science Society*, Austin, TX, Cognitive Science Society.

Schouwstra, M., Tamariz, M. & Kirby, S. (2010). *Semantic structure in a novel communication task*. Unpublished presentation for the workshop 'Evolution of Semantic structure' at Evolang 2010, April 13th 2010, Utrecht.

Schouwstra, M. (2010). Language evolution: the view from second language learners. In A. Smith, M. Schouwstra, B. de Boer, & K. Smith (eds.). *The evolution of language*. Singapore: World Scientific.

Seungho Nam. (1997). Ways of Locating Events. In: Shafto, M.G. and Langley, P. (eds.), *Proceedings of the nineteenth annual conference of the Cognitive Science Society*, p. 542-553. Stanford University.

Leeuwen, A. van. (2010). *Gesturing orders and their interpretation*. Unpublished master's thesis, Utrecht University.

Zacks, J. M., & Tversky, B. (2001). Event structure in perception and conception. *Psychological Bulletin,* 127, p. 3-21.

Zucchi (1999) Incomplete events, intensionality and imperfective aspect. *Natural Language Semantics,* 7(2), p. 179-215.