Cultural evolutionary modeling of patterns in language change

Exercises in evolutionary linguistics
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One of the central tenets in this thesis is that the frequency with which a particular word, meaning, construction or any linguistic item is uttered, has an effect on the item’s fitness: the higher the frequency of use of an item, the bigger the chance it will be saved from possible extinction and oblivion. This might also be true in the habitat of academia, since the frequency in which one’s name, preferably but not necessarily linked to an article or paper, is mentioned, seems to be tightly linked to one’s scientific survival. In these acknowledgements, I will therefore not only kindly thank the people who, in many different ways, have contributed to this work, but by doing so, returning them a favor by increasing their fitness.

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Chapter 1

Introduction

1.1 Language and evolutionary theory

There is something about language and evolutionary theory that has appealed to scientists ever since the days of Darwin. In fact, Darwin himself was one of the first to notice ‘curious parallels’ between the formation and development of languages and species (Darwin 1877 [1889]: 94). Since then, the topic has been a recurring one, especially in studies on language change (e.g. Schleicher 1869 [1883], Sapir 1923, Keller 1994, Lass 1997, Croft 2000, Janda & Joseph 2003, Verhagen 2004).

What, then, are these ‘curious parallels’? First, there is the observation that languages show many parallels with biological species: they change continuously, new languages can form because of lack of contact between two parts of a population, and languages can become extinct. This means that there is something to language that makes it behave in an evolutionary fashion. Second, there are similar mechanisms at work in both language and species, such as transmission from parents to children, the presence of selection pressures favoring one variant over the other (e.g. Verhagen 2000a), adaptation and presumably exaptation (Lass 1990). This means it might be possible to use evolutionary mechanisms to explain linguistic phenomena.

The latter observation will be the starting point of this thesis, which results from a project aimed at creating closer collaboration between the fields of biology and linguistics. More specifically, the aim of this thesis is to look at concrete cases of language change and try to describe and possibly explain them by using a biological, that is, evolutionary, viewpoint. As such, it can be seen as an application of the theory of evolutionary linguistics as introduced by Croft (2000).

1.2 Recent evolutionary approaches in linguistics

Serious interest in the use of evolutionary concepts in language has increased considerably in the last two decades, in different ways. First, the transition to language – which is commonly referred to as ‘language evolution’ – has become an established field of research (Hurford, Studdert-Kennedy & Knight 1998, Hauser,
Language is considered to be a trait in evolutionary terms, and at some point in the evolution of man, early humans have acquired this trait. This fact gives rise to many important questions that are studied in this field. For example, what was so different about early humans when compared to other species in that only they acquired language? What were the first phases of language like? Why has it developed the way it has?

In the study of language evolution, computer modeling has become an important subfield (Steels 1998, Nowak & Krakauer 1999, Vogt 2005, and various papers in Briscoe 2002, Cangelosi & Parisi 2002 and Christiansen & Kirby 2003). In many of these studies, the development of language in a human population is simulated with models that are often referred to as ‘agent-based’ models. These ‘agents’ represent humans with different kinds of cognitive and social behavior that interact with each other in a population. They have some sort of linguistic knowledge, which is shaped on the basis of the input they receive in the interaction with other agents. This set-up makes it possible to simulate different scenarios of language evolution and thus get a better insight into which factors have played an important role in this process.

While most of these simulation studies focus on the transition to language, similar computer models are also used to study the dynamics of language in a fully-grown system, or, in other words, language change. Although the focus is different, both types of models are based on the same rationale: the linguistic knowledge of individuals is (partly) formed by interaction with other individuals. By simulating these interactions, it is possible to get a better understanding of the mechanisms that play a role in the dynamics of this process. Examples of these studies are Niyogi & Berwick (1997), Nettle (1999), Yang (2000) and Baxter et al. (2006, to appear).

Parallel to the increased interest for the evolution of language is the increased interest in the use of evolutionary theory outside biology. Studies such as Cavalli-Sforza & Feldman (1981) and Boyd & Richerson (1985) present mathematical models to apply evolutionary concepts to culture. These models are based on the assumption that evolution is a general phenomenon that is not restricted to biological systems. Instead, evolution is a logical outcome of any system in which there is variation and differential replication of variants, disregarding what is being replicated. This means that culture, in the broad sense of learned traits, is subject to evolution as well: cultural traits such as ideas and beliefs are passed on from individual to individual and show variation. A profound discussion of the implications of this view can be found in Hull (1988) and Dennet (1995).

This notion of a general theory of evolution takes the evolution of cultural traits like ideas, habits, beliefs and also language beyond the idea of ‘parallelism’ or ‘analogy’ with regards to biological evolution, and makes it possible to study them in a more formal way in its own right. The transmission of cultural traits occurs when one individual learns from another, not by the transmission of genetic
material. This difference in the mechanism of transmission does not alter the fact that culture in this sense constitutes a system of information that is inherited by a new generation from the previous one. Cultural traits are also subject to mutation in that copying errors might occur or that traits can be created or altered by individuals. Again, the difference in mechanisms does not alter the fact that culture is an inherited system of information that can change. The existence of both mutation and reproduction results in a system of variation and inheritance, which can lead to evolutionary change in combination with drift or by selection.

Finally, evolutionary concepts are also increasingly used in the field of language classification. This field studies the question how different languages from the same language family are related. It is based on the assumption that languages gradually change. When two languages are compared, one will therefore find differences between the two. If a whole set of languages are compared, one will find that some languages differ more from one another than others. Another assumption is that linguistic similarity is a measure for relatedness: languages that are closely related are more similar than languages that are only distantly related. This means that, by measuring their similarity, it is possible to reconstruct how languages within a language family are related. This approach is called phylogenetic reconstruction.

Of course, language classification itself is not a new enterprise in linguistics. However, a new development in the field in the last decade, is the introduction of computational techniques that were originally developed for biology (e.g. Gray & Atkinson 2003, and Dunn, Terrill, Reesink, Foley & Levinson 2005). Computers are used to reconstruct how a group of languages are related by comparing a large set of characters from each language. These characters are usually ‘basic’ words like ‘hand’ or ‘father’, but they can be structural characteristics as well. The phylogenetic tree is then calculated by comparing the number of cognates that are shared by each set of two languages.

One of the chapters of this thesis is dedicated to phylogenetic reconstruction. However, instead of using these techniques to classify languages within a larger language family, I will use them to study change within a single language. In other chapters, I will use agent-based models like the ones described earlier to study specific cases of language change. This means that I will restrict myself to the evolution of fully developed linguistic systems, and not consider the transition to language.

1.3 A framework of evolutionary linguistics

The agent-based models that I present in this thesis are in many ways similar to the ones I discussed in the previous section: they consist of a population of agents who exchange linguistic utterances, and whose individual behavior can be regulated. A
The difference between them lies in the underlying theoretical basis of the models. While many of the aforementioned models use the theory of generative grammar, I will use a usage-based approach to language. In this section, I will discuss this approach, and its link with evolutionary theory, in more detail.

The usage-based approach to language is a general term for a view of language and grammar in which language and its structural characteristics are considered to be a product of usage over time (Bybee 2006). When compared to the generative approach to language, this means a move away from language as a system in isolation, with usage being peripheral, to a system in space and time, with usage as the core aspect. Speakers are assumed to be continuously sensitive to the language around them: they shape their linguistic knowledge on the basis of the input they receive in communication. This means they are also sensitive to the frequency with which they perceive linguistic input.

This usage-based approach lies at the basis of different, yet related linguistic theories on e.g. grammar (cognitive and construction grammar (Langacker 1987, Croft & Cruse 2004), radical construction grammar (Croft 2001), language acquisition (Tomasetto 2003), exemplar theory (e.g. Daelemans 1998, Pierrehumbert 2001), language change (Traugott & Dasher 2002, Verhagen 2004) and grammaticalization theory (Heine, Claudi & Hünnemeyer 1991, Bybee, Perkins & Pagliuca 1994, Hopper & Traugott 2003). It is also used by Croft (2000), who presents an evolutionary framework of language and language change. His theory is based on the idea that evolution is a general phenomenon that is present in all kinds of systems with certain characteristics, as I mentioned above (e.g. Cavalli-Sforza & Feldman 1981, Hull 1988).

The core notion of Croft’s theory is that (diachronic) patterns in the language of a population can be explained as a result of the behavior of individuals in that population. This approach is very similar to the view on language change as proposed by Keller (1994). In his ‘invisible hand theory’, Keller states that language change is the unintended result of intentional individual behavior. Individuals deliberately use certain strategies when they communicate, and these strategies, or ‘maxims’, have both a communicative and social basis. Examples are ‘talk in such a way that you are communicatively successful’, or ‘talk in such a way that you do not spend superfluous energy’. In other words, individual users select certain linguistic variants over others because they want to be communicatively successful or they want to talk as economically as possible. This selection, in turn, can, but does not necessarily have to, lead to linguistic change. Language users, therefore, can change their language without intending to do so: their intentions are aimed at more ‘local’ goals such as communicative and social success.

Although Keller does not explicitly present his theory as being ‘evolutionary’, it has many similarities to evolutionary theory. First, the phenomenon of language change is reduced to actions at the level of the individual.
Second, there is variation of linguistic items and differential selection of these items through the use of the maxims. Transmission of the items takes place in communication. There is one important issue in which the invisible hand theory differs from evolutionary theory: the latter models change as a two-step process: there is the generation of variation (mutation or innovation) on the one hand, and the possible selection and spread of mutations or innovations through a population on the other hand. In Keller’s theory, however, such a strict distinction of the two processes is absent; change is modeled as a one-step process: as the cumulative effect of individual actions.

Croft’s theory of evolutionary linguistics can be seen as an elaboration of the theory of Keller. Croft argues that the utterance is the unit of transmission and selection, and that a language can be defined as a population of utterances in a speech community (Croft 2000: 26). Utterances are replicated, or transmitted, in communication between individuals within a speech community. By default, utterances are produced and perceived that are already part of the linguistic convention of the speech community, in which case the language remains the same. However, innovations might occur, intentionally or unintentionally, during communication, and when these innovations spread through the speech community, (parts of the) language will change.

An example of an innovation is when a speaker uses an utterance in a way that has not been used before, e.g. the use of going to to express intention instead of a change in location. Similarly, innovation might also occur on the side of the hearer. In the case of going to, an utterance in which a change in location was intended by the speaker might be understood by the hearer as mainly expressing intention.

Croft’s point that innovations can both be intentional and unintentional is interesting, because the nature of the innovations might affect the direction of change. In different chapters in this thesis, I will discuss this topic in more detail. Whether an innovation spreads through a community and leads to a proper linguistic change depends, according to Croft, solely on social factors like speaker status or population structure (Croft ibid.: 178ff). Whether or not this sharp social delimitation of spread, or propagation, is desirable could be debated. The use of an innovation also leads to differences in entrenchment in the head of the hearer, which in turn could lead to altered use. Eventually, this could lead to propagation of the innovation through the speech community without the ‘help’ of any social factors.

Croft’s theory of evolutionary linguistics, with the utterance as the unit of transmission, is a theory that puts language use in the center of the linguistic system. Transmission takes places when individuals communicate with each other, and utterances can be subject to innovation and selection. As such, the approach differs from generative approaches to language change. In a generative framework, individuals in a generation t have a particular linguistic knowledge in the form of
grammar. This grammar is used in utterances in communication and as such, passed on to individuals from the next generation \( t + 1 \). In turn, these individuals have to construct their grammar on the basis of these utterances, but because of the critical period, their input is limited. This limitation can lead to linguistic knowledge in generation \( t + 1 \) that differs from that of the original generation, and if this is the case, language change has occurred. In this approach, transmission and innovation takes place in the process of language acquisition, and selection can occur through the succession of generations of speakers (Croft ibid.: 44). In the usage-based framework, change can also occur within a single generation of speakers, because individuals continuously adapt their linguistic knowledge on the basis of the utterances they perceive in communication. Therefore, in the usage-based framework, the main mechanisms of change are to be found in the factors that affect the transmission of utterances between individuals, instead of those that affect the transmission of knowledge from one generation to another.

1.4 Advantages of an evolutionary approach to language

There are several aspects of the evolutionary linguistic framework that make it appealing for historical linguistic research. As I mentioned earlier, complex phenomena at the population level are taken as the result of individual behavior and the interactions between individuals, which are easier to study and to understand. Also, instead of only looking for system-specific causes when studying linguistic phenomena, patterns and developments in language can now be studied as possibly resulting from general mechanisms as well. Not only will this increase our understanding of these processes, it also makes it possible to apply knowledge from outside linguistics to the field.

Another appealing aspect of an evolutionary framework is that it offers a coherent model of language that can deal with both language change and stasis (or: lack of change). Language is considered an inherently dynamic system that is constantly in motion, but in which this dynamicity does not necessarily have to lead to significant changes. Linguistic variants can come into existence in a range of different ways (e.g. by mutations that occur during production or in the process of perception), but whether or not these variants spread through a population depends on a range of other factors. For example, one allophone might have a selectional advantage over another in that it differs more clearly from other phonemes in the language. If this allophone spreads through the population, there is evolution through selection. Social factors might also lead to selectional advantages for a particular linguistic variant, for example if the individual that uses it has some sort of social prestige in the population. On the other hand, variants can also spread
through a population by chance. In this case, evolution occurs as a result of random drift. The evolutionary framework makes it possible to study these phenomena, and to get a better understanding of the role of the different relevant factors in the process within a single methodology.

The use of evolutionary theory in linguistic research also allows for a strongly quantitative, mathematical view on language change, which enables the use of computer modeling. This tool is increasingly used in historical linguistic research, and the simulation of language use and language change has become an important subfield of linguistics in recent decades. In this respect, linguistics has the advantage over genetics in that our historical knowledge of language exceeds our historical knowledge of genes. Thus, it is possible to use linguistic data in the construction of the models, and in the interpretation of their results.

Approaches differ with respect to the view on language, the linguistic phenomenon that is studied, and the focus on language origin or language change. However, most studies using computer simulations are similar in their basic set-up of the model, which consists of a (small) population of individuals, or agents, who produce and perceive the linguistic item under investigation. By focusing on particular aspects of either individual behavior or population structure, the development of the item in question is then investigated. In this sense, these models could be called ‘evolutionary’, because they investigate language as a product of transmission and selection in a population of agents.

Although computer simulations are a useful tool in the study of language and language evolution, it is necessary to also consider their limitations. Models are supposed to be a simplified representation of real-world phenomena, which, in this case, is language. However, this representation is always based on a number of assumptions about the system that is simulated. Furthermore, the model’s behavior cannot always be understood precisely, because of its complex nature. This does not necessarily imply that the model’s results cannot lead to a better understanding of the phenomenon that is investigated. On the contrary, its use makes it possible to study the role of different factors that cannot be studied as easily otherwise. Still, it does mean that it is necessary to relate both the model’s set-up and its results back to empirical findings as much as possible, and to always remain cautious about the behavior it shows.

1.5 This thesis

As I mentioned earlier, the general goal of this thesis is to apply an evolutionary viewpoint to a number of concrete cases of language change, and to see how such an approach can lead to a better understanding, and perhaps to an explanation, of the changes in question. I will use computer simulations to study these cases. Regarding
linguistic theory, I will use Croft’s framework of evolutionary linguistics (Croft 2000) and basic insights from the usage-based approach (Bybee 2006).

First of all, a series of choices had to be made about the topics in this thesis. The first choice was to focus on semantics. There are two reasons for this choice. First, human language is not unique as a vocal communication system; different species are known to also have a relatively developed vocal communication system that is culturally transmitted: bats, whales and dolphins (also known as ‘cetaceans’), seals, sea lions, and hummingbirds, songbirds and parrots (see Fitch 2005 for an overview). Of these species, songbirds are the largest and best-studied group (e.g. Marler & Slabbekoorn 2004). However, human language stands out because it appears to be the only communication system with an elaborate, open-ended semantic component (Nonhuman primates are known to have quite complex minds, but they ‘lack a communicative mechanism that is capable of expressing most of this mental activity’ (Fitch 2005: 206)). It is therefore interesting to study how changes in this ‘unique’ dimension can be explained in general evolutionary terms; after all, not only the forms but also the meanings are transmitted through cultural processes (that is, learning).

Second, the modeling of semantics is somewhat of a challenge, because meaning is not transmitted directly in communication. When someone perceives an utterance, its phonetic and much of the morphosyntactic structure are directly clear, but its meaning is not. This means that the semantics of an utterance has to be reconstructed on the basis of indirect information. This might be one of the reasons that most of the computer models so far have focused on syntax and phonetics, while, as Steels (2003) points out, unidirectionality and grammaticalization (changes in the function of elements towards that of a grammatical item) have received less attention in this line of research.

Another choice that had to be made was the language of the case studies, and I have chosen Dutch. Of course, choosing a ‘small’ language is a disadvantage for many readers because the material that will be discussed is much less accessible to them. At the same time, the field of historical linguistics is strongly English-centered, and although this is not a bad thing per se, I believe it is good to focus on other languages as well. Also, I believe that a study of change in a particular language demands detailed knowledge of the nuances of the language that only native speakers readily have access to.

The last choice concerned the focus when using computer models. These models allow for testing of the role of every possible factor in language change, which is both their strong and their weak point. It is very important to decide on a limited number of relevant factors to investigate beforehand, in order not to drown in a sea of information. It is therefore also important to keep the model simple; with too many factors involved, it becomes difficult to understand the role of each single
factor in the process as a whole, and this would defeat the purpose of using computer models altogether.

A commonly used distinction is that between so-called ‘functional’ and ‘social’ factors. The former affect the individual behavior of the agent, such as its production, perception, and the way it processes its linguistic experiences. Although these factors also possibly involve the hearing party (while we are dealing with language in use), they can be called ‘agent-internal’ in order to distinguish them from factors that are concerned with phenomena at a group level. These are social factors, such as population structure, age and social status. For this thesis, I have decided to focus mainly on ‘functional’ factors. Note, however, that this does not mean that I consider social factors not to be important in language change.

In the first chapter of this thesis, chapter 2, I introduce a general computer model of semantic change. With the use of this model, I discuss how certain tendencies of semantic change, such as the change from lexical to functional meaning, can be explained by very general factors such as frequency of use.

Chapter 3 deals with the principle of competitive exclusion in language. I argue that this biological principle can be used to explain linguistic competition phenomena as well, such as two forms competing for the same meaning. To illustrate this, I discuss the linguistic equilibrium situations of two variants of adjective-noun combinations, compounds and phrases, in Dutch, German and English. Using a computer model, I argue that competition does not necessarily have to lead to extinction of one of the two forms, if there is a possibility for at least partial semantic differentiation.

Chapters 4-6 all deal with the development of the Dutch verb krijgen (comparable to English *get*). In chapter 4, I introduce the verb with a diachronic corpus study, on the basis of which I give a detailed presentation of its syntactic and semantic development. I also discuss the mechanisms that arguably underlie these developments.

I use these findings in chapter 5, in which I present a computer model of krijgen. This model simulates the semantic development of the verb and combines insights from usage-based and exemplar-based theories in an evolutionary framework. I focus on the notion of preservation and loss of original meaning in verbs like krijgen, which show a great amount of polysemy.

In chapter 6, I introduce a new methodology for historical linguistic research. This method is called phylogenetic reconstruction and is widely used in biology in the reconstruction of historical relations between species. Recently, it has also been introduced in the classification of languages within language families like Indo-European. I now discuss the application of the method in the study of the development of a linguistic item within a single language, that of krijgen. The major
benefit of this method is that a historical reconstruction can be obtained on the basis of synchronic material.

I conclude this thesis with a discussion of the findings from the respective chapters.
Chapter 2

A cultural evolutionary model of patterns in semantic change

2.1 Introduction

When one takes language as a dynamic, continuously changing system, one of the striking features is that many changes do not seem to be arbitrary, but instead show at least some degree of regularity and directionality. Examples from semantics are tendencies such as “non-subjective > subjective > intersubjective” and “premodal > deontic > epistemic”, as described by Traugott & Dasher (2002). Related to this are the paths of grammaticalization as described in Heine, Claudi, & Hünnemeyer (1991), Bybee, Perkins & Pagliuca (1994), Heine & Kuteva (2002), Hopper & Traugott (2003). These paths describe tendencies in morphosyntactic change that are often accompanied by a semantic change and an increase in frequency. An example is the development of *can* (ABILITY > POSSIBILITY), in which *can* has changed from a full verb with lexical meaning (indicating the subject’s ability to perform some activity) to a modal auxiliary with a functional meaning (indicating the likelihood of some situation).

In this chapter, I try to explain such tendencies in semantic change by taking a cultural evolutionary perspective on language, and using an agent-based computer model of cultural evolution. After a general introduction to the behavior of the model, I focus on two concrete examples of tendencies in semantic change. First, I will discuss possible factors that affect (the amount of) change. Second, I will look at some factors that have a possible effect on directionality in changes of the kind “lexical meaning > functional meaning”. An example of such a change in English is the development of *get* (TO TAKE > PASSIVE), in which *get* has gradually lost its agentive meaning and has acquired a use as a marker of passive voice.

The workings of the model will be explained in section 3, after a general discussion in section 2 of possible mechanisms proposed in the literature for

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1 This chapter is a rewritten version of Landsbergen, Frank, Robert Lachlan, Carel ten Cate & Arie Verhagen (in press). 'A cultural-evolutionary model of patterns in semantic change'.
producing directionality in semantic change. The results from the simulations are discussed in section 4, followed by conclusions.

2.2 Possible causes for asymmetries in semantic change

Directionality in semantic change and differences in likelihood to undergo such changes are examples of asymmetries in linguistic change. The division of the phenomenon of linguistic change in the two distinct processes of mutation and propagation leads to the question which of these processes is responsible for such asymmetries.

First, let us consider the asymmetry in likelihood of change. Words in particular constructions that have a general meaning in some conceptual domain, such as English come and go in the domain of movement, grammaticalize, while more specific movement words like walk, stroll, saunter, swim, roll and slide do not. There are different mechanisms that have been adduced as possible explanations for this asymmetry. First, a sole difference in contexts of use can be a cause (Bybee, Perkins & Pagliuca 1994: 5). Second, related to this but still an independent mechanism is the frequency of use, which is likely to be higher in words with a general meaning than words with a specific meaning. A third explanation is given by Traugott & Dasher, who state that ‘innovations can only be minimally different from earlier meanings’ (Traugott & Dasher 2002: 280). Relating this to words like come versus stroll, this could be taken to imply that words with a general meaning allow ‘larger’ semantic innovations than words with a specific meaning, because the relative change to the meaning of the words will be the same.

The second asymmetry concerns the direction of changes. In the literature on grammaticalization, directional change is often referred to as ‘unidirectionality’ to stress that changes take place in one direction (A > B) and not in the opposite one (*B > A). Such types of change could be caused by restrictions on the kinds of mutations people make. On the other hand, it may also be the case that any mutation can occur, but that there are constraints on the interaction between individuals which produces the spread; directionality might then result from certain types of mutations having a bigger chance of spreading than other ones, something that would require independent explanation.

In their work on semantic change, Traugott & Dasher (ibid.) focus on the restrictiveness of new mutations. They state that ‘[...] the path that the meaning of [a] form or construction takes is constrained by speakers’ tendency to recruit referential meanings to less referential functions of language’ (Traugott & Dasher ibid.: 86). In other words, speakers extend the meaning of existing referential words
by a small amount for a somewhat less referential function, and hearers pick this up from the speakers' use of the words. Notice that in this view, these changes themselves take place in a certain direction, i.e. from more to less referential, because of speakers' strategies. Although each change is small, large-scale unidirectionality is seen as the result of this kind of 'directed mutation'.

This approach is similar to the 'principle of the exploitation of old means for novel functions' by Werner and Kaplan (1963), mentioned in Heine, Claudi & Hünnemeyer (1991: 28). According to this principle, 'concrete objects are employed in order to understand, explain, or describe less concrete phenomena', in which 'concrete' is associated with lexical items and less concrete with more functional items. Here too, the mutations themselves are directed.

Haspelmath (1999) uses Keller's maxim of expressivity (Keller 1994: 101) to explain unidirectionality. Speakers are sometimes expressive, but in their need for expressiveness, their possibilities are limited. Haspelmath claims that in the lexicon-grammar continuum, speakers can only freely manipulate the lexical end of the continuum. This will lead to the use of a lexical item for a grammatical function, and not the other way around, since 'functional elements cannot be used outside their proper places' (Haspelmath 1999: 1059); so this is yet another candidate mechanism that is a case of directed mutation.

However, according to Haspelmath, this constraint on mutation is by itself not enough to cause language change. Once the mutation exists, it will spread because grammatical meanings are needed more often in language use than lexical meanings. By following Keller's maxim of conformity ('talk like the others talk'), the use that speakers make of their language will cause this meaning to spread through the population. Thus, unidirectionality of large-scale change is explained by mechanisms in both mutation and propagation.

In summary, words with a general meaning show a stronger tendency to grammaticalize than words with a specific meaning, and this asymmetry has been explained by (i) their higher number of contexts of use, (ii) their higher frequency of use and (iii) their allowing larger mutations. The unidirectionality of the change from lexical to functional meaning has been explained by the factors mutation and frequency in different ways: (i) mutation only occurs in words with lexical meaning and not in words with functional meaning, (ii) the higher frequency of use of functional meanings.

The causal role of these different proposed factors can hardly (if at all) be investigated independently. Thus it would seem that it would be impossible to test claims such as, for example, that directed mutation is or is not necessary for unidirectional change, or that frequency of use by itself is or is not sufficient to produce unidirectionality. However, they can be studied independently, as well as in interaction, in computational models of cultural evolution.
2.3 The model

*Theoretical background*

Following the linguistic theory briefly mentioned in section 2, I take a usage-based approach to language change, in which individuals construct their linguistic knowledge on the basis of the input they receive in communication, in which actual utterances are the units of transmission and in which the locus of mutation is in adult communication (Bybee & Slobin 1982, Croft 2000, Croft & Cruse 2004, Slobin 2005). I assume word meaning to be essentially prototypical and polysemous (cf. Geeraerts 1997, Traugott & Dasher 2002), with words having multiple related senses. Semantic change is regarded as a change in this polysemy structure, in which new senses can be added to the established ones (possibly resulting in a shift of the prototypical meaning over time). Also, I assume a continuum of possible word meaning, reaching from lexical meaning on the one end to functional meaning on the other, rather than a sharp boundary between the two types of meaning.

Semantic mutations are small changes in the total set of existing senses, and are only minimally different. In principle, these may involve both small extensions and small contractions of an existing set of senses of an individual. These changes to the agents’ set of senses can spread through the population through communication. Extensions can introduce novel senses that may be picked up by the hearer, while contractions may spread because senses beyond a certain limit are used less. I will use the term ‘mutation’ over ‘innovation’ to stress the fact that any changes in the system are meant, and not just those that are intended and/or creative.

*Properties of the model*

I use a so-called ‘agent-based model’ of cultural evolution. The approach derives its name from the fact that it is a computer simulation of a group of individuals, or agents. The behavior of each agent can be independently controlled, and its effect on the population can be measured.

The first model is an extremely simple model, containing what are considered the bare necessities for semantic evolution. In order to investigate the various hypotheses to explain unidirectionality, I made a series of alterations to this simple model. These will be described in the subsequent sections.

The simple model I present here simulates the semantic evolution of a single random word $w$ in a population of speakers. The meaning of $w$ is represented by a set of senses, which represent concrete uses of $w$. These senses are positioned on a one-dimensional scale with a range of values between 0 and 1. Each value on this scale represents a specific sense of $w$ with nearby values representing similar
senses. The left end of the scale (with value 0) is arbitrarily chosen to represent lexical senses and the right end of the scale (with value 1) functional senses (figure 1).

Consider the English word *while* in examples (1-3). In Middle English, *while* was used only as a noun with the meaning ‘short period of time’, as in (1). Later it came to be used in adverbial phrases with the meaning ‘during the time’, as in (2). In present day English, *while* has become a marker of co-temporality, as in (3).

1) Whether he lyf lang or short *while*. (1340)
2) I for both have wept when all my tears were bloud, *the while* you slept. (1633)
3) Mr. Montgomerie said rather gallant things to me, … *while* the girls looked shocked. (1908)

In the model, the concrete senses from examples (1-3) may be thought of as represented on the 0-1 scale shown in figure 2. The meaning of the lexical noun *while* is situated at the left end of the scale, and the meaning of the functional marker *while* towards the right end (note that the exact placement of the examples on the scale is arbitrary, and only intended to serve as an example).

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2 Examples 1-3 are taken from the Oxford English Dictionary (1989).
Because words have multiple senses, i.e. they are polysemous, the total meaning of word \( w \) is represented in the model by a continuous set of senses instead of a single sense as in figure 2. On the 0-1 scale, this set can occur on different positions and in different sizes. The position of the set is an indication of the grammatical status of word \( w \): if the set is positioned towards the left side of the scale, the word’s meaning is mainly lexical. By contrast, if the set is positioned towards the right side of the scale, the word’s meaning is mainly functional. Apart from this, the set can also differ in size. Since one value on the scale represents a single sense of the word \( w \), the size of the set of senses is a measure of the range of the word’s meaning: the wider a set, the more senses it can be used in. I will refer to this as the generality or specificity of word \( w \). Note that this means that both lexical and functional meaning can be specific as well as general. In this model, the number of senses determines specificity or generality, not the position: a functional meaning can be specific in meaning in that it can only be used in a very limited number of (functional) senses, while a lexical meaning can be general in meaning by having a wide range of (lexical) senses. Figure 3 shows some examples.

![Figure 3. Examples of the representation of specificity vs. generality in meaning (set size) and lexical vs. functional (set position).](image)

An agent’s knowledge of word \( w \) is simply a continuous set of senses on the [0-1] scale. This set is defined by the values of the lower and upper limit: any value between these limits (excluding the limits themselves) is part of the meaning of \( w \) in an agent’s knowledge. For example, if an agent’s limits are \([0.559, 0.782]\), his knowledge includes all values between these limits, such as 0.55980, 0.62 and 0.78195.

Agents construct their linguistic knowledge on the basis of input they receive during communication. Communication in the model is the random selection
of two agents from the population, one of which is assigned the role of speaker and one the role of hearer. The speaker selects a specific sense $s_i$ (represented by a value) from its set of senses and transmits it to the hearer. This models the evaluation by the speaker that the word $w$ is applicable in the specific context, given the set of senses of $w$ that the speaker knows. The hearer compares the transmitted sense to its own set of senses, i.e. it evaluates whether the word $w$ is applicable in the context, given its set of senses of $w$. When this sense is already part of the hearer’s knowledge of $w$, communication is successful and the communication process comes to an end. However, the speaker can also transmit a sense that is unknown to the hearer, i.e. that is outside the hearer’s range of senses associated with $w$. In that case, communication fails, and the fact of this failure is understood by not only the hearer, but also the speaker. Although such direct feedback might be considered unrealistic, it is plausible to assume that speakers do obtain clues about the successfulness of their utterance, e.g. from the failure to achieve a communicative goal. As such, the feedback in this model is a simplification of this process (compare the ‘language games’ in Steels 1998 and De Boer 2001).

Unsuccessful communication results in a learning process, in which both agents adjust their sets of senses of $w$. The hearer, confronted with a new sense, makes the inference that $s_i$ must be an appropriate sense, since the speaker used it, and will increase its set to include $s_i$. The speaker, confronted with unsuccessful communication, realizes that any values beyond the uttered sense will lead to more unsuccessful communication and therefore decreases its set and changes it to exclude values beyond $s_i$. However, I mentioned earlier that the set’s limits are not part of the agent’s knowledge. To ensure that an uttered sense will be the actual new ‘active’ limit of the agent’s knowledge, $s_i$ is increased or decreased with a very small value. This value is set at $1 \cdot 10^{-6}$. As a result, speaker and hearer end up with similar limits that just include the uttered sense $s_i$. Figure 4 on the next page illustrates this process. An agent’s set can never become bigger than 1, or smaller than $1 \cdot 10^{-5}$.

Apart from the learning process described above, agents also change their linguistic knowledge by mutation. Mutation in the model is a randomly occurring small change in set size. Agents that are selected for communication have a probability $m_r$ to undergo mutation before that communication event. Mutations may be extensions or constrictions on either side of the set. In linguistic reality, possible causes for the former include the need to express something for which there is not yet a signal, and for the latter the need to redress ‘semantic overextension’ or competition by another word. However, in this model I do not directly address the nature of the causes of mutations, and simply start from the assumption that they occur; but I will model certain properties of mutations that were discussed in the

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3 In this chapter and subsequent ones, I will refer to an agent in a simulation as ‘it’.
previous section, such as their size and their likelihood to occur in words with a more lexical or a more functional meaning.

![Figure 4. An example of communication and learning. When a speaker utters a sense that is not known to the hearer, this leads to a learning process in which both speaker and hearer adjust their set of senses.](image)

The size of a mutation is based on the value of parameter $m_s$. During a particular simulation, $m_s$ will have a fixed value, but the actual size of a mutation in an agent’s knowledge can deviate from this value. However, the larger the deviation, the smaller the probability of its occurrence. The equation used for this probability is shown in equation 1.

\[
\text{prob}(m = x) = m_s \cdot e^{-\frac{1}{2}x^2}
\]

**Equation 1.** The size of a mutation is determined by a Gaussian function with a standard deviation of $m_s$.

The model is iterated in 500 cycles called ‘years’. These years are defined in relation to the age and replacement of agents in the population, and the amount of communications between them. In such a communication, two agents are randomly selected from the population as speaker and hearer, and each year, each agent participates in 500 communications on average. This frequency is the usage frequency $f$ of word $w$. Each simulation is initiated with agents having a random age.
between [0, 70] and a set of senses with a fixed size of 0.2 and a variable minimum of $S_{\text{min}} = 0.4 + d$, with $d$ a random value $d \in [0, 0.2]$. The population consists of 100 agents. This value is an intermediate value of those suggested by Dunbar (1998) and Milroy & Milroy (1992) for the size of linguistic communities. In the standard model, the population is considered to be a linguistic unity: there is random communication between all 100 agents in the population. However, I do investigate the effect of non-random communication within the population on the overall linguistic coherency in the next section. It seems realistic to assume that as populations get larger, they will start to become divided into several (socially based) subgroups, within which agents communicate randomly, but between which there is less frequent communication (cf. the notion of ‘social networks’ in sociolinguistic theory, e.g. Milroy & Milroy 1992). I have simulated such a structure by dividing the total population into a number of subgroups and limit communication between individuals from different subgroups. The probability of communicating with an agent from another subgroup is given by factor $g$. For example, if $g = 0.01$, there is a 1 percent chance that agents will communicate with agents from another subgroup, while there is a 99 percent chance of communicating with an agent from the same subgroup. Note that with $g = 1$, there is random communication between all 100 agents.

Agents have a maximum age of 70 years, after which they are replaced by an agent with age 0. Newborn agents start with an exact copy of the set of senses of a randomly assigned ‘parent’, after which they participate fully in the communication between agents. Note that this ‘parent’ is not the agent that is being replaced (because in such a case there would be no need to add generations in the model). Rather, the transmission of the parent knowledge is a simplification of the acquisition process. This means that any evolution displayed by the model is not due to imperfect learning situations in child language acquisition, but to variation coming about and spreading in adults; in this way it is possible to test whether such variation can by itself lead to semantic change. Note that this does not mean that transmission in the model is completely horizontal (i.e. within peer groups only); communication is random between all agents regardless of their age, and therefore transmission can be said to be both horizontal and oblique (Cavalli-Sforza & Feldman 1981).

In section 2, I introduced several factors that have been proposed by linguists to play a role in the (uni)directionality of the change “lexical meaning > functional meaning”. These factors can now be linked to the model. Frequency is the number of times agents communicate with each other each year ($f$). Mutation is the change in set size, with a rate of $m_r$ and a size $m_s$. The set size is an indication of the generality or specificity in meaning, and the position of the set on the scale can be taken as an indication of the lexical or functional status of the word. In the next
section, I will first discuss general properties of the most simple model, and then the effects of these factors on simulations of semantic change, and the way they relate to asymmetries in such changes.

2.4 Results

General behavior of the model

In the standard model described in the previous section, it is found that stable, coherent meanings for word $w$ develop within populations, and then gradually change over time. The simulations show slightly different behaviors each time they are run, with fluctuations in the average meaning size as the result: specialization and generalization both occur. Basically, the simulations exhibit random drift in the direction of both the upper and lower limit of the meaning set. With meanings drifting in both directions along the scale, there is evolution, but no unidirectionality. In most cases, the coherency of populations remains high regardless of the amount of drift. Nevertheless, over 500 years, the meanings of $w$ in different populations can diverge to the extent that communication between them would be seriously limited. This can be seen in figure 5 on the opposite page, which shows the average meaning sets of 10 populations after a simulation of 500 years: while some of these average sets have relatively similar values (e.g. those of populations 1 and 8), most of these sets have very different upper and lower limits. For example, the sets of populations 5 and 8 only show a relatively small amount of overlap.

When focusing on the coherency of the population, note that there is no direct transmission of the ‘total’ meaning of $w$ between agents; they are only exposed to single senses in utterances, and shape their meaning of the word on the basis of this information. The model shows that such indirect transmission does not lead to an incoherent population, when certain conditions are met.

I have tested the effect of three factors on this coherency: mutation rate, frequency of use and population structure. Coherency (represented by $\theta$) was measured as the average amount of overlap of the sets of senses between agents in that population. This is done by first calculating the overlap of the sets of senses of each pair of agents in the population and then calculating the average of all these values (equation 2 on the opposite page). The greater this overlap, the greater the consensus about the meaning of word $w$. 
Figure 5. Examples of random drift of the average meaning of $w$ in 10 populations ($N = 100$) after 500 years, showing both drift on the 0-1 scale and drift in size. Each population started with an average knowledge with limits [0.4 - 0.6]. $f = 500$, $m = 0.01$, $m_s = 0.01$.

$$\theta = \frac{1}{N(N-1)} \sum_{i=1}^{N} \sum_{j=1}^{N} \frac{w_{ij}}{w_i}$$

with $i \neq j$, $w_{ij}$ as the overlap between agents $i$ and $j$, and $w_i$ the set size of agent $i$.

Equation 2. Coherency $\theta$ of the population.

First, the mutation rate in the population should not be too high. A certain amount of communication is needed for a single mutation to spread through the entire population and to even out the emerged variation between the agents. When the number of communications relative to the mutation rate becomes too low, the individual variation caused by mutation is not transmitted to other individuals often enough, thus causing a lower coherency (figure 6a on the next page). Changes in frequency do not affect the coherency of the population significantly (figure 6b, also on the next page). This is due to the fact that, in this model, the rate of mutation is linked to the frequency of use, and therefore the number of communications relative to the mutation rate remains the same.

Second, the population structure involves random communication between all agents. This might be realistic for small groups (of $N = 100$), but not when populations are much larger. In the latter case it seems more realistic to assume a population divided into several (socially based) subgroups. As I mentioned in the previous section, I have simulated such a structure by dividing the total population
Figure 6. The coherency of the population (y-axis) with different mutation rates (6a) and different frequencies of use (6b) after 500 years. \( N = 100, m_r = 0.01 \). For (6a), \( f = 500 \), for (6b), \( m = 0.01 \).

into a number of subgroups and limit communication between individuals from different subgroups and the probability of communicating with an agent from another subgroup is given by factor \( g \).

Not surprisingly, the less communication there is between the subgroups of the total population, the less coherent this population becomes. However, only a very limited amount of between-group communication (\( g = 0.01 \)) is needed to create considerable coherency in the total population. This can be seen on figure 7.
In summary, populations are basically coherent unless there is a great deal of mutation or virtually no communication between groups of agents. At the same time, word meaning gradually evolves within populations over time. Therefore, the model, simple as it is, behaves in a linguistically realistic way, and demonstrates the benefits of a cultural evolutionary approach to language change. Recently, this cultural evolutionary analogy has been the topic of dispute (cf. contributions in Aunger 2000). Sperber (2000) questions the value of the analogy by stating that there is a fundamental difference between genes and memes, the units of cultural inheritance. Genetic replication involves copying, but in the replication of cultural items (such as linguistic structure), copying ‘will only ever be a small proportion of cultural learning. It is but the limiting case of a much more complex process involving multiple steps of inferencing’ (Aunger 2000: 19). However, the results of the model in this chapter seem to indicate that the cultural evolutionary approach can also be valuable when replication involves more than simple copying and requires multiple steps of inferencing on the language user’s part. Individuals must generate their own concept of the range of contexts in which a word can be used, yet they are not directly informed of the limits of the ranges used by others, and they do not hear all of the possible contexts. Nevertheless, the ranges of contexts can be maintained very conservatively throughout the population over time. This is a consequence of the mode of transmission, which might be best characterized as

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Footnote: As such, the question whether the replicator is a mental representation (as is claimed by Sperber 2000) or a token of linguistic structure in an utterance (as Croft 2000 claims and which is also the view adopted in this study) becomes less urgent, since the nature of the replicator does not immediately affect the inferencing that takes place when linguistic structure is passed on in communication.
“many-to-one” (cf. Cavalli-Sforza & Feldman 1981), combined with the ability to generalize to fill in the gaps.

In the next section, I will take a closer look on this behavior with regard to change, and discuss factors affecting patterns of change.

**Factors affecting the rate of semantic change**

As I described in section 2, a major restriction on grammaticalization seems to be that words are not equally liable to grammaticalize: words with a more general meaning do, while more specific words do not. Three possible explanations for this relationship were discussed: words with a general meaning are applicable in a wider range of contexts (factor 1), they will have a higher frequency (factor 2) and they allow wider mutations (factor 3). As to the third factor, recall that the size of an individual semantic mutation in the model is typically rather small, and is determined by a Gaussian function with a standard deviation (\( \mu \)). However, it is conceivable that different meanings allow different sizes for one-step extensions; if so, then it is natural to assume that general meanings will allow larger extensions than specific meanings, rather than the other way around. I have carried out a series of simulations in order to test the feasibility of these three explanations.

The effect of factor 1, the number of contexts, was simulated by initiating different populations with different sizes of the meaning sets. As I explained in section 3, a small meaning set represents a limited number of contexts a word can be used in, and therefore represents words with a specific meaning. A large meaning set, i.e. a wide range of senses, represents a word with a general meaning. Frequency of use, mutation rate and size were kept constant.

As a measure for the liability to change, I take the amount of change in the position of the meaning set on the 0-1 scale after 500 years. In this case, the change involved is ‘drift’, because no selection pressures have been added to the model, and therefore changes can occur in any direction. The amount of drift \( \partial \) is measured as the distance between different groups after 500 years, since they start off in a similar position in the ‘space’ of possible senses. This distance can be calculated by comparing the average middle values of the different groups. For example, an agent with a set of senses \([0.20, 0.46]\) has a middle value of 0.33, and the average middle of an entire group of agents can be calculated by taking the sum of all these middle values and by dividing them with the number of agents in the group. Subsequently, the average middle value of *all* groups can be calculated. Finally, by comparing this value to the average middle value of each group, one gets a measure of the distance between the different groups. This is shown in equations 3-5: equation 3 shows the calculation of \( d \), the average middle of one group, equation 4 shows the calculation of \( d_{av} \), the average middle of all groups, and equation 5 shows the calculation of the
standard deviation between \( d \) and \( d_{av} \), indicating drift \( \partial \). The larger the standard deviation, the greater the value for \( \partial \).

\[
d = \frac{1}{N} \cdot \sum_{i=1}^{N} (S_{\min,i} + ((S_{\max,i} - S_{\min,i})/2))
\]

Equation 3.

\[
d_{av} = \frac{1}{MN} \cdot \sum_{i=1}^{MN} (S_{\min,i} + ((S_{\max,i} - S_{\min,i})/2))
\]

Equation 4.

\[
\delta = \sqrt{\frac{1}{M - N} \cdot \sum_{j=1}^{M} (d - d_{av})^2}
\]

with \( M \) groups of \( N \) agents.

Equation 5.

\[\text{Figure 8. The amount of drift for increasing set sizes. The y-axis shows the average amount of drift over 20 groups.} \quad N = 100, \quad t = 500 \text{ years,} \quad f = 500, \quad m_r = 0.01, \quad m_s = 0.01.\]

The results of this simulation are shown in figure 8. As the figure shows, there are some fluctuations in the amount of drift found, but there is no clear link between set
size and drift. This seems to indicate that a word’s generality in meaning per se does not make the word more liable to change (and thus grammaticalization).

The set sizes themselves also change over time. There are large fluctuations in the final set sizes for each parameter setting: both specialization and generalization occur, which leads to averages that are almost equal to the initial set sizes (figure 9). However, the smaller initial set sizes ($\leq 0.08$) behave somewhat differently, showing more generalization than specialization, and therefore showing an average increase in set size over time. This effect is probably due to the way the model is constructed. First, there is a minimal set size for each agent ($1 \cdot 10^{-5}$). Whenever learning or mutation in the form of contractions leads to a zero set size, the agent is assigned this minimal value instead. Because such a limitation is absent in the case of an extension, this will lead to a slight ‘benefit’ for extensions versus contractions. Second, the variance in set size among agents will be smaller when set sizes are relatively small, and in such an environment, extensions spread more easily than contractions. As figure 9 shows, an average set size of $\sim 0.1$ seems to be a ‘minimal’ set size for the populations with the current parameter settings.

![Figure 9](image)

**Figure 9.** Final set sizes after 500 years for 20 groups, for different initial set sizes. Apart from the averages (in squares), the minimal and maximal values are shown to indicate the large amount of variance between groups. $N = 100, f = 500, m = 0.01, m_r = 0.01$.

The next step is to consider the effect of frequency on change in the model (factor 2), by looking at the effects of different frequencies of use, simulated by manipulating the number of communications per year. In these simulations, the initial set size was kept equal in all cases (width = 0.2), as was the amount of

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1 Limitations to extensions do exist when set sizes would become larger than 1. However, such large set sizes do not occur in the settings used in these simulations.
mutation ($m_r = 0.01$). In order to use somewhat realistic relative differences in frequency, I have used the relative frequencies of some English movement verbs (mentioned as an example in Bybee, Perkins & Pagliuca 1994: 5) as a basis. These are shown in table 1. The frequency of the very general word *come* is more than 7 times higher than the more specific *walk*, and almost 60 times higher than *swim*. I have used similar orders of magnitude in the simulation ($f = \{10, 100, 1000, 10000\}$).

<table>
<thead>
<tr>
<th>verb</th>
<th>frequency (per million words)</th>
<th>frequency relative to <em>come</em></th>
</tr>
</thead>
<tbody>
<tr>
<td>come</td>
<td>1512</td>
<td>-</td>
</tr>
<tr>
<td>walk</td>
<td>215</td>
<td>0.142</td>
</tr>
<tr>
<td>roll</td>
<td>49</td>
<td>0.032</td>
</tr>
<tr>
<td>side</td>
<td>30</td>
<td>0.020</td>
</tr>
<tr>
<td>swim</td>
<td>25</td>
<td>0.017</td>
</tr>
</tbody>
</table>


Figure 10 shows that the amount of drift is strongly correlated with the frequency of use of word $w$: high frequency words show more drift than low frequency words, as a result of a difference in frequency alone. This is an indication that frequency of use is an important factor in the differences in likelihood to change (hence also to grammaticalize) that are found between these types of words.

![Figure 10](image.png)

Figure 10. The role of frequency of use in determining the rate of semantic change. The y-axis shows the average amount of drift between 20 groups for increasing frequencies of use. $N = 100$, $t = 500$ years, $m_r = 0.01$, $m_s = 0.01$. 
To test the effect of the third factor, mutation, I have looked at different values for mutation size $m_s$ and measured its effect on the amount of drift. Both set size and frequency of use were kept constant at 0.2 and $f = 500$ per year, respectively. The mutation rate was kept constant at $m_r = 0.01$, but I varied the mutation size between $m_s = 0.00001$ and $m_s = 0.01$ to test its effect on the amount of drift. The results in figure 11 show a strong increase of the amount of drift for increasing mutation sizes.

![Figure 11](image.png)

Figure 11. The role of mutation in determining the rate of semantic change. The y-axis shows the average amount of drift between 20 groups for increasing amounts of mutation. $N = 100$, $t = 500$ years, $f = 500$, $m_r = 0.01$. 

This suggests that, if indeed words with a general meaning allow for wider extensions than words with a specific meaning, this leads to a higher amount of drift in the former than in the latter type.

When comparing the results of the three factors in the model, it shows that pure differences in the ‘size’ of meaning do not cause differences in the rate of drift by themselves. It is possible that the generality of a word influences the rate of semantic evolution through some other correlated effect that was not included in the model. On the other hand, both differences in frequency and differences in the size of mutations are factors that do lead to a dramatic difference in drift, even if they occur alone. In the basic model, the average knowledge of the populations shifts over time as a result of drift. An increase in either frequency of use or size of mutations allows for larger amounts of drift over the one-dimensional space, without any extra forces added to the model.

All changes described above were non-directional, which is why I have referred to them as ‘drift’. In the next section I will discuss directionality in change.
Factors causing unidirectional semantic change

In section 2, two different kinds of possible explanations were given for unidirectionality in change: first, speakers may only be able to freely manipulate lexical meanings of a word and second, functional meanings are used more frequently than specific, lexical meanings. Haspelmath (1999) argues that the combination of both factors leads to a unidirectional change from lexical meaning to functional meaning.

I tested these two factors in the following way in the model. The first hypothesis is equivalent to an asymmetry in mutation: words with lexical meaning can be adapted to express functional meaning, but not the other way around. To simulate this difference, the mutation rate was kept constant at \( m_r = 0.05 \), but the probability of the direction of mutations was varied with a parameter \( p_m \).

The second hypothesis concerns an asymmetry in the frequency of use: senses with a functional meaning have a higher chance of being used in communication than senses with a lexical meaning. Individuals must select a sense of \( w \) for communication from within their set of meanings, but here I varied how likely they were to pick different senses from within that meaning. In all simulations up to this point, individuals picked a sense according to a uniform random distribution. In the present set of simulations, senses were picked according to an exponential distribution. In this type of distribution, the probability of selecting a certain sense increases with increasing sense values. The strength of this increase can be altered with a parameter \( p_s \). For example, if \( p_s = 2 \), the probability of an agent selecting \( s = 1 \) is twice as big as selecting \( s = 0 \) (provided the agent has both senses in its set of meanings), while with \( p_s = 100 \), the difference in probability is 100 (equation 6).

\[
\text{prob}(s = x) = p_s^x
\]

Equation 6.

In a first simulation, I combined both factors, asymmetry in mutation and asymmetry in frequency of use. For the asymmetry in mutation, I used \( p_m = 0.55 \), which meant a probability of 0.55 for mutations to occur on the functional end of the agent’s set (and a probability of 0.45 for mutations to occur on the lexical end of the set). Because this is only a small asymmetry, the model is more conservative than the hypothesis. For the asymmetry in frequency of use, I used \( p_s = 2 \), which also leads to a weak preference for more functional meanings. Two simulations were run, one in which the agents in the population started with a lexical meaning (with an average set of \([0.1 - 0.3]\)), and one in which they started with a functional meaning.
The latter was added to see whether change in the opposite direction, i.e. from functional to lexical meaning was possible.

Figure 12 is a representation of the average sets of senses in 20 unrelated groups. In this figure, the average middle of each group is shown twice, at the beginning of the simulation (as a grey circle) and after 500 years (as a black square). Its values are plotted on the vertical scale. I will use this representation in subsequent figures as well. In figure 12a, it can be seen that all groups start off with similar starting average middle values of 0.2 (grey circles), while there is some variation in their average middle values after 500 years (black squares).

Both factors combined indeed create a selection pressure that drives the average set of senses of a population from the lexical side of the spectrum to the functional side, even if both factors are weak (figure 12a). Also, the selection pressure blocks any change in the opposite direction (figure 12b). In this simulation, the starting middle value of all groups was 0.8 (indicated by the grey circles), but the average values after 500 years of all groups (indicated by the black squares) do not differ significantly from these starting values.

As a comparison, a simulation was run in which neither factor was operative. As figure 13 shows, changes from lexical to functional meaning can occur as a result of random drift, but changes in the opposite direction are also possible, and no strict unidirectional change is taking place.

Figures 12-13. (12) The effect of asymmetries in mutation and frequency of use together, and (13) the effect of a random drift simulation. The results are shown for 20 unrelated groups (x-axis). The y-axis shows the average position of each group on the 0-1 scale. Grey circles indicate the average starting position of each group, black squares and positions after t = 500 years. f = 500, m = 0.05, m_r = 0.05, p_m = 0.55, p_s = 2. Left: lexical starting point; right: functional starting point.
However, the question remains whether the two factors could also cause unidirectional change when they operate alone. I first tested whether the asymmetry in frequency of use by itself can create a sufficient selection pressure. As figure 14 shows, this is the case. The same value for $p_s$ as previous but now acting by itself creates a selection pressure for functional meaning, thus causing unidirectionality in change.

The next question was whether the small asymmetry in mutation ($p_m = 0.55$) would have a similar effect on the direction of change. It turns out that this factor creates a much weaker selection pressure when compared to the previous factor (frequency). Although change from lexical meaning to functional meaning takes place, changes in the opposite direction are not completely blocked (figure 15).

**Figure 14.** The effect of an asymmetry in frequency of use, using $p = 2$, $f = 500$, $m = 0.05$, $m_r = 0.05$, $p_m = 0.50$. Left: lexical starting point; right: functional starting point.

**Figures 15-16.** The effect of two different asymmetries in mutation. $f = 500$, $m = 0.05$, $m_r = 0.05$, $p_m = 0.55$ (Fig. 15), $p_m = 0.95$ (Fig. 16). Left: lexical starting point; right: functional starting point.
However, the force proposed by Haspelmath (1999) and discussed in section 2 may be a very strong one; his formulation suggests an absolute constraint: ‘functional elements cannot be used outside their proper places’ (Haspelmath 1999: 1059). In the model using $p_m = 0.55$, mutations from functional to lexical still occur in 45 percent of the cases, so I tested a much stronger asymmetry of $p_m = 0.95$, which indeed proves to be a very strong pressure for unidirectional change (figure 16).

While I have compared the effects of some, more or less randomly chosen parameter settings for both factors, their effect can be compared more precisely by measuring the amount of change that takes place. For this, I measured the average distance between the initial meaning and the meaning after 500 years of all agents in the population. This value can be taken as a measure for the strength of the unidirectional change.

Figure 17. The effect of different values of asymmetries in mutation ($p_m$) and frequency of use ($p_s$). The average distance is the distance between the initial average middle and the average middle after 500 years of 20 groups. $f = 500$, $m = 0.05$, $m_r = 0.05$.

Figure 17 is a combination chart that shows the average distance for different settings of both an asymmetry in mutation and in frequency of use. Note that $p_m = 0.50$ and $p_s = 1$ are simulations with random drift. In these simulations, a variable amount of change takes place in the 20 groups as a result of mutation, and these variable amounts results in an average change of around 0.30.

As expected, larger values of both $p_m$ and $p_s$ lead to a higher amount change. A larger $p_m$, giving a higher probability for mutation on the functional end of an agent’s set, leads to more (unidirectional) change, and for $p_s$, the strength of the bias for expressing functional meaning, we see a similar pattern. For $p_s$, the
amount of change quickly increases with $1 < p_s < 1.5$. However, the increase seems to halt around 0.60 while this is not the case for greater values of $p_m$. This turns out to be an artifact of the way the model was constructed. The meaning scale in the model is limited to [0, 1], and when a possible (extending) mutation exceeds one of these limits, another mutation is tried. This means that the closer an agent’s set comes to one of the limits, the higher the chance a contracting mutation will be created. In turn, this will lead to smaller average set sizes, and these smaller set sizes can move closer to one of the limits than larger set sizes.

These results seem to indicate that asymmetries in both mutation and frequency might not have to be working together to create a unidirectional pressure. Small asymmetries in frequency and somewhat larger asymmetries in mutation already lead to clear unidirectional change in the model. However, as noticed above, a large asymmetry in mutation requires a fairly strict distinction between lexical and functional meanings, and this may be at odds with the generally observed gradualness of semantic change, including shifts from lexical to functional (Hopper & Traugott 2003); it may therefore be considered a relatively implausible cause of unidirectionality on its own. In this respect, it is of course interesting that the model shows that the elementary mechanism of a small difference in frequency is powerful enough to cause unidirectionality by itself.

2.5 Discussion and conclusions

The results demonstrate how a cultural evolutionary perspective may be of use in making sense of linguistic hypotheses about language change. I have given a concrete example of this by investigating the phenomena of unidirectionality in the change from lexical to functional meaning and differences in the liability of words to grammaticalize. By using cultural evolutionary simulations it was possible to study several hypotheses independently, something that is more difficult to do with empirical data, where all of the different factors that were investigated may be operating at the same time. By deliberately keeping the model simple, it was possible to elucidate the mechanisms underlying some of these hypotheses. The model presented here shows that with indirect transmission alone (individuals inferred the overall meaning of a word from multiple instances of hearing that word being used), it is possible to maintain a linguistically coherent population, provided that there is sufficient communication between agents, and the mutation rate is not too high. Whether this is in fact the case is an interesting topic for future research, and this is directly linked to the question what order of magnitude the general mutation rate in language actually has.
As for the rate at which semantic change takes place, it seems that the generality of a word’s meaning does not have a direct effect: I found no effect on the amount of change when frequency of use and mutation rate are kept at a constant level. Rather, linguistic consequences of generality (I investigated two examples: a higher frequency of use and a greater ease with which individuals can use a word in new contexts) are more likely to be the direct causes of higher rates of change. Both these factors are mentioned in earlier studies (Bybee, Perkins & Pagliuca 1994, Traugott & Dasher 2002) as possible causes and the results confirm their hypotheses. The results also show that both frequency of use and mutation size have similar effects when operating without the other, and that therefore they do not have to occur together.

A similar point can be made on the basis of the results regarding directionality in change. The results seem to confirm that unidirectionality in semantic change can be understood as a result of different usage properties of words with a lexical meaning versus those with a functional meaning. On the one hand, the fact that functional meanings are more general and abstract and can therefore be used in more contexts than lexical meanings is by itself a force that produces unidirectionality. On the other hand, the relative ease with which lexical meaning can be manipulated, that is, with which mutations can take place, acts as a force for unidirectionality as well. These findings are in accordance with the predictions made by Haspelmath (1999). However, the results of the simulations suggest that each of the two factors alone may already lead to unidirectionality, with only relatively small asymmetries in either mutation or frequency of use.

Several factors that are often associated with change in general and grammaticalization in particular were not included in the model. First, the knowledge of agents was restricted to a continuous meaning set. Old meanings can only remain in use next to newly developed meanings when all the meanings in-between remain in use as well, and this may not always be the case. Second, the notion of entrenchment, connected to the frequency of use of particular senses (e.g. Langacker 1987: 59), was not included in the model either. Related to this, the frequency of use of the word as a whole was constant in the model, while a shift towards functional meaning usually implies an increase in absolute frequency of use. Third, the model simulated words in isolation, disregarding influences from factors such as context, which is argued to play a major role in the grammaticalization process. Lastly, of the non-linguistic factors, I only investigated the effect of the coherency of the population, while it is possible that other factors such as population size and time (as in duration of the simulation) could affect change as well. I do not claim that these factors do not play a role in the process of linguistic change, but instead hope to have shown that the presence of such more
complicated factors is not a necessary condition for basic types of semantic changes that are known from historical linguistics to occur.

Perhaps the most striking result emerging from the simulations presented in this chapter, is that the very basic, 'mechanistic' factor of frequency of use is a recurrent, dominant factor producing regularities in semantic change, even independently of (considerations about) other signals: the model I have used here contains only one word so that issues of competition and relative frequency do not enter into the picture here. Nevertheless, I have been able to reproduce some general properties of processes and products of semantic change, and to indicate more or less plausible factors producing specific patterns of change.
Chapter 3

The competitive exclusion principle in language: a case study of AN-combinations

3.1 Introduction

In ecology, the notion that no two species can co-exist if they occupy the same niche is known as the competitive exclusion principle or Gause’s Law. Based on laboratory experiments, Gause stated that ‘as a result of competition two similar species scarcely ever occupy similar niches, but displace each other in such a manner that each takes possession of certain kinds of food and modes of life in which it has an advantage over its competitor’ (Gause 1934: 19, cited in Chapman & Reiss 1999: 110). In other words, competition for the same niche either leads to extinction of one the two species, or to some sort of differentiation so that both species come to occupy different niches.

With respect to language, a similar principle is known as the isomorphism principle. Like species, different forms with the same meaning (synonyms) or different meanings with the same form (homonyms) can be said to ‘compete’ with each other for the same resource. Hockett (1958: 399) writes: ‘When two forms […] are in competition, then the non-survival of one of them may simply be the negative aspect of the survival of the other. Of course, sometimes both survive indefinitely. When this happens, we usually find that some semantic distinction has arisen, so that, in effect, they have ceased to be in competition.’

An example is given by Keller (1994: 80-82), who discusses the German adjective Englisch. This word used to mean both ‘angelic’ and ‘English’, but the former use has disappeared from the language and has been replaced with engelhaft. In ecological terminology, two meanings, ‘angelic’ and ‘English’, were competing for the same niche, the form Englisch.

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1 I would like to thank Matthias Hünig and Barbara Schlücker, whom I collaborated with on this topic at the FU Berlin. I would also like to thank Michaela Poss for helping me with the German examples, and Ariane van Santen for helping me with the semantic characterization.
Another example deals with the name that had to be given to the mobile phone, which came into general use in the last decade. In Dutch, two words, *gsm* and *mobiele telefoon* (abbreviated as *mobiel(tje)*), were initially used for the object, but recently, the latter form seems to have become the general word of reference. This means that, in the competition for the niche of the name for the object ‘mobile phone’, the form *mobiel(tje)* has survived at the cost of the form *gsm*.

Finally, Dutch had two verbs that meant ‘to throw’ at a certain point in time, *gooien* en *werpen* (Van Bree 1996: 112). However, contrary to the previous example, no extinction of one of the two forms occurred. Instead, semantic differentiation took place, and both verbs now still mean ‘to throw’, but occupy different registers: *gooien* is standard whereas *werpen* has a more formal use.

‘Competition’ of two words is the result of the behavior of individual language users, who base their choice of variants on factors such as the entrenchment of both words and the probability of successful communication. As was noted by Hockett, competition of variants arises in such a situation, because high values (e.g. of entrenchment) for the one necessarily leads to low values for the other variant.

The principles of competitive exclusion and of one form-one meaning both imply that equilibrium states, in which two variants live in free variation in the same niche, are uncommon. If such a case occurs, it is therefore interesting to study it in more detail and to try to come up with explanations for its presence: what are conditions under which an equilibrium between two competing forms can exist over a considerable amount of time, without a change in the mechanisms that mostly lead to the extinction of one of two competing forms?

One such case in language is that of adjective-noun combinations, which appear in many of the Germanic languages. These combinations can appear as both compounds, such as English *widescreen* (single words, with stress on the adjective), and phrases, such as English *full moon* (separate words, with stress on the noun). Both forms occupy the same linguistic ‘niche’ in that they are both category names. However, they seem to be in state of equilibrium in that both forms are productive, not just in English but also in German and Dutch and other Germanic languages as well.

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2 Interestingly, the ‘surviving’ word differs across languages: *cell phone* in American English, *mobile* in British English and *Handy* in German. See also: http://en.wikipedia.org/wiki/Mobile_phone_terms_across_the_world.

3 With regard to isomorphism, Croft (2003: 105-106) provides another explanation by using the interplay between the factors economy and iconicity: synonymy is not iconically motivated because it lacks a one-to-one mapping between words and meanings, nor is it economically motivated: it is superfluous for communication. For both homonymy and monosemy, one of the two factors is not motivated. Polysemy on the other hand is more likely to occur because it is both iconically and economically motivated: several meanings are shared by a single form (economy) and these meanings are related (iconicity).
These adjective-noun (AN) combinations and their equilibria in German, Dutch and English are the topic of the present chapter. I will start by discussing their presence in the three languages in more detail. This will show that within the main type of ‘AN-names’ three semantic subtypes can be distinguished, and that free variation of compounds and phrases only occurs in one the three subtypes. Based on this finding, I argue that this particular distribution can explain the equilibria in the three languages. I will present a computer model in which I simulate the case of AN-names to support this claim.

3.2 AN-combinations in Dutch, German and English

Compounds that consist of an adjective and a noun have a specific function, which is described by Booij (2002: 313) for Dutch as providing ‘names for a relevant class of entities’. Examples of Dutch AN-compounds are zuurkool ‘sauerkraut’ and kleingeld ‘small change’. These compounds are not descriptive: they do not refer to any kool ‘cabbage’ that is zuur ‘sauer’ or any geld ‘money’ that is klein ‘small’, but to specific categories of cabbage and money instead. Such compounds exist in German and English as well; examples are Vollmilch ‘whole milk’ and grandchild.

Whereas compounds are blocked from having a descriptive function, another type of AN-combination exists for which such a restriction does not hold. These are AN-phrases, which can appear both as descriptions and as category labels. In general, phrases are descriptive, as they are a syntactic pattern in which an adjective specifies a noun. Of this type, an almost infinite number of examples could be given: kleine jongen ‘little boy’, rode muur ‘red wall’, zure smaak ‘sour taste’, etc. However, there is a small subset of these phrases which serve as category labels and can be said to have name function. Dutch examples are vrije trap ‘free kick’, rode kool ‘red cabbage’ and harde schijf ‘hard disk’. Like compounds, their meaning is not simply compositional: a harde schijf does not refer to any disk that is hard, but to a particular kind of data storage in a computer. And even when both adjective and noun have literal meaning, like in rode kool ‘red cabbage’, the phrase as a whole does not refer to any cabbage that is red, but to a particular category: a type of cabbage with a reddish (actually a purple) color (with the Latin name brassica oleracea (var. rubra)).

This last type of phrase is generally referred to as a ‘lexicalized phrase’, because it has to be listed in the lexicon. As Booij (2002: 313) puts it: ‘They are conventional, established names for [...] entities, and [have] unpredictable meaning aspects.’ Like AN-compounds, lexicalized AN-phrases also exist in German and
English: saure Sahne ‘sour cream’, kalter Krieg ‘cold war’, whole milk and free market.

**Characteristics of lexicalized AN-phrases**

The lexicalized status of AN-phrases can be shown in several ways. The list below is a summary of characteristics given in several different studies (Bloomfield 1933: 232, Marchand 1969, De Caluwe 1990: 17, Booij & Van Santen 1998: 37, Booij 2002: 314, Hüning 2004: 162-163).

1) The adjective and the noun of lexicalized phrases cannot be separated.

<table>
<thead>
<tr>
<th>General phrase</th>
<th>the red hard brush</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>the hard red brush</td>
</tr>
<tr>
<td>Lexicalized phrase</td>
<td>the red hard disk</td>
</tr>
<tr>
<td></td>
<td>*the hard red disk</td>
</tr>
</tbody>
</table>

2) The adjectives in lexicalized phrases are not gradable.

<table>
<thead>
<tr>
<th>General phrase</th>
<th>the high salary</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>the highest salary</td>
</tr>
<tr>
<td>Lexicalized phrase</td>
<td>the high season</td>
</tr>
<tr>
<td></td>
<td>*the highest season</td>
</tr>
</tbody>
</table>

3) Lexicalized phrases are not semantically compositional.

<table>
<thead>
<tr>
<th>General phrase</th>
<th>a small car = a car that is small</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lexicalized phrase</td>
<td>small change ≠ change that is small</td>
</tr>
</tbody>
</table>

4) Lexicalized phrases have single stress on the noun.

<table>
<thead>
<tr>
<th>General phrase</th>
<th>We are putting red carpet in our living room.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lexicalized phrase</td>
<td>Congress should cut the red tape.</td>
</tr>
</tbody>
</table>

In Dutch, the special status of lexicalized phrases also shows in the inflection of adjectives used with nouns with neuter gender. Normally, these adjectives show compulsory differences in inflection for definite and indefinite use:

5) a. het dikke boek ‘the big book’
   b. een dik boek ‘a big book’
For lexicalized phrases, this difference in inflection of the adjective is much less straightforward. Hüning (2004: 166) shows that there is great variability in the use of this type:

<table>
<thead>
<tr>
<th>form</th>
<th>Google hits (January 2004)</th>
</tr>
</thead>
<tbody>
<tr>
<td><code>het stoffelijk overschot</code></td>
<td>4050</td>
</tr>
<tr>
<td><code>een stoffelijk overschot</code></td>
<td>552</td>
</tr>
<tr>
<td><code>het stoffelijke overschot</code></td>
<td>169</td>
</tr>
<tr>
<td><code>een stoffelijke overschot</code></td>
<td>0</td>
</tr>
</tbody>
</table>

**Table 1.** The frequencies of different uses of *stoffelijk overschot* (‘mortal remains’) (source: Hüning 2004: 166). The ‘correct’ inflection is highlighted in grey.

The data in table 1 shows that the compulsory inflectional differences in (5) are not present in a lexicalized phrase like *stoffelijk overschot*. For the definite use of the phrase, two variants occur, with the ‘incorrect’ one having the highest frequency. According to Hüning, the reason for this is that speakers have a preference for names to have a fixed form (Hüning 2004: 165). In this case, the uninflected form of the definite use is preferred over the inflected form. This tendency for a fixed form makes it possible to distinguish lexicalized phrases from ‘ordinary’ phrases:

6) a. Ordinary phrase: *het centrale station*  
   ‘the station that is centrally located’  
   b. Lexicalized phrase: *het centraal station*  
   ‘the main station in a city’

7) a. Ordinary phrase: *het oude papier*  
   ‘the paper that is old’  
   b. Lexicalized phrase: *het oud papier*  
   ‘the old paper used for recycling’

Another indication that lexicalized phrases are treated as units is that they are often spelled as a single word. Hüning (2004: 167) shows this for *oudpapier*, but it can also be shown with phrases like *rode kool* ‘red cabbage’ and *blinde darm* ‘blind gut’. As can be seen in table 2, both single-word forms are used quite frequently, and the single-word form *blindedarm* is even used more frequently than its two-word counterpart.4

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4 The Dutch dictionary *Van Dale* (1999) even uses the single-word *rodekool* as its lemma.
Despite this complication, Dutch phrases can typically be distinguished from compounds by their orthography, and the same holds for German. Although there will inevitably be certain exceptions to this generalization, it holds for the characterization of most compounds and I will therefore use it in in the categorization following below. For English, however, spelling cannot always be used as a decisive factor. The Longman reference grammar states that 'practice varies as to whether to represent a compound as two orthographic words, one unbroken orthographic word, or a hyphenated word.' (Biber, Johansson, Leech, Conrad & Finegan 1999: 326). Because of this, stress is often proposed as deciding factor (cf. Marchand 1969: 22, Booij 2002: 313): compounds have stress on the adjective (highway, blackbird), phrases on the noun (cold war, black box). This means that hard disk is defined as a compound, because of its stress on hard, and not as a phrase because it is written as two separate words. As for orthography in Dutch and German, it should be noted that the use of stress to categorize certain English compounds is a generalization that will also have its exceptions. However, it is useful for the purpose of obtaining a general classification of compounds and phrases as I do in this study.

AN-phrases do not seem to have any a priori restrictions on the adjectives and nouns that can be used. In this sense they differ from compounds, that have a very strong preference for monomorphemic or even monosyllabic adjectives (Marchand 1969: 64, Bauer 1983: 91, Erben 2000: 43, Donalies 2002: 70, both cited in Hüning 2004: 161-162). Still, Dutch allows comparative forms like Lagerhuis ‘House of Commons, lit. ‘lower house’, and meerwaarde ‘surplus value’ lit. ‘more value’ (Haesereyn, Romijn, Geerts, De Rooij & Van den Toorn 1997: 691), and German allows superlative forms like Schwerarbeit ‘very heavy work’ lit. ‘heaviest work’, Höchstpreis ‘very high price’ lit. ‘highest price’ (Hüning 2004: 162). According to Marchand (1969: 64), the adjectives in English compounds typically denote color, dimension, taste or touch. Although it is hard to prove, it seems that this tendency holds for phrases as well, and can be generalized to Dutch and German.

<table>
<thead>
<tr>
<th>form</th>
<th>Google hits (February 2007)</th>
</tr>
</thead>
<tbody>
<tr>
<td>rode kool</td>
<td>27,700</td>
</tr>
<tr>
<td>rodekool</td>
<td>170,000</td>
</tr>
<tr>
<td>blinde darm</td>
<td>43,300</td>
</tr>
<tr>
<td>blindearm</td>
<td>28,000</td>
</tr>
</tbody>
</table>

Table 2. The frequencies of different uses of Dutch rode kool and blinde darm. The ‘correct’ spelling is highlighted in grey.
**Semantic subtypes among AN-combinations**

So far, I have considered AN-compounds and -phrases as a uniform type, without addressing the question whether any variation is present among them. On the semantic level, this indeed seems to be the case. Example (8) lists a few Dutch compounds and phrases to illustrate this.

8) a. *sneltrein* ‘fast train’, *volle melk* ‘whole milk’
   b. *blauwe maandag* ‘very short period’ (lit. ‘blue monday’), *linke soep* ‘risky business’ (lit. ‘risky soup’)
   c. *dwarsskop* ‘stubborn person’ (lit. ‘stubborn head’), *wijsneus* ‘know-it-all’ (lit. ‘wise nose’)

The ‘standard’ AN-names I have discussed are those in (8a), with a noun with a specifying adjective: a *sneltrein* is a kind of *trein*, and *volle melk* is a kind of *melk*. Although these combinations are semantically transparent with respect to their heads, this is not the case for the specifying adjective; a *sneltrein* is not a *trein* (‘train’) that is just *snel* (‘fast’), but a particular type of train service (serving only major stations). *Volle melk* is not *melk* (‘milk’) that is *vol* (‘full’), but a special type of milk (with a relatively high percentage of fat). I will refer to this type of name as ‘endocentric’ in the usual definition found in e.g. Bloomfield (1933: 235), Bauer (1983: 30) and Van Sterkenburg (1993: 132-133). Note that endocentric names as a whole can also be used metaphorically, as in *heilige koe* ‘car’ (lit. ‘sacred cow’) and *koude douche* ‘rude awakening’ (lit. ‘cold shower’). I will consider these examples endocentric as well, because they are endocentric in their literal interpretation.

The examples in (8b) differ from those in the first group in that their meaning is semantically opaque. A *blauwe maandag* is not a kind of Monday, and *linke soep* is not a kind of soup. It is also not the case that the phrase as a whole has a metaphorical meaning, like in the endocentric *koude douche*, because literally, *blauwe maandag* and *linke soep* do not mean anything. Although it is possible that some interspeaker variation might occur in these cases, it can generally be stated that for most users, these phrases are (no longer) semantically transparent, and I will refer to this type as ‘exocentric’ (see citations above).

The third group is similar to the second group with regards to the head, which is semantically opaque: A *wijsneus* is not a *neus* (‘nose’) that is *wijs* (‘wise’), but a person who is (too) wise, and a *dwarsskop* is not a *kop* (‘head’) that is *dwar* (‘stubborn’). For this reason, this type is usually grouped together with the exocentric examples, and is often referred to as a *bahuovihi compound* (Quirk,
Greenbaum, Leech & Svartvik 1972: 1026). However, the reason I distinguish this type from the group of exocentric combinations is that their meaning, albeit opaque, is not completely unpredictable: they always refer to a person with a specific property. The noun has a metonymical meaning; instead of referring to a person, a body part is used. I will refer to these combinations as ‘metonymic’.

All three subtypes, endocentric, exocentric and metonymic, appear in the AN-combinations of the three languages, German, Dutch and English. Examples of Dutch were given above, and (9) lists some examples in German and English.

9) Examples of semantic subtypes in German and English

endocentric: Dunkelkammer ‘dark room’
cold war
exocentric: grüne Welle ‘phased traffic lights’ (lit. ‘green wave’)
cold turkey
metonymic: Dummkopf ‘dumb person’ (lit. ‘dumb head’)
fatass

There do seem to be both certain tendencies in the distribution of the two forms across these semantic subtypes, and different distributions across the three languages, which I will discuss next.

Differences in productivity across German, Dutch and English

As for both forms, compounds and phrases, there is general consensus for German that they are fully productive (De Caluwe 1990: 16, Booij 2002: 315, Hüning 2004: 161-162). This is also the case for Dutch phrases, but there is sometimes doubt about the status of Dutch compounds because they are believed to be ‘germanisms’ (loan words from German, e.g. Van Lessen 1928: 63). The general view, however, is that Dutch compounds, like phrases, are productive (De Caluwe 1990: 14, Haesereyn et al. 1997: 691) and I will follow this view in this study. The status of compounds in English is not totally clear. According to Longman’s reference grammar (Biber et al. 1999: 327), compounding is productive. On the other hand, Marchand (1969: 63) claims that this form ‘has probably ceased to be productive’, and Booij (2002: 315) follows this view. So, what is correct? Longman’s reference grammar (Biber et al. 1999: 227) gives some results of a corpus study of spoken and written English, to show that the form is productive. However, the examples given are highway and grandmother, and these words date back from earlier times, according to Marchand (1969: 63). He states that ‘in the last 100 years there appear to be only the words strongpoint (a military term) and strongman (chiefly political)’ (Marchand 1969: 64). The word software could be added here, since its first
attestation in the Oxford English Dictionary is from 1960. Its counterpart *hardware* is first found in the sixteenth century (Marchand 1969: 63), with the meaning ‘small ware or goods of metal’ and *software* could have been created by analogy. The question is, however, if creation by analogy should be interpreted differently from productivity, because both processes describe the creation of a new form based on existing forms with the same structure. Apart from *software*, other recently added compounds are *high definition* and *flatscreen*. Taken all this in consideration, I assume compounding to be productive in English, yet only marginally when compared to phrases.

Turning to the semantic subtypes, I mentioned earlier that all three of them (endocentric, exocentric, metonymic) are present in the three languages, but that there seem to be certain tendencies in their distributions. A first tendency is that exocentric meaning seems to be restricted to phrases in all three languages: *grüne Welle*, *böses Blut* ‘bad blood’ (lit. ‘angry blood’) (German), *blauwe maandag*, *rode draad* ‘connecting theme’ (lit. ‘red thread’) (Dutch), *cold turkey*, *red tape* (English). The only exception that I have found in the studies mentioned throughout this chapter is the Dutch exocentric compound *koudvuur* ‘gangrene’ (lit. ‘cold fire’). This compound dates back to at least 1557 (WNT). Of course, I do not rule out the existence of exocentric compounds in English and German, but I do believe it is safe to say there is at least a very strong preference for exocentric meaning to appear in phrases. An explanation for this tendency could be that the adjective and the noun that together constitute the name both have their own separate semantics, and that this is not possible when they are part of a compound.

Similarly, metonymic meaning seems to be restricted to compounds: *Bleichgesicht* ‘paleface’, *Dummkopf* ‘stupid person’ (lit. ‘stupid head’) (German), *bleekneus* ‘paleface’ (lit. ‘pale nose’), *dwarskop* ‘stubborn person’ (lit. ‘stubborn head’) (Dutch), *egghead*, *loudmouth* (English). Again, it is impossible to claim that no metonymic phrases exist, mainly because there are currently no exhaustive lists of lexicalized (AN)-phrases in the three languages. Still, it is safe to say that there is at least a strong tendency for metonymic compounding.

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6 Interestingly, the WNT also mentions that, prior to the compound *koudvuur*, the phrase *dat quade vier* was used in Middle Dutch.
<table>
<thead>
<tr>
<th>Compounds</th>
<th>Phrases</th>
</tr>
</thead>
<tbody>
<tr>
<td>German</td>
<td></td>
</tr>
<tr>
<td>Altpapier</td>
<td>freier Markt</td>
</tr>
<tr>
<td>Breitbild</td>
<td>gelbes Trikot</td>
</tr>
<tr>
<td>Dickdarm</td>
<td>kalter Krieg</td>
</tr>
<tr>
<td>Doppeltür</td>
<td>saure Sahne</td>
</tr>
<tr>
<td>Edelgas</td>
<td></td>
</tr>
<tr>
<td>Fremdsprache</td>
<td></td>
</tr>
<tr>
<td>Geheimschrift</td>
<td></td>
</tr>
<tr>
<td>Hartholz</td>
<td></td>
</tr>
<tr>
<td>Hochsaison</td>
<td></td>
</tr>
<tr>
<td>Kleingeld</td>
<td></td>
</tr>
<tr>
<td>Neumond</td>
<td></td>
</tr>
<tr>
<td>Rotwein</td>
<td></td>
</tr>
<tr>
<td>Schnellzug</td>
<td></td>
</tr>
<tr>
<td>Vollmilch</td>
<td></td>
</tr>
<tr>
<td>Dutch</td>
<td></td>
</tr>
<tr>
<td>breedbeeld</td>
<td>oud papier</td>
</tr>
<tr>
<td>edelgas</td>
<td>dikke darm</td>
</tr>
<tr>
<td>geheimschrift</td>
<td>dubbele deur</td>
</tr>
<tr>
<td>hardhout</td>
<td>vreemde taal</td>
</tr>
<tr>
<td>hoogseizoen</td>
<td>nieuwe maan</td>
</tr>
<tr>
<td>kleingeld</td>
<td>rode wijn</td>
</tr>
<tr>
<td>sneltrein</td>
<td>volle melk</td>
</tr>
<tr>
<td>English</td>
<td></td>
</tr>
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<td>old paper</td>
</tr>
<tr>
<td>hardwood</td>
<td>large intestine</td>
</tr>
<tr>
<td>small change</td>
<td>double door</td>
</tr>
<tr>
<td>fast train</td>
<td>noble gas</td>
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<tr>
<td></td>
<td>foreign language</td>
</tr>
<tr>
<td></td>
<td>secret code</td>
</tr>
<tr>
<td></td>
<td>high season</td>
</tr>
<tr>
<td></td>
<td>new moon</td>
</tr>
<tr>
<td></td>
<td>red wine</td>
</tr>
<tr>
<td></td>
<td>whole milk</td>
</tr>
<tr>
<td></td>
<td>free market</td>
</tr>
<tr>
<td></td>
<td>yellow jersey</td>
</tr>
<tr>
<td></td>
<td>cold war</td>
</tr>
<tr>
<td></td>
<td>sour cream</td>
</tr>
</tbody>
</table>

Table 3. A list of 18 endocentric compounds and phrases in German, and their translations in Dutch and English.
Endocentric meaning can be considered to be the ‘basic’ semantic subtype, not only because it is regular but also because it outnumbers metonymic and exocentric names. Contrary to these last two subtypes, there does not seem to be a clear tendency in the distribution of compounds and phrases for endocentric meaning. Table 3 lists examples of both forms in the three languages. The first conclusion that can be drawn on the basis of this table is that endocentric meaning indeed appears in both forms across German, Dutch and English. Second, as to the relative distribution of both forms in the three languages, this is not so easy to determine from the table alone; eighteen examples of German compounds and phrases are listed, and their respective translations in Dutch and English. While the table shows that both Dutch and English use phrases for some of the German compounds, it also suggests a stronger preference for phrases in English when compared to Dutch. Although this picture is based on a low number of examples, it is in fact supported by the image that emerges from reference grammars and different studies on the topic (cf. De Caluwe 1990, Haesereyn et al. 1997, Biber et al. 1999, Booij 2002, Hüning 2004).

Thus, while the exact distributions of both forms might not have been determined for any of the three languages, it is evident that their distributions differ. And the question how this is possible, is the topic of this chapter.

Selection pressures at work across compounds and phrases

Whereas compounds only have a naming function, phrases exist both as descriptions (as in ‘the red car’) and as names. It might seem strange that, in a system in which the naming function is already performed by compounds, how phrases can acquire a naming function altogether. However, there are a number of possible reasons, and I will discuss these here in short.

A first reason is given by Hüning (2004: 168). He argues for German that phrases such as kleiner Zeh ‘little toe’ and grüne Welle ‘phased traffic lights’ (lit. ‘green wave’) can serve as names and continue to serve as such, because they are ‘protected’ by their frequency and their semantics respectively. Kleiner and Zeh occur together with such a high frequency that this makes the combination sufficiently recognizable as a name. In the case of grüne Welle, we are dealing with a combination of A and N that does not make much sense when interpreted literally. This means that the concept is sufficiently recognizable as a name because of its semantics, despite its lack of a fixed form. Other examples of such phrases are Heilige Kuh ‘car’ (lit. ‘sacred cow’, Doppelter Boden ‘hidden meaning’ (lit. ‘double bottom’) and Kalter Krieg ‘cold war’.

A second reason is that a group of phrases exists that has a ‘protected status’. The reason is that AN-compounds (at least in the West-Germanic languages) only allow for monomorphemic adjectives; consequently, combinations such as
‘brennende Frage’ ‘burning question’ and ‘generative Grammatik’ ‘generative grammar’ have to appear as phrases, and do not compete with compounds.

The above can be described as mechanisms that allow for a steady addition of phrases to the class of AN-names besides compounds, and as such as a selection pressure for phrases, at least under certain conditions. However, there is another possible selection pressure that is working against phrases. This selection pressure has to do with the presence of a case system and the resulting variability of the phrase form.

Hüning (2004: 165) argues that names are characterized as fixed form-meaning combinations. When a combination starts to become used more and more commonly as a name, the ‘need’ to give this combination a fixed form increases. In German, compounds have a fixed form, while phrases do not because of the case system. Hüning (ibid.) illustrates this by means of the compound *Dünndarm* (‘small intestine’); as a phrase, this would have to exhibit a considerable amount of formal variation in different cases, as shown in the following example:

10) a. *der dünne Darm* machte ihm Schwierigkeiten
    b. ihm wurde sein *dünner Darm* entfernt
    c. er wurde an seinem *dünnen Darm* operiert
    d. die Entfernung seines *dünnen Darms*

According to Hüning, this variability in form of phrases in German is the reason that for names, compounds are generally preferred over phrases. Because phrases have no such variability in English, there is no preference to use compounds. Dutch takes a middle position in this respect, in that phrase forms are mostly, yet not always, invariable. Only adjectives that are combined with neuter nouns show an inflectional difference between definite and indefinite use, as shown in (11), while the form of the adjective with common gender nouns is constant (cf. (12)):

11) a. *Het wilde zwijn* ‘the wild boar’
    b. *Een wild zwijn* 

12) a. *De gele kaart* ‘the yellow card’
    b. *Een gele kaart*

In summary, there are opposing selection pressures present in the system of AN-names: on the one hand, phrases can acquire and retain a naming function because of frequency and special semantics, as well as allowing multi-morphemic adjectives. On the other hand, phrases may be selected against because of greater variability in its form.
Above, I have described the contours of a system in which two forms, compounds and phrases occur in a single niche, that of category naming. Within this niche, three semantic sub-niches can be distinguished. Finally, there are two opposing selection pressures at work within the system. The next question is whether this system can indeed lead to the different equilibria that are found in German, Dutch and English. This can be tested by using a computer model that simulates such a system, which I will do in the next two sections.

3.3 The model

The dynamics of two kinds of AN-combinations, compounds and phrases, can be studied with an agent-based computer model. Such a model is able to simulate a complex system at the population level by reducing it to a series of algorithms that direct the behavior of the individuals, or agents, within that population. Thus, it is possible to study the unintended effects of intentional, individual behavior (cf. Keller 1994), and therefore, these models are generally used in different fields of historical linguistics (e.g. De Boer 2001, Steels 2003, Brighton, Smith & Kirby 2003 on the transition to language, Niyogi & Berwick 1997 on language change, Nettle 1999 on language variation).

In the model I present here, the linguistic knowledge of a population of agents consists of AN-names. These names correspond to the category names that I have described in the previous section: combinations of an adjective and a noun, such as full moon and hardwood in English. Each name is represented by a unique random number in the model, and there are 10,000 different names in the ‘name pool’. Each of these names can have either of two forms: compound (c) or phrase (p). This form is not assigned to a name right away; the agents themselves ‘choose’ a form for a name when they bring a new name in the simulation (called the innovation process), and this ‘choice’ depends on their knowledge of compounds and phrases at the time of innovation. Apart from this, the assignment of form to a name that enters the simulation at any particular time also depends on two other mechanisms, which I will explain later. In short, the relative number of compounds and phrases in the population will vary throughout the simulation, and we can explore what factors affect this number.

Initialization and basic set-up of the model

The population consists of a group of 100 agents and this group does not change throughout the simulation. Agents do not reproduce or die: this factor is left out of the simulation in order to keep the model simple. The changes in the model appear
CHAPTER 3

as changes within the knowledge of a non-changing population. In other words, the knowledge of agents is continuously prone to change, as it is based on their actual linguistic experience.

At the start of the simulation, all agents in the population are given the same initial 100 names. These names are all compounds: I take compounds as the default form for names (since words have compulsory name function, and phrases do not).

Agents are involved in a series of communication acts, in which a randomly selected speaker utters an AN-name to a randomly selected hearer. The hearer, in turn, stores the perceived AN-name in its memory. This process is then iterated. In total, the simulation is run for 10,000 iterations, and in each iteration, each agent is involved as the speaker in 100 communication acts on average.

An agent who is selected as speaker in a communication act will have to select a name to transmit to the hearer. By default, the speaker will select a random name from its memory. This memory consists of 100 slots in which the most recently perceived names are stored. When an agent is the hearer, the oldest name in memory is removed and replaced by the new name (as a result, more frequent names have a higher chance of remaining in memory for a long time). This representation of memory is, of course, a simplification. However, it remains a fairly realistic way to simulate one of the main axioms of usage-based approaches to language, namely that individuals are continuously sensitive to linguistic experience (e.g. Pierrehumbert 2001, Baxter et al. 2006, Bybee 2006, Wedel 2006, Baxter et al. to appear).

The three main parameters of the model

The model has three main parameters that can all have a possible effect on the relative number of compounds and phrases in the population, and whose effect I will discuss in the results section. These parameters are the probability of innovation ($m$), the probability that descriptive phrases turn into lexicalized phrases ($\varphi$) and variability in form of phrases ($\nu$).

Innovation in the model is the creation of a new name by a speaking agent. The parameter $m$ gives the probability that, in communication, a speaker will create a new name instead of selecting an existing name from memory. For example, if $m = 0.05$, this means that in each communication act, there is a chance of 0.05 that a speaker will not select a name from memory, but create a new one.

In the creation process, the speaker uses its present knowledge to decide on the form (compound or phrase) of the new name. The probability of each form is simply based on its type frequency in the speaker’s knowledge. In other words, the relative number of instances of a form is a measure for the probability that a newly created name will have that particular form. For example, if a speaker has 80
compounds and 20 phrases in its memory, the probability \( p(c) \) of creating a compound name is \( 80 / (20 + 80) = 0.8 \), while the probability of creating a phrase \( p(p) \) is \( 20 / (80 + 20) = 0.2 \) \( (= 1 - 0.8) \). This is shown in equation 1.

\[
\begin{align*}
p_c(c) &= \frac{\sum c}{\sum c + \sum p} \\
p_f(p) &= 1 - p_c(c)
\end{align*}
\]

Equation 1.

As for the other two parameters, I mentioned in the previous section that there are opposing selection pressures at work in the system of AN-compounds and -phrases. First, descriptive phrases can turn into lexicalized phrases with name function (such as *kleine Zeh* ‘little toe’). This process is represented in the model by a parameter \( \varphi \), which gives the probability that a new name with phrase form is introduced in the population. The introduction of such a new phrase is done by a speaker during communication. For example, if \( \varphi = 0.001 \), this means that during each communication act, there is a probability of 0.001 that a speaker will be assigned a new name with phrase form and utter this to the hearer.

The second selection pressure in the system of AN-names that I discussed above has to do with the variability in form. This variability occurs in phrases as a consequence of the case system, and is said to be acting as a pressure against phrases, in favor of compounds. It is represented in the model by a parameter \( \nu \). This parameter gives the probability that, when a speaker creates a new name and this name is a phrase, it will change its form into a compound. A language with an elaborate case system like German will arguably have a higher value for \( \nu \) than a language like English, in which the case system has disappeared completely when it comes to form variability of adjectives. Note that these are relative differences with regard to this parameter: in order to assign absolute values to a parameter such as \( \nu \), a much more elaborate study of each language would be required.

A restriction to the parameter \( \nu \) is that an agent must have compounds in its memory in order to be able to change a newly created phrase into a compound. After all, it must have the knowledge that compounds can also be names. Thus, the parameter \( \nu \) only applies when the type frequency of compounds in the speaker’s memory is greater than 0.

The preference to create compounds over phrases is not solely dependent on the amount of phrase variability; it also partially dependent on the knowledge of compounds and phrases of the agent who is to create a new name. In the model, the
‘strength’ with which a particular form is linked to the function of being an AN-name is based on the relative number of that form within the agent’s memory. Therefore, the relative number of phrases in an agent’s memory should affect the probability of creating a compound over a phrase. This is modeled by linking the parameter \( \nu \) to the type frequency of phrases in the agent’s knowledge: the greater the relative number of phrases \( (f_p) \), the smaller the impact of parameter \( \nu \). The parameter \( \nu' \) gives the actual probability of a newly created phrase to turn into a compound.

\[
\nu' = (1 - f_p) \cdot \nu
\]

Equation 2.

Enabling semantic subtypes

In the basic model described above, agents only have knowledge of the form of the names in their memory. The model can be extended with the addition of meaning, in which case a particular type of meaning is assigned to each name. There are three possible meaning types, \( m_1 \), \( m_2 \), and \( m_3 \), which represent the subtypes endocentric, exocentric and metonymic that were discussed in the previous section.

The addition of meaning affects three aspects of the model: initialization, the addition of phrases and the creation of a new name. During initialization, 100 random compounds are assigned to the agents, which now also have to be assigned one of the three meanings. As I discussed in the previous section, I assume compounds to be excluded from exocentric meaning. As far as endocentric and metonymic meaning are concerned, there is no reason to assume any initial preference for one of the two. Therefore, 50 of the initial compounds get endocentric meaning, and the other 50 compounds get metonymic meaning.

As for the addition of phrases, I discussed in the previous section how I assume these phrases to be excluded from metonymic meaning. Similar to initialization, there is no reason to assume any preference for one of the two other meanings. Therefore, phrases that are added both have a probability of 0.5 to get endocentric or exocentric meaning.

When a new name has to be created with the addition of meaning, an agent first selects one of the three meaning types at random, with the restriction that it can only select a meaning that is present in its memory. After a meaning has been selected in the name creation process, the agent has to choose the proper form to go with the selected meaning. Two kinds of type frequency are used to determine each form’s probability: the general type frequency of each form, and the type frequency of each form for the particular meaning. The general type frequency is a measure of
the overall occurrence of a form, which will affect a form’s productivity. But the type frequency of a subset of each form can also be assumed to affect productivity, namely of those forms that have the same meaning as the name that must be created. Therefore, the average of both kinds of type frequency is used. The measure for both forms is shown in equation 3: the probability of creating a compound given a particular meaning \( p_{f(\omega(m))} \) is calculated as the sum of the relative number of compounds and the relative number of compounds with that particular meaning, divided by two. Naturally, the calculation for the probability of phrases is similar.

\[
\begin{align*}
\frac{1}{2} \left( \frac{\sum c}{\sum c + \sum p} + \frac{\sum (c \mid m)}{\sum (c \mid m) + \sum (p \mid m)} \right)
\end{align*}
\]

Equation 3.

3.4 Results

The basic model

Let us first look how the main parameters in the model behave in the absence of meaning. As I mentioned in the previous section, the simulation starts with all agents having the same 100 names as their knowledge, and all these names are compounds. This means that it is not meaningful to test the effect of parameter \( m \) in isolation: this parameter simulates name innovation, but since a speaker will base the form of the new name on its knowledge of names, only new compounds will be created and there will be no change in the relative number of compounds and phrases. I therefore start by testing the effects of both parameters \( m \) and \( \varphi \) together. The parameter \( \varphi \) regulates the number of phrases that enter the system and using this parameter thus leads to a steady addition of phrases into the population. Because agents choose the form of a new name on the basis of their knowledge of the relative number of compounds and phrases, it is interesting to see how different values of both \( m \) and \( \varphi \) affect the system. Figure 1 shows the results of a set of different values for these parameters. In this figure (and the other figures in this section, unless otherwise indicated), the development of the relative number of compounds
in the population over 10,000 iterations is plotted. This means that the lines in the graph are a representation of the proportion of compounds and phrases in the population: a value of 0.4 means that 40 percent of the names in the population are compounds, and 60 percent of the names are phrases.

![Graph showing development of compounds over iterations](image)

**Figure 1.** Development of compounds in a system of compounds and phrases with different values for $m$ and $\phi$. Top: $\phi = 0.0001$, middle: $\phi = 0.001$, bottom: $\phi = 0.01$.

As the different graphs clearly show, all tested parameter values lead to a system in which the number of compounds steadily decreases over time, until they eventually

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7 Although the result of only one run is shown, I have performed 20 runs for each setting. Unless otherwise mentioned, the results of these runs were always similar in that all 20 runs roughly had the same outcome.
disappear completely from the system, and fixation of phrases has taken place: in none of the runs with these parameter values a system develops in which both compounds and phrases co-exist in some sort of stable equilibrium.

The main force in this development is the pressure \( \phi \), of which a low value of \( \phi = 0.0001 \) turns out to be already sufficient to lead to fixation of phrases. As figure 1 shows for \( \phi = 0.0001 \), a higher innovation rate (parameter \( m \)) can slow down this process, but not stop it: at first, innovation will add only compounds to the system, but as the number of phrases increases, phrases will also start to be added to the system by innovation, hence increasing their number. Figure 1 also shows that for higher values of \( \phi \) (\( \phi = 0.001 \) and \( \phi = 0.01 \)), the fixation of phrases occurs at a very rapid rate.

In the above simulations, there was no pressure against phrases (\( v = 0 \)). It seems probable that the presence of such a pressure will lower the speed with which phrases take over the system. Figure 2 shows the results of a series of simulations in which this pressure is added to the system together with three different values for parameter \( \phi \) and two values for parameter \( m \).

The results in figure 2 show that the addition of the selection pressure \( v \) in some cases can slow down the increase and eventual fixation of phrases, and that it can even lead to a system in which phrases and compounds coexist in a seemingly stable equilibrium (shown in the graph by a more or less straight line). In general, the value of parameter \( v \) has to be sufficiently large compared to the value of parameter \( \phi \) for such an equilibrium to evolve. With \( \phi = 0.0001 \) and \( v = 0.1 \), equilibria develop for both tested settings of \( m \) (\( m = 0.005 \) and \( m = 0.05 \)): these settings apparently lead to a system in which the one selection pressure ‘in favor’ of phrases (\( \phi \)) is successfully opposed by the selection pressure ‘against’ phrases (\( v \)).

The innovation rate \( m \) turns out to be a factor working against phrases in this respect. A higher value of \( m \) (\( m = 0.05 \) as opposed to \( m = 0.005 \)) makes it harder for phrases to take over the system, because new names with compound form are added to the system at a relatively high rate. This either means an equilibrium with a higher percentage of compounds (the top two graphs in figure 2) or the difference between absence or presence of an equilibrium (the middle two graphs in figure 2).
The addition of meaning

In a second series of simulations, ‘meaning’ is added to the model. Agents start with a set of 100 compounds and these compounds either have ‘endocentric’ \( (m_i) \) or
‘metonymic’ ($m_3$) meaning, with a 0.5 : 0.5 distribution. When phrases enter the system, they either have ‘endocentric’ ($m_1$) or ‘exocentric’ ($m_2$) meaning, also with a 0.5 : 0.5 distribution.

These distributions have the effect that, throughout the entire simulation, compounds are blocked from having exocentric meaning, and phrases are blocked from having metonymic meaning. In other words, the addition of meaning leads to a division of the main niche of AN-names into three, semantically based, sub-niches, of which only one is accessible to both forms. With this in mind, the question is how the distribution of compounds and phrases develops in the system as a whole, and in the niche of endocentric meaning in particular.

Let us first look at the runs with meaning in which the selection pressure against phrases is absent ($\nu = 0$) for the same range of values for $m$ and $\phi$ that I discussed above in the first set of runs without meaning. Figure 3 on the next page shows the development of compounds in the endocentric meaning niche.

The main difference between these results and those from the runs without meaning is that the current runs show a much more stable system: in the majority of runs, an apparently steady equilibrium develops. However, these equilibria differ with respect to the relative distribution of compounds and phrases. For all settings, table 4 shows the average relative number of compounds with endocentric meaning between iteration $t = 1000$ (when the equilibrium state has been reached in all runs) and $t = 10,000$.

<table>
<thead>
<tr>
<th>creation rate</th>
<th>$\phi = 0.0001$</th>
<th>$\phi = 0.001$</th>
<th>$\phi = 0.01$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$m = 0.001$</td>
<td>0.35</td>
<td>0.01</td>
<td>0</td>
</tr>
<tr>
<td>$m = 0.005$</td>
<td>0.47</td>
<td>0.24</td>
<td>0</td>
</tr>
<tr>
<td>$m = 0.01$</td>
<td>0.47</td>
<td>0.33</td>
<td>0.03</td>
</tr>
<tr>
<td>$m = 0.05$</td>
<td>0.50</td>
<td>0.46</td>
<td>0.24</td>
</tr>
<tr>
<td>$m = 0.1$</td>
<td>0.50</td>
<td>0.48</td>
<td>0.34</td>
</tr>
</tbody>
</table>

Table 4. Average relative number of endocentric compounds for different values of $\phi$ and $m$.

Both parameters $\phi$ and $m$ turn out to affect the occurrence and, if so, the value of the equilibrium. The higher the value of $\phi$, which controls the entrance of phrases into the system, the lower the amount of compounds in the equilibrium. The higher the value of $m$, the higher this amount of compounds. In fact, the only settings in which no equilibrium develops are those with a very low value for $m$. Apparently, the
process of name creation ‘supports’ the compounds in this case, by adding more (metonymic) compounds to the system.

Figure 3. Development of compounds with endocentric meaning in a system of compounds and phrases with different values for $m$ and $\nu$. Top: $\psi = 0.0001$, middle: $\psi = 0.001$, bottom: $\psi = 0.01$. $\nu = 0$.

These results contrast sharply with those from the runs without meaning. In these runs, it was impossible for an equilibrium to develop without the presence of the selection pressure against phrases ($\nu$), even for high values of $m$. In the current runs in which the three meanings are added to the system, equilibria develop in most runs, without this selection pressure against phrases needed. Even though phrases
are continuously added to the system through parameter \( \phi \), the continuous presence of metonymic compounds brings a stable number of compounds to the system as a whole. This leads to a sufficient number of endocentric compounds being created, because the name creation process is partly based on the general type frequency of both compounds and phrases.

Figure 4. Development of compounds with endocentric meaning for different values of \( \nu \) and \( \phi \). \( m = 0.005 \) (left) and \( m = 0.05 \) (right).
So what effect does the addition of the third parameter, the selection against phrases (ν), have in the model with meaning? I have tested the same settings for the three main parameters ν, m and ϕ, as in the model without meaning, and the results are shown in figure 4. Parameter ν adds a selection pressure against phrases to the system and it is therefore not surprising that the results show equilibria for almost all settings. The only exception is the case in which a relatively high value of ϕ is combined with a relatively low value of m: phrases are entering the system at too high a rate, and neither the creation of new names nor any tested value of selection pressure ν is sufficient to stop endocentric compounds from going extinct.

As a matter of fact, the value of ν does not seem to have a significant effect on the value of the occurring equilibria for any of the settings. For all tested values of ϕ and m, the different values of ν all show very similar results: it is hard to distinguish the outcomes of the different settings in the graphs. The average values of the equilibria are shown in table 5, to which I have added the relevant values for ν = 0 from the previous table.

<table>
<thead>
<tr>
<th></th>
<th>average relative number of endocentric compounds</th>
<th>m = 0.005</th>
<th>m = 0.05</th>
</tr>
</thead>
<tbody>
<tr>
<td>ϕ = 0.0001</td>
<td>ν = 0</td>
<td>0.47</td>
<td>0.50</td>
</tr>
<tr>
<td></td>
<td>ν = 0.001</td>
<td>0.46</td>
<td>0.50</td>
</tr>
<tr>
<td></td>
<td>ν = 0.005</td>
<td>0.46</td>
<td>0.50</td>
</tr>
<tr>
<td></td>
<td>ν = 0.01</td>
<td>0.46</td>
<td>0.51</td>
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<tr>
<td></td>
<td>ν = 0.05</td>
<td>0.53</td>
<td>0.57</td>
</tr>
<tr>
<td>ϕ = 0.001</td>
<td>ν = 0</td>
<td>0.24</td>
<td>0.46</td>
</tr>
<tr>
<td></td>
<td>ν = 0.001</td>
<td>0.23</td>
<td>0.46</td>
</tr>
<tr>
<td></td>
<td>ν = 0.005</td>
<td>0.23</td>
<td>0.46</td>
</tr>
<tr>
<td></td>
<td>ν = 0.01</td>
<td>0.23</td>
<td>0.47</td>
</tr>
<tr>
<td></td>
<td>ν = 0.05</td>
<td>0.27</td>
<td>0.53</td>
</tr>
<tr>
<td>ϕ = 0.01</td>
<td>ν = 0</td>
<td>0</td>
<td>0.24</td>
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<tr>
<td></td>
<td>ν = 0.001</td>
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<tr>
<td></td>
<td>ν = 0.005</td>
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<tr>
<td></td>
<td>ν = 0.05</td>
<td>0</td>
<td>0.27</td>
</tr>
</tbody>
</table>

Table 5. Average relative number of endocentric compounds for different values of ϕ, m and ν.
As table 5 shows, the tested values of $\nu$ give very similar results with regards to the height of the equilibrium. Only a sufficiently high value for $\nu$ ($\nu = 0.05$) is capable of increasing the relative number of endocentric compounds in the system.

So why is the effect of parameter $\nu$ more limited in the model with meaning than in the model without meaning? The reason seems to be that the parameter only functions for a subset of all the names that enter the system. If a metonymic name is created, it will get a compound form and if an exocentric meaning is created, it will get a phrase form. In the latter case, phrases will never turn into compounds because of parameter $\nu$, because no compounds exist in this niche. Thus, parameter $\nu$ is only effective in the niche of endocentric meaning and therefore has a limited effect on the system as a whole. Importantly, equilibria can develop without $\nu$, and with meaning, indicating that meaning itself is a resource for which forms compete, and thus provide a selection pressure for the reproduction of forms.

In summary, I have tested the effect of the three main parameters on the existence of compounds in the system. When meaning is absent, it turns out to be very hard for compounds to remain present. Phrases are constantly added to the model, and because the choice of type (compound or phrase) during name creation depends on the type frequency of compounds and phrases, more and more phrases are being added, until compounds become extinct. Compounds can only remain present in the system with a sufficiently large pressure against phrases (parameter $\nu$), in combination with a low value of $\phi$ (addition of phrases) and a relatively high name creation rate.

When meaning is added to the model, the system becomes much more stable. Both types have one of the meaning niches exclusively to themselves, so that they only have to share one meaning niche. This gives each type a strong base of names that prevents them from easily going extinct in the shared niche, and an equilibrium develops for most of the tested settings of the main parameters. Parameter $\nu$, representing phrase variability, turns out not to have a very strong effect in the runs with meaning, because its scope is limited to the subset of endocentric meaning. Whether or not an equilibrium develops depends mainly on the interplay between the innovation rate and the addition of phrases.

However, in both simulations with and without meaning, compounds are the ‘weaker’ name type of the two: they can still go extinct in the endocentric meaning niche with a sufficient addition of phrases. Generally though, the existence of meaning niches gives compounds a sufficiently strong buffer against the invasion of phrases.
3.5 Discussion and conclusions

In this chapter, I have discussed the phenomenon of free variation in the domain of AN-names in three West-Germanic languages. Although the domain of category naming is typically the territory of words, compounds in this case, we find that this function is performed by lexicalized phrases as well. Hence, there are two forms ‘competing’ for the same function, or meaning in a broad sense.

This phenomenon has a biological parallel in the case of species competing for the same ecological niche. A principle in the field of ecology known as the ‘principle of competitive exclusion’ states that this situation cannot lead to an equilibrium. Due to stochastic processes, one of the two species will eventually take over the niche completely, unless some sort of differentiation or specialization takes place. Only in the latter case can the two species co-exist in a state of equilibrium, because they have ceased to compete for the same niche.

I have proposed to consider the domain of AN-names as a ‘niche’ for which the two linguistic variants compete, and discussed two main selection pressures that are at work in this system. A first selection pressure is a factor, or complex of factors, that leads to phrases steadily entering the system. A second selection pressure is that, due to the presence of a case system, phrases show variability in their appearance, which results in a preference for compounds over phrases.

Using an agent-based computer model, I have shown that a system with two forms competing for the same niche is indeed a very unstable system. Compounding is the ‘basic’ form for category names, but phrases enter the system at a slow but steady rate, and as a result, eventually take over this function completely. The presence of a selection pressure against phrases can slow down this process but not stop it, unless the pressure is very strong. This means that the preservation of compounds in a language like German, with its elaborate case system, might be explained in this way, but the fact that compounds are also preserved in Dutch and English, which exhibit little or no phrase variability, cannot.

However, the case of AN-names turns out to be more complex. I have shown how three semantic subtypes of AN-names can be distinguished: those with endocentric, exocentric and metonymic meaning. This means that the two forms have the possibility for semantic specialization, and such specialization has indeed taken place. The metonymic sub-niche is the exclusive domain of compounds, and the exocentric sub-niche that of phrases, while both forms are present in the endocentric sub-niche.

With the computer model, I have shown that this particular distribution might be the actual cause of the equilibria in the three languages. The fact that both forms have an exclusive presence in one sub-niche gives them a basic frequency, which leads to preservation in the shared niche of endocentric meaning. Thus, it can
be claimed that the possibility for niche specialization leads to linguistic preservation.

Some points should be added to this finding. First, I have assumed that the exclusiveness of the metonymic and exocentric domain is a *cause* and not an *effect*. I have made this assumption partly for linguistic reasons, but also partly as a demonstration of the effect of such a scenario. The second point is related to this issue, and concerns the simplicity of the model. It was my goal to show varying dynamics of two linguistic variants in a simple system, not to have a truly realistic representation of the complexities of language. One simplification was the construction of the agents’ memory: only the 100 most recently perceived names were stored. Because new names were constantly added to the model, it was impossible for names to remain present in the system for a longer period of time. This, of course, is a simplification of reality: as we have seen, various names have been around for centuries. It might very well be the case that the presence of these ‘relic’ names affects the system as a whole, in that compounds are able to remain around for longer. Coming back to the first point, this might mean that, even with a less strict separation of meanings for the forms as I have used in the model, equilibria could be possible. In general, it should be noted that the way an agent’s memory and behavior is modeled has a significant effect on the outcome of the model.

A third point is the linking of the findings of the model to the actual languages German, Dutch and English. In the model without meaning, phrases eventually take over the system because of the parameter $\varphi$, which represents the steady addition of phrases to the system. This process can only be countered by high values of the parameter $\nu$ (which represents phrase variability). It certainly seems plausible that German has a higher value for phrase variability than Dutch (and English), because of its elaborate case system. On the other hand, there is no reason to assume that phrases enter the system at very different rates in the two languages. So it could be the case that the reason why German differs from Dutch and English in the presence of compound forms can be explained by these parameters. However, to conclude this, we would have to know the actual ratio of these parameters in these languages.

In the runs with meaning, the value of parameter $\nu$ had no significant effect on the relative number of endocentric compounds. This outcome means that the pressure that this parameter represents – phrase variability – cannot be used to explain the differences in the number of endocentric compounds between Dutch and German. Instead, these differences would have to be explained by differences in innovation rate and the addition of phrases. Again, to conclude whether this is actually the case, we would have to know the ratio of both parameters in Dutch and German.
A conclusion that can be drawn from this chapter is that the isomorphism principle might be better reinterpreted as an exclusion principle. The isomorphism principle states that language has a tendency for a one-to-one mapping between form and meaning. However, this principle seems to be violated often, for example in the case of polysemy (cf. chapters 2 and 5). It is mostly in cases of competition that a one-to-one mapping of form and meaning occurs; ‘the non-survival of one of them may simply be the negative aspect of the survival of the other’, as Hockett (1958: 399) puts it. In other words, one-to-one mappings of form and meaning seem to be the product of competition of forms for the same resource: meaning. Polysemy, on the other hand, consists of a multiplicity of meanings (or ‘senses’) associated with a single form; this violates isomorphism (one-to-one mapping), but it is compatible with the exclusion principle as presented here. In the case of polysemy, meanings could be construed as competing for the same form, but this would be a wrong kind of construal. The communicative power of a system is not diminished if it can still express multiple meanings with the same form, and therefore, polysemy should not be regarded as a competition between meanings. This actually seems to follow from the way a form’s ‘meaning’ is constructed in the usage-based approach: as a collection of multiple, very specific form-meaning combinations. This leads to a notion of meaning that is almost necessarily polysemous, but in which the specific form-meaning combinations do not ‘compete’ with each other but co-exist ‘peacefully’ instead.
Chapter 4

The syntactic and semantic development of the Dutch verb *krijgen*

4.1 Introduction

In their famous dictionary of the German language, the Grimm brothers refer to the German verb *kriegen* as ‘eins der merkwürdigsten wörter unserer sprache, mit mehreren dunklen stellen in seiner geschichte’. Indeed, *kriegen* is quite a remarkable verb: it can be both a main verb and an auxiliary, it can take an agentive subject, an agentive indirect object or no agent at all, and it can be used in the semi-passive construction.

The Grimm brothers most probably would have given the Dutch verb *krijgen* the same description, had they written about Dutch. Not only is *krijgen* a cognate of *kriegen*, the two verbs shows a similarly wide array of use. The Dutch historical dictionary, *Het Woordenboek der Nederlandsche Taal* (*WNT*), the counterpart of the Grimm brothers’ dictionary of German, writes:

Het is vrijwel onmogelijk een volledige opsomming te geven van alle toepassingen waarin *krijgen* wordt gebezigd; een overzicht van het gebruik moge dus volstaan. (*WNT s.v. krijgen*)

[It is almost impossible to give a complete list of all uses of *krijgen*; an overview of its usage may therefore suffice.]

The rich variation in the present-day use of *krijgen* should be seen as a reflection of its history. As I will show in this chapter, *krijgen* is a textbook example of grammaticalization.

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1 Parts of this chapter have been published previously in Landsbergen 2006a and Landsbergen 2006b.

2 The entire phrase is: ‘Es gilt heutzutage für ein niedriges, ja fast für ein pöbelwort, ist aber geschichtlich eins der merkwürdigsten wörter unserer sprache, mit mehreren dunklen stellen in seiner geschichte.’ [It nowadays counts as a humble, yes almost a word for the masses, but it is historically one of the strangest words of our language, with several dark places in its history.]

The history of *krijgen* will be the subject of the next three chapters. The main goal of this study is to see how different quantitative and cultural evolutionary methods can be used as complementary tools in diachronic linguistic research. I argue that such tools may provide extensive additional insight in historic processes and their underlying mechanisms.

In the present chapter, I start by presenting the historical development of *krijgen*, which serves as the basis for the subsequent two chapters. For this, I have performed a conventional diachronic corpus study, which will identify the verb’s main syntactic and semantic development from early middle Dutch to present-day Dutch. I will show that *krijgen* has changed from a concrete, agentive verb to a more abstract, non-agentive verb, although some relics of the original use still exist today. I will also discuss how the different present-day auxiliary uses of *krijgen* have come into existence.

Apart from a description of the verb’s history, I will also discuss the mechanisms that might have led to the changes. For this, I will mostly focus on the development of the transitive use and the role of the direct object therein.

This last aspect of *krijgen*’s change is also the topic of chapter 5. I will use the findings of the current chapter and apply them to a computer model that simulates the development of *krijgen*’s meaning. The main focus of this chapter is the model itself and the way it deals with the indirect transmission of meaning. I will also discuss the notion of semantic extension versus semantic shift, which is a relevant issue in semantic change in general and in the case of *krijgen* in particular.

In chapter 6, I will present a technique that makes it possible to reconstruct the diachrony of *krijgen* on the basis of synchronic data. This technique is called ‘phylogenetic reconstruction’ and is generally used in biology and linguistic typology. The goal of the chapter is to introduce this technique to historical linguistic research, and to discuss its merits and pitfalls. I will do so by comparing its results with the results of the diachronic study from the present chapter.

4.2 Current and past use of *krijgen*

Before I start with the results of the diachronic corpus study, I will first discuss the synchronic variation of *krijgen* in more detail in this section, and shortly mention what is already known about *krijgen*’s past. Examples (1-10) show most of the common uses of *krijgen* in present-day Dutch:

1) Andrew kriegt voor zijn verjaardag een fiets.
   ‘Andrew gets a bike for his birthday.’
Notice first that in many, yet not all, examples, *krijgen* is translated with English ‘get’. Although the verbs are very similar in their use, there is no complete overlap. I will therefore use translations that are as semantically close to the original Dutch sentence as possible throughout this chapter, sometimes using get, sometimes using verbs like obtain or receive or even a totally different construction. See Landsbergen (2006b) for a further discussion about the similarities between the two verbs.

Examples (1-10) give a good impression of the syntactic and semantic variation of *krijgen*. The use in (1), with a ‘receiving’ meaning and a recipient subject is the most common use for native speakers of Dutch, together with that in (2), in which the subject has a patient role. Examples (1-3, 7, 9) have a clear non-agentive subject, while the subject in (6, 8, 10) is at least partially agentive. Example (5) is somewhat ambivalent. The subject clearly has the intention of obtaining

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3 The two verbs are apparently unrelated, yet show a similar original meaning and a similar development. This gives rise to the question whether this similarity is due to universal grammaticalization tendencies that are inherent to the type of verb (a basic verb with a ‘transfer’ meaning), or whether this could be a case of grammatical replication: the transfer of linguistic structure from language to another by contact (Heine & Kuteva 2005).
something, yet the actual act of transfer is carried out by a (implicit) third party. Direct objects can be both concrete (1) and abstract (3-4). In some examples, the direct object becomes the ‘possession’ of the subject, either in an abstract or in a concrete way. Yet this is not the case for examples (2-4, 7, 10), in which *krijgen* does not express a transfer, but rather a change of state.

At the syntactic level, *krijgen* is a main verb in (1-6), and an auxiliary in (7-10). In (9), *krijgen* is an auxiliary of the semi-passive. These four auxiliary uses also differ strongly from each other. Examples (7-8) both have a *te* + INF complement, but (7) has a recipient subject while (8) has an agentive subject. Examples (9-10) also have formal similarities, yet differ in that (9) has a recipient subject and (10) has an agentive subject.

It should be noted that examples (6) and (8) take the compulsory complements in *handen* and *te pakken* respectively. If (6) were used without *in handen*, the unmarked reading would be one of ‘receiving’, with a non-agentive subject, and the same applies when *te pakken* is left out from (8).

<p>| | |</p>
<table>
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</table>
| 6) | a. ADO heeft de koppositie in de competitie in handen gekregen.  
'ADO has gained the first position in the soccer league.'  
b. ADO heeft de koppositie in de competitie gekregen.  
'ADO has been given the first position in the soccer league.'  

<p>| | |</p>
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<thead>
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</table>
| 8) | a. Als ik je ooit te pakken krijg, heb je een groot probleem.  
'If I ever get ('obtain') you, you have a big problem.'  
b. Als ik je ooit krijg, heb je een groot probleem.  
'If I ever get ('receive') you, you have a big problem.'  

With the exception of this construction, *krijgen* has a default non-agentive meaning in its unmarked, transitive use. Only in a limited set of more or less specific constructions it can take an agentive subject. Example (5) should also be seen in this light. Although *krijgen* is used as a bare transitive, its semi-agentive use could be said to be limited to a construction with the modal verb *kunnen*.

**The semi-passive and resultative constructions**

Example (9) shows the so-called ‘semi-passive’ use of *krijgen*. This construction typically consists of verbs like *aanbieden* ‘to offer’, *uitreiken* ‘to hand out’, *overhandigen* ‘to hand over’, and *voorschotelen* ‘dish up’: verbs that describe a specific kind of transfer. Its characteristics are described in Royen (1952), Hoekstra (1984) and Broekhuis & Cornips (1994). Historically, the semi-passive seems to be a relatively new construction in Dutch. Royen (ibid.: 259) mentions a first occurrence in 1907:
Ze moest nog lessen betaald krijgen, Godfried ook.
‘She still had to get paid classes, and Godfried as well.’
(Duykers, Rosa 189 (example from Royen 1952: 259))

The semi-passive differs from the regular passive in that not the direct but the indirect object of the active construction becomes the subject:

12) a. active
De rector reikt de diploma’s uit aan de scholieren.
‘The principal hands out the diplomas to the students.’

b. regular passive
De diploma’s worden door de rector aan de scholieren uitgereikt.
‘The diplomas are handed out to the students by the principal.’

c. semi-passive
De scholieren krijgen de diploma’s uitgereikt door de rector.
‘The students get the diplomas handed out by the principal.’
(all examples from Landsbergen 2006a: 158)

Hoekstra (1984: 71) has noted that the participant that has the agent role can be expressed with two different prepositions in the semi-passive construction, door ‘by’ and van ‘from’:

13) Zij kregen van/door de KNVB nieuwe grensrechters toegewezen.
‘They were assigned new linesmen by the KNVB.’
(example from Hoekstra 1984: 71)

An explanation for this phenomenon lies in the ambivalent nature of the semi-passive construction. In regular transitive constructions of krijgen, the source role is expressed in an adjunct phrase with the preposition van ‘from’ (14). In regular passive constructions, this is done with the preposition door ‘by’ (15). Since the semi-passive construction can be interpreted as a mixture of both constructions, it is not strange that both prepositions can be used interchangeably.

14) Het meisje kreeg een brief van haar oma.
‘The girl got a letter from her grandmother.’

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1 Hoekstra (ibid.) gives a formal explanation for this phenomenon. In the case of van, the PP-phrase is an argument of krijgen rather than being part of the small clause: Zij [kregen van de KNVB] [nieuwe grensrechters toegewezen]. However, the ‘giver’ can also be expressed as an argument in the small clause, in which case door is the usual preposition used in combination with participles: Zij [kregen] [door de KNVB] [nieuwe grensrechters toegewezen].
15) De brief werd gestuurd door haar oma.
   ‘The letter was sent by her grandmother.’

Returning to examples (1-10), there is another auxiliary use of *krijgen* that is
formally identical to the semi-passive, in that it also takes a direct object and a
present participle:

10) De AiO kreeg het artikel maar niet afgemaakt.
   ‘The PhD student could not get the article finished.’

However, a closer look shows that there are both syntactic and semantic differences
between the two constructions. In the semi-passive construction, the agent role is
expressed by an oblique phrase that may also be absent. In the construction in (10),
the agent role is expressed by the subject, and therefore, an indirect object is not
possible. On the semantic level, the meaning of the semi-passive construction can
still be described as an act of transfer (16). The construction in (10) has a very
different meaning, in which the subject changes the state or location of the direct
object (17). I will refer to this use as the resultative construction.

16) *semi-passive construction*
   [SUBJ is given DIR OBJ in manner PART (by OBL)]

17) *resultative construction*
   [SUBJ changes DIR OBJ in manner PART]

This use has been called ‘the new *krijgen*’ by Van der Horst (2002: 174). In a short
article, he describes this apparently new use of *krijgen*. Consider the following
examples:

18) Het kind krijgt zijn eten niet naar binnen.
   ‘The child cannot get his food inside him.’

19) De AiO kreeg zijn abstract afgekeurd.
   ‘The PhD student’s abstract was rejected.’

20) Hij krijgt zijn computer niet gestart.
   ‘He cannot get his computer started.’

21) De lezer vraagt zich af hoe hij dit eiwit zo snel geklopt krijgt.
   ‘The reader wonders how he gets the egg white whipped so fast.’
   (example from Van der Horst 2002: 175)
Van der Horst notices that in the middle of the twentieth century, examples such as (18-20) are used. In these examples, *krijgen* can be combined with a complement which has the form of a prepositional phrase or an adverbial phrase, with an agentive subject (18). These complements can also be participles (19-21). At first, the action described in them is not performed by the subject: in (19), the PhD-student is not rejecting the abstract himself, but someone else has done this instead. Gradually, examples start to appear that are ambiguous with regards to who is performing the action. Example (20) can either mean ‘he does not succeed in that he starts up the computer’ or ‘he does not succeed in having the computer start up’, with the two examples having the subject and the direct object performing the action respectively. Only in the 1990s of the twentieth century, examples like (21) start to appear, in which the subject clearly is the one performing the action. It is in this last step that *krijgen* can be considered a proper auxiliary.

Although this scenario is not implausible, we will see that the corpus data I will discuss in the next section do not support it. Instead, there seems to be a development that is reverse to what Van der Horst proposes: a change from the use with the subject performing the action to a use in which the subject is not performing the action. Also, the development seems to have started much earlier than the twentieth century.

Regardless of this, Van der Horst makes the very interesting observation that the use of *krijgen* as in (21) can be taken as a new auxiliary that would ‘complete’ part of the Dutch auxiliary system: where *worden* ‘to become’ has the meaning ‘to get into a state of being’, *krijgen* has the meaning ‘to get into a state of having’. The relationship between *worden* and *zijn* is analogous to that between *krijgen* and *hebben*.

22)  

   *worden* : *zijn*  
   *krijgen* : *hebben*  

Van der Horst explicitly states that this auxiliary use of *krijgen* is not a finished process, and that it is not even sure if it will ever become a full auxiliary. Indeed, the ambivalent status of *krijgen* in this construction can be shown by two simple tests. First, Dutch verb clusters allow scrambling as long as a verb remains in final position, but with *krijgen*, this leads to a questionable sentence (23c-d).

23)  

   a.  Hij wil zijn mailtje morgen verstuurd hebben.  
   b.  Hij wil zijn mailtje morgen hebben verstuurd.  

   ‘He wants to have his email sent by tomorrow.’
c. Hij wil zijn mailtje morgen verstuurd krijgen.
d. ?? Hij wil zijn mailtje morgen krijgen verstuurd.
   ‘He wants to get his email sent by tomorrow.’

The fact that verstuurd ‘sent’ cannot be put at the end of the sentence seems to suggest that it is not interpreted as a verb but rather as an adjective. This, in turn, would make krijgen the main verb of the sentence instead of the auxiliary. This can also be shown by the possible positions of krijgen in three-word clusters: verstuurd cannot be put in the middle of the cluster or at the end, but has to precede it (24).

24) a. …dat hij zijn mailtje verstuurd heeft gekregen.
   b. ?? …dat hij zijn mailtje heeft gekregen verstuurd.
   c. ?? …dat hij zijn mailtje heeft verstuurd gekregen.
   ‘…that he has got his email sent.’

In a similar way, the auxiliary status of krijgen in the semi-passive can also be questioned. In (25-26), it is the participle uitgereikt ‘handed out’ that does not always behave like a full main verb.

   b. ?? De student heeft het diploma gekregen uitgereikt.
   ‘The student was handed out the diploma.’

26) a. De student zal het diploma morgen uitgereikt moeten krijgen.
   b. ?? De student zal het diploma morgen moeten krijgen uitgereikt.
   ‘The student will have to be handed out the diploma tomorrow.’

This behavior of uitgereikt is an indication that in the semi-passive as well, krijgen should not be considered a full auxiliary. Rather, its syntactic properties can better be described by treating it as a main verb to which a participle (uitgereikt) is added to specify the kind of transfer.

This is in line with the explanation of the origin of the German semi-passive with kriegen by Kuteva (2004: 39). She states that the German semi-passive has come into existence by a process of specification, in which an adjectival participle is added to an initially transitive structure, and kriegen should still be considered a full main verb. Interestingly, kriegen differs from krijgen in that its semi-passive use has grammaticalized further. The construction in (27) is ungrammatical in Dutch (28).

27) Dann kriege ich immer geschimpft.
   ‘Then I always get scolded.’
   (example from Lehmann 1991: 516-517 [see Kuteva 2004: 39])
28) *Dan krijg ik altijd uitgescholden.
   ‘Then I always get scolded.’

The semi-passive shares some of its characteristics with *te + INF, in that the thematic roles of the two constructions are assigned to the syntactic roles in a similar way. The passive characteristics of the *te + INF construction were also observed by Hoekstra (1984: 69-70). The main difference between the two is that the subject of the infinitive in the *te + INF construction is the subject of *krijgen (29), while the subject of the participle in the semi-passive is another participant (which is possibly implicit) (30).

29) De studenten kregen het diploma te zien.
   ‘The students got to see the diploma.’
   ≈ ‘The students saw the diploma.’

30) De studenten kregen het diploma uitgereikt.
   ‘The students were handed out the diploma.’
   ≈ ‘Someone handed out the diploma to the students.’

Linking the present variation to the past

The use of *krijgen with an agentive subject seem to be a reflection of the original meaning of the verb, which had an almost exclusive agentive meaning. According to the Middle Dutch Dictionary (MNW), *krijgen (then spelled *crigen) originally had both an intransitive and a transitive use. The intransitive use had the meanings ‘to fight’, ‘to proceed to’ and ‘to strive for’, which probably derived from the noun *crijch ‘effort’, ‘stubbornness’, ‘fight’, ‘war’ that was also current in Middle Dutch. *Crijch, later spelled *krijg, has become extinct in present-day Dutch, but still exists as a bound morpheme describing military activities: *krijgsmacht ‘military force’, *krijgsraad ‘court-martial’ and *krijgsgevangene ‘prisoner of war’.

The transitive use of *krijgen in Middle Dutch is described in the MNW as ‘to obtain with effort’, ‘to win’, ‘to persuade someone’ and the not necessary agentive meaning ‘to contract, to catch’ when combined with objects such as *schande ‘shame’ and *angst ‘fear’.

In Middle Dutch, the verb *gecrigen is also in use. It is almost similar in use to *crigen, with the addition that *gecrigen can also be used with a complement, in which case it gets the meaning ‘to get someone from somewhere’ or ‘to get someone to do something’.

According to the *Woordenboek der Nederlandse Taal (WNT), which roughly describes the period 1500-present, the sense of effort has gradually disappeared from the meaning of the verb. This led to the use of the verb as it is known today, in
which the subject becomes the possessor of something (either in a concrete or abstract way) without his or her action or even intention.

The main development of the verb *krijgen* seems to be clear from the descriptions in the historical dictionaries. In the next section, I will take a closer look at this development and try to get a better understanding of the mechanisms behind it.

### 4.3 Exploring *krijgen*’s history: a corpus study

**Data collection**

For the diachronic study of *krijgen*, I collected 1276 sentences from the period 1300-2000, which roughly covers the periods of Middle Dutch, Modern Dutch and present-day Dutch. Data collection was done using two electronic corpora, the CD-ROM *Middelnederlands* (MNW, 1300-1500) and the electronic version of the *Woordenboek der Nederlandse Taal* (WNT, 1500-1979). The former is a collection of medieval texts, both prose and poetry, and both religious and worldly. The latter also consists of non-fiction texts such as newspaper articles and scientific works.

Although present-day Dutch is commonly considered a homogeneous language, especially in written sources, the same cannot be said about earlier stages of Dutch. Middle Dutch is a collective name for a number of dialects that were spoken and written in the region that is now covered by the Netherlands and parts of Belgium: Brabantian, Hollandic, low Saxon, Limburgish and Flemish (De Vooys 1970: 34-40, Van der Wal 1992: 108-121). These dialects sometimes differed quite significantly in their phonetic, morphologic and syntactic characteristics.

Two other complicating factors that are well known among all those doing diachronic research are genre and dating. Both corpora embody different genres, and there are often considerable linguistic differences between them. This is mostly due to differences in register; some texts are a strong reflection of spoken language while other texts use a more ‘elevated’ style. Also, texts in rhyme should be treated with caution because their language might be affected by the poetic license of the writer.

‘Dating’ is problematic because it sometimes cannot be determined when exactly a text has been conceived. Even if a date is known, one can still be dealing with a rewriting of an earlier work, in which case it is unknown how much the scribe altered the original work.

For the research presented here, I have chosen not to distinguish between genres or dialects, but to use all available uses of *krijgen* and to assume that the large sample size would lead to a reliable picture of the general development of the
verb. Also, I will discuss certain characteristics of genres on the way. As for dating, I will use the dates given by the two corpora, and group the sentences by century.

From both corpora, I collected all instances of the lexemes krijgen and gekrijgen with their different spellings. Gekrijgen was added because it was found that it was already almost synonymous with krijgen in Middle Dutch, and because it has been gradually replaced by krijgen since then. From all these instances, I randomly selected around 200 sentences per century. When referring to the ‘corpus’, I am referring to this collection of sentences.

Krijgen (and gekrijgen) have been spelled in many different ways over the centuries. These differences do not only reflect changes in orthography (such as the replacement of ‘c’ by ‘k’ in the 17th century), but also a phonological change: crigen in Middle Dutch was pronounced [kriɣən], while probably around the 16th-17th century, the [iː] changed into [ɛi]. German kriegen still has the original vowel.

For reasons of clarity, I will use the spelling krijgen, even when discussing Middle Dutch use. This means that its spelling in the text might differ from that of the examples, especially in the older examples.

Decline of the intransitive

From the general introduction of the use of krijgen in present-day Dutch and the descriptions of its use in earlier stages, it is clear that somewhere on the way, the intransitive use of krijgen must have become extinct.

The MNW (s.v. crigen) gives three different meanings of the intransitive use: ‘to fight’, ‘to proceed to’ and ‘to strive for’, and all three meanings are indeed found in 14th century sentences in the corpus (31-33).

31) to fight
   Here, wil nicht met u cryghen, was yr spricht, das is waer.
   ‘Lord, I do not want to argue with you. What you say, is true.’
   (Haagse liederenhandschrift; 1390)

32) to proceed to
   Doen hi sach, dat met nide die viande al ten hertoge creghen, woude hi hen met crachte jeghen.
   ‘When he saw that the enemy proceeded to the duke with passion, he wanted to oppose them with force.’
   (Jan van Heelu - Rymkroniek; 1395)
33) *to strive for*

Hier beghinto een eewich hongher die nummermeer vervult en wert. Dat es een inwindich ghiren ende crighen der minnender cracht [...].

‘Here starts an eternal hunger that is never fulfilled. It is an inner longing and striving of the loving force.’

(Jan van Ruusbroec - Die gheestelike brulocht; 1335)

<table>
<thead>
<tr>
<th>century</th>
<th>intransitive use</th>
</tr>
</thead>
<tbody>
<tr>
<td>14th.</td>
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<tr>
<td>15th.</td>
<td>1 / 159</td>
</tr>
<tr>
<td>16th.</td>
<td>3 / 183</td>
</tr>
<tr>
<td>17th.</td>
<td>1 / 167</td>
</tr>
<tr>
<td>18th.</td>
<td>1 / 167</td>
</tr>
<tr>
<td>19th.</td>
<td>0 / 194</td>
</tr>
<tr>
<td>20th.</td>
<td>0 / 250</td>
</tr>
</tbody>
</table>

Table 1. Number of intransitive sentences with *krijgen* per century, compared to the total number of sentences per century in the corpus.

Figure 1. Relative number of intransitive sentences with *krijgen* per century.

These intransitive uses of *krijgen* do not remain in use for very long. Although it is generally considered that the intransitive use of *krijgen* has preceded the transitive, its use is already not highly frequent anymore in the 14th century, and disappears almost completely after that (table 1 and figure 1). The last intransitive sentence in the corpus dates from 1721. Another indication that the intransitive use is already on its way out in the 14th century is that a majority of the examples are found in the works of only two authors, Jan van Ruusbroec (*Dat rijcke der ghelieve*, Een
spieghel der eeuwigher salicheit, Vanden XII beghinen and Die gheestelike brulocht) and Jacob van Maerlant (Spiegel Historiacel). Intransitive use with the meaning ‘to strive for’ is only found in Ruusbroec’s works. Later examples (from 1688 and 1721) are from a bible translation and a work that uses biblical language, and should not be considered standard.

**Decline of gekrijgen**

It is assumed (in the historical dictionaries MNW and WNT) that originally, *krijgen*, without the perfective prefix *ge-* was used intransitively, and *gekrijgen* was used transitively, but examples from the 14th century show that *krijgen* is already being used as a transitive as well in that period. The loss of the prefix *ge-* is not restricted to *krijgen* alone, it is a common process in the transition from Middle Dutch to Mo-

<table>
<thead>
<tr>
<th>century</th>
<th>use of gekrijgen</th>
</tr>
</thead>
<tbody>
<tr>
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<td>92 / 119</td>
</tr>
<tr>
<td>15th.</td>
<td>47 / 141</td>
</tr>
<tr>
<td>16th.</td>
<td>55 / 172</td>
</tr>
<tr>
<td>17th.</td>
<td>7 / 148</td>
</tr>
<tr>
<td>18th.</td>
<td>1 / 145</td>
</tr>
<tr>
<td>19th.</td>
<td>0 / 171</td>
</tr>
<tr>
<td>20th.</td>
<td>0 / 221</td>
</tr>
</tbody>
</table>

**Table 2.** Number of uses of *gekrijgen* per century, compared to the total number of transitive sentences per century in the corpus. Instances in which *gekrijgen* is the past participle in a sentence were left out, because this is the participle of both *krijgen* and *gekrijgen*.

**Figure 2.** Relative use of *gekrijgen* in transitive sentences in the corpus per century.
dern Dutch. Ge- originated as a Gothic prefix ga- meaning ‘together’ (still found in examples like gebroeders ‘brothers’), but gradually turned into a marker of perfectivity (Van Loey 1970: 159-160). Due to loss of stress it has disappeared from the non-perfective use of many verbs (gelukken > lukken ‘to succeed’, gelijken > lijken ‘to be alike’), while it has remained present in participles where it still had a clear perfective function (Van Loey ibid.: 115). Apart from this, the quick downfall of the intransitive krijgen has probably had an accelerating effect on the loss of ge- in gekrijgen, since the necessity to formally distinguish between the two meanings was no longer present. As figure 2 shows (with the absolute data in table 2), gekrijgen has gradually been replaced in the transitive use by krijgen, and this process seems to be completed in the 18th century.

Decline of the agentive subject

Apart from the intransitive use, 14th century krijgen has two other main uses: (1) a ‘bare’ transitive (34), which is the unmarked transitive use with a subject and a direct object, and (2) a transitive use in combination with a complement with a resultative meaning (35).

34) Daer ne was sward geen so goet, al had Walewein gecregen.
   ‘There was no sword so good, as the one Walewijn had gotten into his possession.’
   (Roman van Moriaen; 1300)

35) Het staet so onderwilen, dat ment niet uutgecrigen en mach [uit het oor], om dat so diepe es daerin gesteken met onwisen handen.
   ‘It is sometimes the case, that one cannot get it out of the ear, because it has been put in there by unsteady hands.’
   (Cyrurgie, Boek III-V; 1353)

These uses are related in their sense of ‘effort’ the subject has to make in order to obtain something. In (34), the direct object, a sword, becomes the possession of the subject. In (35), this sense of possession is less strong but the subject does obtain control over the direct object and changes its location. At this point, it is useful to look at the development of get, which occurs in a similar resultative construction. It has been argued that this construction has developed from the transitive use in a series of steps (Givon & Yang 1994, Gronemeyer 1999). First, an optional indirect object (tos) was possible in the benefactive use of get, giving a causative meaning (36). Locative complements become possible by considering the benefactive object as a target location of the direct object (to God in 37).
36) Get us som mete and drynke, and make us cheere
   ‘Get us some food and drinks, and make us happy.’
   (1340-1400; example from Givon & Yang 1994: 123)

37) For with that orison sche getyth to god ful many soules that were in oure
    power fast beforn.
    ‘For with that prayer she gets to God many souls that had been firmly in our
    power.’
    (1470-1500; example from Gronemeyer 1999: 24)

For *krijgen*, it is possible that the locative complements of (35) have developed
according to a similar scenario, and this must then have happened before 1300. The
only argument against this scenario is that the benefactive use of *krijgen* that is
needed as a first step occurs very rarely in the corpus, with a first occurrence in 1569
(38).

38) Jck creegh hem (een fles wijn) om nyet, vry sonder betalen.
    ‘I got him a bottle of wine for free.’
    (Med. V. A. 1938, 126; 1569)

I will discuss the further development of the resultative construction in more detail
later on, and now focus on the gradual loss of subject agentivity.

The three main uses of *krijgen* in the 14th century that I have mentioned so
far all have a clearly agentive subject. This again, is in line with a noun ‘effort’ as
origin, and the verbal derivative ‘to make an effort’. However, already in the 14th
century, the transitive is also used with subjects that show different degrees of
agentivity:

39) *Partial agentivity*
   Heete speciën, machmense ghecrighen, ... sijn goet dan (voor de
   gezondheid),
   ‘Hot herbs, if one can get them, … are good for the health.’
   (Jacob van Maerlant – Heimelijkheid der Heimelijkheden.; 1300)

40) *Possible agentivity*
   “Twi wasic,” seit hi, “ie geboren. In gecreech nie geval, noch nembermeer
   hebben ne sal.”
   ‘“Why was I ever born,’ he said. ‘I never got any luck, nor will I ever have
   it.”’
   (Roman van den riddere metter mouwen; 1300)
In (39), it is the subject’s intention to obtain the herbs, but, in a standard reading, the actual transfer is done by another person. In (40), geval ‘luck’ is an object that cannot simply be ‘obtained’, but a reading is possible in which the subject makes an effort to get it. Only in (41), it is hard to detect any possible agentivity of the subject. At most, the subject has the desire or hope to get the object. Other examples of this latter type are sentences in which objects are used that have a negative effect on the subject, such as zoene ‘punishment’, beteringhe ‘fine’. Together, four degrees of agentivity can be distinguished (42):

\[
\begin{array}{cccc}
& 1 & 2 & 3 \\
\text{full agentivity} & > & \text{partial agentivity} & > \text{possible agentivity} > \text{no agentivity}
\end{array}
\]

This division can be used to see how the use of krijgen changes over the centuries. I leave the intransitive use, which should be considered fully agentive, out of the further discussion because of its marginal frequency, and restrict myself to the transitive use, with and without complements. Figure 3 (with the absolute data in table 3) shows the development of the four types of agentivity from 1300-2000.

<table>
<thead>
<tr>
<th>century</th>
<th>no agentivity</th>
<th>possible agentivity</th>
<th>partial agentivity</th>
<th>full agentivity</th>
</tr>
</thead>
<tbody>
<tr>
<td>14th.</td>
<td>19 / 140</td>
<td>23 / 140</td>
<td>52 / 140</td>
<td>46 / 140</td>
</tr>
<tr>
<td>15th.</td>
<td>45 / 158</td>
<td>14 / 158</td>
<td>50 / 158</td>
<td>49 / 158</td>
</tr>
<tr>
<td>16th.</td>
<td>74 / 180</td>
<td>15 / 180</td>
<td>46 / 180</td>
<td>45 / 180</td>
</tr>
<tr>
<td>17th.</td>
<td>105 / 166</td>
<td>9 / 166</td>
<td>18 / 166</td>
<td>34 / 166</td>
</tr>
<tr>
<td>18th.</td>
<td>122 / 166</td>
<td>7 / 166</td>
<td>14 / 166</td>
<td>23 / 166</td>
</tr>
<tr>
<td>19th.</td>
<td>129 / 194</td>
<td>5 / 194</td>
<td>24 / 194</td>
<td>36 / 194</td>
</tr>
<tr>
<td>20th.</td>
<td>183 / 250</td>
<td>13 / 250</td>
<td>20 / 250</td>
<td>34 / 250</td>
</tr>
</tbody>
</table>

Table 3. Use of the four different types of agentivity in transitive sentences (both ‘bare’ transitives and transitives with complements) in the corpus.
Figure 3. Relative use of the four different types of agentivity in transitive sentences (both ‘bare’ transitives and transitives with complements) in the corpus.

Immediately obvious is the sharp increase of sentences that have no subject agentivity, rising from 14 percent in the 14th century to 73 percent in the 20th century. The three uses with lesser or more subject agentivity all show a gradual decrease in frequency over time. However, their frequencies are already quite low in the 14th century. Does this mean that 14th century krijgen was already not that agentive? I argue against this, from the four types of agentivity I distinguish here, only one is clearly not agentive. The types I have labeled ‘fully agentive’ and ‘partial agentive’ (with examples of their use in 38 and 39) lumped together make up almost 70 percent of the sentences in the 14th century, and this number decreases to about 11 percent in the 20th century. Of the sentences labeled ‘possibly agentive’ it is hard to determine whether they should be considered agentive or not. It is likely that their interpretation is largely dependent on the prototypical use of transitive krijgen. This would mean that 14th century speakers of Dutch would have interpreted their use as agentive, while current speakers would interpret it as non-agentive.

In the above description, I have not considered possible differences in distribution of the agentive subject use between different sentence types. However, a distinction can be made between sentences like het zwaard krijgen ‘get the sword’ (ex. 34) and iets uit het oor krijgen ‘get something out of the ear’ (ex. 35). I will refer to the former type as ‘bare transitives’ and to the latter as ‘complement sentences’. It turns out that the decline of agentive subject use was initially restricted to bare transitives. Only since the 18th century, complement sentences start to occur with non-agentive use: iets te zien krijgen ‘be shown something’ and iets aangeboden krijgen ‘get offered something’, the semi-passive construction. Figure 4 on the next page (with the absolute data in table 4) shows the different development of both types of krijgen.
Table 4. Subject agentivity (both partial and possible agentivity) in transitive sentences, shown per transitive sentence type: bare transitives and complement sentences.

<table>
<thead>
<tr>
<th>century</th>
<th>subject agentivity in bare transitive sentences</th>
<th>subject agentivity in complement sentences</th>
</tr>
</thead>
<tbody>
<tr>
<td>14th.</td>
<td>90 / 132</td>
<td>8 / 8</td>
</tr>
<tr>
<td>15th.</td>
<td>93 / 152</td>
<td>6 / 6</td>
</tr>
<tr>
<td>16th.</td>
<td>73 / 162</td>
<td>18 / 18</td>
</tr>
<tr>
<td>17th.</td>
<td>30 / 144</td>
<td>22 / 22</td>
</tr>
<tr>
<td>18th.</td>
<td>20 / 148</td>
<td>17 / 18</td>
</tr>
<tr>
<td>19th.</td>
<td>30 / 159</td>
<td>30 / 35</td>
</tr>
<tr>
<td>20th.</td>
<td>23 / 208</td>
<td>31 / 42</td>
</tr>
</tbody>
</table>

As figure 4 also shows, agentive subjects have not completely disappeared from the bare transitive use of *krijgen* in 20th century Dutch. Instead, their occurrence seems to have stabilized at a low frequency since the 18th century. They appear with fully agentive subjects (43-44) and sentences with partially agentive subjects (45-46).

43) „Nú? Om dézen tijd?” riep hij verbaasd, zijn horloge uit zijn vestzak krijgend.
   ‘“Now, at this time?” he said surprised, getting his watch out of his waistcoat-pocket.’
(Mooy, Maastr. 2, 152; 1928)
For most 21st century speakers of Dutch, example (43) sounds a bit odd. Instead, its meaning would be paraphrased as in (43'), with the verb *pakken* or *halen*, both with the meaning ‘to take’.

(43’) „Nú? Om déze tijd?” riep hij verbaasd, zijn horloge uit zijn vestzak pakkend/halend.
‘“Now, at this time?” he said surprised, getting his watch out of his waistcoat-pocket.’

However, (43) could also be interpreted in a different way, as a transitive sentence with a locative complement:

(43’’) „Nú? Om dézen tijd?” riep hij verbaasd, zijn horloge uit zijn vestzak krijgend.
‘“Now, at this time?” he said surprised, while succeeding in removing the watch from his pocket.’

(43’’) (Mooy, Maalstr. 2, 152; 1928)

As such, the sentence is perhaps less ungrammatical for present-day speakers, yet still not fully grammatical. I will come back to this issue later, when discussing the development of the complement sentences.

The only fully agentive, transitive use of *krijgen* that has remained in use in present-day Dutch is that of (44). Its use is restricted to a very specific construction in which the direct object is usually a person that is being caught against his or her will, and the construction has an exclamative intonation:
47) Form: [SUBJ DIR OBJ (nog wel) krijgen]
   Meaning: [get a person against his/her will]
   Prosody: [stress on krijgen, exclamation]

The loss of subject agentivity in bare transitives over time correlates with other phenomena. First, there is a gradual increase in the use of inanimate subjects (48-49), as also be seen in figure 5 (with the absolute data in table 5 shown below).

<table>
<thead>
<tr>
<th>century</th>
<th>inanimate subjects</th>
</tr>
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<tbody>
<tr>
<td>14th.</td>
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</tr>
<tr>
<td>15th.</td>
<td>5 / 152</td>
</tr>
<tr>
<td>16th.</td>
<td>4 / 162</td>
</tr>
<tr>
<td>17th.</td>
<td>12 / 144</td>
</tr>
<tr>
<td>18th.</td>
<td>13 / 148</td>
</tr>
<tr>
<td>19th.</td>
<td>16 / 159</td>
</tr>
<tr>
<td>20th.</td>
<td>67 / 208</td>
</tr>
</tbody>
</table>

Table 5. Number of sentences with inanimate subjects in bare transitive sentences per century. Personifications are counted as animate.

Figure 5. Relative number of sentences with inanimate subjects in bare transitive sentences per century.

48) ‘t Engels Fregat de C. ... (wiert) soodanigh ... getroffen, dat 3 schooten onder water kreeg, en gants reddeloos was.
   ‘The English frigate C. was hit in such a way, that it got three shots under water, and was past recovery.’
   (Holl. Merc. 18; 1673)
Dit word gezeid van wijn die door lang wan gelegen te hebben een smaak naar het vat krijgt.
‘This is said of wine that acquires the taste of the barrel after having laid half full for a long time.’
(Halma; 1729)

Second, as mentioned earlier, direct objects start to appear that cannot be combined well with an intentional, agentive subject (50-51).

Doe ghecreech ic van u sulc eenen hurt, dat mijn dryakelbusse wiert ghesturt.
‘Then I got such a push from you, that my box of antidote was thrown over.’
(Keuren van de ambachten; 1441)

Doen cregen wy een moye coelte uyten zuyden, also da het men onse riemen in leyde, ende maeckten seyl.
‘Then we got a nice breeze from the south, so that we shipped the oars and prepared the sails.’
(O.-I. e. W.-I. Voyag. 1, 72 c; 1598)

In order to get a better understanding of the mechanisms behind the loss of agentivity, it is revealing to take a closer look at two classes of objects: objects that describe states or conditions of the subject, like ‘disease’, ‘impression’ and ‘appetite’ (52), and those that describe mostly abstract transfer like ‘answer’, ‘consent’ and ‘order’ (53).

Hij kreeg er (in het kamp) al gauw malaria en dysenterie, [maar] vocht er niet tegen,
‘He soon got malaria and dysentery at the camp, but did not fight it.’
(Oriëntatie 23-24, 3; 1949)

De scheepswerf „Voorwaarts” in Hoogezand kreeg van haar opdracht voor de bouw van een „botel”.
‘The shipyard “Voorwaarts” in Hoogezand got her order to build a “botel”.’
(Ons Zeew. 58, 12, 14 b; 1969)

Over time, there is a slow increase in the use of objects denoting states, from around 13 percent in the 14th century to 43 percent in the 20th century (figure 6 and table 6 on the next page). This type of objects is therefore already present when *krijgen* still has a mainly agentive meaning, although the prototypical objects denoting states (such as the ones mentioned earlier) do not allow for an agentive reading.
Chapter 4

<table>
<thead>
<tr>
<th>Century</th>
<th>Objects Denoting States</th>
</tr>
</thead>
<tbody>
<tr>
<td>14th.</td>
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</tr>
<tr>
<td>15th.</td>
<td>51 / 152</td>
</tr>
<tr>
<td>16th.</td>
<td>49 / 162</td>
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<tr>
<td>17th.</td>
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<tr>
<td>18th.</td>
<td>63 / 148</td>
</tr>
<tr>
<td>19th.</td>
<td>54 / 159</td>
</tr>
<tr>
<td>20th.</td>
<td>91 / 208</td>
</tr>
</tbody>
</table>

Table 6. Number of sentences with objects denoting states in bare transitive sentences.

Figure 6. Relative number of sentences with objects denoting states in bare transitive sentences.

However, I have shown that already in the 14th century, *krijgen* is not exclusively agentive anymore. Sentences with non-agentive meaning make up around 14 percent of the total transitive sentences. It could be possible that the objects denoting states are found with non-agentive meaning. However, this is not the case. In exactly half of the sentences, objects denoting states are combined with more or less agentive subjects in the 14th century (54-55). This can also be seen in figure 7 (and table 7).

54) Hoe si best sonder meer wigen *haren pays* mogen gecrigen.
   ‘How they can get their peace without any more effort.’
   (Spiegel Historiael; 1315)

55) Est dat ghi wilit den rechten weg te volcomenheden gaen, soe piint u boven al te gecrighene *zuverheid van herten*.
   ‘If you want to take the right way of perfection, then do your best to gain purity of the heart above all.’ (Horologium; 1340)
Table 7. Development of the number of agentive (full, partial and possible) subjects in sentences with different kinds of objects in bare transitive sentences.

<table>
<thead>
<tr>
<th>Century</th>
<th>Objects denoting states</th>
<th>Abstract objects</th>
<th>Concrete objects</th>
</tr>
</thead>
<tbody>
<tr>
<td>14th.</td>
<td>66 / 132</td>
<td>0 / 132</td>
<td>122 / 132</td>
</tr>
<tr>
<td>15th.</td>
<td>63 / 152</td>
<td>76 / 152</td>
<td>141 / 152</td>
</tr>
<tr>
<td>16th.</td>
<td>43 / 162</td>
<td>43 / 162</td>
<td>137 / 162</td>
</tr>
<tr>
<td>17th.</td>
<td>15 / 144</td>
<td>8 / 144</td>
<td>73 / 144</td>
</tr>
<tr>
<td>18th.</td>
<td>17 / 148</td>
<td>0 / 148</td>
<td>70 / 148</td>
</tr>
<tr>
<td>19th.</td>
<td>9 / 159</td>
<td>0 / 159</td>
<td>61 / 159</td>
</tr>
<tr>
<td>20th.</td>
<td>5 / 208</td>
<td>26 / 208</td>
<td>83 / 208</td>
</tr>
</tbody>
</table>

Figure 7. Relative number of agentive (full, partial and possible) subjects in sentences with different kinds of objects in bare transitive sentences.

This unexpectedly high percentage does not hold long; over time, the proportion of sentences with objects denoting states and agentive subjects decreases dramatically, making way for the non-agentive use. A similar development takes place with objects denoting abstract transfer, only one century later (see figure 7). Initially, there are no sentences with abstract objects, but in the 15th century, objects like respij ‘extension of time’ and wille ‘consent’ (56) appear. Later, objects like antwoord ‘answer’ and opdracht ‘order’ start to appear.

56) Ic sal u tot eenen wive trouwen. Ic hope het en sal ons niet berouwen. Ic heb ghcreghen algader mijnder moeder wille ende vader.

‘I will marry you to be my wife. I hope we will not regret it. I have obtained my mother’s and father’s consent.’

(Roman van Jonathas ende Rosafiere; 1495)
Like with the objects denoting states, we initially find a high percentage of objects that are combined with an agentive subject (50 percent in the 15th century), but a sharp decline in this use over time. However, this trend starts about a century later than is the case for the objects denoting states. On the other hand, the decline in frequency of agentive subjects in sentences with abstract objects takes place at a higher speed, thereby making up for the later start. In the 17th century, the percentage of agentive subjects combined with abstract objects is already lower (5.5 percent) than those combined with objects denoting states (10.3 percent).

Concrete objects used are objects such as geld ‘money’, potlood ‘pencil’ and mensen ‘people’, and are used in combination with krijgen throughout the whole corpus. Interestingly, the distribution of agentive subjects differs strongly from that of both abstract objects and objects denoting states (see figure 7). Although there is a clear decrease in agentive subjects over time, this tendency has started later than for both other object types, and also seems to have stabilized at a higher rate than the other two uses. In the 20th century, concrete objects are still combined with subjects that show some degree of agentivity in 40 percent of the sentences.

Summarizing, transitive krijgen shows a loss in the use of agentive subjects over time, but this loss is unevenly distributed over the different direct objects it is combined with. Of the three main groups of objects, objects denoting states started to be used with non-agentive subjects first, followed by abstract objects around a century later, and concrete objects another two centuries later. This order seems to suggest that the loss of agentivity of krijgen has originated in the use with objects denoting states, and from there has spread to other uses as well.

Of course it is hard to determine cause and effect from examples alone. The semantic change of krijgen could have been initiated by another mechanism, and this could have affected the objects used with the verb. But what goes against this is the uneven distribution of agentive subjects among the different kinds of objects. If krijgen had started to lose its agentivity in a way in which the objects played no causal role, an even, or at least more even distribution of agentive subjects would be expected among the objects than was found.

The hypothesis raises two related questions: (1) how exactly did this change take place, and (2) why has this change originated in the use with objects denoting states?

Let us say that krijgen at one point, probably in the mid 13th century, was a fully agentive verb with the meaning ‘obtain with effort’. This entails a use with objects that are compatible with this meaning: objects like ‘storm’, ‘beating’, ‘critique’ or ‘blushes’ were not possible, but objects like ‘castle’, ‘sword’ and ‘food’ were. It is in this context that examples like (57-58) start to appear, in which we find the obtaining of a state by an agentive subject, mostly in Christian contexts.
Op dat wy overmids inwendigher oefeninghen ghestadicheit van herten mochten crighen ende onsen lieven Heer aenhanghen.

‘So that we by means of inner practice can obtain stability of the heart and join our Lord.’

(Brugman; 1400)

Dieselve leerre scrijft aldus mede: “Met pinen gekrijcht hi gesondichede, wien die quale so hout verblent, dat hi hem selven ne siet no kent”.

‘That same doctrine also writes: “With hardship he, who is kept so blinded by the disease, that he sees nor knows himself, gets healthy”’

(Spiegel der sonden; 1440)

However, such mental or physical states are not typical objects that are obtained with intention and effort like a castle or a sword. Instead, they are usually obtained without any intention, let alone effort. It is likely that this particular aspect of states has played a crucial role in the semantic change of krijgen. Although states were initially used with agentive subjects, the nature of the direct object led to a less agentive interpretation. This might have specifically occurred when the context was not disambiguating, as in (59).

So began si te dencken op die salicheit hare sielen want si en hadde gheen hope weder te crighen ghesontheit des lichaems.

‘Thus she started to think about the salvation of her soul, because she had no hope of obtaining physical health again.’

(Marialegenden en –exempelen; 1479)

This process led to a changing role for the other participant that could appear in an oblique phrase. Initially, this participant had a source role: an object was obtained from the other participant. As the subject gradually lost its agentivity, this gave way for the other participant to take over this active role. Many examples in the corpus are ambiguous with regard to the roles of the subject and the (sometimes implicit) other participant (60-61). Only (62) has a clear non-agentive subject.

Als David inden sonden vel, hy bekende sijn misdade, hy riep an God, hi bat ghenade, soe langhe dat hi creech perdoen.

‘When David fell into sin, he confessed his crimes, he called to God, he prayed for mercy so long until he obtained forgiveness.’

(gedichten Hildegaersberch; 1470)
61) (=56) Ic sal u tot eenen wive trouwen. Ic hope het en sal ons niet berouwen. Ich heb ghecreghen algader mijnder moeder wille ende vader. ‘I will marry you to be my wife. I hope we will not regret it. I have obtained my mother’s and father’s consent.’ (Roman van Jonathas ende Rosafiere; 1495)

62) Den XIXen ende XXen februarij creghen de ghues ghoede tijdijnghe. ‘On February 19th and 20th, the rebels received good news.’ (v. Vaernewijck, Ber. T. 2, 125; 1567)

Development of the complement construction

Earlier, I mentioned that 14th century krijgen can be used as an intransitive verb, a bare transitive verb and a transitive verb with a complement, such as (63-65).

63) (=35) Het staet so onderwilen, dat ment niet uutgecregen en mach [uit het oor], om dat so diepe es daerin gesteken met onwisen handen. ‘It is sometimes the case, that one cannot get it out of the ear, because it has been put in there by unsteady hands.’ (Cyrurgie, Boek III-V; 1353)

64) Op dat ic Gelloene mach eenechsijns te campe gecrigen. ‘So that in some way I can get Gelloene to fight me (litt. ‘get Gelloene at a fight’).’ (Roman der Lorreinen; 1340)

65) Mocht sine in haren arm ghecrighen, hine souten haer niet swighen. ‘Should she get him in her arms, he would not conceal anything from her.’ (Borchgravinne van Vergi; 1350)

These complements are all locative, they describe the movement of a person or object from or to a certain location. It is not until the 15th century that complements start to occur that describe locations that should be interpreted as figurative rather than literal locations such as in his hand (66).

66) Aldus hielden si haer lant, tot dat die hertoge van Brabant, […] titel, wapene, ende lant al weder creegh in sijn hant. ‘Thus they kept their land, until the duke of Brabant […] got title, weapon and land back in his possession again (litt. ‘back in his hand’).’ (Brabantsche yeesten; 1432)

As a next step, adjectives denoting states first appear in the 16th century (67), and soon after, a specific type of adjective, the adjectival participle, appears as well (68-
69). Adjectival participles are adjectives derived from verbs, and therefore, this marks an important step in the development of *krijgen* as an auxiliary.

67) Ende so daer de eene Sluetel niet op en paste, sy mochte eene andere versoecken […] dat sy het Slot op crege.
   ‘And because the key did not fit, she tried another one, so that she got the lock open.’
   (Marnix, Byenc; 1569)

68) Desen dach waren eenige ruyteren uyt Heusden naer des viants leger gereden […] ende rencontreerden eenige voeragiers, daeraf sij eenigen gevangen crege.
   ‘On this day, some horsemen had ridden from Heusden towards the enemy’s army, and encountered some freebooters, of which they took some prisoner (litt. ‘of which they got some caught’).’
   (Duyck, Journ.; 1600)

69) Sij […] konden haar drank niet als met een gemeen Herbergs vuur ontdoid krijgen.
   ‘They could not get their drink defrosted like they would with an ordinary fire at the inn.’
   (Selds. Walvisv. 52; 1684)

These examples can be interpreted in two ways: as ‘to get a person/object in a V-ed state’ and ‘to V a person/object’. In the latter interpretation, the main activity described in the examples is reduced to that of the complement, which is a first indication of a reanalysis of *krijgen* from main verb to auxiliary. This would mean that (68-69) can be regarded as the first examples of what Van der Horst (2002) calls the ‘new *krijgen*, in which case this use is much older than the early 1990s which was originally proposed (Van der Horst ibid.: 176). A schematic representation of this process is given in (70).

70) Auxiliation cline of *krijgen*

\[
\begin{align*}
{krijgen + PP (location)} & \rightarrow {krijgen + PP (state)} & \rightarrow {krijgen + AP (state)} & \rightarrow {krijgen + PART (state)} \\
{Vf + complement} & \rightarrow & {AUX + Vf}
\end{align*}
\]

This new, aspectual use of *krijgen* has not replaced the original resultative constructions with complements denoting locations or states. In present-day Dutch, the latter type is still productive (*ik krijg die spijker niet uit de muur* ‘I can’t get that nail out of the wall’, *het kind krijgt zijn bord niet leeg* ‘the child can’t get his plate empty’). It is in these constructions that the subject has kept at least some of the agentivity of the original *krijgen*. However, over time, some more idiomatic
complement use of *krijgen* has developed in which the agentivity of the subject seems less strong than in the examples given above, such as *in het verzicht/oog krijgen* (71-72), *in zicht krijgen, onder zijn hoede krijgen, in het vizier krijgen* (73). I assume that these were originally used with an agentive subject, but have gradually lost some, but not all, of this agentivity, possibly under the influence of the development of the transitive use. Since there are very few examples of this particular use in the corpus, this has to remain a hypothesis.

71) Zo de Kogel te laag [...] gevallen is, dan laat ik het Stuk agter in de Broek zo veel neerzakken, tot dat ik [...] wederöm myn begeerde punt B *in 't Verzicht* kryg.
   ‘If the ball has fallen too low, I will lower the piece in the back of the sail until I get my wanted point B in sight again.’
   (v. Kinsbergen, Zeem.-Handb. 2, 5, 154; 1782)

72) Bij een bocht van den weg, krijg ik de eerste rietvelden *in het oog*.
   ‘At a curve in the road I get the first reed lands in sight.’
   (v. Moll, De Natuur, 281 b; 1896)

73) De twee luchtvloten krijgen elkaar *in 't visier*!
   ‘The two airfleet get each other in sight.’
   (Natuur en Vernuft 1, 41 b; 1916)

An interesting characteristic of both the resultative use and the aspectual use of *krijgen* is that they seem to be used mostly in negative contexts, and are often combined with the modal verb *kunnen* ‘can’, although both elements are by no means obligatory. Semantically, it is questionable whether both uses should be considered fully agentive in present-day Dutch. Its use in the imperative sounds rather odd (74).

74) a. ??Krijg de soep opgegeten!
   ‘Get the soup eaten!’

   b. ??Krijg je bord leeg!
   ‘Get your plate empty!’

And the same is the case when the construction is embedded as a complement of verbs such as *beloven* ‘to promise’ (75).

75) a. ??Ik beloof je de soep opgegeten te krijgen.
   ‘I promise you to get the soup eaten.’

   b. ??Ik beloof je mijn bord leeg te krijgen.
   ‘I promise you to get my plate empty.’
The question is whether the resultative use of *krijgen* has always been not fully agentive but rather ‘pseudo-agentive’, or whether this is a later development. A major problem is that examples like the ones above do not occur in the corpus, and that, of course, their grammaticality cannot be tested with constructed examples. Still, I would argue for a scenario in which the agentivity of *krijgen* has weakened over time. I have shown that *krijgen* has a highly agentive origin and that the resultative construction has already been present from this early stage on. Where the transitive use of *krijgen* has lost almost all its agentivity over the centuries, it seems most likely that this has had its effect on the resultative construction as well.

*Development of the non-agentive complement use*

There is considerable variation among the different auxiliary uses of *krijgen* with respect to subject agentivity. The auxiliary use in the resultative construction [krijgen DIR OBJ PARTICIPLE] has developed from the complement construction in which at least part of the subject agentivity of *krijgen*’s original use has remained present. However, subject agentivity is absent in two other auxiliary uses (76-77, repeated from above).

76) (=7) Tijdens de vlucht kregen we Casino Royale te zien.
   ‘During the flight we got to see Casino Royale.’

77) (=9) De prins kreeg het eerste exemplaar uitgereikt door de directeur.
   ‘The prince was handed the first exemplar by the director.’

The construction [DIR OBJ te INF krijgen] first occurs in the corpus in the beginning of the 18th century (78). Although *krijgen* can be interpreted as either ‘receive’ or ‘take’, the latter is the most probable because of the adjunct time phrase. The next occurrence in the corpus has a clear non-agentive subject (79).

78) Die ’t ambacht kan, krygt de neering, zei de snyder, en hy kreeg een paar kousen in de Paaschweek te verzoolen.
   ‘He who knows the craft gets customers, said the tailor, and he was given a pair of stockings to resole in the Easter week.’
   (Tuinman 1, 261; 1726)

79) Hier krijgt men op zijn best alle dagen ééne schotel vruchten te zien.
   ‘At its best one is shown one fruit dish on all days here.’
   (J. v. Lennep, Lev. v. D. J. v. L. 1, 237; 1806)

I argue that this construction has originated in a process of specification, in which a te + INF adjunct has been added to the phrase to clarify the reason for the transfer of
the direct object to the subject. In (78), this reason is to let the tailor resole the stockings. In (79), the reason (‘to look at the fruit dish’) has moved to the background and the main meaning of the adjunct phrase is better described as specifying the manner in which the transfer takes place (seeing instead of actual transfer).

Apart from this specifying function, the \textit{te} + INF adjunct also disambiguates the sentence with respect to the thematic roles. This might have been a helpful tool in the period when this construction comes into use. \textit{Krijgen} is already mostly used with non-agentive subjects in the 18\textsuperscript{th} and 19\textsuperscript{th} century (figure 4). However, \textit{krijgen} still has mostly agentive subjects when combined with concrete objects (figure 9). When speakers wanted to express a non-agentive subject with a concrete object, such as in (78-79), it is therefore not surprising that they used adjuncts like \textit{te} + INF for disambiguation.

The other ‘auxiliary’ use of \textit{krijgen} with a non-agentive subject is the semi-passive construction. Its first occurrence in the corpus is from 1920 (80).

80) ‘s Avonds kreeg zij, keurig in enveloppe, f 50 thuisgestuurd.
‘At night, she got sent home fifty guilders, nicely in an envelope.’
(Naeff, Veulen; 1920)

In order to understand how and why this construction came into existence at this time, let us look again at some examples of the aspectual use of \textit{krijgen}:

81) Ook kreeg zij […] haar borden nog \textit{gewasschen} en haar pannen \textit{geschuurd}.
‘Also she got her plates washed and her pans scrubbed.’
(Schart.-Ant., Sprotje 2, 44; 1909)

82) Mijnheer Pardoes zat als verwezen en durfde waarlijk niet zeggen dat zijn \textit{éénige bijdrage} ’t half geld was waarvoor hij de advertentie had \textit{geplaatst} gekregen.
‘Mr Pardoes was dismayed and did not dare to say that his only contribution was that he got the advertisement \textit{placed} for half price.’
(Ned. Volksalm.; 1859)

83) Het ophouden te arbeiden, ten einde zekere eischen \textit{doorgevoerd} te krijgen,
of zekere eischen der werkgevers te weerstaan.
‘Stopping their work, in order to get certain demands \textit{carried out}, or to withstand certain demands by the employers.’
(Levit.-Polak, Diam.; 1908)

In these examples, the subject carries out an action to produce the result indicated by the participle. However, the examples differ with respect to the subject of the
participle. In (81), the subject of *krijgen* is also the subject of the participles *gewassen* en *geschuurd* ‘washed and scrubbed’. In (82-83), on the other hand, the subject of *krijgen* has *someone else* carrying out the respective actions of placing the advertisement and carrying out the demands.

In the corpus, the latter construction appears later than the former, which makes it probable to consider the latter an extension of the ‘new *krijgen*’: one in which the grammatical subject is still the agent, but in which it is no longer the subject of the participle. Although this step does not immediately change the agentive role of the subject, it does open the door for possible ambiguity. Note that in this light, it is not clear whether (84) is really a semi-passive or an ambiguous case of the ‘aspectual use of *krijgen*’, without more knowledge of the context.

84)  
Ze moest nog lessen betaald krijgen, Godfried ook.  
‘She still had to get paid classes, and Godfried as well.’  
(Duykers, Rosa 189; 1907 (example from Royen 1952: 259))

This reanalysis is made possible by the split between the subject of *krijgen* and the subject of the main verb. This creates an extra argument role, and the agentive role shifts from the subject of *krijgen* (in reading 85i) to this new argument (in reading 85ii), the subject of the main verb. Reading (85iii) represents the state in which the grammatical subject ‘he’ is no longer given an agentive interpretation.

85)  
Hij kreeg de advertentie geplaatst.  
‘He got the advertisement placed.’

i. He succeeded in having the advertisement placed.

ii. He succeeded in having the advertisement placed (by someone).

iii. Someone placed the advertisement (for him).

This last step is not a coincidence, but a consequence of the semantic change that the verb *krijgen* has undergone by the beginning of the twentieth century. The subject of *krijgen* has lost its agentivity in almost all transitive uses, except for the resultative constructions. When the agentive role shifts to the subject of the main verb, the subject of *krijgen* gets the role it also has in the transitive use, that of recipient. This process might be considered a case of ‘combined analogical pressure’, a term coined by Givón & Yang (1994: 130) for the similar case of the development of the *get*-passive. The main point of using this term is to stress that the development of the new form, in this case the semi-passive with *krijgen*, cannot be attributed to one ‘parent’ construction, but rather to two. The formal similarities between the transitive use and the auxiliary use most probably will have reinforced this process.
Increase in the frequency of use

Grammaticalization of a linguistic item usually leads to an increase in the frequency of use of the item. This is due to the fact that by processes of semantic bleaching and extension, the item can be used in a much wider array of contexts than when it still had lexical status. In the design of the corpus study of which I have discussed the results above, a study of the increase in frequency is not possible. In my data collection, I have randomly reduced all the instances of *krijgen* to around 200 per century. Another obstacle was the fact that the WNT-corpus consists of single sentences serving as examples for the entries throughout the dictionary. However, for a frequency study it would be necessary to have a large body of texts from which the occurrences of a single lexeme in different time periods can be measured.

In order to get a better understanding of the development in the frequency of use of *krijgen*, I have therefore carried out a separate frequency study, apart from the study above. A major practical problem was that there is not one historical corpus of Dutch that covers the period 1300-2000 in which each century is represented comparably in text size. I have therefore created a collection of texts from this period from two sources that were electronically available: the CD-ROM *Klassieke Literatuur*, a collection of Dutch literary texts from the period 1300-1900, and the DBNL, an online resource of Dutch language and literature. The collection consisted of texts from all genres, with roughly comparable amounts of words for each century (over 500,000 on average). Next, I searched for all instances of the lexemes *krijgen* and *gekrijgen* in all their different spellings. Figure 8 shows the results.

![Figure 8. Frequency of the lexemes *krijgen* and *gekrijgen* per century in a 3,500,000 word corpus.](http://www.dbnl.nl/titels/titels.php?c=15&s=c)
Figure 8 shows that the frequency of *krijgen* has increased dramatically since the 14th century. The sharpest increase occurred between 1300-1600. On the basis of the graph alone, it is hard to say whether the frequency of use has since then stabilized, or that it has continued to increase at a much slower rate. The latter seems to fit better with the continuing generalization process of the verb, which has given rise to new uses such as the ‘new *krijgen*’, the semi-passive, and shows a strong increase in the use of inanimate subjects in the 20th century (figure 5). The relatively low frequency of *krijgen* in the 19th century is somewhat surprising. One explanation could be that this period in Dutch literature is characterized by the use of a high-register kind of Dutch. Possibly under the influence of German (see Grimm’s quote in the beginning of the chapter), *krijgen* was considered ‘lower standard’ and replaced by synonyms like *bekomen* and *ontvangen*.

4.4 Discussion and conclusions

Present-day Dutch *krijgen* is a verb with a rich past. In this chapter I have given a detailed overview of how it has developed from its Middle Dutch use to the present. In the 14th century, *krijgen* is used in intransitive, transitive and complement constructions. These uses are all highly agentive, although the transitive use of *krijgen* already shows different degrees of agentivity. In the 15th century, the intransitive use has become almost completely extinct. The transitive shows a sharp decrease in agentive use, a process that will continue until at least the 17th century. This change occurs similarly with an increase in the use of objects that denote subject states. The decrease in agentivity of *krijgen* seems to take off in this particular use, followed by abstract objects a century later. The use with concrete objects does not seem to lose its agentivity until the 17th century.

In the 16th century, the use of inanimate subjects starts to increase, while the non-agentive use of transitive *krijgen* continues to expand. The complement use of *krijgen*, on the other hand, is still fully agentive. By the 17th century, the change from agentive to non-agentive seems to slow down. Most transitive use has now become non-agentive, although agentive use still lives on. Around this time, the first non-agentive complement sentences start to appear, which marks the beginning of the semi-passive.

Between the 18th century and the 20th century, the transitive use of *krijgen* is rather stable, with only the number of inanimate subjects still increasing. During this time, the auxiliary uses of *krijgen* start to develop. Except for the resultative construction, these uses have a non-agentive meaning. The original agentive meaning also lives on in a restricted number of specific transitive uses.
In a time span of less than 700 years, *krijgen* has undergone typical grammaticalization processes such as semantic bleaching and extension (e.g. Verhagen 2000b, Heine & Kuteva 2002, Hopper & Traugott 2003). Bleaching has probably been triggered by the use of direct objects denoting states of the subject. While these objects were initially combined with an agentive subject, their nature allowed a less agentive interpretation. This possibly has led to a loss of subject agentivity in the local context of objects denoting states, after which the process soon spread to other objects as well. Earlier, I mentioned that the initial use of objects denoting states with agentive subjects is found mainly in Christian contexts. An interesting question is therefore whether this specific context has played a crucial role in the development of *krijgen*, or that the change would have also taken place without it. Unfortunately, it is impossible to support either of these theories at this point, and a more thorough study is needed in order to do so.

It is probable that the loss of subject agentivity led to a reanalysis of the role of other participants (later expressed as indirect objects) from source to agent in specific contexts. Gradually, *krijgen* turned from a verb with a specific, lexical meaning (‘to obtain, to get into possession’) to a verb with an aspectual, ingressive meaning (‘to get into a state of having’).

The loss of semantic content is paralleled by an increase in the frequency of use. It can be argued that the latter process is a result of the former, although it is impossible to prove. In this scenario, the ‘bleached’ *krijgen* could be used in new contexts, such as those in which possession did not play a role (*we krijgen goed weer* ‘we are getting good weather’), in which the object was negative for the subject (*hij kreeg griep* ‘he got the flu’) and, in general, with inanimate subjects. This extension of use has led to an increase in the frequency of use. However, it should be noted that the sharpest increase in frequency seems to have occurred between the 14th and 15th century, while the strongest change to non-agentive use seems to have started slightly later.

The (semi-) auxiliary *krijgen* finds its origin in the transitive use with locative complements. When participles started to be used in these complements, they were at some point reanalyzed as the main verb of the phrase, turning *krijgen* into an auxiliary.

Development of new use did not mean an automatic disposal of the old: the grammaticalization of *krijgen* has progressed gradually and most of the various stages in the process are co-existing today. The locative complement construction from which most auxiliary use developed is still in use, and *krijgen*’s agentive past remains present in very restricted contexts.

The development of *krijgen* shows the typical process that change in general and grammaticalization in particular starts in highly local contexts (Bybee, Perkins & Pagliuca 1994: 11, Traugott 2003). On the other hand, the development of
the semi-passive seems to suggest that the semantics of the different uses of *krijgen* were not totally isolated from each other. Instead, they seem to have intertwined, with the semi-passive as a result.
Chapter 5

Simulating the semantic change of *krijgen* with an exemplar model of language

5.1 Introduction

In the previous chapter, I discussed how the verb *krijgen* has developed since the Middle Dutch period. Its main changes have been the loss of subject agentivity and the development of several auxiliary uses. Around 1300, *krijgen*’s prototypical meaning was ‘to obtain’, with an agentive and therefore animate subject. In its present day use, *krijgen* has two main prototypical uses, one that can be best described as ‘to receive’ (e.g. *De omroep kreeg veel reacties* ‘The broadcasting company received many reactions’) and one with a ‘change of state’ meaning (*Krijgen we ooit nog een strenge winter?* ‘Are we ever going to get another cold winter?’). In both of these cases, the subject is no longer the agent, and does not have to be animate. This bleached meaning of *krijgen* subsequently enabled the development of different auxiliary uses.

I argued that the main mechanism operative in these changes was the extension of the set of objects used with the verb. The characteristics of this set gradually changed, and in turn this led to a changing interpretation of the meaning of *krijgen*.

In this chapter, I will continue the study of *krijgen* with a series of computer simulations. I will present a model of the semantics of *krijgen* that is based on existing exemplar models that were developed for phonology and syntax. Meaning is particularly hard to model because it is not transmitted as directly as other aspects of language like morphology, phonology and even morphologically marked aspects of syntax such as case: while sounds and forms can be perceived and imitated, meaning generally has to be inferred. Of course, there is no absolute difference between the transmission of meaning on the one hand and the transmission of sounds and forms on the other hand. Rather, it can be argued that these aspects of language can be placed on a continuous scale of mode of transmission, in which sounds and forms would be positioned on one end, that of
direct transmission, and meaning would be positioned on the other, that of indirect transmission. The transmission of meaning itself can also occur more directly in some situations than in others; in the case of explicit instruction at school, new meanings are transmitted more directly than when they have to be inferred from context.

In the model I present in this chapter, I will represent this arguably continuous scale of transmission in a simplified way, with form transmitted directly, and meaning indirectly. In this system, the recipient agent in communication needs to infer the meaning of a particular utterance. For this, it will use both its present knowledge (which has been constructed in previous communications) and clues from the utterance itself. I will argue that in such a system, certain regularities and tendencies appear as well, and that these can be directly linked to semantic phenomena such as those observed in the case of *krijgen*. In other words, even a relatively ‘fuzzy’ system like semantics behaves in mechanistic ways that can be modeled, which is very much in line with the view on semantics as proposed in Traugott & Dasher (2002) and various studies on grammaticalization (e.g. Hopper & Traugott 2003). The model of transmission of meaning is in line with the model proposed by Croft (2000).

In this chapter, I will argue that the indirect transmission of meaning leads to a system that is relatively stable, but also easily prone to change. I will discuss factors that affect the amount of change, and factors that affect the preservation or loss of original meaning after a change has occurred. These factors include parameters that affect the individual behavior of agents – such as the likelihood to create new exemplars and the way agents link exemplars to abstract categories – as well as ‘external’ parameters such as population size and the run time of the model. I will argue that an exemplar-based model can produce a relatively realistic simulation of the development of *krijgen*.

### 5.2 Exemplar models and usage-based approaches to language

The main idea behind the model presented here is that a speaker’s knowledge of verb meaning consists of both specific instances, or exemplars, of use of the verb in context, and abstractions that are based on these exemplars. This approach is similar to that proposed by Bybee (2006), who argues for an incorporation of exemplar models (as used in e.g. Pierrehumbert 2001, Bod 2006 and Wedel 2006) into the usage-based view of language (e.g. Bybee 1985, Barlow & Kemmer 2000). Also, the model is in many ways similar to that of De Boer’s model of the vowel system, in which agents construct vowel exemplars based on ‘phonetic’ input (De Boer...
Exemplar theory is based on the notion that speakers are continuously sensitive to linguistic experience (Wedel 2006: 250 and references cited there). Linguistic categories (e.g. vowels or syntactic structures) are represented in memory by a large cloud of remembered tokens of that category (Pierrehumbert 2001: 140). These representations are ‘exemplars’: encoded versions of the perceived tokens. Each exemplar has a particular ‘strength’ or ‘activation’ level, which is based on both the frequency with which the exemplar has been perceived, and the recency of the last perception. The assumption is that memory decays over time, and that therefore exemplars are transitory. They can only remain part of the speaker’s knowledge if they are regularly activated by ongoing use.

The notion that linguistic knowledge is directly linked to linguistic experience is also one of the main tenets of usage-based approaches to language, such as construction grammar (Croft & Cruse 2004). Here too, we find the assumption that individual linguistic expressions that are perceived in communication are stored in memory, and that abstract categories are formed on the basis of generalization over these specific units (Bybee 1985, 2001, 2006). Bybee also introduces the notion of ‘lexical strength’, which is roughly similar to that of ‘strength’ or ‘activation’ in exemplar theory: ‘Each time a word in processing is mapped onto its lexical representation it is as though the representation [is] traced over again, etching it with deeper and darker lines each time. Each time a word is heard and produced it leaves a slight trace on the lexicon, it increases in lexical strength. The notion of lexical strength allows us to account for the various effects that frequency has on the behavior of words’ (Bybee 1985: 117, 2006). Another aspect that is shared by both construction grammar and exemplar models of language is the fact that both specific instances (e.g. an utterance like the older, the wiser) and abstract constructions based on these specific uses (the X-er, the Y-er) are part of an individual’s linguistic knowledge. Abstract categories, called schemas by Bybee (2001: 22), are constructed on the basis of similarities between specific exemplars. The number of exemplars of a category, the token frequency of that category, determines its strength. The token frequency will also have an effect on the productivity of the category, in that the higher the number of exemplars that belongs to a category, the greater the likelihood that this category will be used to form new items.

However, not all exemplars contribute equally to the category: the strength of an exemplar’s contribution is inversely linked to its frequency. A high frequency of a specific exemplar only strengthens its own representation, not that of its superordinate category, which is supported by the number of different exemplars.
Exemplars with a high frequency are more autonomous than those with a lower frequency (Bybee 2006: 715), and this autonomy reduces their contribution to the superordinate category (figure 1).

Both ‘layers’ of linguistic knowledge are included in the model I present here: ‘concrete’ exemplars representing actual utterances and abstract categories constructed on the basis of similar exemplars.

![Figure 1. A representation of the different role of exemplars on the strength of a particular category. Exemplars 1 and 2 are constructed on the basis of two utterances, and contribute equally to their superordinate category. Exemplar 3 is constructed on the basis of much more utterances: this higher frequency strengthens its own representation, but weakens its relative contribution to the superordinate category.](image)

### 5.3 Basic structure of the model

In this section, I will give a general description of the computer model, while I will discuss the mathematical details in the next section.

The computer model presented here simulates changes in the transitive use of *krijgen*. The design of the model is based on the model I discussed in chapter 2. In the present model, a group of agents ‘communicate’ with each other by exchanging utterances, which represent sentences containing the verb *krijgen*. The agents base their knowledge of the verb on the utterances they perceive in communication, and the way this occurs is based on two main assumptions that I discussed in the previous section. First, agents are continuously sensitive to linguistic experience: they alter their knowledge of the verb after each communication. This key aspect of the usage-based approach to language is also incorporated in the model presented by Baxter et al. (2006, to appear). Second, agents have no direct access to the meaning of the verb in an utterance, and therefore have to resort to other ‘strategies’ to reconstruct this meaning. In the model, there are two such strategies: (1) agents use their existing knowledge of the meaning of the verb, and (2) agents use contextual information from the utterance.
they perceive. In reality, ‘contextual information’ can be any information that is provided in the utterance that is directly transmitted. In the model, ‘context’ is limited to the direct object. At a later stage in the chapter, I will also discuss an elaborated version of the model, in which this ‘context’ is extended to both the direct object and the kind of subject.

Another key feature of the model which I also discussed in the previous section is that an agent’s knowledge of the meaning of *krijgen* consists of two ‘layers’: specific instances, or exemplars, of use of *krijgen*, and abstractions that are based on these exemplars.

Utterances in the model are represented as [verb - direct object] combinations:

1) **example sentence:** De jongen krijgt een cadeautje
   ‘The boy gets a present’

   **representation in the model:** [V O]

   ![Figure 2](image.png)

   **Figure 2.** The representation of the meaning of *krijgen* on a \([-1, 1]\) scale of agentivity. The example sentences serve as indications of the value of *krijgen* associated with the particular uses.

In the model, I will represent both the meaning of the verb (‘V’ from here on) and the kind of direct object (‘O’ from here on) on a one-dimensional scale, which leads to a two-dimensional space if the two are combined. The meaning of the verb is represented on a one-dimensional scale of agentivity, which ranges from ‘maximal subject agentivity’ on one end to ‘no agentivity’ in the middle, to ‘maximal other participant agentivity’ on the other end (figure 2). This range is based on the different meanings of transitive *krijgen* that I presented in chapter 4.
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In chapter 4, I also discussed how the different direct objects that are used with *krijgen* over time could be described in terms of ‘controllability’. The nature of some objects (like *sword* or *present*) is such that they allow for a controlling agent, while other objects (like *fever* or *good weather*) cannot easily be combined with any agent. Note that, in principle, controlling agents can be either the grammatical subject, or another participant (as in *Hij kreeg een cadeau van zijn vader* ‘He got a present from his father’, in which the father is the agent performing the action). In the model, objects that can be used in utterances with *krijgen* are represented on a one-dimensional scale of controllability, ranging from ‘maximally controllable’ to ‘maximally uncontrollable’ (figure 3).

Figure 3. The representation of the objects used in utterances with *krijgen* on a [0, 1] scale of controllability.

![Figure 3](image_url)

*Figure 3.* The conceptual space of the possible uses of utterances of *krijgen*. Each coordinate on the map represents a single possible utterance. The area within the dotted line shows the most probable uses.
As I mentioned above, the reduction of utterances to $V$-$O$ combinations, in which both items are represented as values on a one-dimensional scale, makes it possible to position each utterance as a point on a two-dimensional map, with verb meaning on the horizontal axis, and object controllability on the vertical axis. The result is a conceptual space that can be used in the analysis of the development of the verb’s meaning (Gärdenfors 2000: 159), as shown in figure 4.

The simulation consists of the iteration of ‘communications’ in which agents produce and perceive $V$-$O$ utterances. For each communication, two random agents are selected from the population, one speaker and one hearer. The speaker produces an utterance and the hearer perceives it. Of this utterance, the direct object $O$ is transmitted directly from the speaker to the hearer: its properties in terms of controllability are directly clear to the hearer. This is, of course, an idealization, but one that is legitimate for the purposes of this simulation: to model the hypothesis that knowledge of a verb’s meaning is (partly) derived from independent information about the objects it is combined with, and that this is a cause of semantic change. In the model, the form of $V$ is thus directly transmitted, but its meaning is not; the hearer has to reconstruct the verb’s meaning before it can store the utterance as an exemplar. I will explain how this reconstruction works in the next section.

When the hearing agent has reconstructed the value of $V$, it stores the perceived utterance as an exemplar in its memory. In addition, it will also create or adapt its knowledge of the abstract categories of $krijgen$ in its memory. This means that an agent’s knowledge of $krijgen$ is present in both stored exemplars of specific utterances and in the abstractions.

It is the speaking agent’s task to produce a $V$-$O$ utterance. This production is either the selection of an exemplar from its memory, or the creation of a new exemplar on the basis of an abstract category in the speaker’s memory. The former can be interpreted as conventional language use by means of a cliché, with the transmission of an existing exemplar (retrieved from memory only). The latter can be said to represent conventional but ‘novel’ language use, because it concerns the creation of a new linguistic item according to some general rule.

### 5.4 Mathematical details of the model

As I mentioned in the previous section, the model consists of a population of agents who produce and perceive $V$-$O$ combinations. This population consists of 20 agents. Generational turnover, in which agents die and are replaced by newborns, is left out of the model. This way, the effects of the addition of generations can be studied at a possible later stage. The standard simulation consists of 100,000 iterations, and
during each iteration, each agent is involved in 1 communication act as a speaker on average. Agents are randomly assigned the role of speaker and hearer.

Representation of knowledge of exemplars and abstract categories

Before explaining how the communication process works, I will first discuss how utterances are represented in the model, and how an agent’s knowledge is constructed. Agents have knowledge of both specific utterances, exemplars, and of abstract categories that are formed on the basis of similar exemplars. Utterances are V-O combinations, and both V and O are represented on a one-dimensional scale. This means that each utterance can be represented by its coordinates (x, y), with x [-1, 1] as the value for V on the scale of agentivity, and y [0, 1] as the value for O on the scale of controllability.

Agents have a memory in which they store both the utterances they perceive in communication as exemplars, and the abstract categories that they form on the basis of similar exemplars. This memory is not limited to a particular size. However, an agent’s memory is updated after each communication and exemplars that have not been used or perceived for a particular time are removed. I will discuss this process in more detail later on.

In memory, the coordinates e(x, y) of each exemplar e, are stored, together with the frequency of the utterances of which the exemplar is a token f(e) and its most recent use r(e). Recent use, or recency, keeps track of the number of iterations that have passed since the exemplar was last perceived in communication. For example, r(e) = 3 means that the particular exemplar was last perceived 3 iterations earlier. r(e) = 0 means that the exemplar has just been perceived.

Agents also have knowledge of abstract categories that are formed on the basis of similar exemplars in memory (Gärdenfors 2000: 109-110). This knowledge consists of the coordinates of the abstract category c(x, y) and its token frequency ftoken(c). The token frequency is the number of different exemplars that together make up the abstract category. I will discuss how exemplars are linked to a particular abstract category later on.

The coordinates of the abstract category are calculated by taking the average coordinates of the exemplars that belong to that category. As I discussed in section 5.2, exemplars with a high frequency contribute less to an abstract category than exemplars with a low frequency. Therefore, each exemplar’s contribution to the coordinates of the abstract category is weighed by using the inverse of its frequency. The equations for this calculation are shown in equation 1, and figure 5 gives a graphical representation.
Equation 1. Calculation of the x,y coordinates of exemplar \( c_i(x) \) and \( c_i(y) \), based on the coordinates of a set of exemplars \( e_i(x) \) and \( e_i(y) \) and the weight \( w_i \) of each exemplar. \( N \) is the number of relevant exemplars.

\[
\begin{align*}
  w_i &= \frac{1}{f(e_i)} \\
  c_i(x) &= \frac{\sum_{i=0}^{N} (w_i \cdot e_i(x))}{\sum_{i=0}^{N} w_i} \\
  c_i(y) &= \frac{\sum_{i=0}^{N} (w_i \cdot e_i(y))}{\sum_{i=0}^{N} w_i}
\end{align*}
\]

Figure 5. Representation of exemplars \( e \) (black circles) and its abstract category \( c \) (open circle). The x, y coordinates and frequency of each exemplar are given, and the coordinates of the abstract category are calculated based on these coordinates, using equation 1. The thickness of the lines represents the strength with which the exemplars contribute to the category.

Production of an utterance in communication

An agent who is selected to be a speaker in communication will either select an existing exemplar from its memory, or create a new exemplar based on one of the abstract categories in its memory, which represents novel use. The probability that a particular existing exemplar is selected is proportional to its frequency, a feature that is also present in the utterance selection model of Baxter et al. (2006, to appear). The probability of novel use is given by the parameter \( m \). For example, if \( m \) is set at 0.1, a speaker has a 10 percent chance of creating a new exemplar in communication.

In the case of novel use, an agent first selects an abstract category from its set of categories, using the token frequencies of the categories as probabilities. This
abstract category is a ‘prototype’ of a cluster of exemplars that have similar characteristics; the coordinates of the category are the center of this prototype, and the further away one gets from this center, the less strong the connection to the prototype becomes (cf. Geeraerts 1997, Gärdenfors 2000: 5). The coordinates of the new exemplar are based on the coordinates of the abstract category. The new exemplar’s coordinates can deviate from the abstract category’s coordinates, but as the deviation gets bigger, the probability of these coordinates get smaller. For both \( x \)- and \( y \)-coordinates, the deviation \( s \) from the abstract category’s coordinate is calculated with equation 2. In this equation, \( \alpha \) is the maximum allowed distance of a new exemplar from its prototype. In the basic model, \( \alpha = 0.05 \), but I will also discuss the effect of different values.

\[
prob(s = x) = \alpha \cdot e^{-\frac{s^2}{2}}
\]

Equation 2.

**Perception and reconstruction of an utterance in communication**

I mentioned above that the hearing agent stores the perceived exemplar \( e(x, y) \) in its memory. However, before it can do so, the hearer will have to reconstruct the coordinates of this exemplar. The value \( y \) is directly clear to the hearer: it is the value of the object \( O \) that is directly transmitted from speaker to hearer. On the other hand, the value \( x \), which represents the agentivity of \( V \), has to be reconstructed.

In the first step of the perception process, the hearer will try to reconstruct the agentivity of \( V \) with the help of the object \( O \) from the utterance. It assumes that utterances with similar objects will have similar meanings. Therefore, the hearer will scan its memory and compare the stored objects to the uttered object \( O \). First, it will scan the exemplars in its memory. If it finds an exemplar with an object that is similar to that of \( O \), it will assume that the meaning of \( V \) of exemplar and utterance are also similar. It will then store the utterance as this particular exemplar, add 1 to the exemplar’s frequency and set the recency to 0.

If the hearer finds no matching exemplar, it will start to compare the uttered object \( O \) with the objects of the abstract categories in its memory. It will find the most similar object by calculating the distance between \( O \) (the \( y \) value of the utterance) and the \( y \)-coordinate of each abstract category. Only abstract categories for which the distance is smaller than \( \alpha \) are considered, since this is the maximum distance of a newly created exemplar from its prototype.

If a closest category is found, the hearer will assume that the utterance belongs to the particular category. It will then reconstruct the value of \( V \) using the \( x\)-
coordinate of the category as a basis. $V$ will deviate from this $x$-coordinate with a variable amount $s$. The amount of deviation from the category’s coordinate is in principle unlimited, but the probability of the deviation is linked to its value: as the deviation gets bigger, the probability gets smaller. This is calculated by using equation 2, which was shown earlier.

If no category is found, the hearer assumes that it is being exposed to an unfamiliar utterance. It will then construct a new exemplar $e$ based on the utterance. The utterance’s object $O$ is directly clear (see above), and this object will become the object of the new exemplar. Verb meaning is not transmitted directly, and the hearer will use the characteristics of the object to reconstruct it. This reconstruction takes place using a complex procedure. It is based on the characteristics of the object, but the hearer’s present knowledge of verb meaning and the amount of controllability of the object also play a role. Basically, not all objects can be combined equally well with all meanings of *krijgen*. For example, uncontrollable objects like luck or bad weather combine better with non-agentive than with agentive verb meaning. Similarly, objects like sword or present combine better with agentive than non-agentive meaning (cf. chapter 4). The hearer uses this knowledge in his reconstruction of the meaning of the uttered verb.

A complicating factor in the reconstruction is that there is no exact one-to-one relationship between object and verb meaning. When objects with some controllability are used (e.g. sword), both an ‘obtain’ and a ‘receive’ meaning are possible. These meanings are very different in terms of agentivity: in the former, the subject has the role of agent, while in the latter, another participant has this role. In this case, the hearer cannot determine the kind of agentivity on the basis of the object alone. It will therefore use its existing knowledge of verb meaning to determine which of the two kinds of agentivity is most likely. In other words, agents are conservative in meaning construction, as seems realistic.

For example, let us say that a hearer is exposed to an utterance with $O = 0.8$ (which e.g. could represent an object like sword) and needs to determine the utterance’s verb meaning $V$. On the basis of $O$ alone, the verb could be either low on agentivity (representing a ‘receive’ sense) or high (representing an ‘obtain’ sense). The former will have an $x$-coordinate of -0.8, the latter of 0.8. (in other words, the value of $O$ determines the value of $V$, like I discussed in §5.3). The hearer will choose between one of these values by checking which meaning is more likely based on its present knowledge of verb meaning. It will divide its agentivity scale, which runs from -1 to 1, into two parts, with $V \geq 0$ representing an ‘obtain’ sense, and $V < 0$ representing a ‘receive’ sense. For both sides, it will then take the sum of the type frequencies of all abstract categories. Say that the hearer has two abstract categories in its memory. The coordinates of these two categories are [-0.8, 0.7], with a token frequency of 25, and [0.8, 0.9], with a token frequency of 5. In that
case, these sums are simply 25 for $V < 0$, and 5 for $V \geq 0$. The probability that the hearer will select a particular side is based on the sum of the side’s token frequency: $p = 25/30$ for $V < 0$ and $p = 5/30$ for $V \geq 0$.

The choice between one of the two main senses (‘obtain’ for $V \geq 0$ and receive’ for $V < 0$) works well when the uttered object $O$ is relatively controllable (representing objects like present or sword). However, for less controllable objects like luck, a clear agentivity of either ‘obtain’ or ‘receive’ is generally absent, and it is therefore more difficult to determine between one of the two main senses. In other words, the boundary between these two senses is often blurry for less controllable objects, and this aspect is also represented in the model. Before the hearer will select one of the two senses based on the procedure I explained above, there is a probability it will select one of the two at random. This probability is dependent on the controllability of the uttered object $O$: the lower its value, the higher the probability. This is calculated using equation 3. The object’s controllability value $O$ (the $y$-coordinate of the utterance) is compared to a value $v$, which is generated using a Gaussian distribution. This means $v$ has a large chance of being close to 0, and a decreasing chance of deviating from 0. If $O$ is smaller than $v$, verb meaning $V$ will be selected at random. For example, if $O = 0.1$ and there is random meaning selection, the choice between $V = 0.1$ and $V = -0.1$ is random.

\[
\text{prob}(v = x) = 5e^{-\frac{x^2}{2}}
\]

\textbf{Equation 3.}

Finally, once the hearer has successfully reconstructed the coordinates of the new exemplar, it will store this exemplar in its memory with type frequency $f(e_i) = 1$ and recency $r(e_i) = 0$.

\textit{Additional updates of the agent’s knowledge after communication}

As mentioned earlier, in exemplar theory it is assumed that memory decays, and that exemplars can disappear from memory if their activation level becomes too low. This transitory notion of exemplars is also part of the model presented here. After each communication, the knowledge of both speaker and hearer is updated. This means a review of all exemplars in memory, and a removal of those that have not been used (either in production or perception) for a considerable amount of time. More specifically, the probability of removing an exemplar is inversely proportional to its recency $r$: the less recent an exemplar has been used, the greater the chance of removal, with a threshold of 100 iterations as a minimum age for removal. If a
category has lost all its exemplars, the category itself will be removed from memory as well: empty categories do not remain in existence. Although frequency is not used as a factor in this removal procedure, it is a side effect of a high frequency that the exemplars involved are protected from removal because their high frequency will generally lead to a more recent use.

Apart from the possible removal of exemplars, the knowledge update has two other operations. First, categories that are too close to each other merge and become one new category, a feature that is also present in De Boer’s model of vowel systems (De Boer 2001: 54). The maximum allowed distance between two categories is set at $2^\alpha$, in which $\alpha$ is the maximum possible distance an exemplar can have to a prototype for an agent to consider it to be belonging to that prototype.

The newly created category consists of the exemplars of the two merged categories, and its coordinates are the averages of the two original categories, weighted with their respective type frequencies.

The second operation that can occur after communication is a split off of an exemplar with a high frequency from its category, and the formation of a new category. This feature is in line with the assumption that high frequency elements contribute less to their abstract categories than low frequency ones, due to their relative autonomy (Bybee 2006). Whether the frequency of a particular exemplar is high enough for a split off is determined by taking the product $d$ of its distance to the abstract category’s coordinates and its frequency $f(e)$ (equation 4). If this value $d$ is higher than a threshold level (set at 10,000), the exemplar will split off from the category and form a new category. The coordinates of this new category are simply the coordinates of the exemplar. This means that both the exemplar’s relative and absolute frequency play a role in the split off procedure: the distance to the abstract category is a measure of its relative frequency.

\[
d = f(e) \cdot \sqrt{(x_c - x_e)^2 + (y_c - y_e)^2}
\]

Equation 4.

Initialization of the simulation

The agents start with an initial knowledge of 10 exemplars, with values randomly distributed between [0.85 - 0.95] for the verb meaning, and [0.85 - 0.95] for the objects, $r = 0$ and $f_{token} = 1$. This represents the use of *krijgen* in the fourteenth century, as shown in chapter 4, with controllable objects and strongly agentive subjects. This initial setting is then run for 1000 iterations, to allow for new exemplars and abstract categories to form and to prevent the initial 10 exemplars from playing a disproportionally big role in the actual simulation. After this
initiation period, the frequency $f$ of all exemplars of all agents is reset to 1, and their recency is set to 0. Figure 6 shows the knowledge of a random agent at the start of the simulation, after the initiation period, represented in the conceptual space that was shown in figure 4.

**Figure 6.** Knowledge of a random agent at the beginning of the simulation. Black circles indicate exemplars, the grey circle indicates the abstract category.

*Measurements*

At initiation, the agents are assigned different exemplars within a certain range, and throughout the simulation, this variance in linguistic knowledge remains present because no two agents are exposed to exactly the same linguistic input. The meaning of *krijgen*, therefore, is slightly different for each agent in the population. At the same time, the variation between agents is limited because they use each other’s linguistic input to construct their knowledge. In order to get a good insight in the exact ‘coherency’ of a population in this respect, I calculate the standard deviation of the knowledge of a population of agents. Standard deviation is a measure of variation among the agents: a low standard deviation means the agents’ knowledge differs only little, a high standard deviation means the variation is big. In the presentation of the first results in the next section, I will describe in more detail how exactly I have applied this measure.

Of course, terms like ‘little’ and ‘big’ do not have much relevance unless they are taken relatively: in a model like this, it is not possible to determine that a particular value of the standard deviation represents an ‘incoherent’ population, and another value a ‘coherent’ population. What the measure can give, however, is a means to compare the results of different settings.
Investigated parameters

In the next section, I will discuss the behavior of the model and the effects that different parameters have on the results. I will start with the basic model, whose outline I presented in this current and the previous section. For this basic model, I will show the effect of different settings for parameter $m$, the probability that a speaking agent creates a new exemplar for production. I will then discuss the effect of different alterations to the model. These alterations include ‘agent-internal’ aspects, such as the way input is processed and utterances are produced, and ‘agent-external’ aspects, such as the number of iterations and the size of the population.

5.5 Results

The main goal in this chapter is to try and find simulation parameters that would cause the model I present here to behave like the documented change in the transitive use of *krijgen* (as I presented in the previous chapter). A ‘successful’ simulation of the verb would therefore cause an extension in meaning, followed by a loss of the original meaning. This change should also happen over a realistic time span.

The basic model

In a first series of simulations, the probability of creating a new exemplar in production is set at $m = 0.1$, which means that 1 out of 10 times, a speaking agent will create a novel exemplar instead of selecting one from its memory.

Figure 7 on the next page shows the development of one agent’s knowledge of *krijgen* over 100,000 iterations with this parameter setting. As a matter of fact, the lack of development is the most obvious, because the knowledge at the end of the simulation is very similar to that at the beginning. That is, more abstract categories have formed over time, but there is no significant change in the kind of combinations of objects and verb-meanings. The growing number of categories is due to the fact that over time, more exemplars obtain a frequency that is high enough to become a new category. This, in turn, is due to the relatively high probability of selecting existing exemplars instead of creating new ones.

In figure 7, only the development of one agent from the population is shown; the interesting question is, however, how the knowledge of the population as a whole develops over time. Figure 8 on the next page is a plot of the knowledge of all agents in the population after 100,000 iterations; it shows the range of knowledge of categories of each agent in the population on the meaning scale.
Figure 7. Development of knowledge of a random agent over 100,000 iterations, with $m = 0.1$. Black circles indicate exemplars, grey circles indicate categories.

Figure 8. Representation of the knowledge of a population of $N = 20$ agents. Each grey bar indicates the range of knowledge of categories on the meaning scale for one agent.
As figure 8 shows, there is variation in the linguistic knowledge of the agents, but this variation is not too large. The amount of variation on both sides differs: there is more variation on the minimum side than on the maximum side.

This is due to the fact that the agents’ knowledge is limited to values between -1 and 1. The maximum value of the knowledge of many agents has reached its upper limit, while this is not the case for the minimum value. In any case, the population can be said to be linguistically quite coherent.

As I mentioned in the previous section, the amount of linguistic coherency in the population can be measured by the standard deviation of the agents’ knowledge: the smaller the deviation, the greater the linguistic coherency between the agents in the population. This is shown in figure 9. This figure is a graph in which both the linguistic knowledge and the standard deviation are shown. For the linguistic knowledge, the average minimum and maximum meaning values of the population is calculated and plotted as two dots on the x-axis. The minimum values are represented by squares, the maximum values by circles (note that in figure 9, the circles are all on the bottom right corner). The standard deviation of this knowledge for the population is plotted on the y-axis. Thus, one pair of dots in figure 9 represents one population or run, and the figure shows the result of 20 runs with the same settings as the previous graphs. The position of a dot on the y-axis is in indication of how much the knowledge of the agents within a particular population differs: the greater the value, the greater the difference among the agents.
Figure 10a, b. Examples of the development of knowledge after 100,000 iterations for different settings of $m$. From top to bottom, $m = (0.3, 0.5, 0.7, 0.9)$. For each setting, the result of one agent in a random run is shown in figure (a), and the result of 20 independently run populations is shown in figure (b), with the average knowledge of the meaning extremes on the x-axis and the coherency on the y-axis.
As figure 9 shows, this particular setting leads to a system in which, after 100,000 iterations, the linguistic knowledge of the population has consistently but marginally expanded, while the original knowledge, as was shown in figure 6, remains present. There is some variation among the agents in the population (with the standard deviation ranging between 0.08 and 0.16 for the minimum meaning value) but overall, the linguistic knowledge of all agents is relatively consistent.

The question is with what differences in parameter settings a system can be obtained that shows more change. An obvious candidate for this is the amount of novel use in the system. A higher creation rate of new exemplars (m) will lead to more variation, and variation is a necessary source for change.

Figure 10a shows the results of increasing values for m (0.3, 0.5, 0.7, 0.9) after 100,000 iterations for one agent. Figure 10b shows the results of 20 different populations in a similar way as in figure 9, with the average minimum and maximum meaning on the x-axis and the standard deviation on the y-axis.

By looking at the results in figures 10a and 10b, it is obvious that the amount of novel use correlates with the amount of change. With m = 0.3, categories develop that have change of state meaning (in the bottom middle of the graph), and with increasing values for m, the number of categories with this meaning grows. At the same time, this development usually does not go any further for m = 0.3, m = 0.5 and m = 0.7: it is only with m = 0.9 that in most of the simulations, a ‘receiving’ meaning comes into existence (with values on the meaning scale between -1 and 0).

A striking aspect about the development of the verb in all these cases is that it is extending and never shifting: the original meaning of the verb remains present in all the performed runs in all settings. Apparently, there is not enough pressure for these original meanings to disappear.

The graphs also show that a higher amount of novel use (and a bigger amount of extension of the linguistic knowledge) seems to correlate with a lower linguistic coherency of the population: the standard deviation of the agents’ knowledge, particularly of their minimum meaning value, increases with higher values for m. The average standard deviation of the minimum value over 20 runs for m = 0.1 is 0.11, while it is 0.21 for m = 0.3 and 0.33 for m = 0.9. This suggests that a higher rate of novel use correlates with bigger differences in individual linguistic knowledge. One probable reason for this is that an increased rate of m leads to more novel exemplars created on the basis of *individual* knowledge instead of on the basis of communication between agents; this will decrease the coherency between the agents. An agent might have created a novel use with a stronger ‘receiving’ sense and use this in communication, upon which this use spreads to the other agent.

However, the high amount of novel use *limits* the spread of this new use, because the use of conventional exemplars is low per definition; this will lead to a decrease in coherency between the agents. The high values in standard deviation can
be explained by the fact that an extension in linguistic knowledge (towards the ‘receiving’ sense) has not spread to all agents in the population. To give an example, in one of the runs with $m = 0.9$, 4 of the 20 agents had a minimum meaning value between 0.66 - 0.89, while all other agents had a minimum meaning value between 0 - 0.2. This seems to be a typical outcome for this setting: a majority of 14 - 16 agents with an extension in their linguistic knowledge towards the ‘receiving’ sense, and a small group of agents who do not share this extension. This particular outcome might also well be the result of the limited amount of exchange of conventional exemplars between agents.

In summary, an increase in the relative amount of novel use does lead to an extension of the use of *krijgen*. At the same time, a ‘receiving’ sense only comes into existence with a very high rate of novel use ($m = 0.9$). Change occurs, but only in the form of extension; a loss of the original meaning of *krijgen* cannot be obtained with these settings. For all settings, the changes occur in the majority of the agents in the population.

**Different values of parameter $\alpha$**

In the model, $\alpha$ is a parameter that affects the way exemplars are connected to their prototypes: it gives the maximally allowed distance of an exemplar from its prototype. Also, it is a measure of the maximal distance between two abstract categories. In the basic model, $\alpha = 0.05$. I now look at how two different rates of $\alpha$ affect the development of meaning, with different values for $m$. Figure 11 shows the results for $m = 0.9$ for both $\alpha = 0.025$ and $\alpha = 0.075$. I have left out the results for other values of $m$ (0.1, 0.3, 0.5, 0.7, 0.9), because, despite the differences in numbers of prototypes and exemplars per prototype, the different values of $\alpha$ do not lead to significant changes in the amount of change after 100,000 iterations, compared to the results of the basic model (figures 7, 9 and 10). For both values of $\alpha$, an increase in the value of $m$ leads to an extension of the use of the verb, comparable to that of the basic model.

With $\alpha = 0.025$, the maximally allowed distance of an exemplar from its prototype is twice as small as in the basic model. On the one hand, this means that in interpretation, exemplars will sooner have exceeded this maximally allowed distance and as a result, an interpreting agent could form a new prototype on the basis of this prototype. On the other hand, exemplars will differ less from their prototype in the process of exemplar production.
Figure 11a, b. Top: $\alpha = 0.025$, bottom: $\alpha = 0.075$. Examples of the development of knowledge after 100,000 iterations for $m = 0.9$. For each setting, the result of one agent in a random run is shown in figure (a), and the result of 20 independently run populations is shown in figure (b), with the average knowledge of the meaning extremes on the x-axis and the coherency (measured as the standard deviation between the agents’ meaning knowledge) on the y-axis.

For $\alpha = 0.075$, we would expect the opposite: exemplars will be interpreted as belonging to a particular existing prototype easier, while in production, exemplars can differ more from their prototype than in the basic model. Also, the parameter $\alpha$ is used in the possible merging of prototypes: if prototypes are less than $2*\alpha$ away from each other, they will become one new prototype. Therefore, with a smaller $\alpha$, more prototypes will remain in existence, while with a bigger $\alpha$, less prototypes will remain in existence.

As expected, the runs with a different value for $\alpha$ do show a difference in the number of exemplars per prototype and the number of prototypes: a low $\alpha$ leads to relatively many prototypes, with relatively few exemplars per prototype. A high $\alpha$ leads to the opposite: relatively few prototypes, with relatively many exemplars per prototype. Also, a high $\alpha$ leads to more coherency in the population, which can also be prescribed to the lower number of prototypes.
Differing the value of $\alpha$ does not seem to have an effect on the amount of change that takes place in the model, with different values of $m$. As figure 11 shows, $m = 0.9$ leads to an extension of meaning for both $\alpha = 0.025$ and $\alpha = 0.075$, similarly to the outcome for $\alpha = 0.05$ in the basic model. What is also similar is the outcome that in both cases, no loss of the agentive meaning occurred.

**Allowing the frequency of use to vary**

In the model, frequency of use plays a key role in shaping the linguistic knowledge of the agents: exemplars that are perceived frequently become entrenched more strongly and will become a stable part of an agent’s knowledge. Also, frequency is the crucial factor that determines whether an exemplar should be separated from an existing category and form its own new one.

In the basic model, the frequency of use was set at 1 communication act per agent per iteration on average. In the present alteration to the basic model, the frequency of use per iteration is allowed to vary, meaning that the average number of communications between agents is no longer fixed, as it is in the basic model. Arguably, the frequency of use of a word is at least partially linked to its range of meanings, since these meanings reflect the range of contexts in which the word can be used.\(^1\)

A variable frequency of use $\varphi_{use}$ is added to the basic model by linking the number of communications per iteration to the number of exemplars of the agents in the population. The total number of exemplars at $t = 0$ is taken as the standard, from which the relative number of exemplars at any time is calculated (equation 5). For example, let us say that the number of exemplars of all agents in the population at $t = 0$ is 100, and that, at the present moment ($t = T$), this number is 250. This means that the original frequency of use is now multiplied with $250/100 = 2.5$. The frequency of use at the present moment is therefore 2.5 times higher than at $t = 0$, due to the fact that the agents have more exemplars. The general form of this calculation is shown in equation 5.

\[
\varphi_{use} = \frac{\sum_{i=0}^{N} e_i^T}{\sum_{i=0}^{N} e_i^0} \quad \text{with } N = 20 \text{ agents}
\]

**Equation 5.**

\(^1\) Examples of other factors that could possibly affect the frequency of use are the word’s register and the presence of (near-)synonyms in the language.
Figure 12a, b. Examples of the development of knowledge after 100,000 iterations in which the frequency of use is allowed to vary. From top to bottom, \( m = (0.1, 0.3, 0.5, 0.7, 0.9) \). For each setting, the result of one agent in a random run is shown in figure (a), and the result of 20 independently run populations is shown in figure (b), with the average knowledge of the meaning extremes on the \( x \)-axis and the coherency on the \( y \)-axis.
Figure 12 on the previous page shows the results. It is obvious from these results that they are very similar to the ones in the basic model: there are no significant differences between them. There is an extension of the use of *krijgen* with higher rates of novel use, but a loss of the original meaning does not occur.

If we look more closely at the average values of the minimum meaning in figure 12b, it seems though as if the flexible frequency has a slight impeding effect on change in the population. In the basic model, the average minimum value got smaller with an increasing value for $m$: $0.52$ ($m = 0.1$), $-0.22$ ($m = 0.5$), $-0.66$ ($m = 0.9$). The current model, with a variable frequency of use, shows a similar tendency, but the average minimum value does not decrease as much as in the basic model: $0.50$ ($m = 0.1$), $-0.10$ ($m = 0.5$), $-0.49$ ($m = 0.9$). This ‘slower’ pace is accompanied by a slightly higher coherency of the population. In the basic model, the average standard deviations are $0.11$ ($m = 0.1$), $0.21$ ($m = 0.5$) and $0.33$ ($m = 0.9$). In the current model with a variable frequency of use, these values start off lower for low values of $m$, but ‘catch up’ when $m$ gets higher: $0.10$ ($m = 0.1$), $0.11$ ($m = 0.5$) and $0.35$ ($m = 0.9$).

Overall, a flexible frequency does not seem to lead to significant changes in the results of the simulations. If there is any difference with the basic model, it is that it actually has a small impeding effect on change. However, a combination of both extension and loss of meaning does not seem to occur in this particular extension of the basic model.

*Using a skewed distribution in the frequency of use*

When trying to obtain a more realistic simulation in terms of frequency of use as I did in the previous section, the question is whether there is an even distribution in the frequency of use over all different senses of *krijgen*. One reason to argue against this is that strongly agentive uses only allow for intentional and thus animate subjects, while non-agentive uses allow for both animate and inanimate subjects, because the subject does not have to be intentional. This means that the non-agentive use, if it exists, has a relatively higher probability of being used in communication than the agentive use, i.e. has a bigger chance of being selected by a speaker than an exemplar of agentive use, even when the frequencies are the same. I will discuss this feature in more detail in this section.

In a subsequent extension of the model, the probabilities of using agentive and non-agentive senses of *krijgen* differ: non-agentive senses are given a greater chance of being used in communication than agentive senses. This simulates the idea that non-agentive senses have an advantage over agentive senses, in that they can be used with a wider range of subjects: animate and inanimate. In the basic model, the probability of selecting an exemplar in conventional use is determined by
its frequency, and the probability of selecting a category for novel use is determined by its token frequency. In the extended model, these probabilities are made partially dependent on the position of the exemplars or categories on the meaning scale. That is, both an exemplar’s frequency and its x-value determine its chance of being selected for communication. Similarly, both a category’s token frequency and its x-value determine its chance of being used for the creation of a novel exemplar.

This dependency on the position of an exemplar or category on the meaning scale is represented by the parameter $s$; an exemplar’s frequency or a category’s token frequency is multiplied with this value, which is dependent on the position of the exemplar, or category, on the meaning scale ($V$). I will discuss two functions to calculate $s$.

**Function 1: linear**

In this function, the value of $s$ is linked to the agentivity scale by a simple linear function, as figure 13 and equation 6 show. With this function, the chance of selecting or creating an exemplar decreases linearly with increasing meaning values, with $s$ ranging between $s = 1.0$ for agentive meanings and $s_{\text{max}}$ for non-agentive meanings.

![Figure 13. The value of $s$ depends on the position of the exemplar on the verb agentivity scale and $s_{\text{max}}$.](image)

$$s = \frac{(1-s_{\text{max}}) \cdot V}{2} + 0.5 \cdot s_{\text{max}} + 0.5$$

**Equation 6.**

Next, I will explore the consequences of different values of $s_{\text{max}}$. The higher this value, the stronger the advantage for non-agentive use. I will use a fixed value for the rate of novel use and vary the value of $s_{\text{max}}$ between 1.1 and 1.4 (note that $s_{\text{max}} = 1.0$ is equal to not using this parameter at all). For the rate of novel use, I use a value of $m = 0.5$, which means that existing exemplars are used in utterances in 50 percent of communication, and newly created exemplars in the other 50 percent. As I have shown earlier, this value leads to an extension of the use of *krijgen* to a change of state meaning in the runs with both a fixed and a variable frequency of
use. In a few cases, a ‘receiving’ sense started to develop, but this sense never became fully grown. Also, the original agentive meaning remained present in all runs.

![Graphs showing the development of knowledge after 100,000 iterations with different settings for $s_{max}$ using a linear function, with $m = 0.5$. From top to bottom, $s_{max} = (1.1, 1.2, 1.3, 1.4)$. For each setting, the result of one agent in a random run is shown in figure (a), and the result of 20 independently run populations is shown in figure (b).](image-url)
Figure 14 shows the results after 100,000 iterations for four different settings for $s_{\text{max}}$ (1.1, 1.2, 1.3, 1.4). The results of one random agent from a population in the graphs are shown in 14a, and the average minimum and maximum meaning values of 20 populations from 20 runs are shown in 14b. Quite surprisingly, the addition of the parameter $s$ to the model does not seem to lead to significantly different development for any of the values tested when compared to the basic model. Although $s$ adds a preference for non-agentive meaning to the model, this preference is apparently not strong enough to lead to a strong development of non-agentive meaning, let alone a loss of agentive meaning. Also, the value of $s$ does not seem to make a significant difference either: for all four tested values, the results are comparable to the runs with the same value for $m$ in the basic model (shown in figures 7, 9 and 10).

Function 2: a fixed $s$ for non-agentive meaning
In this function, there is no linearly increasing preference for non-agentive meaning. Instead, the value of $s$ is fixed at $s = 1$ for strongly agentive meanings and fixed at $s_{\text{max}}$ for all non-agentive meanings. The value of $s$ decreases from $s_{\text{max}}$ to 1 between $V = 0$ and $V = 0.5$. This function can be argued to be a more realistic representation of preferences for non-agentive meaning versus agentive meaning than the previous function. Non-agentive senses have a bigger chance of being used than agentive senses, but there is no difference in preference within the non-agentive senses themselves: since all non-agentive senses can be used with similar animate and inanimate subjects, their chance of being used is the same. Figure 15 and equation 7 show the function of $s$, figure 16 on the next page shows the results.

Figure 15. The value of $s$ depends on the position of the exemplar on the verb agentivity scale and $s_{\text{max}}$.

\[
\begin{align*}
&\text{if } V \leq 0 & s &= s_{\text{max}} \\
&\text{if } V > 0 \text{ and } V < 0.5 & s &= s_{\text{max}} - 2 \cdot s_{\text{max}} \cdot V + 2 \cdot V \\
&\text{if } V \geq 0.5 & s &= 1.0
\end{align*}
\]

Equation 7.
Figure 16a, b. Examples of the development of knowledge after 100,000 iterations with different settings for $s_{max}$ using a non-linear function, with $m = 0.5$. From top to bottom, $s_{max} = (1.1, 1.2, 1.3, 1.4)$. For each setting, the result of one agent in a random run is shown in figure (a), and the result of 20 independently run populations is shown in figure (b), with the average knowledge of the meaning extremes on the x-axis and the coherency on the y-axis.
Let us first look at the results of one random agent in figure 16a. In all previous settings, the runs with $m = 0.5$ did not lead to a strong development of the receiving sense. For example, in the basic model, (shown in figure 10), the minimum value that developed after 100,000 iterations was -0.22, averaged over 20 runs with 20 agents each. In the current setting, the receiving sense develops much stronger, with -0.39 ($s_{\text{max}} = 1.1$), -0.47 ($s_{\text{max}} = 1.2$), -0.67 ($s_{\text{max}} = 1.3$) and -0.89 ($s_{\text{max}} = 1.4$). Just as higher values of $m$ lead to a stronger development of the receiving sense, so do higher values of this function of $s_{\text{max}}$.

Contrary to the linear function of $s_{\text{max}}$, the current function of $s_{\text{max}}$ also leads to an interesting development of the original agentive meaning for similar values of $s_{\text{max}}$. In the basic model and in the linear function of $s_{\text{max}}$, this meaning generally remained present in the linguistic knowledge of the agents in the population. This is also true for $s_{\text{max}} = 1.1$ and $s_{\text{max}} = 1.2$. Yet, as figure 63a shows, the original meaning already starts to become weaker for $s_{\text{max}} = 1.3$ and has disappeared from the linguistic knowledge of the agent shown for $s_{\text{max}} = 1.4$ after 100,000 iterations. In the latter case, a shift in verb meaning has taken place, instead of just an extension. The parameter $s_{\text{max}}$ for this function might therefore be interpreted as a pressure not only favoring the receiving sense, but also against the agentive use. The mechanism underlying this pressure is the frequency of use: the fact that it can be used more for one sense than for another will act as a pressure for change.

Still, figure 16a only shows the knowledge of one randomly chosen agent, and it is important to see whether this shift in knowledge also occurs throughout the population. In figure 16b, let us first look at the minimum meaning. For $s_{\text{max}} = 1.1$ and 1.2, the standard deviation of the populations is quite high (0.23 for $s_{\text{max}} = 1.1$ and 0.26 for $s_{\text{max}} = 1.2$), which means the linguistic coherency in the population is not that high. In the previous settings, high values in standard deviation were not merely a sign of little linguistic coherency. Rather, they were the result of a difference in knowledge between a small minority in the population and the majority. Such a clear divide is not that obvious in the present settings for $s_{\text{max}} = 1.1$ and $s_{\text{max}} = 1.2$. For $s_{\text{max}} = 1.1$, the minimum meaning values of the agents in one random population after 100,000 iterations range between -0.01 and -0.78, without a clear grouping of agents on either ‘side’ of these two extreme values. Rather, they were the result of a difference in knowledge between a small minority in the population and the majority. Such a clear divide is not that obvious in the present settings for $s_{\text{max}} = 1.1$ and $s_{\text{max}} = 1.2$. For $s_{\text{max}} = 1.1$, the minimum meaning values of the agents in one random population after 100,000 iterations range between -0.01 and -0.78, without a clear grouping of agents on either ‘side’ of these two extreme values.

The results for $s_{\text{max}} = 1.3$ and $s_{\text{max}} = 1.4$ in figure 16b might show an explanation of this lack of coherency in the population. For $s_{\text{max}} = 1.3$, the standard
deviation is also still relatively high, but decreasing (0.21), and for \( s_{\text{max}} = 1.4 \), it is very low (0.08): the agents have reached the limits of their knowledge as far as the model is concerned, with -1 being the minimum meaning value that is possible. The higher values for the standard deviation in the other settings of \( s_{\text{max}} \) are probably caused by the fact that the linguistic knowledge is shifting towards the minimum, but that this shifting takes place at a different rate for each agent. When we look at the maximum meaning, the agentive senses, we see a similar pattern: as \( s_{\text{max}} \) gets bigger, the pressure towards the receiving sense gets stronger and the coherency between the agents gets weaker.

As an agent’s knowledge gradually shifts from ‘agentive’ towards more ‘receiving’, the original agentive meaning slowly weakens and finally disappears. In this process, a few exemplars with a high frequency can resist disappearing for quite a while, due to their high frequency. This can be seen in figure 17. Such survival of a very specific use of a once much broader knowledge is in fact quite realistic. For example, as I discussed in the previous chapter, the original meaning of *krijgen* is still used in present-day Dutch, but only in a few highly specific uses.

![Figure 17](image)

*Figure 17. Example of a run in which the prototypical use of the verb has shifted after 100,000 iterations, but in which some of the original use remains in existence. \( s_{\text{max}} = 1.4, m = 0.5 \).*

**Allowing the model to run for 500,000 Iterations**

In all previous settings, the simulations have been run for 100,000 iterations. However, this number is a rather random limit, primarily chosen for reasons of time and computing power. It might well be possible that interesting developments in the model need more time and may occur beyond the current limit of 100,000 iterations. To check this, I have therefore also run the model for 500,000 iterations, in the settings of the basic model, with different values for \( m \). Figure 18 shows the results.
Figure 18 a, b. Examples of the development of knowledge after 500,000 iterations with different settings for m. From top to bottom, m = (0.1, 0.3, 0.5, 0.7, 0.9). For each setting, the result of one agent in a random run is shown in figure (a), and the result of 20 independently run populations is shown in figure (b), with the average knowledge of the meaning extremes on the x-axis and the coherency on the y-axis.
In the runs with the basic model and 100,000 iterations (shown in figures 7, 9 and 10), there was virtually no development of non-agentive meaning for low values of \( m \), while higher values of \( m \) lead to an extension to non-agentive meaning. As is obvious from figure 18, the results after 500,000 iterations are very similar to this. For example, with a low amount of creation of novel uses (\( m = 0.1 \)), there is only a slight extension of knowledge, but this extension seems to come to a stop instead of continuing slowly but steadily: if the extension would keep on occurring, we would expect a bigger extension after 500,000 iterations than after 100,000 iterations, but this has not happened. An explanation for this is that a low amount of novel use automatically means a high amount of conventional use (with a rate of 0.9). This means that the already existing exemplars and categories are used much more frequently in communication than novel exemplars are created, which will only increase their entrenchment (in the form of high frequencies for the exemplars). Simply said, novel exemplars cannot ‘compete’ with this, and therefore will never survive long enough in order to lead to a significant change in the population’s knowledge. The small extension that has taken place has probably occurred at the beginning of the simulation, when the frequencies of the existing exemplars are still relatively low. Also, we do not see any differences with regards to the loss of agentive meaning when the model is run for an extended number of iterations. For higher values of \( m \), the development of meaning after 500,000 iterations does not differ significantly from that after 100,000 iterations: in both cases there is development of non-agentive meaning, while agentive meaning remains present.

Before, I showed that the use of parameter \( s_{\max} \) (in the non-linear function) could lead to a loss of the original agentive meaning with a relatively high value for \( s_{\max} \). Figure 19 shows the results of using this parameter for 500,000 iterations. In general, increasing the number of iterations does not seem to lead to very big changes in the results of the model. With increasing values of \( s_{\max} \), we see an extension towards non-agentive meaning. As in the case of 100,000 iterations, we also see a loss of the original agentive meaning for \( s_{\max} = 1.3 \) and \( s_{\max} = 1.4 \). In these runs, there were differences between the agents’ meanings: while some showed a loss of agentive meaning, this meaning remained present for others, albeit in the form of a few abstract categories. The main difference between \( s_{\max} = 1.3 \) and \( s_{\max} = 1.4 \) was one of degree: the number of agents that showed a loss of agentive meaning was higher for \( s_{\max} = 1.4 \) than for \( s_{\max} = 1.3 \).

The main difference between the results after 100,000 and 500,000 iterations is also one of degree. When given more time, more agents in the population show a loss of agentive meaning for \( s_{\max} = 1.3 \): the average meaning range of the agents is (-0.82 - 0.85) while it is (-0.67 - 0.92) after 100,000 iterations. For \( s_{\max} = 1.4 \), the results of the two settings are almost similar: the average meaning ranges for 100,000 iterations and for 500,000 iterations are (-0.90 - 0.65) and (-0.89 - 0.63).
Figure 19 a, b. Examples of the development of knowledge after 500,000 iterations with different settings for $s_{max}$ using the non-linear function, with $m = 0.5$. From top to bottom, $s_{max} = (1.1, 1.2, 1.3, 1.4)$. For each setting, the result of one agent in a random run is shown in figure (a), and the result of 20 independently run populations is shown in figure (b).
Summarizing, an extended run time of 500,000 iterations does not lead to results that differ significantly from those after 100,000 iterations. This can be seen as an indication that a run time of 100,000 iterations is sufficient to catch the main developments and effects of investigated parameters in the model.

**Using a population of \( N = 50 \)**

In the previous runs, the population size has been set at \( N = 20 \). This value was chosen as a compromise between a sufficiently realistic group size and computing power and speed. However, group size might have an effect on the behavior of the population in its development of linguistic knowledge: in a bigger population, it could be harder for innovations to spread because the relative amount of communication between agents decreases. This latter factor might also lead to a lower coherency of the population.

For \( N = 50 \), I have tested the settings of the basic model, and the settings for the parameter \( s_{\text{max}} \) (in the non-linear function, with \( m = 0.5 \)). Figure 20 on the next page shows the result for the ‘basic’ setting. As the figure shows, using a larger population size of \( N = 50 \) leads to a development for different values of \( m \) that is very similar to using a population of \( N = 20 \) (which is shown in figures 7, 9 and 10): with increasing values of \( m \), there is an increasing extension of the meaning range towards non-agentive meaning. For example, for \( m = 0.1 \), the average minimum meaning over 20 populations is 0.52 for a population of \( N = 20 \) and 0.51 for \( N = 50 \) and for \( m = 0.9 \), the average minimum meaning for a population of \( N = 20 \) is -0.66 while it is -0.68 for a population of \( N = 50 \). This similarity also shows in the coherencies of the two settings. The average coherency measured of the minimum meaning and \( m = 0.1 \) over 20 populations is 0.11 for both \( N = 20 \) and \( N = 50 \). For \( m = 0.9 \), these values are 0.33 (\( N = 20 \)) and 0.30 (\( N = 50 \)). However, a difference between the two settings is the variation in the amount of coherency, when measured over 20 runs. In this model, coherency is measured as the standard deviation of the average (minimum and maximum) meanings of the agents in a population. That is, a high standard deviation means that there is a high degree of difference between the agents’ meanings within the population: one agent could have developed a strong non-agentive meaning while the other has not. A low standard deviation means the agents’ meanings are more alike. When we compare the coherency measurements from figure 20b (\( N = 50 \)) to those of figures 9 and 10b (\( N = 20 \)), it turns out that over 20 runs, there is less variation in coherency for \( N = 50 \) than for \( N = 20 \). If we measure the standard deviation of the 20 measures of coherency for \( m = 0.1 \), this is 0.022 (\( N = 20 \)) and 0.015 (\( N = 50 \)). For \( m = 0.9 \), it is 0.045 (\( N = 20 \)) and 0.028 (\( N = 50 \)). A larger population in this model thus does not
Figure 20 a, b. Examples of the development of knowledge after 100,000 iterations with a population of $N = 50$ and with different settings for $m$. From top to bottom, $m = (0.1, 0.3, 0.5, 0.7, 0.9)$. For each setting, the result of one agent in a random run is shown in figure (a), and the result of 20 independently run populations is shown in figure (b), with the average knowledge of the meaning extremes on the $x$-axis and the coherency on the $y$-axis.
lead to a difference in the amount of change or differences in the coherency in the model, but it does seem to lead to a more coherent pattern in development. This could be explained by the fact that in larger populations, the effect of one individual with knowledge that differs from that of the rest of the population, is less than in smaller populations.

I also tested the use of parameter $s_{\text{max}}$ with a non-linear function for a population of $N = 50$ (figure 21). Again, the main development with the use of this parameter is similar to that for a population of $N = 20$: an increasing value of $s_{\text{max}}$ leads to a shift from agentive to non-agentive meaning. For $s_{\text{max}} = 1.4$, the original meaning has disappeared in the knowledge of most individuals in the 20 tested populations. The main difference is that for $s_{\text{max}} = 1.3$, there is a stronger shift for $N = 50$ than for $N = 20$. The average minimum and maximum meanings over 20 runs is (-0.87 - 0.74) for $N = 50$, while it is (-0.67 - 0.92) for $N = 20$. In other words, the same value of $s_{\text{max}}$ leads to higher amount of change with a larger population size.

This finding runs contrary to the expectation I mentioned at the beginning of this section, that a larger population size might show less change than smaller populations, because it is more difficult for innovations to spread through a larger population. The rationale behind this is that there is relatively less contact between agents when population size is large. Still, that this effect does not show in this model is not surprising. A larger population size has no effect on the amount of communication between agents, because, no matter what the size of the population is, agents still communicate with each other on average one time during each iteration cycle. This could also explain the higher rate of shift that we see for $N = 50$: more agents create new exemplars that have non-agentive meaning and because the relative amount of communication remains the same, there is a higher chance that these ‘innovations’ can spread and that, as a result, there is a general shift in knowledge throughout the population.

### 5.6 Discussion and conclusions

In this chapter, I have presented a series of computer simulations of the semantic development of the Dutch verb *krijgen*. These simulations were carried out with a computer model that was based on existing exemplar models and usage-based approaches to language.

The main point of this chapter was to show that the historical development of meaning, too, can be modeled in terms of exemplars. Although the transmission of meaning might be occurring indirectly, the interpretation of meaning can be linked to aspects of transmission that take place more directly. That is, language
Figure 21 a, b. Examples of the development of knowledge after 100,000 iterations with a population size of $N=50$ and with different settings for $s_{\text{max}}$ using the non-linear function, with $m = 0.5$. From top to bottom, $s_{\text{max}} = (1.1, 1.2, 1.3, 1.4)$. For each setting, the result of one agent in a random run is shown in figure (a), and the result of 20 independently run populations is shown in figure (b), with the average knowledge of the meaning extremes on the $x$-axis and the coherency on the $y$-axis.
users are not completely clueless in their interpretation of utterances, but use their knowledge from previous communications and cues from the utterances themselves. As I have shown in this chapter, this makes it possible to construct a model that simulates semantic development in a relatively realistic way. In such a model, linguistic knowledge consists of both stored exemplars of specific uses of the verb, and abstract categories constructed on the basis of these exemplars. Although this means that no two agents have exactly the same linguistic knowledge (as no two agents are exposed to exactly the same input), the overall knowledge of the agents in the population remains highly similar. ‘Change’ in the model occurs when new uses of the verb are introduced and spread through the population.

The construction of this model shows how the implementation of linguistic theory in a model forces one to be precise. This is particularly true for the notion of frequency and the autonomy of exemplars. As I discussed in section 5.4, exemplars in the model can split off from their abstract category and form an abstract category of their own if their frequency becomes very high. This feature is in line with the assumption that high frequency elements contribute less to their abstract categories than low frequency ones (Bybee 2006).

One striking result of the simulations was that semantic extension could be easily obtained by allowing either more novel use in the system or by using a skewed distribution of the frequency of use. However, semantic shift, which actually occurred in the case of *krijgen*, turned out to be much harder to simulate. This kind of development only took place with the presence of a skewed distribution for the frequency of use of different uses of the verb. On the one hand, this added feature can be said to be realistic: it is based on the observation that some uses of the verb can be applied more frequently than other uses. Also, this outcome seems to support that of the model I discussed in chapter 2, in which differences in the frequency of use also served as a pressure for directional change.

On the other hand, it is also interesting to note that without the skewed frequency, only extension of knowledge took place and not shift. This indicates that an exemplar approach predicts that, in the absence of any selection pressures, extension of linguistic knowledge, and not shift, is the standard development.

Apart from this dichotomy of either preservation or loss of the original meaning, the model also captured an aspect of semantic change that may actually be occurring more frequently than either one of the above ‘extreme’ scenarios: that of semantic shift with the preservation of certain highly concrete original uses.

In the model of *krijgen* I have presented in this chapter, out of all conditions and parameter settings, one setting generated results that were comparable to the actual changes that occurred in the verb. This, however does not necessarily have to mean that there could be other ways to achieve similar results: I have only been able to
investigate the role of a limited number of conditions and parameters, which meant excluding other possible interesting factors. For example, the model is a one-word model, but words are commonly not used in isolation. It might therefore be feasible that competition between *krijgen* and other words (particularly words with comparable semantics) has played an important role in the verb’s development as well. In this model, agents communicated with each other a fixed number of times in each iteration, disregarding the size of the population. This led to the unexpected effect that, for some settings, there was more change in larger populations than for smaller populations (actually due to a higher frequency of innovations in a larger population). However, this set-up of communication might not be realistic with larger population sizes: a more complex social structure and non-random communication between agents are therefore potentially interesting parameters.

Also, the simulations suggest that the coherency of the population is tightly linked to the amount of change that takes place in the population: the higher the amount of change, the smaller the coherency. However, it is difficult to compare the coherency of the agents in this model to that of actual language users in the real world, in order to see what coherency values are actually realistic. To formulate the same point more positively: here the development of the model clearly raises new questions that invite further theoretical and empirical research.

Summarizing, the verb *krijgen* can be said to be combining two dimensions: that of object controllability and that of verb agentivity. In this chapter, I have demonstrated how such a constellation leads to change (in the form of either extension or shift) in a particular direction. Although the model was specifically built to simulate *krijgen*, it is conceivable how this result can also be interpreted on a more general level. That is, any verb with the combination of verb agentivity and object controllability might show the same kind of development. I mention two examples suggesting that such a scenario is plausible. First, the English equivalent of *krijgen*, *get*, shows a development that is very similar to that of *krijgen* (Givon & Yang 1994, Gronemeyer 1999, Landsbergen 2006b). Second, the Dutch verb *hebben* ‘to have’ also has both dimensions and seems to have developed along similar lines, from the concrete, agentive meaning ‘to hold in one’s hand’ to the very general, non-agentive meaning ‘to have’ (*WNT* s.v. *hebben*).
Chapter 6

Reconstructing the diachrony of *krijgen* with synchronic data using phylogenetic inferencing techniques

6.1 Introduction

Phylogenetics is the study of historical relationships between species in biology. These relationships are reconstructed by looking at similarities and differences between the species in the present, and by assuming that, through time, new species develop out of existing ones by a process of mutation and selection. The similarities and differences between species can be studied at two levels: the morphological and the molecular level. The former deals with any relevant formal, phenotypic characteristics, such as warm- or cold-bloodedness, the shape of the beak, or the presence of a backbone. The latter involves sequences of DNA or RNA.

Outside biology, phylogenetic inferencing techniques have recently become increasingly popular in comparative linguistics to study the historical relations between languages within larger language families, such as Indo-European (Warnow 1997, Gray & Atkinson 2003, McMahon & McMahon 2003, Bryant, Filimon & Gray 2005, Nakleh, Ringe & Warnow 2005), Bantu (Holden, Meade & Pagel 2005), Austronesian (Gray & Jordan 2000, Greenhill & Gray 2005) and Papuan (Dunn, Terrill, Reesink, Foley & Levinson 2005).

These studies are often met with suspicion by ‘conventional’ linguists. As McMahon & McMahon (2005: 26) put it, there is often the fear that ‘historical linguists, with their deep knowledge of individual languages and groupings [are replaced] by sleek, humming computers and programs which smooth out all the

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1 I would like to thank Michael Dunn, who has introduced the phylogenetic method to me during the 2007 LOT Winterschool in Nijmegen, and who has given me valuable advice on the analysis.
bumps’. However, computational methods should not be considered to be a replacement, but instead to be an additional tool in historical research that can be used for testing hypotheses or gaining insight. For example, the phylogenetic study by Gray & Atkinson (2003) was carried out in order to find quantitative support for one of two conflicting hypotheses about the origin of Indo-European, the ‘Anatolian farming hypothesis’ and the ‘Kurgan expansion’ theory. Similarly, the study by Gray & Jordan (2000) supported one of several hypotheses about the colonization of the Pacific by Austronesian-speaking people. Also, the computer programs that carry out the analyses have to be fed with manually collected material, which usually consists of lists of cognates. The choice whether or not two words are considered cognates is not done by the computer, but has to be done by a trained linguist. Therefore, linguistic expertise will remain needed at all times, and computers will not take over the field.

Going back to biology, phylogenetic studies can be carried out on very diverse scales. On the largest scale, there are the relationships between the major lineages of life, such as eukaryotes and bacteria. On a smaller scale, there are the relationships between the kingdoms such as plants, animals and fungi, and on an even smaller scale, there are the relationships between for example groups of vertebrates such as fish, dinosaurs and mammals. Even within one species, phylogenetic methods can be performed, for example to reconstruct the origin and divergence of the human race (Cavalli-Sforza, Menozzi & Piazza 1994).

In linguistics, phylogenetic studies are usually carried out on languages that are part of a larger language family like Indo-European or Austronesian (see references above), but, similar to biology, there is no a priori reason to restrict oneself to this particular scale. An example of a study on a slightly smaller scale is Minett & Wang (2003), who look at the relationship between seven dialects of Chinese.

The possible use on different scales leads to the question whether phylogenetic methods can also be used to study the development of one particular linguistic item within a single language, as is the typical object of study in historical linguistics and grammaticalization research. As an example, let us consider the English word *while*. This word today exists as a noun, a temporal marker and a concessive marker. These three uses co-exist today, but this has not always been the case. The noun *while* is the original use of the word, and from this noun, a temporal marker developed (while the original noun remained in use). In a later phase, a concessive marker developed from the temporal marker. This means that, analogous to the cases for species and languages described above, we have an item showing descent with modification, leading to a situation of variation in the synchronic state. With the use of the phylogenetic method, it might therefore be possible to
reconstruct the historical relationship between these items. In other words, one could reconstruct a word’s history on the basis of its current synchronic variation.

In this chapter, I will explore the usability of this approach. The linguistic item I will use for this exploration is the Dutch word *krijgen*. In this chapter 4, I have discussed both the synchronic variation of the verb and its historical development and I will use this as a basis for the enterprise in this chapter. I will focus on two main questions: (1) is it possible to get a reliable reconstruction of the development of *krijgen* on the basis of synchronic data, and (2), what are the limitations of this approach?

In the next section, I will first give a more detailed description of the phylogenetic method in general. In section 6.3, I will define the different uses of *krijgen* in terms of this method, followed by results in 6.4 and a discussion in 6.5.

### 6.2 Phylogenetic inferencing methods

In this section, I will give a brief introduction to phylogenetic inferencing methods in general and their use in linguistics in particular. Although these methods are gradually becoming more popular in linguistics, the explanatory literature on the topic is still almost solely written for a biological audience (e.g. Felsenstein 2004, Ridley 2004). An introduction into the method that is specifically meant for linguists is McMahon & McMahon (2005), and in several other linguistic studies the main principles are briefly introduced as well (e.g. the collection of articles in Mace, Holden & Shennan 2005). Still, linguists that are interested in the subject will need to resort to the biological literature as well.

Phylogenetics is the study of historical relations between items, such as species or languages. These historical relations can be studied in different ways and hence there are different phylogenetic techniques that are used. In this respect, two main approaches can be distinguished: so-called ‘character-based’ and ‘distance-based’ methods. Character-based methods use characters such as morphological features or DNA-sequences from the relevant species. Each of these species can be defined by the state of a series of these characters (e.g. ‘present’ or ‘absent’ for morphological features and C, T, G and A for DNA). A tree is then reconstructed in which, in the smallest number of steps, the character sets of all species can be fitted, thus giving insight in the most likely order in which these species are related historically.

Distance-based methods also use these character sets, but instead reduce these sets into single values representing the distance between one species and the

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Note that in phylogenetic research, the term ‘characters’ is used in the sense of ‘characteristics’.
other. A tree can then be reconstructed that accounts for the actual evolutionary distance between species, or languages.

To illustrate both methods with an example, let us consider four randomly chosen species: a frog, a rat, a chimpanzee and a human. For each species, or taxon, a set of (relevant) characteristics can be gathered. We want to reconstruct the history of these four taxa on the basis of this data: how are the four species related?

**Distance-based methods**

Table 1 is a made-up example of a set of characters, and shows a sequence of 12 bases of mitochondrial DNA for our four species, in which each base can be either A, C, G or T.

<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>11</th>
<th>12</th>
</tr>
</thead>
<tbody>
<tr>
<td>human</td>
<td>A</td>
<td>A</td>
<td>C</td>
<td>T</td>
<td>G</td>
<td>G</td>
<td>A</td>
<td>G</td>
<td>T</td>
<td>C</td>
<td>A</td>
<td>G</td>
</tr>
<tr>
<td>chimpanzee</td>
<td>A</td>
<td>A</td>
<td>C</td>
<td>T</td>
<td>A</td>
<td>G</td>
<td>G</td>
<td>G</td>
<td>C</td>
<td>C</td>
<td>A</td>
<td>G</td>
</tr>
<tr>
<td>rat</td>
<td>G</td>
<td>A</td>
<td>T</td>
<td>G</td>
<td>A</td>
<td>G</td>
<td>T</td>
<td>G</td>
<td>A</td>
<td>C</td>
<td>T</td>
<td>G</td>
</tr>
<tr>
<td>frog</td>
<td>A</td>
<td>C</td>
<td>T</td>
<td>G</td>
<td>A</td>
<td>C</td>
<td>T</td>
<td>G</td>
<td>A</td>
<td>C</td>
<td>T</td>
<td>G</td>
</tr>
</tbody>
</table>

Table 1. A fictitious representation of a DNA sequence of four species.

In the distance-based method, the relationships between the species are calculated by looking at the distance between the taxa. The distance between two taxa is the number of steps (or mutations) it takes to get from one taxon the other. This information is shown in the distance matrix (table 2).

<table>
<thead>
<tr>
<th></th>
<th>human</th>
<th>chimpanzee</th>
<th>rat</th>
<th>frog</th>
</tr>
</thead>
<tbody>
<tr>
<td>human</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>chimpanzee</td>
<td>3</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>rat</td>
<td>7</td>
<td>6</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>frog</td>
<td>8</td>
<td>7</td>
<td>3</td>
<td>-</td>
</tr>
</tbody>
</table>

Table 2. Distance matrix of the four species. The values indicate the number of mutations to get from the DNA sequence of one species to another.

We can now construct a tree on the basis of the values from the distance matrix (figure 1). In this tree, the branch lengths represent the distances between the taxa.
The tree in figure 1 is a so-called ‘unrooted’ tree: it only provides us with information about the distance between the taxa and does not give any information about the order of the taxa in a tree. The usual way to add the latter is to use an ‘outgroup root’: a taxon that is known to predate the taxa that are subject of study. Figure 2 shows the rooted version of the tree from figure 2, using ‘drosophila’ as the outgroup root.

There are different algorithms to construct trees from a distance matrix. The most commonly used are UPGMA and neighbor-joining. The neighbor-joining algorithm is an iterative algorithm which clusters the two closest taxa under one node, and then
goes on to calculate other distances, treating the two clustered taxa as one single taxon. UPGMA stands for Unweighted Pair Group Method using Arithmetic Mean. Like neighbor-joining, it also uses an iterative clustering algorithm, but the methods differ in the exact way of clustering and the calculation of distances. Another major difference with neighbor-joining is that UPGMA is based on the assumption that evolution within all branches of the tree takes place at the same rate. This is known as the molecular clock hypothesis in biology (Zuckerkandl & Pauling 1962). Although I explained before that distance-based methods produce unrooted trees, this is not true for the UPGMA-method. In this algorithm, the constant rate assumption makes it possible to reconstruct the historical order of the branching (needless to say: only if the assumption about the rate of evolution is valid).

A special kind of distance method is the NeighborNet method (Bryant & Moulton 2002). This method does not produce trees but networks instead. Normally, distance methods will always create a tree, even if support for branches might be weak. The NeighborNet method will not necessarily give one optimal tree as output, but allows for a network structure in which several alternative trees are suggested.

**Character-based methods**

Another way to reconstruct the relationship between taxa is the character-based method. Unlike distance-based methods, this method does not reduce the character sequence (e.g. as the one shown in table 1) to a single distance value. Instead it aims to produce a tree that can account for all character sequences in the smallest number of steps.

As an example, let us consider our four species frog, rat, chimpanzee and human again. For this method, the fictitious DNA sequences from the previous examples can again be used. However, other types of characters can also be used for both methods, and to illustrate this I will use morphological and behavioral characters in this example. These characters are usually presented with binary coding, giving either absence or presence of each character. Table 3 gives an example.

<table>
<thead>
<tr>
<th></th>
<th>tool use?</th>
<th>cold blooded?</th>
<th>vertebrae?</th>
<th>language?</th>
</tr>
</thead>
<tbody>
<tr>
<td>human</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>chimpanzee</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>rat</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>frog</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
</tr>
</tbody>
</table>

*Table 3. An example of binary coded morphological and behavioral characters for the four species.*
In trying to infer the relationships between the four example species, we reconstruct the steps that lead from the character sequence of one taxon to the other, using the information from table 3. A step would be either 0 > 1 or 1 > 0: it takes one step to get from human to chimpanzee, two steps to get from human to rat, one step to get from rat to frog, etc. Example 1 shows the steps to get from the human character sequence to the sequence of the other species:

1) a. human \(1 0 1 1\) > \(1 0 1 0\) chimpanzee

\[
\begin{align*}
1 & \quad \text{chimpanzee} \\
1 & \quad \text{human}
\end{align*}
\]

b. human \(1 0 1 1\) > \(0 0 1 1\) > \(0 0 1 0\) rat

\[
\begin{align*}
1 & \quad \text{rat} \\
1 & \quad \text{human}
\end{align*}
\]

c. human \(1 0 1 1\) > \(0 0 1 1\) > \(0 0 1 0\) > \(0 1 1 0\) frog

\[
\begin{align*}
1 & \quad \text{frog} \\
1 & \quad \text{rat} \\
1 & \quad \text{human}
\end{align*}
\]

With this information, the unrooted tree in figure 3 can be reconstructed, in which the intermediate steps are represented by vertical lines.

**Figure 3.** An unrooted phylogenetic tree of four species based on a set of four characters. The vertical lines indicate transitions between the sets.

As is the case for the distance-based methods, the trees that can be reconstructed in character-based methods are basically unrooted and an outgroup root can be added to construct a rooted tree. Using the taxon ‘drosophila’ again (with the fictitious character sequence 0100) as our outgroup root, this would lead to the rooted tree shown in figure 4.
In this example, it is obvious which single tree can be reconstructed from the data. However, with more taxa and more characters, this reconstruction becomes more complicated, as more trees become possible. As for distance-based methods, several different character-based methods have been developed, such as the method of maximum parsimony and that of maximum likelihood. For maximum parsimony, trees are given a ‘score’ and this score is determined by the number of steps required in the tree. The tree with the least number of steps is said to be the most parsimonious tree. The method of maximum likelihood resembles the method of maximum parsimony in that it also assign scores to a set of possible trees, yet it differs from the former method in that it does not necessarily aims at finding the ‘shortest’ tree (i.e. the number of steps), but at finding the tree with the highest statistical probability.

A special kind of character-based method that has been increasingly used in recent years, also in linguistic research (e.g. Gray & Atkinson 2003, Holden, Meade & Pagel 2005) is Bayesian inference. Bayesian methods are described by Holden et al. (ibid.: 60) as ‘not [a] search for the best tree(s) according to an optimality criterion, but instead [as sampling] a large number of trees in proportion to their likelihood. Trees with a higher likelihood will be sampled proportionately more often, but trees with an intermediate likelihood which occur more frequently in the universe of possible trees, will also be represented in the sample. The aim is to represent phylogenetic uncertainty in the sample.’
The method is usually used together with a so-called Markov Chain Monte Carlo (MCMC) simulation. Basically, MCMC stands for the actual searching of a sample of the tree space, “preferably steering toward those trees which maximize a value called the ‘posterior probability’” (Wichmann & Saunders 2007: 390). This posterior probability reflects the probability that a given tree is the correct one for the dataset. With the continuing search in the tree space, a point will be reached when this posterior probability will not improve. A sample of trees from beyond this point is then collected, from which a consensus tree is constructed. Each branch in the consensus tree has a score to represent its strength, representing the number of times the node is found in the tree sample. Branches for which there is too little support (those that appear in the tree sample under a certain threshold level, which is usually set at 50 percent), are left out of the consensus tree.

**Phylogenetic methods in linguistics**

In the study of historical relationships between languages, both distance-based methods (e.g. Swadesh 1950, Gray & Jordan 2000 for Austronesian) and character-based methods (e.g. Ringe, Warnow & Taylor 2002 and Gray & Atkinson 2003 for Indo-European) have been used.

In these studies, the groups that are usually compared to one another are languages from a single language family such as Indo-European, and the character sets used in these studies are usually based on lexical data, counting the number of cognate words in the different languages. Table 4a gives an example of such a cognate list for the words of four semantic categories in five randomly chosen Indo-European languages (based on table 5.1 in Bryant, Filimon & Gray 2005: 70). In table 4b, the same information is represented in binary form, with languages that share a specific cognate receiving the value 1, and languages that do not the value 0.

<table>
<thead>
<tr>
<th></th>
<th>'father'</th>
<th>'foot'</th>
<th>'four'</th>
<th>'fish'</th>
</tr>
</thead>
<tbody>
<tr>
<td>Greek</td>
<td>pateras</td>
<td>podhi</td>
<td>teseris</td>
<td>PSARI</td>
</tr>
<tr>
<td>Irish</td>
<td>athair</td>
<td>COS</td>
<td>cesthair</td>
<td>iasc</td>
</tr>
<tr>
<td>Spanish</td>
<td>padre</td>
<td>pie, piede</td>
<td>quattro</td>
<td>pesce</td>
</tr>
<tr>
<td>Riksmål</td>
<td>far</td>
<td>BEN</td>
<td>fire</td>
<td>fisk</td>
</tr>
<tr>
<td>Dutch</td>
<td>vader</td>
<td>voet</td>
<td>vier</td>
<td>vis</td>
</tr>
</tbody>
</table>

*Table 4a. Cognate list of four semantic categories in five Indo-European languages. Non-cognates are shown in capital letters.*
Table 4b. The data from table 4a in binary form.

<table>
<thead>
<tr>
<th></th>
<th>‘father’</th>
<th>‘foot’</th>
<th>‘four’</th>
<th>‘fish’</th>
</tr>
</thead>
<tbody>
<tr>
<td>Greek</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Irish</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Spanish</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Riksmål</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Dutch</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>

The choice whether or not two languages share the same cognate has to be made manually, and as table 4a suggests, a good knowledge of the comparative method is necessary. Also, one has to keep in mind the possibility that words can be borrowed from another language without the two languages necessarily having to be related (see Minett & Wang 2003 and Warnow, Evans, Ringe & Nakleh 2004 for methods of taking borrowing into account).

**Phylogenetic methods in this study**

In this chapter, I will consider three different phylogenetic methods on a data set of the Dutch verb *krijgen* and discuss how the results of the methods are compatible with the findings from chapter 4. These methods are the distance-based methods NeighborNet and neighbor-joining, and a Bayesian analysis, which is used in character-based methods. This choice is partially inspired by a study by Wichmann & Saunders (2007), who tested several methods on a dataset of Native-American Languages and concluded that these three methods gave the most reliable results.

The three analyses are carried out using two open source software packages: the Splitstree program\(^3\) (Huson & Bryant 2006) for the NeighborNet and neighbor-joining analyses, and the BayesPhylogenies package (Pagel & Meade 2004)\(^4\) for the Bayesian analysis.

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\(^3\) [http://www.splitstree.org/](http://www.splitstree.org/)

\(^4\) [http://www.evolution.rdg.ac.uk/BayesPhy.html](http://www.evolution.rdg.ac.uk/BayesPhy.html). Extensive information about the different packages that are on the web can be found on the PHYLIP-website by Joseph Felsenstein: [http://evolution.genetics.washington.edu/phylip.html](http://evolution.genetics.washington.edu/phylip.html)
6.3 Defining taxa and characters for *krijgen*

The problem of defining taxa and characters for a single linguistic item

As I explained in the previous section, constructing a phylogenetic tree is a two-step process. First, each taxon is characterized by a set of characters and second, the relationships between taxa are calculated on the basis of this character set.

In the reconstruction of historical relationships between linguistic items within a single language, the first step in the process already leads to a problem. Contrary to the phylogenetic reconstruction of species within a larger family of species, or of languages within a language family, the taxa in the case of different uses of a linguistic item are not known beforehand. How should one proceed?

Of course, in defining taxa and characters in the case of a single linguistic item such as *krijgen*, we are not starting completely from scratch: we can use both the information embedded in the synchronic variation of the item and rely on general knowledge about the development of comparable items. For example, for a modal verb such as *can*, it is known that these kinds of verbs often change in the kinds of subjects (animate vs. inanimate) and complements (noun phrases vs. verb phrases) they take. Therefore, it is useful to define taxa on the basis of these properties. If it turns out that some characterizations do not lead to any useful distinctions, they can be left out at a later stage.

Also, one could use the knowledge that in modal verbs such as *can*, different uses such as main verb, mental ability, ability and root possibility constructions are distinguished. This knowledge can be combined with information about the synchronic variation of the item.

Another complexity is the choice of an outgroup root if we want to produce rooted trees. For *krijgen*, the intransitive use is an obvious candidate for an outgroup root. However, this means we need the independently motivated knowledge that the intransitive use indeed predates the transitive. For the case of *krijgen*, this knowledge can be found in most historical dictionaries. It can be argued that using this knowledge does not interfere with the goal of the reconstruction itself, which is to gain insight in how the different transitive uses of the verb are historically related. That is, we would accept the generally known historical order of development (intransitive > transitive) and use the phylogenetic reconstruction to focus on the development of the latter part of the development. Strictly speaking, however, using an outgroup necessarily means relying on more than just synchronic data.

In the next section, I will define the characters and taxa of *krijgen*, using the knowledge of its synchronic variation that I discussed in the chapter 4.
**CHAPTER 6**

**Taxa and characters for krijgen**

When focusing first on the transitive use of *krijgen*, the following ‘constructions’ can be identified on the basis of the direct object:

2) **Concrete object-construction:**
   - een cadeau krijgen (van iemand)
     - ‘to get a present (from someone)’

   **Abstract object-construction:**
   - antwoord krijgen (van iemand)
     - ‘to get an answer (from someone)’

   **Internal objects-construction:**
   - griepp krijgen
     - ‘to get the flu’

The construction with abstract objects can be further refined when looking at the role of transfer. In (3), *antwoord* ‘answer’ necessarily involves (metaphoric) transfer from one person to another, but in (4), no transfer takes place and *krijgen* only seems to have aspectual meaning: a ‘change into a state of having’.

3) De hoogleraar kreeg een onduidelijk antwoord van de student.
   - ‘The professor got an unclear answer from the student.’

4) Ik hoop dat we dit jaar op vakantie beter weer krijgen.
   - ‘I hope we will get better weather on our holiday this year.’

Within the construction with concrete objects, a subdivision is also possible when focusing on the role of the subject, which has a recipient role in (5) and an agent role in (6).

5) De zoon kreeg voor zijn verjaardag van zijn vader een auto.
   - ‘The son got a car from his father for this birthday.’

6) De criminelen deden alles om de auto te krijgen.
   - ‘The criminals did everything to get the car.’

Finally, in the construction with internal objects, a subdivision is possible between those objects that can be possibly be controlled by the subject (7), and those that cannot (8).

7) De vrouw kreeg na jaren van yogalessen eindelijk de gemoedsrust die ze al zo lang had gezocht.
   - ‘After years of yoga classes, the woman finally got the peace of mind that she had been looking for for so long.’
Apart from the transitive constructions, *krijgen* is also used in combination with various adjuncts, like in the resultative construction (9), the aspectual use of *krijgen* with a participle (10-11, with a difference in the grammatical subject of the second verb), the semi-passive (12) and the use with *te* + infinitive (13).

9) Met dit nieuwe afwasmiddel krijgt men zelfs de meest vieze pannen weer schoon.
   ‘With this new detergent, one gets even the dirtiest pans clean again.’

10) Lukt het je nog dit mailtje vandaag verstuurd te krijgen?
    ‘Will you still be able to get this mail sent today?’

11) De gijzelnemer kreeg zijn eisen ingewilligd.
    ‘The hostage taker got all his demands complied with.’

12) De volkszanger kreeg de koninklijke onderscheiding uitgereikt door de burgemeester.
    ‘The popular singer got his royal decoration handed out by the mayor.’

13) De deelnemers kregen pas na lange tijd de uitslag te horen.
    ‘The contestants were only told the result after a long time (litt. ‘got to hear the result’).’

These eleven different constructions (shown in examples 3-13) can be considered as the taxa that are needed for the reconstruction. They now need to be further defined, using a set of characters.

In general, the more characters that can be used in the description of the different taxa, the better, because it will lead to a more refined characterization of each taxon. For example, the word list used in the study of Indo-European by Gray & Atkinson (2003) consisted of 200 items, and the list of structural features used in the study of Papuan languages by Dunn et al. (2005) consisted of 125 items. Of course, only those characters should be added that are relevant in distinguishing the taxa (which obviously means leaving out those characters that render similar values for all taxa). Furthermore, it is also important to minimize correlations between characters, although it is impossible to rule out all covariance.

For the characterization of the *krijgen* taxa, it will not be possible to obtain a set of characters in the order of magnitude of those mentioned above. The question is whether this is a major obstacle in the pursuit of getting a reliable reconstruction of the historical development of the verb *krijgen*. It could very well be possible that...
some linguistic items are more suitable for this particular line of research than others, since they allow for a higher number of characters that can describe them. Starting with characters that relate to the subject, the following questions can be listed:

14) I Is the subject animate?
   II Is the subject agentive?
   III Can the action be the intention of the subject?
   IV Is there a change of state of the subject?
   V Is the subject of krijgen the subject of the main verb?

These questions give yes (1) and no (0) answers. Questions (I-II) are straightforward. Question III is necessary to distinguish uses like *geluk krijgen* ‘to get luck’ from uses like *koorts krijgen* ‘to get fever’. In both cases, the subject is not the agent, but objects like *geluk* ‘luck’ can be obtained by an intentional subject, while objects like *koorts* ‘fever’ cannot.

Uses like *een waarschuwing/antwoord krijgen* ‘to get a warning/an answer’ mostly go with animate subjects because of the nature of the direct object. This is not the case for the use with abstract objects like *goed weer krijgen* in which there is no transfer, and for the use with concrete objects, as examples (15-16) show.

15) De voorlichtingscampagne kreeg een feestelijke start.
   ‘The information campaign got a festive start.’

16) Bij het inchecken krijgt de bagage een nieuw label.
   ‘At check-in, the baggage gets a new label.’

A change of state of the subject, as in question IV, occurs in uses with an internal object, like *koorts/geluk krijgen* ‘to get a fever/luck’. Question V is specifically relevant for aspectual use of *krijgen*. In (17), the main verb of the sentence is *versturen* ‘to send’, and the subject of this verb is also the subject of *krijgen*. This is not the case in (18), in which *inwilligen* ‘to comply with’ is not done by the hostage taker, but by another, implicit participant.

17) (=10) Luikt het je nog dit mailtje vandaag verstuurd te krijgen?
   ‘Will you still be able to get this mail sent today?’

18) (=11) De gijzelnemer kreeg zijn eisen ingewilligd.
   ‘The hostage taker got all his demands complied with.’

The list of characters can be extended with a set of questions that relate to the used direct objects.
19) VI Is the direct object a concrete object?  
VII Does the direct object become the possession of the subject?  
VIII Is the object controllable?  
IX Is there a change of state of the direct object?

These questions also give yes (1) or no (0) answers, and all are straightforward. The resultative uses and the semi-passive mostly get a concrete direct object (e.g. *de piano de trap op krijgen* ‘get the piano up the stairs’), while this is not the case for the use with the *te* + infinitive (e.g. *het antwoord te horen krijgen* ‘get to hear the answer’). The group of controllable objects largely overlaps with that of concrete ones, with the exception of objects like *geluk* ‘luck’ and *genade* ‘mercy’. Direct objects undergo a change of state in the resultative use, in which the changed state is expressed by an adjunct phrase.  

A final set of questions relates to different aspects, such as the presence or absence of an adjunct phrase (as in the resultative use) or another participant (as the entity who is responsible for the actual transfer). Question XIII distinguishes the resultative use with PP or AP adjuncts from the aspectual use with verbal adjuncts.

20) X Is there a compulsory adjunct phrase?  
XI Is an extra participant needed for the transfer?  
XII Is there (metaphoric) transfer?  
XIII Does *krijgen* describe the main action?

In order to produce a rooted tree, it is necessary to add an outgroup root to the list of taxa. As I explained in the previous section, the intransitive use of *krijgen* (which has the meaning ‘to fight, to strive for’) is a proper candidate. It is distinguished from the other uses by adding a final question to the list:

21) XIV Is there a direct object?

Together, this leads to the following table of taxa and characters (table 5 on the next page). I will apply this dataset to three different phylogenetic methods, and compare the outcomes with the results of the diachronic study of *krijgen* from the previous chapter.
Table 5. The taxa of krijgen with their corresponding character values. A description of each character is found in the text above. Each taxon has been given a short name that will be used in the actual phylogenetic study.

|   | INTTRANSITIVE |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
| 1 | Ø krijgen     | 1 | 1 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| 2 | CONCR.OBJ.1   | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 0 | 0 | 0 | 1 | 1 | 1 |
| 3 | CONCR.OBJ.2   | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 1 |
| 4 | ABSTR.OBJ.1   | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 |
| 5 | ABSTR.OBJ.2   | 0 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 0 | 1 | 1 | 1 | 1 |
| 6 | INT.OBJ.1     | 0 | 1 | 1 | 1 | 1 | 0 | 1 | 0 | 0 | 0 | 1 | 1 | 1 |
| 7 | INT.OBJ.2     | 0 | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 |
| 8 | RESULTATIVE   | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 1 | 0 | 0 | 1 | 1 |
| 9 | ASPECTUAL.1   | 1 | 1 | 1 | 0 | 0 | 1 | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 1 |
| 10| ASPECTUAL.2   | 1 | 1 | 1 | 0 | 1 | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 1 |
| 11| SEM-PASSIVE   | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 0 | 1 |
| 12| TE+INFINITIVE | 0 | 0 | 1 | 0 | 1 | 1 | 0 | 0 | 0 | 1 | 1 | 1 | 0 | 1 |
6.4 Results

In this section, I will discuss the results of three methods of phylogenetic reconstruction, NeighborNet, neighbor-joining and Bayesian analysis and compare these results to the development of *krijgen* in chapter 4. I will start this section with a short overview of the findings of this chapter.

**A short overview of the development of *krijgen***

In the previous chapter, I have discussed the history of *krijgen* based on diachronic data. *Krijgen* started as an intransitive verb ‘to fight, to make an effort’, with an agentive subject. From this use, the first two branches are a transitive variant with the meaning ‘to obtain by effort’ and a resultative variant with the meaning ‘to get X at/from location Y’, both appearing before 1400. The transitive use is initially combined with concrete objects like ‘sword’ and ‘chess board’. Later, this set of objects is extended to mental and physical states of the subject and abstract objects (*wille ‘consent’, antwoord ‘answer’*).

Over time, the transitive use loses its subject agentivity, and this process starts with the use with ‘state’ objects, followed by the use with abstract objects and, lastly, with concrete objects.

From the resultative use, new uses also develop: first there is an extension from locative complements to PP-complements describing states. Later, these ‘state’ complements also allow the use of participles, which can be seen as the first aspectual use of *krijgen*. All these uses keep an agentive subject, which runs contrary to the development of the transitive use.

There are two auxiliary uses of *krijgen*, and both appear relatively late in the verb’s history. The *te* + infinitive construction is first found in the 18th century and is used with a non-agentive subject. This use seems to have developed in a process of specification from the transitive use with a non-agentive subject.

The second auxiliary use is the semi-passive, and this use is the latest development of *krijgen*, appearing first in the early 20th century. I hypothesized that this use developed from the aspectual use of *krijgen*, in an environment in which the prototypical (transitive) use of the verb had become almost completely non-agentive.

Next, I will subject the dataset from the previous section to three different methods of analysis, and compare the outcomes with the diachrony of *krijgen* mentioned above.
NeighborNet

NeighborNet is a distance-method that produces networks instead of trees. This means that it does not produce one optimal tree, but a network in which several alternative trees are suggested as well.

Figure 5 shows the resulting network, in which the names of the different taxa are those found in table 5. Obviously, the network does not have a very strong tree-like structure, which is due to the fact that most taxa can be linked to each other in different ways. This means that, on the basis of the given data, there is no strong support for a single possible relationship between the different uses of *krijgen*.

![Figure 5. NeighborNet analysis of the 12 taxa of *krijgen*. The branch lengths indicate relative distance.](image)

The most strongly supported ‘branch’ is that of the resultative and aspectual uses. The network correctly suggests that the aspectual use has developed from the resultative. The order of the two aspectual uses is also as was hypothesized in the
previous chapter: first, the subject of the participle is similar to the subject of *krijgen* (aspectual_2), while later the two subjects can be different (aspectual_1).

The network does not provide any strong clues about the relationships between the early transitive uses of *krijgen* in the middle of the graph. Still, based on the relative distances between these different uses in the graph and the fact that the intransitive use is the original use of *krijgen*, there is some (yet weak) support for the path of development that was also found in the diachronic corpus study:

22) concrete objects with an agentive subject (concrete_object_1)
   | internal objects with an agentive subject (internal_object_1)
   | internal objects with a non-agentive subject (internal_object_2)
   | abstract objects with a non-agentive subject (abstract_object_1)
   | abstract objects with a recipient subject (abstract_object_2)
   | concrete objects with a recipient subject (concrete_object_2)

Also, the network does show some support for a grouping of uses with an agentive subject (in the top part) versus those with a recipient subject (in the bottom part), with non-agentive use in the middle. This intermediate position of the non-agentive use gives some support for the hypothesis that *krijgen* first developed its non-agentive use from its agentive use, and that the ‘receive’ sense developed from this non-agentive use later, as was found in the corpus study.

Interestingly, the semi-passive and *te* + infinitive use are grouped with the ‘receive’ senses in the bottom left part of the network. This supports the hypothesis that both uses have developed from the ‘receiving’ use.

**Neighbor-joining**

The neighbor-joining analysis is one of the methods that construct a tree on the basis of the relative distances between the different taxa. It clusters the two closest taxa under one node, and then goes on to calculate other distances, treating the two clustered taxa as one single taxon. Strictly speaking, the resulting neighbor-joining tree therefore does not provide any information about the history of *krijgen*. However, the distances between the different constructions can be used as an indication of their historical relatedness, using the assumption that the closer two constructions are in distance, the closer related they are in time. These distances are
represented in the branch lengths in the tree. Neighbor-joining trees can be both unrooted and rooted when an outgroup root is assigned.

Contrary to the NeighborNet network, neighbor-joining analysis always produces a tree, even when there is little support for certain branches. A way to obtain an idea how well the branches in the tree are actually supported by the data is to perform a so-called bootstrapping procedure (Holder & Lewis 2003: 279, Felsenstein 2004: 334ff).

Bootstrapping randomly resamples the data set to produce pseudo-replicate data sets, and the tree-building algorithm is then repeated on these replicate sets. Pseudo-replicate data sets have the same data as the original data set, but the order of the data has been altered. By also searching for trees in these ‘extra’ sets, it can be measured how many times each branch in the original tree is recovered, thus giving a measure of its robustness. These values are shown in the trees in figures 6 and 7.

Figure 6. Unrooted consensus tree of 1000 bootstrap replicates, using the neighbor-joining method. The branch lengths indicate relative distances between taxa. The values on each branch show the percentage that the branch is present in the replicate set.

The unrooted tree (figure 6) strongly resembles the NeighborNet-network: the uses with an agentive subject are found close to the original intransitive use in the top part of the graph, the uses with a recipient subject in the bottom left part of the
graph, and the non-agentive use in the right middle. Again, the semi-passive and the 
te + INF uses are grouped with the recipient uses of krijgen.

Although many of the branches have considerably high bootstrap values, 
the branches that differentiate the main uses of krijgen (agentive subject / non-
agentive subject / recipient subject) do not. Their bootstrap values never exceed 50, 
which means they are supported by the data in less than half of the cases. This 
finding is comparable to that of the NeighborNet analysis.

Figure 7. Rooted consensus tree of 1000 bootstrap replicates using the neighbor-joining 
method. The branch lengths indicate relative distances between taxa. The values on each 
branch show the percentage that the branch is present in the replicate set. The intransitive use 
is added as outgroup root.

Figure 7 shows the rooted version of the neighbor-joining tree, with the intransitive 
use as outgroup root. Basically, it holds the same information as the unrooted tree in 
figure 6, with the addition that the branches are now positioned based on their
relative distance to the root. The horizontal axis can therefore be taken as a representation of time, moving from old (left) to new (right). In general, the tree reflects the historical development reasonably well, with the use with an agentive subject (both transitive and resultative) appearing first, followed by the development of non-agentive use, and the use with a recipient subject after that. The semi-passive, which was found to be one the newest constructions in the diachronic corpus, also appears in the tree as the newest use, having developed from the use with concrete objects and a recipient subject (‘concrete_object_2’ in the graph).

However, when looking at the tree in more detail, some of the branches turn out to be problematic. The first split in the tree creates a branch of strongly agentive uses in the top part of the graph and a branch of less agentive uses in the bottom part of the graph. This split runs contrary to the hypothesis that the use with an internal object and an agentive subject (‘internal_object_1’ in the graph) has developed from the use with a concrete object and an agentive subject (‘concrete_object_1’). The tree never shows a direct development of one use from another, like the aspectual use with a VP as adjunct developing out of the resultative use with a PP as adjunct, although such a development is possible in a phylogenetic tree. Instead, related uses share a common ancestor. Another example of this is the non-agentive use with an internal object (‘internal_object_2’), that shares a common ancestor use with the original agentive use with an internal object (‘internal_object_1’).

**Bayesian analysis**

As I explained in section 6.2, Bayesian analysis samples a large number of trees in proportion to their likelihood, using a so-called Markov Chain Monte Carlo (MCMC) simulation. From this sample, a consensus tree is constructed, and each branch is given a score that represents the number of times the node is found in the tree sample.

The first step in the Bayesian analysis is therefore to search the space of possible trees. Figure 8 shows the results of this search, with the posterior probabilities of the sampled trees quickly reaching a point of convergence. It was found that 10,000 generations and a sampling of every 10th tree was enough to reach a reasonable point of convergence (these values can differ strongly, depending on the number of taxa and characters in the dataset). The last 250 trees were kept, giving a so-called ‘burn in’ of 750 trees before the convergence point. From these 250 trees, a consensus tree was made using Splitstree.
Figure 8. Posterior probabilities scores of 10,000 generations of trees, using a Markov Chain Monte Carlo simulation. The score for each 10th tree is shown. The dotted line indicates the point in which the score has reached a reasonable convergence.

Figure 9. Majority-rule consensus tree based on the sample of 250 trees that was obtained with the MCMC simulation. The tree is rooted with the intransitive use. Branch lengths indicate distance, values are posterior probability scores.
The most obvious aspect of the resulting tree (figure 9) is that it has far less branching than the trees that were produced with the neighbor-joining analysis. There are only two major branches, one with the uses with a recipient subject in the top of the tree, and one with the uses with an agentive use in the middle, but even these two branches are poorly supported by the data. However, the branching within these main branches is similar to that in the neighbor-joining tree. For the rest, the Bayesian tree does not provide any information about the development of *krijgen*, or it has to be that no single path of development is supported by the data.

This result runs contrary to the finding of Wichmann & Saunders (2007: 391), who conclude that the results of the Bayesian analysis are superior to those of other methods. How can this difference be explained?

The major problem with the dataset I have used in this study is its size. Where cognate sets or typological features can give 100 or more characters, the number of characters in this study was only 12. This low number of characters obviously leads to branches that cannot be supported by a significant number of character values, as would be the case with a bigger character set. This is especially a problem for the Bayesian analysis, because this analysis works with a consensus tree that is constructed on the basis of multiple trees. With a low number of characters, the analysis will come up with differently structured trees that still have similar likelihoods, and these different structures will disappear in the consensus tree. Based on this study alone, it is therefore not possible to make a good judgment about the usefulness of the Bayesian method for this type of research.

### 6.5 Discussion

Phylogenetic inferencing techniques allow for historical research without historical data. It is therefore a possibly very useful tool in the study of linguistic change, both across and within languages. In this study, I have introduced the technique for the study of the development of linguistic items within a language. The first results are promising, yet the method has to be improved in order to become more useful.

The biggest challenge in using phylogenetic techniques in the study of single linguistic items such as *krijgen* is to establish an objective and workable character set. First, the character set that I used for *krijgen* was very small (12 characters). This has lead to branches that are sometimes based on only a single shared character value, and to the fact that conflicting branches can also be supported. With a higher number of characters, relationships between groups will be constructed more reliably. The question is whether a significant increase in the number of characters is possible for this type of historical research. I am inclined to say it is, but with the recognition that this limits the number of linguistic phenomena
that can be investigated. The best candidates are therefore those linguistic items that have undergone significant changes on all linguistic levels: syntax, semantics, phonology and pragmatics, and thus allow for a large character set. Also, these diachronic changes have to be traceable in the synchronic variation.

A second problem with the character set is the possible correlation between characters. Ideally, characters should ‘behave’ independently from each other, but for the characters used in this study, it cannot easily be determined whether this is the case. For example, I have used separate characters for ‘subject agentivity’ and ‘subject animacy’, while a degree of overlap, and thus correlation, between the two is rather likely.

The third problem is related to the first two and has to do with the fact that there is a degree of arbitrariness in the choice of characters. For each linguistic item to be studied, a new character set will have to be determined, and there seems no clear objective way to decide which characters have to be selected.

In conclusion, I would argue that using phylogenetic techniques in the study of single linguistic items is a promising enterprise in historical linguistics, while keeping in mind that there are several difficulties that have to be dealt with. However, with the limitations that I discussed above in mind, the method can still be considered useful in that it can be used as a supporting method in actual historical research.
Chapter 7

Conclusions

The purpose of this thesis was to use an evolutionary approach in the field of historical linguistics, and to discuss several cases of language change from this perspective, using agent-based computer models. As such, this thesis aimed to explain specific phenomena of language change as instances of more general behavior of evolutionary systems. In this final chapter, I will give a short overview of these case studies and their results, and discuss the general conclusions that can be drawn from them.

The approach to take language as an evolutionary system and to use computer modeling techniques has been used in several studies in recent years. Many of these studies focus on ‘language origin’: the question how a system like language can have evolved in early hominids (see Fitch 2005: 15 for an overview of recent publications). Other studies focus on language change (e.g. Niyogi & Berwick 1997, Nettle 1999, Yang 2000), and the present work should be regarded as a contribution to the latter field. At the same time, this thesis differs from it in that it is written from a strong linguistic perspective, using concrete linguistic examples and linguistic theory (cf. Croft 2000, Bybee 2006), while most of the aforementioned studies are more mathematical or artificial intelligence-based. Needless to say, this is not a judgment, but rather a remark on the perspective of these works. This thesis’ intended audience are historical linguists, who are concerned with very specific linguistic questions on language change, and who have little or no knowledge of evolution theory or computer modeling. The thesis’ goal is to present to them an approach that may at first seem complicated, but on closer inspection turns out to be insightful and explanatory, and a useful tool in research on language change.

For this reason, I have discussed a number of case studies on different issues in historical linguistics, such as unidirectionality, isomorphism, and preservation or loss of original meaning. I have used actual linguistic material to illustrate these cases.
An overview of the chapters and their conclusions

The case studies in this thesis deal with different topics, and I will review each of them and their conclusions briefly before turning to more general conclusions.

Chapter 2 deals with general tendencies in semantic change, and chapter 3 with isomorphism and the problem of free variation. Chapters 4-6 all deal with the Dutch verb *krijgen*, but can be read as independent chapters. Chapter 4 differs from all other chapters in that it is the least ‘evolutionary’ and contains no computer modeling, but rather a ‘traditional’ historical linguistic study on the development of *krijgen*. I have used these findings in the subsequent chapters 5-6. In chapter 5, I discuss how semantic change as observed in *krijgen* can be modeled, and discuss mechanisms affecting preservation and loss of original meanings. In chapter 6, I show a new technique to reconstruct diachrony based on synchronic data, and compare its outcome with the results from chapter 4.

In chapter 2, I discussed a general computer model of semantic change. In this model, agents have knowledge of the meaning of one word, and this ‘meaning’ is polysemous, consisting of multiple related senses (cf. Geeraerts 1997). Semantic change is a change in this polysemy: there can be a change in the number of senses, or a shift in the kind of senses that make up the total meaning. The main result of the computer simulation was that unidirectionality in semantic change can be understood as a result of different usage properties of lexical meaning versus functional meaning. First, functional meanings are more general and abstract, which enables them to be used in more contexts. This gives them a frequency of use that is higher than that of lexical meanings, and that produces unidirectional change. Second, the assumption that lexical meaning can be manipulated more easily than functional meaning has a similar effect. The latter can be conceived of as an asymmetry in the occurrence of mutations, and it also leads to unidirectional change.

In chapter 3, I discussed the principle of competitive exclusion in language. This principle explains the one form-one meaning tendency in language as a result of competition: two forms that compete for the same resource (meaning) cannot remain in a stable co-existence. Instead, due to stochastic processes, one of the two forms will become the single form linked to the particular meaning, at the expense of the other form. The only way for two competing forms to both remain in existence is either full or partial differentiation of the resource, that is, the meaning. To illustrate this, I used the example of adjective-noun combinations in German, Dutch and English, which function as category names and appear as both compounds (*grandson, software*) and as lexicalized phrases (*full moon, cold war*). Interestingly, both forms appear in the three languages in a seemingly stable equilibrium, which is at odds with the principle of competitive exclusion. I have proposed to consider the domain of AN-combinations as a ‘niche’ for which the two
linguistic variants compete, and discussed two main selection pressures that are at work in this system. First, certain factors of usage (frequency, special meaning) and form cause phrases to enter the system regularly, and second, the presence of a case system leads to a preference for compounds over phrases.

Such a system of competing forms is in principle unstable, as I have shown with a computer model. Because phrases enter the system at a slow but steady rate, they will eventually always drive compounds to extinction. A selection pressure against phrases, due to the presence of a case system, can slow this process down, but cannot stop it.

However, the system of AN-combinations turns out to be more complex. Three different semantic types of AN-combinations can be distinguished, and free variation only occurs in one of these types. I show that this semantic differentiation can explain the stable equilibrium. Both forms appear exclusively in one of the semantic sub-niches, which guarantees them a basic frequency. In turn, this basic frequency leads to preservation in the shared sub-niche. Thus, I claim that the possibility for semantic specialization leads to linguistic preservation. Theoretically, this gives rise to the proposal to replace the traditional isomorphism principle with the (biologically inspired) exclusion principle.

As I mentioned earlier, chapter 4 is a traditional study of the history of the Dutch verb *krijgen*. This verb’s development is a classic case of grammaticalization: it gradually changes from a main verb with a concrete and agentive meaning into a verb with a general, abstract meaning, both as a main verb and as an auxiliary. Originally, it is exclusively used with intentional, human subjects, but over time, the use with inanimate subjects increases. Also, its overall frequency increases as well. I proposed how the development of the verb can be explained by mutations in the use of the direct object. The extension of the set of direct objects from concrete objects to that of ‘inner states’ (such as ‘luck’ and ‘peace of mind’), allowed a less agentive interpretation, and in turn, a reanalysis of the role of other participants. Thus, the agent role became less strongly linked to the grammatical subject, which led to both non-agentive uses of *krijgen* (comparable to English ‘get’ in uses like *I feel like I’m getting sick*) and uses in which the grammatical subject had a recipient role (comparable to ‘get’ in uses like *I’m getting a new bike from my parents*). These ‘bleached’ meanings in turn enabled the development of auxiliary uses, such as that of semi-passive marker.

In chapter 5, I continued the study of *krijgen*, with a focus on the development of its transitive use. The main goal of this chapter was to present how a computer model of semantic change can be constructed, and to show what mechanisms affect preservation and loss of an original meaning in the system. The computer model is based on existing exemplar models of language. The basic assumption of these models is that language users are continuously sensitive to
linguistic experience, and that their linguistic knowledge consists of representations of both specific instances (exemplars), and of abstractions based on these instances. In this chapter, I show how such an approach can be applied to model semantics as well. Meaning is transmitted indirectly, but the interpretation of meaning can be linked to aspects of transmission that take place (more) directly, such as the properties of the direct object in the usage of *krijgen*.

In such a system, it turns out that it is much easier to obtain semantic extension in which the original meaning is preserved, than to obtain semantic shift, in which the original meaning is lost. By allowing more innovation in the system, the range of meanings for *krijgen* grows, but the original meaning remains present in the system. The addition of a skewed frequency of use, in which less agentive uses will be used more frequently than the original agentive uses, led to a loss of the original meaning. With such a set-up, it was also easy to account for the frequently occurring cases of semantic shift, in which the original meaning survived only in highly concrete uses.

Finally, in chapter 6, I investigated the use of phylogenetic inferencing in the field of historical linguistic research. This method makes it possible to reconstruct historical relationships between particular uses on the basis of synchronic variation. I applied this technique to the verb *krijgen*, and compared the outcome with the results of the diachronic study in chapter 4. Phylogenetic inferencing is a biological technique that is used mainly in the classification of species in larger families, but recently, it has also been applied in linguistic classification studies. Its strength is that it uses present-day data to reconstruct the past, and as such it can be a valuable addition to historical research. Historical data is often incomplete, in that material from some centuries can be hard to find. Also, collecting and interpreting historical material is time-consuming. For these reasons, phylogenetic inferencing is a welcome new tool, although I need to stress that it will have to be used as an additional tool, and not as a replacement of conventional methods.

As a first investigation, the phylogenetic reconstruction of *krijgen*’s past is successful. With only a small set of characteristics, it is possible to reconstruct the general development of *krijgen*. However, the limited size of the set of characteristics also turns out to be the method’s weak point as far as historical research of a particular linguistic item is concerned. With a low number of characteristics, branches in the phylogenetic tree are sometimes unreliable, being based on a single shared characteristics value. The best candidates to be investigated with this method are therefore those linguistic items that have undergone significant changes on all linguistic levels: syntax, semantics, phonology and pragmatics, and thus allow for a large set of characteristics. Of course, another important condition is that these different uses are still present in the item’s present-day use.
In summary, the following conclusions can be drawn from this thesis:

- Unidirectionality in change can be understood as a result of different usage properties of lexical versus functional meaning.
- The biological principle of competitive exclusion can be used in linguistics to explain the tendency for meaning to be uniquely linked to a single form.
- (Partial) semantic specialization can lead to a violation of the principle of competitive exclusion.
- The semantic bleaching of Dutch *krijgen* can be understood as the result of an extension of its direct object use.
- In the absence of competing words, semantic extension occurs more easily than semantic shift.
- Semantic shift can occur by assuming a higher frequency of use for non-agentive senses than for agentive senses.
- It is possible to reconstruct the historic development of single words within a language (such as *krijgen*) with synchronic data, using phylogenetic inferencing techniques.

General conclusions and recommendations for further research

This thesis did not have a single main research question. It is the result of a project that intended to apply evolutionary computer models to language in different case studies, and, by doing this, to show the benefits of such an approach. If, however, a single conclusion had to be drawn on the basis of this starting point, it would be that an evolutionary approach is indeed a valuable tool in the study of language change. In the chapters in which I presented agent-based models, I showed that the approach makes it possible to reduce complex linguistic phenomena to a set of mechanisms that can be studied independently. In the chapter on phylogenetic reconstruction, I showed that the development of a single verb can be reconstructed using techniques from evolutionary biology.

Behind the argument that the evolutionary approach is a valuable tool lies the assumption that language can be considered an evolutionary system in its own right: a system consisting of a vast number of utterances that by use are transmitted from one individual to the other, and that are subject to mutation and selection. A system, also, that is never static but constantly changing, sometimes rapidly, sometimes so slowly that it can hardly be witnessed. The evolutionary approach to language shows how usage and change are tightly linked.

From the three chapters in which I used agent-based models, another conclusion can be drawn. In these three cases, I showed how different linguistic phenomena – unidirectionality, violations of the isomorphism principle, and
preservation versus loss of meaning – can be explained by very basic mechanisms like innovation and frequency of use: general mechanisms that are present in all evolutionary systems. This is an interesting finding, because it shows that, at least in some ways, these linguistic phenomena are not ‘special’ to human language, but that they are manifestations of behavior that can also be witnessed in other evolutionary systems.

Another conclusion that can be drawn from this thesis is that it has only scratched the surface of what can be achieved in this field. In many ways I had to restrict myself in this study, both in scope and in depth. As I hope to have shown, computer models are very useful in gaining a better understanding of how particular processes work and what role certain conditions and parameters play. However, it is important to remain aware of their limitations. A particular model does not necessarily have to represent reality: although its results make it feasible to make claims about certain parameters, this does not rule out the possibility that similar results could also be obtained with different parameters. The computer models I have used consisted of small populations with no population structure (such as social networks) and no or only negligible generation effects. This means that I have not considered the possible roles of these factors in the phenomena I investigated. Although this limitation has to be kept in mind, it certainly does not make the results from computer modeling less interesting. I have shown that explanations can be given for certain linguistic phenomena on the basis of non-social factors that are basic components of elementary linguistic communication (including frequency of use and frequency of communication between individuals). Whether or not social factors are also involved in these phenomena, this does not affect these results. In fact, this issue again shows the value of the evolutionary modeling approach, in that the role of different mechanisms can be independently studied. I would even like to argue that they must be studied independently, because only then will it be possible to fully understand their proper role in some phenomenon, and only then can the inference that other mechanisms produce this phenomenon be rejected.

Apart from further investigation of the effects of social factors on language change using computer models, another interesting path for future research is the implementation of more realistic data on language use. A recent study (which unfortunately appeared too late to be incorporated in the research in this thesis) measured the actual language use of individuals per day (Mehl, Vazire, Ramirez-Esparza, Slatcher & Pennebaker 2007). With this finding, it becomes possible to estimate the actual use of a particular word (using word frequency tables), and to incorporate this into a computer model. Comparable to this are two recent studies in which quantitative data has been used to get a better understanding of the role of frequency in lexical replacement (Pagel, Atkinson & Meade 2007) and in the
regularization of irregular verbs in English (Lieberman, Michel, Jackson, Tang & Nowak 2007).

Again, this indicates the range of work that still is to be done in the exciting field of evolutionary linguistic computer modeling. A field to which I hope that this thesis, in one way or another, has contributed.
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Grimm. See Deutsches Wörterbuch


MNW. see CD-ROM *Middelnederlands*.


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WNT. See Woordenboek der Nederlandse Taal.


Samenvatting in het Nederlands

Cultureel-evolutieaire modellen van patronen in taalverandering

Dit proefschrift is het resultaat van een project uit het NWO-programma *Evolutie en gedrag*, een programma dat is opgezet met het doel het gebruik van de evolutie-theorie in de menswetenschappen te bevorderen. In het project draaide het daarbij om de vraag hoe inzichten uit de evolutie-theorie gebruikt kunnen worden bij de bestudering van menselijke taal en taalverandering. Meer specifiek is het doel van dit proefschrift om een aantal concrete gevallen van taalverandering te beschrijven en, waar mogelijk, te verklaren, gebruik makend van de evolutie-theorie.

Dit ‘gebruik’ van de evolutie-theorie geldt op twee niveaus. Allereerst heb ik taal beschouwd als een evolutieair systeem: een dynamisch systeem van variatie, overdracht en selectie of drift. Daarnaast heb ik de kennis die er in de biologie over evolutieaire systemen bestaat gebruikt om enkele concrete gevallen van taalverandering te analyseren. In drie gevallen heb ik daarvoor evolutieaire computermodellen ontwikkeld op basis van bestaande computermodellen uit de biologie. In een vierde geval heb ik de zogenaamde phylogenetische reconstructietechniek, een techniek die in de biologie wordt gebruikt om verwantschappen van soorten te berekenen, gebruikt om de historische ontwikkeling van een bepaald woord te reconstrueren. Hieronder zal ik zowel de evolutieaire aanpak als de concrete deelonderzoeken in meer detail beschrijven.

Om onduidelijkheid te voorkomen: in dit proefschrift heb ik me niet beziggehouden met het *ontstaan* van taal, een onderzoeksgebied dat ook vaak met *evolutie van taal* wordt aangeduid. Bij deze richting gaat het vooral om de vraag hoe het taalvermogen zich heeft kunnen ontwikkelen bij de eerste mensachtigen. In mijn onderzoek heb ik mij echter gericht op het tot volledige wasdom geëvolueerde taalsysteem: taal zoals wij dat dagelijks gebruiken. Die taal verandert voortdurend, soms snel en duidelijk merkbaar voor zijn gebruikers, soms langzaam en vrijwel onmerkbaar.

Uit de verschillende onderzoeken die ik in dit proefschrift presenteer, komt duidelijk naar voren dat een evolutieaire aanpak een zeer nuttig gereedschap is bij onderzoek naar taalverandering. In deze aanpak kunnen complexe fenomenen in taal worden teruggebracht tot het resultaat van individuele handelingen van de gebruikers van een taal, en dit proces kan met behulp van computermodellen worden gsimuleerd en bestudeerd. Daarnaast laat de evolutieaire benadering zien dat verschillende,
soms complexe, processen van taalverandering, zoals unidirectionaliteit, behoud en verlies van betekenis en schendingen van het isomorfieprincipe, verklaard kunnen worden met zeer ‘basale’ factoren als innovatie en frequentie: algemene mechanismes die niet taalspecifiek zijn maar die we aantreffen in alle evolutionaire systemen.

Op het eerste gezicht lijken evolutie en taal weinig met elkaar gemeen te hebben: evolutie is de voortdurende verandering die we in het planten- en dierenrijk aantreffen, een proces dat kan leiden tot de vorming van nieuwe soorten. Taal is daarentegen een systeem dat mensen gebruiken om met elkaar te communiceren. Waar zit de gemene deler?

Die vinden we als we onder de oppervlakte van de menselijke taal en de planten- en dierenwereld kijken. Evolutie vindt plaats als er variatie in kenmerken is, als deze kenmerken worden overgedragen van individu op individu en als er verschil bestaat in de kans op de overdracht van de varianten. In de natuur zijn deze drie aspecten aanwezig: er is variatie, zoals bijvoorbeeld een individu met een bepaalde kleur die als schutkleur functioneert in de leefomgeving, en een individu met een (iets) andere kleur. Deze variatie wordt genetisch overgedragen van ouder op kind en de twee varianten hebben een verschillende kans om hun eigen genen weer door te geven op hun nageslacht. In dit voorbeeld kunnen we voor het gemak stellen dat het individu met de schutkleur een grotere kans heeft te overleven en op die manier nageslacht te produceren, dan het individu zonder schutkleur. Dit proces wordt ook wel natuurlijke selectie genoemd.

De drie aspecten die een evolutionair systeem vormen vinden we echter ook buiten de planten- en dierenwereld, bijvoorbeeld in menselijke taal: in taal vinden we variatie, wordt de variatie overgedragen van individu op individu en bestaan er verschillen in de kans op de overdracht van de varianten.

Dat er in taal variatie bestaat is eenvoudig observeerbaar. Variatie is overal aanwezig, zowel tussen individuen als binnen één individu, bijvoorbeeld in uitspraak (denk aan de verschillende manieren waarop Nederlanders de _r_ uitspreken), betekenis (krijgen betekent wat anders in _Ik krijg je nog wel!_ als in _Zij kreeg het lintje uitgereikt_) en woordkeuze (_het boek wat/dat ik gelezen heb_).

Daarnaast is ook de overdracht van taal, en daarmee van variatie, evident: iedereen leert als kind de taal die hij of zij om zich heen hoort en ook als volwassene blijven we gevoelig voor veranderingen in de taal om ons heen, en worden dus de eigenschappen van varianten telkens opnieuw gereproduceerd.

Bij het verschil in kans op de overdracht van varianten moeten we denken aan factoren waardoor een taalgebruiker ‘kiest’ – bewust of onbewust – voor een bepaalde variant. Er zijn verschillende soorten oorzaken te noemen. Zo kunnen sociale factoren een rol spelen: taalgebruikers passen hun taal aan om wel of niet bij
een bepaalde groep te horen. Maar ook andersoortige factoren kunnen invloed hebben. De ene variant kan bijvoorbeeld minder moeite kosten om uit te spreken dan de andere variant – een economisch principe – of de ene variant heeft een grotere kans op communicatieve verwarring dan de andere – een communicatief principe. Ten slotte is er een zogenaamde ‘taalinterne’ oorzaak die een mogelijke rol speelt en deze oorzaak staat centraal in dit proefschrift. Om deze oorzaak goed te begrijpen is het echter zaak om eerst een duidelijker beeld te krijgen van wat het begrip overdracht precies inhoudt.

In dit proefschrift volg ik de theorie van Croft (2000) over overdracht. Croft stelt dat overdracht plaatsvindt tijdens communicatie: iedere keer als wij spreken, worden klanken, woorden en grammaticale constructies van onze taal gereproduceerd. De taaluiting zelf staat hiermee centraal in deze theorie; zij is de drager van de linguïstische eenheden die telkens gereproduceerd worden. Croft stelt dat een taal is op te vatten als een populatie van taaluitingen gebruikt in een populatie van mensen, en iemands taalkennis als de representatie in zijn/haar geheugen van de linguïstische eenheden die gerealiseerd zijn in de verzameling van alle uitingen die op hem of haar zijn overgedragen (inclusief de zelf geproduceerde uitingen), waarbij die representatie ook relaties tussen de eenheden en algemene patronen en regels omvat (dus systematisch is). Bij deze aanname horen nog een aantal gerelateerde punten. Ten eerste wordt taal opgevat als een dynamisch systeem, omdat taalgebruikers gedurende hun leven constant blootgesteld zijn aan taaluitingen. Ten tweede wordt ervan uitgegaan dat mensen gedurende hun hele leven gevoelig zijn voor de taaluitingen om hen heen. Natuurlijk hebben de uitingen die men als kind hoort het grootste effect op iemands taalkennis, maar dit komt met name omdat kinderen zonder enige kennis beginnen. De gevoeligheid voor de taal die we om ons heen horen verdwijnt echter niet abrupt aan het einde van onze kindertijd; alleen het effect ervan zal minder groot zijn dan eerder omdat we al de beschikking hebben over een min of meer volwaardig taalsysteem. Toch kunnen aspecten als woordgebruik en uitspraak ook bij volwassenen nog behoorlijk veranderen. Ten derde betekent gevoeligheid voor taaluitingen dat de frequentie waarmee we deze uitingen horen een zeer belangrijke rol speelt in de manier waarop onze taalkennis is opgebouwd. Met andere woorden: woorden, constructies of klanken die we met een hoge frequentie waarnemen zullen sterker in onze taalkennis verankerd zijn dan woorden, constructies of klanken die we met een lage frequentie waarnemen. Omdat we continu gevoelig zijn voor de uitingen die we om ons heen horen, betekent dit dat de mate van ‘verankering’ door de tijd kan veranderen, bijvoorbeeld omdat we in een korte periode een bepaalde nieuwe variant heel vaak, dus met een hoge frequentie, waarnemen.

Het verband tussen dit laatste punt en de kans op de overdracht van een bepaalde variant is dat de mate van ‘verankering’ van linguïstische eenheden...
invloed heeft op de kans dat we, in communicatie, een bepaalde uiting zullen gebruiken. Om een (fictief) voorbeeld te geven: stel dat we voor een mobiele telefoon duizend keer het woord *mobieltje* en honderd keer het woord *gsm* horen, dan beïnvloedt de frequentie waarmee we beide varianten hebben waargenomen, de kans dat we ze zelf zullen gebruiken: de kans om *mobieltje* te gebruiken is groter dan die om *gsm* te gebruiken. Dit is een voorbeeld van varatie op woordniveau: twee vormen voor één betekenis. Het principe geldt echter voor alle aspecten van taal.

De hierboven beschreven aanpak van Croft heet ook wel *evolutionaire taalkunde*, omdat het taal beschouwt als dynamisch, evolutionair systeem. Deze aanpak staat niet geheel op zichzelf, maar heeft de zogenaamde *usage-based* taalkunde als uitgangspunt. Dit is een stroming binnen de taalkunde die ervan uitgaat dat *taalgebruik* het taalsysteem bepaalt, waarbij het hierboven genoemde aspect van frequentie een centrale rol vervult.

Wat de evolutionaire benadering van taal interessant maakt, is dat het een compleet raamwerk vormt waarin plaats is voor diverse bestaande theorieën zoals de *usage-based taalkunde* maar ook de sociolinguistiek, en dat het een benadering is die een verklaring biedt voor zowel taalverandering als het uitblijven daarvan. De benadering gebruikt daarbij algemene (evolutionaire) mechanismes om specifieke, talige veranderingen te verklaren. Gevallen van taalverandering op populatieniveau kunnen ermee worden teruggebracht tot verschillen in de mate van reproductie van bepaalde eenheden in taaluitingen, en zijn daarmee te zien als het (onbedoelde) resultaat van de handelingen van individuen binnen die populatie. Zoals ik hierboven beschreef kiezen individuele taalgebruikers vaak meer of minder bewust voor een bepaalde uiting: wat dat betreft handelen zij met een bepaalde intentie; de intentie van de taalgebruiker is echter een communicatieve, niet de intentie om de taal te veranderen. Het onbedoelde effect van intentionele communicatieve handelingen kan echter wel degelijk taalverandering zijn. Deze visie op taalverandering is te herleiden tot het werk van Keller (1994) en zijn zogeheten onzichtbare handtheorie.

Het is overigens niet gezegd dat bepaalde handelingen van individuen noodzakelijk tot verandering op populatieniveau, dat wil zeggen, in de taalkennis van de populatie van sprekers, zullen leiden. Het kan zijn dat één spreker in de populatie een nieuwe variant introduceert, bijvoorbeeld een nieuwe uitspraak van de klank /aa/. Er is echter pas sprake van taalverandering als deze mutatie (in taal ook wel innovatie genoemd) zich verspreidt over de andere taalgebruikers. De evolutionaire benadering van taal biedt een duidelijk raamwerk om deze fenomenen te onderzoeken.

Evolutionaire taalkunde is bij uitstek een *kwantitatieve* of meetbare benadering. In dit proefschrift heb ik dan ook gebruik gemaakt van een aantal computermodellen. Deze modellen heten ook wel *agent-based* modellen, omdat ze
bestaan uit een groep agents (agenten), ofwel individuen, die bepaalde eigenschappen hebben en die op een bepaalde, welgedefinieerde manier met elkaar interageren. Voor de bestudering van taal en taalverandering hebben de agenten een bepaalde (beperkte) kennis van taal en bestaat de interactie tussen agenten uit het uitwisselen van taaluitingen. Deze opzet maakt het mogelijk bepaalde concrete gevallen van taalverandering te simuleren en de invloed van verschillende factoren op deze verandering te bestuderen. Het voordeel van computermodellen is daarbij dat zowel de invloed van factoren op zich, als de invloed van verschillende tegelijk werkende factoren op het geheel kunnen worden bestudeerd, iets wat zonder hulp van de computer al snel te ingewikkeld wordt.

**Hoofdstuk 2: een cultureel-evolutionair computermodel van patronen in betekenisverandering**

In hoofdstuk twee beschrijf ik een eerste computermodel om bepaalde processen van betekenisverandering te simuleren. Een interessant aspect van taalverandering in het algemeen en van betekenisverandering in het bijzonder is dat de veranderingen niet willekeurig lijken, maar dat er zekere tendensen in lijken te bestaan. Aan de ene kant blijkt dat woorden verschillen in hun waarschijnlijkheid om betekenisverandering te ondergaan. Aan de andere kant blijken betekenissen vaak te veranderen in een bepaalde richting. Voor beide asymmetriën zijn verschillende verklaringen geopperd en met behulp van een computermodel heb ik deze verklaringen nader onderzocht.

De soort betekenisverandering waar ik me in dit hoofdstuk op richt wordt ook wel grammaticalisation genoemd. Deze term beschrijft de tendens dat woorden als zij veranderen steeds grammaticalder worden. Een voorbeeld hiervan is de veel voorkomende verandering van zogenaamde inhoudswoorden naar functiewoorden. Inhoudswoorden (ook wel lexicale woorden genoemd) zijn woorden die verwijzen naar iets in de werkelijkheid, zoals tafel of stoel. Functiewoorden (ook wel grammaticale woorden genoemd) verwijzen niet zozeer naar de werkelijkheid maar vervullen vooral een functie in de zin, zoals er, het of hoewel. Een woord als terwijl is begonnen als het inhoudswoord wijl (‘tijd’) en is geleidelijk veranderd in een functiewoord: een voegwoord dat twee zinnen verbindt (waarbij het gelijktijdigheid kan aanduiden maar ook wel andere soorten verbanden).

Het is belangrijk te beseffen dat algemeen onderkend wordt dat woorden niet maar één betekenis hebben, maar een heel palet aan (verwante) betekenissen in zich herbergen (polysemie), waarbij betekenisverandering inhoudt dat er verschuivingen optreden in dit palet aan betekenissen, hetzij omdat er nieuwe verwante betekenissen bijkomen (die ik in dit proefschrift met de evolutionaire term mutaties aanduidt) of omdat een van de al bestaande betekenissen prominenter wordt.
Wat de eerste asymmetrie betreft blijkt dat woorden met een algemene betekenis, zoals bijvoorbeeld de Engelse werkwoorden *come* en *go*, een sterkere neiging hebben te grammaticaliseren dan meer specifieke woorden, zoals bijvoorbeeld *walk* en *stroll*. Voor deze asymmetrie zijn in de literatuur verschillende verklaringen te vinden. Allereerst zou het aantal gebruikscontexten een rol spelen. Een andere verklaring is dat de gebruiksfrequentie een belangrijke rol speelt. Een derde verklaring is dat bij woorden met een algemene betekenis grotere mutaties mogelijk zijn dan bij woorden met een specifieke betekenis.

Wat betreft de tweede asymmetrie blijkt dat grammaticalisatie vrijwel altijd plaatsvindt in één bepaalde richting. Zo is het erg onwaarschijnlijk dat het huidige woord *terwijl* in een inhoudswoord met de betekenis ‘tijd’ zal veranderen. Het zelfstandig naamwoord *richting* wordt tegenwoordig ook als voorzetsel gebruikt (*Hij liep richting het station*), maar een verandering in de omgekeerde richting, van voorzetsel naar zelfstandig naamwoord, is erg onwaarschijnlijk. Ook voor deze tendens zijn verschillende verklaringen te geven. Allereerst zouden de mutaties (of variaties) die sprekers in hun gebruik van de woorden creëren zelf asymmetrisch zijn: sprekers gebruiken concrete betekenissen om minder concrete fenomenen te beschrijven. Een andere verklaring is dat de functionele betekenis van een woord in gebruik vaker nodig is dan de lexicale betekenis en dat het daaruit voortvloeiende verschil in frequentie de betekenisverandering in de richting van de functionele betekenis stuurt.

In een computermodel heb ik de mogelijke betekenissen die een abstract woord *w* kan hebben afgebeeld op één dimensie, lopend van 0 tot 1. Elke waarde op deze dimensie staat voor een mogelijke betekenis van een woord, waarbij waarden dichterbij 0 een lexicale betekenis hebben en waarden dichterbij 1 een functionele betekenis. Woorden zijn polyseem, ze bestaan uit een palet van verwante betekenissen, en kunnen daarom op de dimensie worden geregideerd met een deelverzameling van waarden. Een inhoudswoord kan bijvoorbeeld de verzameling betekenisnissen [0.10-0.21] hebben en een functiewoord de verzameling [0.74-0.92].

Het model bestaat uit een populatie van 100 ‘agenten’ die met elkaar communiceren en elk hun eigen kennis van woord *w* hebben dat ze hebben opgebouwd op basis van hun communicatie met andere agenten uit de populatie. De ene agent kan voor woord *w* dus de verzameling [0.20-0.29] hebben, terwijl de andere agent [0.24-0.32] heeft. Gedurende een bepaalde periode communiceren steeds twee willekeurig gekozen agenten uit de populatie met elkaar. Deze communicatie houdt in dat de ene agent (de spreker) een betekenis uit zijn verzameling kiest, ofwel een waarde, en deze uitspreekt, ofwel zendt, aan de andere agent (de hoorer). Deze agent vergelijkt de waarde die hij hoort met zijn eigen verzameling: als deze geen deel uitmaakt van zijn verzameling past hij zijn verzameling erop aan, waarbij de beperking geldt dat een verzameling altijd een
aanengesloten stuk moet zijn. Daarnaast is er mutatie mogelijk: eens in de zoveel tijd past een willekeurige agent de randen van zijn verzameling enigszins aan (de gedachte is dat dit correspondeert met de af en toe optredende behoefte om iets te communiceren waarvoor nog niet een passend woord bestaat, waarvoor dan een 'in de buurt' liggende betekenis wordt gebruikt, dus uitgebreid in zijn toepassing).

In een dergelijk model construeren de agenten in de populatie hun taalkennis op basis van indirecte transmissie: de verzameling betekenissen die een agent heeft blijft immers 'onzichtbaar' voor andere agenten. Toch blijkt uit de simulaties van het computermodel dat er een populatie kan ontstaan met een grote coherentie in taalkennis, mits er (a) voldoende communicatie tussen de agenten is, en (b) er niet te veel mutaties zijn.

Uit de simulaties blijkt dat de waarschijnlijkheid waarmee woorden grammaticaliseren sterk is gerelateerd aan frequentie en de grootte van de mutaties: woorden met een hogere frequentie en woorden waarbij grotere mutaties voorkwamen vertoonden meer betekenisverandering dan woorden met een lage frequentie en woorden met kleine mutaties. Aan de andere kant blijken woorden met een algemene betekenis niet significant meer verandering te vertonen dan woorden met een specifieke betekenis.

Uit de simulaties blijkt verder dat de directionaliteit in grammaticalisatie het resultaat kan zijn van zowel een asymmetrie in mutaties als een asymmetrie in de gebruiksfrequentie van de verschillende betekenissen.

Hoofdstuk 3: het principe van wederzijdse uitsluiting in taal: een onderzoek naar AN-combinaties

Het isomorfieprincipe stelt dat er in taal een tendens lijkt te bestaan voor één vorm - één betekenis. Wanneer twee (of meer) woorden eenzelfde betekenis hebben (synonymie) of wanneer één vorm verschillende (niet verwante) betekenissen heeft (homonymie), blijkt dit zelden een stabiele situatie op te leveren. In veel gevallen zal na verloop van tijd de perfecte synonymie of homonymie dan ook verdwijnen.

In de biologie bestaat het principe van wederzijdse uitsluiting (competitive exclusion) dat een vergelijkbaar fenomeen verklaart: competitie van twee soorten om dezelfde niche levert geen stabiel evenwicht op, maar zal óf leiden tot het uitsterven van een van de soorten, óf tot een vorm van differentiatie, zodanig dat de twee soorten zich niet langer in dezelfde niche bevinden.

In dit hoofdstuk stel ik onder andere voor dat het principe van isomorfie beter kan worden gezien als een principe van exclusie: de basis van het isomorfieprincipe is dat er in taal een tendens zou bestaan voor één vorm - één betekenis. Deze tendens is echter het resultaat van competitie, waarbij twee vormen of twee betekenissen 'strijden' om dezelfde niche.
In dit hoofdstuk bespreek ik een voorbeeld van schending van het principe van wederzijdse uitsluiting in taal, waarbij toch een bepaald evenwicht is bereikt. Het gaat hierbij om de combinaties van bijvoeglijke naamwoorden (A) en zelfstandige naamwoorden (N), zoals zuurkool en volle maan in het Nederlands. Deze combinaties komen in twee vormen voor (als samenstelling en als woordgroep) maar hebben dezelfde betekenis: ze hebben allebei een zogenaamde ‘naamfunctie’ en refereren aan een bepaalde klasse. Zuurkool is niet zomaar kool die zuur is en volle maan is geen maan die vol is: beide vormen zijn geen algemene beschrijvingen maar verwijzen naar een specifieke categorie van entiteiten. Naast het Nederlands komen beide vormen in de drie talen in verschillende relatieve frequenties voor: in het Duits zijn samenstellingen frequenter, terwijl in het Engels juist de woordgroepen frequenter zijn. Het Nederlands zit hier tussenin.

De vraag die deze AN-namen oproepen is hoe het mogelijk is dat er, in de drie talen, twee vormen van kunnen voorkomen in een schijnbaar stabiel evenwicht. Daarnaast is de vraag hoe de verschillen in frequentie tussen de twee vormen in de drie talen verklaard kunnen worden.

In de eerste plaats heb ik uitvoerig naar het gebruik van de AN-namen gekeken. Uit een kort onderzoek bleek dat, hoewel beide AN-vormen op het eerste gezicht eenzelfde ‘betekenis’ hebben (hun naamfunctie), er toch drie verschillende subbetekenissen zijn te onderscheiden: endocentrische (met een semantisch transparant zelfstandig naamwoord als hoofd met een (niet transparant) specificerend bijvoeglijk naamwoord zoals sneltrein), exocentrische (met een semantisch niet-transparante betekenis van het woord als geheel, als in blauwe maandag, dat niet ‘een maandag die blauw is’ betekent) en metonymische (met een niet volledig transparant zelfstandig naamwoord als in wijsneus, waarbij het zelfstandig naamwoord verwijst naar een persoon) betekenissen. De subbetekenissen blijken ongelijk te zijn verdeeld over de vormen: exocentrische betekenissen komen exclusief voor in woordgroepen en metonymische betekenis exclusief in samenstellingen. Endocentrische betekenissen komen voor bij beide vormen. Deze verdeling geldt voor alle drie de talen.

Vervolgens heb ik de mechanismes beschreven die mogelijk een rol spelen bij de verschillende frequenties van beide AN-vormen in de drie talen Engels, Duits en Nederlands. Uit de literatuur komen twee mechanismes naar voren: ten eerste lijkt er een selectiedruk te zijn voor woordgroepen. Sommige AN-combinaties zijn alleen mogelijk als woordgroep (zoals combinaties met een samengesteld bijvoeglijk naamwoord) en daarnaast kunnen sommige woordgroepen blijven bestaan vanwege hun hoge gebruiksfrequentie, waardoor ze voldoende duidelijk als AN-naam herkenbaar zijn (zoals kleine teen). Ten tweede lijkt er echter ook een selectiedruk te

Met behulp van een computermodel heb ik bekeken of het mogelijk is het schijnbaar stabiele evenwicht waarin AN-samenstellingen en -woordgroepen in de drie verschillende talen voorkomen, met de hierboven beschreven kennis van subbetekenissen en selectiedrukken te simuleren. Ook dit computermodel is een zogenaamd agent-based model. In een populatie van honderd agenten beginnen alle agenten met dezelfde kennis van honderd AN-samenstellingen. Agenten communiceren gedurende een bepaalde tijd met elkaar, waarbij de ene agent een AN-naam noemt en de andere agent deze AN-naam opslaat in zijn geheugen. Het geheugen van een agent bestaat uit honderd ‘vakken’ waarin de meest recente honderd AN-namen zijn opgeslagen.

Een agent die een AN-naam moet uiten, kiest daarvoor standaard een willekeurige naam uit zijn geheugen, of hij creëert een nieuwe naam en produceert deze. De vorm die hij deze nieuwe naam geeft (samenstelling of woordgroep) hangt samen met het aantal samenstellingen en woordgroepen in zijn geheugen.

Ook de twee selectiemechanismen zijn in het model aanwezig. Ten eerste wordt met een bepaalde frequentie een nieuwe woordgroep toegevoegd aan het geheugen van een van de agenten. Ten tweede is er een bepaalde kans dat nieuw gevormde woordgroepen toch samenstelling worden, als simulatie van het voorkomen van naamvallen.

Uit een eerste serie simulaties blijkt dat deze opzet leidt tot een zeer onstabiel systeem, waarbij in de meeste gevallen de samenstellingen na korte of iets langere tijd uit het systeem verdwijnen en woordgroepen als enige vorm overblijven. Dit gebeurt ongeacht de verschillende waarden van de parameters die beide hierboven beschreven selectiedrukken representeren. De enige uitzondering vormt een parameterinstelling waarbij woordgroepen met een hele lage frequentie aan het systeem worden toegevoegd, terwijl er tegelijk een grote selectiedruk tegen woordgroepen aanwezig is.

In een tweede serie simulaties heb ik betekenis toegevoegd aan het model. De agenten beginnen met vijftig endocentrische en vijftig metonymische samenstellingen. Woordgroepen die aan het systeem worden toegevoegd hebben een endocentrische of een exocentrische betekenis. Agenten die een nieuwe AN-naam creëren, kiezen eerst een willekeurige betekenis en kiezen vervolgens de vorm, waarbij de kans op de vorm gereduceerd is aan het aantal voorkomens van de vorm in het geheugen van de agent.

Uit de simulaties met deze opzet van het model blijkt dat de toevoeging van betekenis in veel gevallen leidt tot een stabiel evenwicht van beide vormen. Elke
Samenvatting in het Nederlands

Vorm heeft een van de drie betekenissen voor zichzelf, wat de vormen een stabiele basis geeft. Alleen de endocentrische niche moet worden gedeeld met de andere vorm. Wel blijkt dat de parameter die het naamvalssysteem representeert zeer weinig invloed heeft op de uiteindelijke waarde van het evenwicht (de verhouding van het aantal samenstellingen en woordgroepen in de endocentrische niche). Wel invloed hebben de innovatiesnelheid en de snelheid waarmee woordgroepen aan het systeem worden toegevoegd. Dit zou betekenen dat deze laatste twee parameters, en niet het verschil in het wel of niet voorkomen van een naamvalssysteem, de reden is voor de verschillen tussen het Engels, Duits en Nederlands.

Hoofdstuk 4: de syntactische en semantische ontwikkeling van het werkwoord krijgen

De laatste drie hoofdstukken van dit proefschrift hebben als onderwerp het werkwoord krijgen. In dit hoofdstuk bespreek ik de geschiedenis van het werkwoord aan de hand van een corpusonderzoek over de periode 1300-1979 en bespreek ik de mechanismes die de historische ontwikkeling van het werkwoord kunnen verklaren. De bevindingen van dit onderzoek vormen de basis voor de afsluitende twee hoofdstukken.

Hedendaags krijgen is een werkwoord met een grote variatie in het gebruik, zowel op syntactisch als semantisch gebied. De kernbetekenissen van het werkwoord zijn ‘ontvangen’ (De jongen krijgt een cadeautje), waarbij het onderwerp een (passieve) recipiensfunctie heeft, en een betekenis die een toestandsverandering aanduidt, als in Krijgen we ooit nog een strenge winter? en Zij kreeg een flinke verkoudheid. Daarnaast kan krijgen ook gebruikt worden met een onderwerp in een veel actievere rol, in verschillende gradaties, zoals de volgende zinnen laten zien: Ik kan nergens de juiste ingrediënten krijgen, ADO heeft de koppositie in de competitie in handen gekregen, Als ik je ooit te pakken krijg heb je een groot probleem. Ook in een zin als De aio kreeg het artikel maar niet afgemaakt heeft het onderwerp een bepaalde vorm van agentiviteit. In een syntactisch verwante zin, met krijgen eveneens als hulpwerkwoord, heeft het onderwerp echter juist een recipiensfunctie: De prins kreeg het eerste exemplaar uitgereikt door de directeur. Dit laatste gebruik wordt ook wel de semi-passief genoemd, een constructie die verschilt van het reguliere passief omdat het meewerkend voorwerp van de actieve variant in deze constructie het onderwerp wordt, in tegenstelling tot het lijdend voorwerp bij het reguliere passief.

Aan de hand van de uitkomsten van het corpusonderzoek ontstaat een duidelijk beeld van de ontwikkeling van al deze varianten van krijgen. Het werkwoord was oorspronkelijk intransitief en had de betekenis ‘vechten’, ‘strijden’. Dit gebruik komt nog redelijk vaak voor in de veertiende eeuw maar verdwijnt
daarna snel. Het hoofdgebruik van *krijgen* is echter vanaf het begin van de veertiende eeuw transitief, met een sterk agentieve betekenis ‘iets door inspanning in bezit krijgen’. Wel bestaat er in het gebruik verschil in de mate van agentiviteit van het onderwerp: in het corpus komen ook zinnen voor als *Elc criget loon na sijnre verdient* (Elk krijgt zijn verdiende loon), waarbij het onderwerp niet agentief is. Door de eeuwen heen is er een gestage toename van zinnen met een niet-agentief onderwerp te vinden en een gestage afname van zinnen met een sterk agentief onderwerp.

De afname van het gebruik van agentieve onderwerpen correleert met een aantal verschillende zaken. Ten eerste is er door de eeuwen heen een gestage toename van het aantal onbezielde onderwerpen te zien: onderwerpen die geen agentieve functie kunnen hebben. Daarnaast verschijnen er steeds meer lijdende voorwerpen die niet goed met een agentief onderwerp gecombineerd kunnen worden, zoals *eenen hurt* (een stoot) en *een moye coelte uyten zuyden* (een fijne koelte uit het zuiden).

Als we dit laatste aspect in meer detail bekijken, blijkt er iets opmerkelijks aan de hand te zijn. Al in de veertiende eeuw komt *krijgen* voor met lijdende voorwerpen die een toestand aanduiden, zoals *pays* (vrede) en *zuverheit van herten* (zuiverheid van het hart), maar in de helft van deze gevallen hebben deze zinnen wel een agentief onderwerp. Met andere woorden: het onderwerp doet moeite om een bepaalde toestand te bereiken. Deze toestanden zijn over het algemeen dan ook voor het onderwerp aangenaam (zoals *vrede*). In de erop volgende eeuwen zien we echter dat de zinnen met een lijdend voorwerp dat een toestand aanduidt, steeds minder agentief onderwerp krijgen, en dat ook steeds meer voorwerpen gebruikt worden die voor het onderwerp niet per se aangenaam zijn (zoals ziektes en geweld). In dit gebruik wordt *krijgen* dus in de loop van de tijd steeds minder agentief.

Naast de voorwerpen die een toestand aanduiden, wordt *krijgen* in de veertiende eeuw ook gecombineerd met concrete voorwerpen (*geld, potlood, kasteel*). Ook bij dit type zinnen zien we dat het onderwerp door de eeuwen heen steeds minder agentieve functie krijgt, maar deze tendens zet pas later in dan bij de voorwerpen die een toestand aanduiden. Bij die laatste groep begint de afname al in de veertiende eeuw, bij de ‘concrete’ voorwerpen pas rond de zeventiende eeuw.

Een derde groep voorwerpen zijn abstracte voorwerpen als *respijt* en *antwoord*. Deze voorwerpen zijn interessant, omdat ze een extra persoon impliceren die in de zin de agentieve functie vervult. Deze groep voorwerpen zien we echter pas opkomen in de vijftiende eeuw.

Uit de data komt het beeld naar voren dat de betekenisverandering van *krijgen*, de afname van een agentief onderwerp, is begonnen in zinnen met een toestand-aanduidend lijdend voorwerp en dat deze verandering pas later is ingezet in zinnen met een concreet of abstract lijdend voorwerp. Hieruit kunnen we, bij wijze
van hypothese, opmaken dat de lijdende voorwerpen die een toestand aanduiden een cruciale rol moeten hebben gespeeld in de betekenisverandering: hoewel toestanden als vrede en gezondheid best met een agentief onderwerp zijn te combineren, zijn toestandsvoorwerpen toch typische zaken die niet met inspanning verworven worden, in tegenstelling tot concrete voorwerpen als een kasteel of een zwaard. Deze aard van toestandsvoorwerpen kan dan ook geleid hebben tot herinterpretatie van de rol van het onderwerp als minder agentief en op deze manier tot een herinterpretatie van de betekenis van krijgen. Met dit proces eenmaal in gang werden uiteindelijk voorwerpen mogelijk waarbij het onderwerp überhaupt geen agentieve functie kon vervullen, zoals vergiffenis, goed nieuws en griepe. De veranderende rol van het onderwerp had ten slotte ook als gevolg dat er herinterpretatie optrad van zinnen met een concreet lijdend voorwerp, zoals cadeau: in de standaardbetekenis was het onderwerp niet langer de handelende persoon (die het cadeau verkreeg door inspanning), maar de ontvangende persoon.

Naast het hierboven besproken transitieve gebruik van krijgen wordt het werkwoord in de veertiende eeuw ook in een zogenaamde complementsconstructie gebruikt: moet in hare arm gecrigen, ... (“Mocht zij hem in haar armen krijgen”). Ook in deze constructie heeft het onderwerp een agentieve rol, een rol die eigenlijk tot op de dag vandaag behouden is gebleven, zoals in een zin als Hij kreeg het artikel niet afgemaakt. In feite is deze hedendaagse constructie (ook wel de resultatieconstructie genoemd) dus een gebruik waarin de oorspronkelijke betekenis van krijgen bewaard is gebleven, een bevinding die haaks staat op de theorie van Van der Horst (2002), die stelt dat dit gebruik pas is opgekomen rond 1990.

Binnen de complementsconstructie vindt overigens een duidelijk grammaticalisatieproces plaats: oorspronkelijk duidt het complement een concrete locatie aan. In de zestiende eeuw vindt er echter een uitbreiding plaats en komen er ook bijvoeglijke naamwoorden en voltooid deelwoorden voor die een toestand aanduiden, zoals gevangen.

Het huidige krijgen komt ook voor in combinatie met te + infinitief (te zien krijgen). Deze constructie komt voor het eerst in het corpus voor aan het begin van de achttiende eeuw, als de hoofdbetekenis van het werkwoord al sterk verminderd agentief is. Daarnaast komt krijgen vanaf het begin van de twintigste eeuw ook voor in de semi-passiefconstructie. Deze constructie lijkt zich in een proces van heranalyse te hebben ontwikkeld uit de resultatieconstructie. Een voorbeeld van deze laatste constructie is Zij kreeg haar borden gewassen, waarbij het onderwerp de handeling wassen uitvoert. Later vinden we echter zinnen als Zij kregen hun eisen doorgevoerd, waarin het doorvoeren duidelijk niet uitgevoerd wordt het onderwerp, maar door iemand anders, wat het onderwerp niet-agentief maakt. Deze
heranalyse is waarschijnlijk een gevolg van de in deze periode al sterk ontwikkelde niet-agentieve betekenis van *krijgen*.

Ten slotte komt uit een (apart) corpusonderzoek nog naar voren dat de gebruiksfrequentie van het werkwoord *krijgen* vanaf 1300 sterk is toegenomen. Dit is niet verwonderlijk: *krijgen* is zowel semantisch als syntactisch steeds algemener in gebruik geworden. Dit zijn typische kenmerken van grammaticalisatie.

**Hoofdstuk 5: een simulatie van de betekenisverandering van krijgen met een exemplar-model**

Dit hoofdstuk gaat verder met het werkwoord *krijgen* en richt zich op de betekenisontwikkeling van het werkwoord in het transitieve gebruik. Het lastige aan betekenis is dat het een aspect van een uiting is dat niet direct wordt overgedragen van individu op individu (“In deze zin bedoel ik met *krijgen* ‘ontvangen’ en niet ‘met inspanning bemachtigen’”). Een individu zal dus bepaalde strategieën moeten aanwenden om de betekenis van een woord als *krijgen* in een zin te kunnen reconstrueren.

Deze indirectheid van betekenisoverdracht betekent dat het ook lastig is om concrete gevallen van betekenis op een realistische manier te simuleren met een computermodel. In dit hoofdstuk presenteer ik een manier om dit, met een zogenaamd *exemplar-based* model, toch te doen.

Aan de hand van de resultaten van simulaties met het computermodel laat ik zien dat ook in de indirectheid van betekenisoverdracht duidelijke regelmatigheden en tendensen bestaan, die we ook in de ontwikkeling van een woord als *krijgen* waarnemen. Indirecte overdracht van betekenis leidt tot een systeem dat relatief stabiel is, maar waarin tegelijkertijd veranderingen redelijk makkelijk kunnen plaatsvinden. Daarnaast bespreek ik enkele factoren die invloed hebben op het proces van betekenisverandering.

*Exemplar-based* modellen zijn gebaseerd op de aanneming dat agenten zowel kennis hebben van *exemplars*, de specifieke gebruiksgewassen (de zinnen die zij waarnemen), als daarvan afgeleide abstracte categorieën. Deze laatste veranderen voortdurend, omdat ze direct afhankelijk zijn van de specifieke input.

In het model wisselen agenten in een populatie representaties van zinnen met *krijgen* uit, die bestaan uit het werkwoord en een lijdend voorwerp. Van deze uiting wordt in het model het lijdend voorwerp direct overgedragen (anders gezegd: daarvan is de betekenis transparant). Dit geldt echter niet voor de betekenis van *krijgen*. De hoorder moet deze dan ook reconstrueren en heeft hiervoor in het model twee strategieën: hij gebruikt zijn bestaande kennis van de betekenis van *krijgen* en hij gebruikt de aard van het gebruikte lijdend voorwerp.

Een sprekende agent kiest of een exemplaar uit zijn geheugen, of hij creëert een nieuw exemplaar op basis van een bestaande abstracte categorie. Een horende agent slaat elke uiting die hij hoort, op in zijn geheugen. Dit houdt in dat hij de coördinaten van de uiting in de conceptuele ruimte opslaat. De waarde van het lijdend voorwerp is direct toegankelijk, die van het werkwoord echter niet. Als eerste zal hij in zijn geheugen kijken of er bij het gehoorde lijdend voorwerp al een exemplaar bestaat: het nieuwe exemplaar krijgt dan dezelfde coördinaten. Als dit niet het geval is zal de agent kijken welke abstracte categorie het beste past bij de uiting, ook weer op basis van het lijdend voorwerp. De betekenis van krijgen wordt dan gereconstrueerd op basis van de betekenis van de abstracte categorie (en kan daardoor enigszins verschillen van de door de spreker geuite betekenis). Het kan ook nog gebeuren dat er ook geen geschikte abstracte categorie wordt gevonden. In dit geval kan de hoorder alleen afgaan op de aard van het lijdend voorwerp, en reconstrueert hij hiermee de coördinaten van een nieuw exemplaar.

In de simulaties beginnen de agenten allemaal met een kennis van krijgen die vergelijkbaar is met die rond het jaar 1300: een agentieve betekenis met vooral concrete lijdende voorwerpen. Hierna volgt een serie van een groot aantal communicatiehandelingen tussen willekeurige agenten in de populatie.

Uit de simulaties blijkt dat het gebruik van krijgen zich uitbreidt volgens de patronen die ook in het corpusonderzoek naar voren zijn gekomen: de betekenis van krijgen wordt steeds minder agentief. Wel correleert de verandering sterk met het percentage innovaties dat plaatsvindt. Daarnaast geldt ook dat een hoge frequentie van innovatie leidt tot minder coherente in de populatie. Opvallend is verder dat er steeds sprake is van uitbreiding van de kennis: terwijl er nieuwe betekenissen bijkomen, blijft de oude betekenis van krijgen steeds behouden, wat echter niet met het ‘echte’ krijgen is gebeurd; met andere woorden: deze simulatie modelleert niet de reële evolutie van krijgen. Ook met verschillende andere parameterinstellingen is
dit het geval. Een van die wijzigingen is het toelaten van een variabele frequentie: hoe meer exemplars een agent heeft, hoe vaker hij *krijgen* zal gebruiken. Ook wanneer de simulatie langer voortduurt of de populatie groter is, verdwijnt de oude betekenis niet.

De enige parameterinstelling die wel leidt tot verlies van de oorspronkelijke betekenis is de toevoeging van een zogenaamde ‘scheve’ distributie van de gebruiksfrequentie. Met deze instelling wordt gesimuleerd dat het gebruik van *krijgen* met een niet-agentieve betekenis hoger ligt dan dat met een wel-agentieve betekenis, bijvoorbeeld omdat in het laatste geval alleen bezielde, intentioneel handelende onderwerpen gebruikt kunnen worden.

**Hoofdstuk 6: een reconstructie van de ontwikkeling van *krijgen* met synchrone data en phylogenetische reconstructietechnieken**

Phylogenetische reconstructie is een techniek die in de biologie wordt gebruikt om de verwantschap van soorten te reconstrueren. Het resultaat van een dergelijke reconstructie is een phylogenetische boom met vertakkingen. De basis voor reconstructies is de variatie die er tussen deze soorten bestaat, bijvoorbeeld in uiterlijke kenmerken of in het DNA. Het interessante van deze techniek is dat aan de hand van hedendaagse (ofwel synchrone) variatie een historische (ofwel diachrone) ontwikkeling wordt gereconstrueerd.

Deze techniek wordt ook in de taalkunde toegepast om de verwantschappen van talen binnen een taalfamilie te reconstrueren. Een andere, nog niet eerder uitgevoerde mogelijkheid is om de verwantschap van variaties in het gebruik van één woord te reconstrueren, zoals de variatie in gebruik van het werkwoord *krijgen*. In dit hoofdstuk ga ik na in hoeverre phylogenetische reconstructie op dit gebied mogelijk is.

Phylogenetische reconstructie is gebaseerd op de aanname dat soorten die sterk aan elkaar verwant zijn meer eigenschappen gemeen hebben dan soorten die minder sterk met elkaar verwant zijn. Van elke soort wordt een serie eigenschappen vastgesteld en vervolgens gebruikt men de overeenkomsten en verschillen in deze series om verwantschap te bepalen. Zoals gezegd beschrijven deze eigenschappen vormelijke kenmerken (bijvoorbeeld ‘wel of geen zoogdier’, ‘wel of niet gewerveld’) of DNA-sequenties. Een serie eigenschappen bestaat daarbij uit een serie enen en nullen die de aan- of afwezigheid van eigenschappen bij elke soort aangeven (bijvoorbeeld 011010011100) of een DNA-patroon (bijvoorbeeld *CTTTGAAATTGA*).

Voor de verwantschapsreconstructie zelf bestaan verschillende technieken. Bij zogenaamde ‘afstandgebaseerde’ technieken wordt uit de serie eigenschappen van elk paar soorten eerst de afstand tussen dit paar bepaald (weergegeven met een...
bepaalde waarde), waarna een boom wordt opgesteld aan de hand van deze afstandwaarden. Bij ‘karaktergebaseerde’ technieken zoekt men naar de kleinste hoeveelheid stappen die er nodig zijn om de series eigenschappen van alle soorten in een boom te kunnen onderbrengen. Elk van deze technieken heeft bepaalde voor- en nadelen.

Voor *krijgen* heb ik de verschillende constructies van het werkwoord gebruikt als analogie van de soorten bij biologische phylogenetische reconstructie. Deze groepen worden ook wel *taxa* genoemd. Daarnaast heb ik gezocht naar alle mogelijke eigenschappen om deze taxa te beschrijven. Hierbij kwam ik uit op elf verschillende taxa en veertien verschillende eigenschappen.

Phylogenetische reconstructie op zich geeft slechts relatieve verwantschappen van taxa aan en geeft geen inzicht in de historische volgorde waarin de taxa zijn ontstaan. Het is echter mogelijk om deze historische volgorde aan een boom toe te voegen door een zogenaamde *outgroup root* aan de taxa toe te voegen. Dit is een taxon waarvan men weet dat het ouder is dan alle andere taxa. In het geval van *krijgen* heb ik daarom het intransitieve gebruik van het werkwoord als *outgroup root* als twaalfde taxon toegevoegd.

Ik heb een aantal verschillende technieken getest. De eerste is de afstandsmethode *NeighborNet* die een netwerk weergeeft. Dit is een boom waarin ook alternatieve paden zijn aangegeven. In het netwerk komen bepaalde ontwikkelingen naar voren die ook in het corpusonderzoek zichtbaar waren. Zo suggerereert het netwerk dat het zogenaamde ‘aspectuele’ gebruik van *krijgen* (zoals een mailtje versstraarden) zich heeft ontwikkeld uit het resultatief gebruik (als in het slot open *krijgen*). Daarnaast komt uit het netwerk ook naar voren dat de ‘ontvangen’ betekenis van het werkwoord minder sterk verwant is aan de agentieve betekenis dan de niet-agentieve betekenis (als in *griep krijgen*). Dit komt overeen met de bevinding uit het corpusonderzoek dat de betekenis ‘ontvangen’ zich later heeft ontwikkeld dan de niet-agentieve betekenis.

Een tweede techniek een andere afstandgebaseerde methode, *Neighbor-joining*. In tegenstelling tot *NeighborNet* produceert deze techniek wel een boom. Het is mogelijk om bij elke vertakking een waarde te krijgen die de mate van betrouwbaarheid ervan weergeeft: hoe hoger de waarde, hoe groter de betrouwbaarheid. De boom geeft een aantal ontwikkelingen correct weer. Zo is het agentief gebruik met een concreet lijdend voorwerp het oudste gebruik en is daarna de niet-agentieve betekenis ontstaan. Ook is de semi-passief de nieuwste vertakking van de boom. Tegelijkertijd komen er in de boom ook een aantal problematische vertakkingen voor. Zo geeft de boom geen steun aan de hypothese dat het agentief gebruik met een ‘intern’ lijdend voorwerp (zoals *innerlijke vrede* of *geluk*) is ontstaan uit het agentief gebruik met concrete lijdende voorwerpen. Ook zit het niet-agentief gebruik met een intern lijdend voorwerp op een hele andere plaats in de
boom dan het agentief gebruik met eenzelfde lijdend voorwerp, terwijl de hypothese is dat de eerste zich heeft ontwikkeld uit de laatste.

Een derde en laatste techniek is de zogenaamde *Bayesiaanse analyse*. In deze methode worden uit een verzameling mogelijke bomen een deelverzameling geselecteerd van bomen die een grote waarschijnlijkheid hebben. Uit deze deelverzameling wordt ten slotte een zogenaamde *consensus-boom* gereconstrueerd, waarbij de betrouwbaarheid van de vertakkingen een indicatie is van het aantal keer dat een vertakking is aangetroffen in de deelverzameling. Ook deze boom geeft een aantal vertakkingen juist weer, zoals de late ontwikkeling van de semi-passiefconstructie en dat het aspectuele gebruik van *krijgen* zich heeft ontwikkeld uit de resultatieconstructie. Een groot probleem is echter dat de boom erg weinig vertakkingen kent. De eerste vertakking is direct een vertakking in een zestal constructies, waardoor de verwantschap tussen deze constructies niet goed is in te schatten.

Uit dit verkennende onderzoek komt naar voren dat het wel degelijk mogelijk is om phylogenetische reconstructie ook te gebruiken bij historisch onderzoek naar de ontwikkeling van een bepaald woord binnen een taal. Aan deze toepassing zitten wel enkele haken en ogen. Ten eerste is het erg moeilijk om een grote verzameling eigenschappen te verkrijgen, terwijl grote aantallen eigenschappen een voorwaarde zijn voor betrouwbare bomen. Ten tweede horen de eigenschappen onafhankelijk van elkaar te zijn, terwijl dat in dit type onderzoek niet altijd eenvoudig is te bepalen. Ten derde is er een vorm van willekeur in de keuze van de eigenschappen, omdat er geen objectieve manier is om deze verzameling eigenschappen samen te stellen. Ondanks deze tekortkomingen kan de phylogenetische reconstructie wel degelijk een nuttige ondersteunende rol spelen in historisch-taalkundig onderzoek.
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After coming back to the Netherlands in 1996, he enrolled in the Industrial Engineering program at the Technical University of Delft. He earned his *propedeuse* degree there, but decided to move to Leiden University and continue in the General Linguistics program. After a year, he switched to the study of Dutch Language and Culture, where he could combine his specialization in modern linguistics with courses in literature. He graduated in 2002.

From 2003 until 2007, he held a position as a PhD student at the Leiden University Centre for Linguistics, participating in an NWO-funded interdisciplinary project. His research during that period, on cultural-evolutionary modeling of patterns in language change, resulted in the present study. From 2007 until the spring of 2009, he worked at the Taalcentrum-VU in Amsterdam. At present, he works as a computer linguist on the European IMPACT program at the Leiden Institute for Lexicology (INL).