Språk- och Literaturcentrum
Master’s Thesis
VT 2011
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The Neural Representations of Function Words

Neurolinguistic Beliefs Reconsidered in the Light of Grammaticalisation Theory

Submitted: 02nd June 2010

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Abstract

It has in recent years been shown that some linguistic items, in particular lexical and abstracted movement verbs, activate the motor cortex in the human brain while being processed. The present study sets out to investigate how far this activation is retained for grammaticalised motion verbs which have shed their lexical content in exchange for grammatical functionality. Traditional literature suggests that content words and function words are stringently separated in the brain, which becomes questionable in the light of grammaticalisation processes. An analysis of leg movements primed with lexical and grammaticalised leg movement verbs as well as non-movement verbs found a significant effect of both semantic and functional motion words. This finding does not only further support the hypothesis that the processing of certain types of words involves the motor cortex, but also suggests that this activation is retained if words become grammaticalised. If function words, as generally assumed, do at some point experience a restriction to the brain's core language areas, this development must take place at a very late stage in grammaticalisation, possibly with the loss of either the subjacent content word or the awareness of the relatedness of content and function word, due to extreme phonetic reduction.

1 Introduction

A lot of research in the area of neurolinguistics has recently approached the question of how the motor cortex is involved in language processing. A number of studies carried out by Véronique Boulenger (Lyon) and Friedemann Pulvermüller (Cambridge) have shown that the brain's movement centre is active for verbs referring to bodily movement, even if those are used in an abstracted, metaphorical form. Evaluating their results against the backdrop of Hebbian Learning Theory, Boulenger and Pulvermüller consider the involvement of the motor cortex in language to be grounded predominantly in word semantics, resulting from a frequent meaning-related co-activation of language and motor areas. The involvement of the motor cortex in language processing is therefore seen as limited to particular types of content words. Given the obvious importance of word meaning for the activation of the motor cortex in this framework, Pulvermüller and colleagues argued that only certain types of content words are processed with the help of the motor cortex. This means, in consequence, that all other content words, due to different semantics, and all function words, due to a complete lack of semantic content, are incapable of activating the motor cortex.

This claim, however, appears quite drastic and somewhat unreasonable in the light of grammaticalisation theory. It is a well-known fact that, unlike content words, function words are not 'invented' out of nothingness. Instead, function words universally and virtually exclusively develop out of content words in a process of abstraction, desemanticisation and 'functionalisation'. Hence, despite their *de facto* entirely different purposes in language, function words as linguistic entities are inherently closely connected to content words. Given their evolutionary interdependence and relatedness, it is not easily comprehensible why the two should be strictly separated from a neurological point of view. Especially in early stages of the grammaticalisation process, it is likely that the original content word and the emerging function words are similarly distributed throughout the brain.

Given these basic contemplations, the present paper will attempt to shed some light on the neural distribution of grammaticalised function words. It will take a close look at the English movement future construction ‘be going to’, a contemporary future intention marker that evolved out of the movement verb ‘go’ close to five centuries ago. In a choice reaction time experiment, it will analyse whether the grammaticalised construction has an effect on leg movement times in the same way as the ungrammaticalised verb would be expected to. It will do so by using several different primes consisting of the movement verb ‘go’, three co-existing forms of the future construction ‘be going to’ which show different degrees of grammaticalisation, and two non-movement verbs as controls. In this way, the study hopes to detect whether grammaticalised movement verbs have an influence on movement times, which would indicate their being processed with the help of the motor cortex. If this is the case, it can be argued that grammaticalised movement verbs have the same transcortical distribution as the original movement verbs. This would be strong evidence for the assumption that content words and function words are not necessarily treated differently in the brain. The use of three differently strong grammaticalised forms will potentially help to further determine at what stage in the grammaticalisation process a possible neural restriction of function words takes place.

2 Theoretical Background and Previous Research

The following part of the paper will briefly consider the theoretical background of the study. It will first look at the general assumption that the motor cortex is involved in certain language processes and that this involvement is initially meaning-dependent and restricted to content words[1] referring to bodily movements. Subsequently, grammaticalisation processes in which content words in general and movement words in particular are turned into function words will be looked

[1] Content words, as the name suggests, are words with a high lexical, semantic content. Typical words falling into this category are those belonging to ‘open word classes’ like nouns, verbs or adjectives. Function words, on the other hand, are words that have a high functional, grammatical ‘content’, e.g. prepositions, determiners or auxiliary verbs. These words generally belong to ‘closed word classes’. Content words and function words have entirely different purposes in language. While content words provide language with meaning, function words are employed to tie the given meaning together, giving it structure and connections and signaling relations.

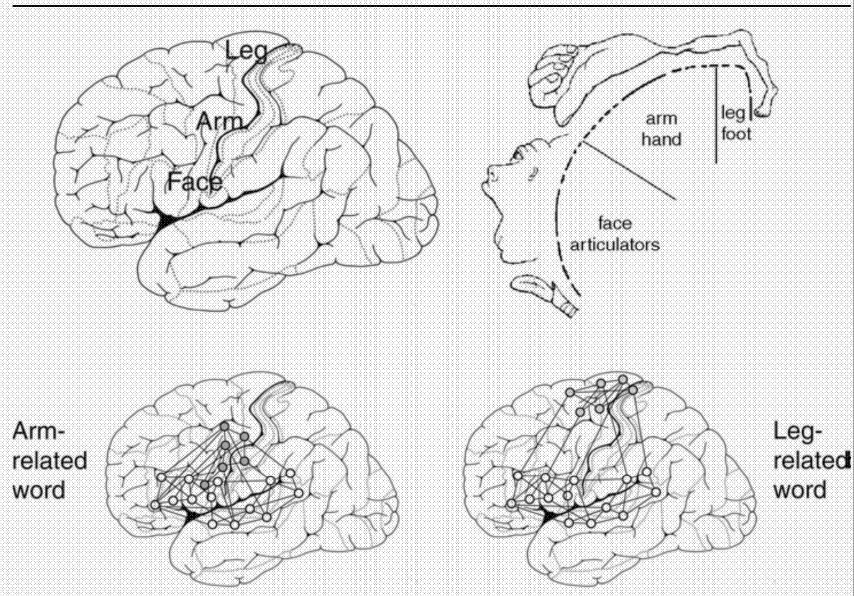
at. Challenging the idea of a purely meaning-related activation of the motor cortex, different scenarios will be proposed according to which the brain's movement centre could be involved not only in the processing of certain content words but also in the processing of certain function words.

2.1 The Motor Cortex and Language

As early as 1965, Geschwind noted that the motor cortex is essentially involved in language processes. Although largely hypothetical at the time, his assumptions were generally recognised and later supported with findings from empirical research. Today, it is a well-established assumption in neurolinguistics that the motor cortex, located in the precentral gyrus (BA 4), plays an important role in language processing.

As sketched out in Figure 1 below, the motor cortex is divided into several sub-areas associated with different parts of the human body. This implies that different areas of the motor cortex are activated when movements are carried out with e.g. the lips, the tongue, the hand or the foot. While the motor cortex can be divided into a great number of distinct sub-areas accurately pertaining to very small units of the human body (e.g. fingers, wrist, elbow, arm, shoulder) it is in a generalising manner often divided into three collective parts: a mouth-related, an arm-related and a leg-related part.

Figure 1: Somatotopic organization of the motor cortex according to Penfield & Rassumssen (1950) (Pulvermüller, 2005, p. 21)



Ever since the middle of the 20th century the involvement of the motor cortex in language processes was suspected but could not be proven scientifically. Recent research has been able to provide evidence for such claims. Possibly exceeding initial expectations, research has brought forward findings that suggest that the motor cortex is not only active during actual movement (i.e. general bodily movements or mouth and face movements when producing spoken language) but also when people read or hear words referring to human bodily movements. In an fMRI experiment in 2004, Hauk, Johnsrude & Pulvermüller were the first to demonstrate convincingly that the processing of words referring to arm movements activates the arm-related part of the motor cortex, while leg movement words more strongly activate the leg-related part and face movement words the face-related part. Many similar studies since have been able to provide further supporting results. Remarkably, in 2008, Boulenger, Hauk & Pulvermüller could show an activation of the motor cortex even for phrases containing abstracted, metaphorised action words.

These findings, possible through both a growing interest in the subject and the availability of new technology, could for first time prove the long held belief that the motor cortex is involved in certain linguistic processes. The fact that only some words, i.e. words originally referring to bodily movement, elicit an activation of the motor areas, suggest that the involvement of the motor cortex is connected to word semantics. A conclusive explanation for this semantic influence is offered by Hebbian Learning Theory which will therefore briefly be considered below.

2.1.1 *Hebbian Learning Theory*

Hebbian Learning Theory suggests that a frequent co-activation of cerebral cells or areas results in strengthened neural connections and, consequently, the formation of closely connected neural systems in the human brain. Given this premise, in the course of language acquisition "semantic representations [become] distributed in a systematic way throughout the entire brain." (Hauk, Johnsrude & Pulvermüller, 2004, p. 305) Words with a high semantic content, i.e. content words, are usually uttered in a specific set of everyday situations and thus coupled with a number of non-linguistic stimuli that activate different areas in the brain. (cf. Pulvermüller, 1995) This typical meaning-dependent co-activation gives rise to specific neural systems. In consequence, every (type of) content word attains a characteristic transcortical network. The utterance of a concrete noun like 'table', for example, would often co-occur with the visual input of the denoted object itself. This frequent co-occurrence of linguistic and visual stimuli for concrete nouns would thus lead to a semantic representation of the noun in the visual cortex. Movement verbs, on the other hand, tend to co-occur with the very movement to which they refer. Verbs like 'kiss', 'throw' or 'step' would therefore be strongly connected with the motor cortex. (cf. e.g. Pulvermüller, 1995; Pulvermüller, Hauk, Nikulin & Ilmoniemi, 2005; Hauk, Johnsrude & Pulvermüler, 2004; Boulenger, Roy, Pauligman, Deprez, Jeannerod & Nazir, 2006; Boulenger, Roy, Paulignan, Déprez, Jeannerod & Nazir, 2006; Boulenger, Hauk & Pulvermüller, 2009; Pulvermüller & Fadiga, 2010)

Many recent studies have been able to practically prove the existence of these semantic-specific transcortical networks through findings that show that different types of words do in actual fact activate different sensory areas. Interestingly, this activation is not bound simply to collective word types, but to the semantics of the individual words. This can, for example, be seen in the fact that different action verbs provoke an activation of different parts of the motor cortex depending on the body part to which the movement is related. (cf. e.g. Hauk, Johnsrude & Pulvermüler, 2004) Findings like these suggest that sensory areas are not per se associated with certain word types, but that the association results from individual learning processes based on a frequent real-life co-occurrence of linguistic and sensory input. Further support for this claim stems from the fact that an activation of sensory areas does not occur "for nonhuman actions (for example, barking and tailwagging) and may not occur in subjects who cannot perform an action owing to a neurological disease." (Pulvermüller, 2010, p. 355)

An activation network can thus only develop as a result of an individual learning processes. Once such a network is acquired, however, it can remain in force even if the word on which it is based becomes polysemous and some of its uses no longer refer to the original bodily movements. (cf. Boulenger, Hauk & Pulvermüller, 2008) An acquired transcortical network is thus active for both lexical and abstracted movement words.

2.1.2 *Implications for Content Words and Function Words*

Pulvermüller and other supporters of the Hebbian Learning Model, as outlined above, see content words as spread out in "distributed neural assemblies with cortical topographies that reflect word semantics." (Hauk, Johnsrude & Pulvermüller, 2004, p. 301) In this line of thought, movement words are considered to be associated with the motor cortex as the utterance of movement words often co-occurs with the conduction of the movement to which they refer. These activation-circuits, however, once acquired, are also activated for abstracted forms of the original movement words. It can thus be argued that only the acquisition of the network is strictly meaning-related.

Given the important influence of meaning for transcortical networks in Hebbian Learning Theory, function words, which are devoid of semantic content and are therefore not coupled with particular non-linguistic stimuli, are generally not believed 'to build networks that exceed the leftlateral perisylvian language areas.' (cf. Pulvermüller, 1995, p.2 281) It is therefore argued that there is a clear cut division of content words and function words, with the former having large distributed transcortical networks and the latter being limited strictly to the perisylvian cortex.

This division, however, is not necessarily reasonable, considering that there are frequent historical change processes in language during which content words are first abstracted, a state in which they have been shown to still activate the transcortical networks, and subsequently turned into grammatical function words, without, however, initially experiencing a change in phonological form. Why would neural networks, founded on word semantics, be activated for abstracted words with a clearly diverging meaning but not for grammaticalised words?

Before investigating this question by means of a reaction time experiment, it is important to get a best possible understanding of the nature of grammaticalisation.

2.2 Grammaticalisation Theory

Grammaticalisation theory[2] is based on two fundamental assumptions: the idea that language is a flexible system, which at any point in time is subject to change processes and the notion that not only lexical or 'open' word classes but also 'closed', i.e. functional word classes are open to the addition of new items.

The most essential claim brought forward by grammaticalisation theory is that language in its very beginning was but a system of nouns and verbs and that all grammatical functions, be it in the form of function words or morphology, developed from this set of purely lexical items. (cf. Heine & Kuteva, 2002a; 2007) The process in which content words acquire grammatical function and at later stages already grammaticalised items experience an increase in their degree of grammaticity is claimed to be steady, universal and unidirectional. (cf. e.g. Hopper & Traugott, 1993/2003)

In comparative synchronic and diachronic studies, a number of general mechanisms and fixed paths or clines have been identified along which grammaticalisation operates cross-linguistically. Some of them will be considered in more detail in the following parts of this paper.

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[2] The term 'grammaticalisation' is ambiguous as it can be used to describe both a particular kind of language change process as well as the research framework that has formed to investigate it. To avoid confusion, the present paper will speak of 'grammaticalisation' only when referring to the actual process and refer to the research framework as 'grammaticalisation theory' instead.

2.2.1 *The Mechanisms and Clines of Grammaticalisation*

As specified above, all grammaticalisation processes are believed to follow certain paths which are universal and unidirectional. The most general of these paths is the 'cline of grammaticality' which has the following form:

> content item> grammatical word> clitic > inflectional affix
> (Hopper & Traugott, 1993/2003, p. 7)

The cline of grammaticality adeptly summarises the assumption that, in grammaticalisation, lexical words turn into function words which themselves can be further grammaticalised into clitics, which in consequence can turn into inflectional affixes. This process is believed to be irreversible and unidirectional[3]. Words and constructions always start at a level of no or low grammaticality and rise to a higher one. In the process, however, stages can be skipped and the development of many words ends at an intermediate stage, rather than undergoing the complete process.

Many linguists have tried to define more detailed mechanisms or parameters that mark the process of grammaticalisation. As a result, many different models co-exist. (e.g. Hopper & Traugott, 1993 [2003]; Lehmann, 1995; Bybee, 2003) While it would extend the scope of the present paper to discuss the different concepts in detail, it is worthwhile mentioning the three generally accepted mechanisms that occur within grammaticalisation: desemanticisation (also known as semantic bleaching or generalisation), decategorisation (downgrading) and erosion ([phonetic] reduction). (Heine & Kuteva, 2002a; 2007) These three mechanisms generally take place in succession.

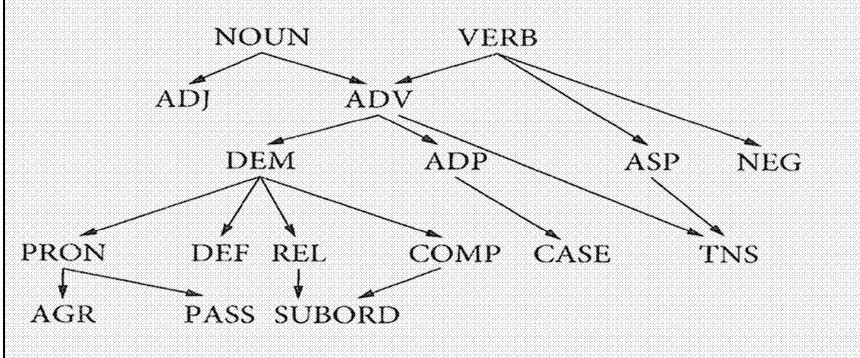
Generalisation or desemanticisation, at first, leads to a loss of semantic content. Content words are abstracted, generalised and extended to new contexts, resulting in often highly polysemous entries. The abstracted forms slowly shed their semantic substance. Once their meaning is 'bleached', grammaticalising words start losing their word class specific features like inflections or other morphosyntactic properties. With this loss, they become decategorised from their previous major categories (i.e. open word classes such as nouns or verbs) to a minor, grammatical category (i.e. function words). (cf. Hopper & Traugott, 1993/2003) Once semantic

[3] The claim of the unidirectionality in grammaticalisation has been controversially discussed and challenged by possible counter examples (cf. Norde, 2009; Fischer, Norde & Perridon, 2004; Heine & Kuteva, 2007), yet, cases in which linguistic items increase in their degree of grammaticality are well-attested diachronically and cross-linguistically and considerably outweigh the counter examples.

content decreases and functionality increases, phonetic erosion processes starts. Words become shortened and reduced, often to the degree that they turn into clitics or even inflectional affixes.

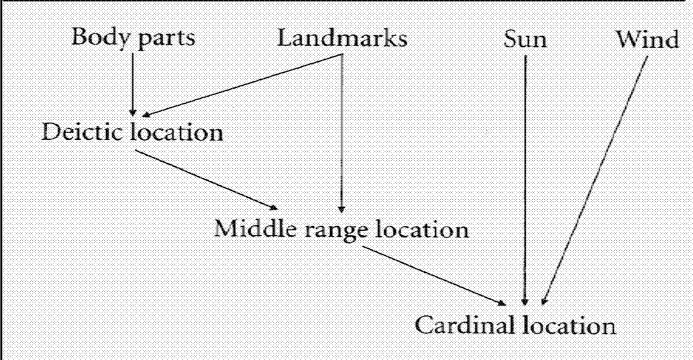
While grammaticalisation can affect, in principle, any word and any type of word, some changes happen particularly frequently. It is a crosslinguistic fact, for example, that certain types of content words are more likely to turn into some kinds of function words than others. Nouns, for instance, have a tendency to turn into adjectives. Consider the English words ‘orange’, ‘silver’ or ‘bronze’. (cf. Heine & Kuteva, 2007, p. 60) Figure 2 shows a network of such frequent paths of the word class changes that are most common in grammaticalisation.

Figure 2: Some Salient Paths of Categorical Shift in Grammaticalisation (Heine & Kutevea, 2002a, p. 383)



Typical paths in grammaticalisation, however, do not only affect particular word classes, but more explicitly even words expressing certain semantic concepts. Nouns describing body parts, for instance, have in many languages been attested to have turned into markers of location or direction. In English, this can be seen in words like ‘back’ and ‘ahead’. Figure 3 gives a high-level overview of common crosslinguistic grammaticalisation processes that lead to the emergence of location markers. Heine and Kuteva (2002b) assembled and analysed such “common pathways of grammaticalization” (Heine & Kuteva, 2002a, p. 383) and identified more than 400 different types. One of those pathways, namely the grammaticalisation of the semantic concept ‘go to’ into future markers, is of particular importance for this paper and will be considered more closely below.

Figure 3: The Main Source Domains of Spatial Orientation (Heine & Kuteva, 2002a, p. 386)



2.2.2 *'Go' as a Future Marker*

In grammaticalisation theory, it is a long-acknowledged fact that "verbs of movement typically come to express the intentions of human agents and ultimately develop into markers of futurity" (Hilpert & Koops, 2008, p.243) Typical verbs which most often form the starting point for this process are 'come to', 'go to' and 'take' as well as the venitive. (cf. Heine & Kuteva, 2002b)

More closely looking at the verb 'go' in this process, instances of its grammaticalisation into future markers can be found in many languages throughout different language families. Table 1 below aims to give an overview of the languages in which this development has been attested.

Table 1: Overview of Languages With Grammaticalised 'Go' as a Future Marker[4]

Language Family	Language	Literature
Indo-European	English	Perez, 1990; van Olmen & Mortelmans, 2009
	Dutch	van Olmen & Mortelmans, 2009
	French	El-Chaar, 1994; van Olmen & Mortelmans, 2009
	Spanish	El-Chaar, 1994; Torres-Cacoullos, 2011
	Portuguese	El-Chaar, 1994
	Romanian	El-Chaar, 1994
	Krio CE	Heine & Kuteva, 2002b
	Negerhollands CD	Heine & Kuteva, 2002b
	Haitian CF	Heine & Kuteva, 2002b
Nilo-Saharan	Bari	Heine & Kuteva, 2002b
	Teso	Heine & Kuteva, 2002b
Niger-Congo	Klao	Heine & Kuteva, 2002b
	Igbo	Heine & Kuteva, 2002b
	Sotho	Heine & Kuteva, 2002b
	Zulu	Heine & Kuteva, 2002b
Afro-Asiatic	Margi	Heine & Kuteva, 2002b
	Hausa	Abdoulaye, 2001
Quechuan	Ecudaorian Quechua	Heine & Kuteva, 2002b
Mayan	Tzotzil	Heine & Kuteva, 2002b
Dravidian	Tamin	Heine & Kuteva, 2002b
isolated language	Basque	Heine & Kuteva, 2002b

4 The given overview is by no means meant to be exhaustive. Even if it did display all attestations of 'go'-based movement futures ever mentioned in the literature, it is more than likely that the phenomenon occurs yet unreported or undetected in many other languages. Similarly, some languages are at present not included in the above list but appear to be currently undergoing a grammaticalising process that might lead to the formation of new future markers from movement verbs. One example of a contemporary grammaticalising 'go' construction can be seen in pseudo-coordinations with 'gå' (Engl. 'go') in Danish, Swedish and Norwegian. (cf. Hilpert & Koops, 2008)

As evident from the broad collection of attested cases above in which ‘go’ evolves into a future marker, this particular grammaticalisation pathway appears to be highly consistent and universal. The fact that the process does not only take place in one language or a set of related languages, but across many different language families and even in an isolated language like Basque, strongly substantiates this claim. Although the starting point and the end result in the different languages may not always be fully identical (cf. van Olmen & Mortelmans, 2008), the overall process is so homogeneous that it is fairly safe to speak of a steady cross-linguistic process in which the movement verb ‘go’ grammaticalises into a future marker.

This process is of particular interest to this study as it shows the change of a lexical movement verb into a function word. A process, which according to prevalent neurolinguistic claims depicts the change from a word, processed with the help of the motor cortex, into a word which is restricted to the perisylvian cortex. It is comparatively easy to test the claimed restriction of function words to the ‘core language centre’ with the help of this path of grammaticalisation. Using different types of words as primes for subsequent actions it has been shown that movement words, due to their motor cortex activation, affect consequent movements. By extending this concept and using grammaticalised movement future constructions as movement primes, it is possible to reinforce or refute the suggested restriction by a mere analysis of movement times. If movement futures have the same effect on consequent movements as lexical movement words, it can be assumed that they are still processed with help of the motor cortex, which means that a limitation to the brain’s language centre cannot be assumed to have yet taken place. Thus, if there is no observable effect for function words but only for content words, the claimed restriction is plausible.

The present experiment will test this idea with the help of the English ‘be going to’ construction, which at present functions as a future intention marker based on the original lexical verb ‘go’. As this construction will be the basis for the experiment, it seems essential to track its development through time from lexical ‘go’ to the contemporary grammatical construction(s). The following section of the paper will therefore make a digression and describe the historical development of English ‘be going to’, before returning to the question of how the diverging ideas of the (un)relatedness of content and function words in grammaticalisation theory and neurolinguistics are related.

2.2.3 *The Grammaticalisation of 'Be Going To' in English*

The change of 'go' into a future marker is so salient that many linguists have used the English 'be going to' construction as a starting point for explaining general grammaticalisation processes. (e.g. Bybee, 2003; 2007; Heine & Kuteva, 2007; Hopper & Traugott, 2003; Kuteva, 2001; Traugott, 2003) In addition, a great number of individual studies on English 'be going to' have been carried out. (e.g. Disney, 2009; Bergs, 2010; Perez, 1990; Pertejo, 1999; van Olmen & Mortelmans, 2008; Véliz-Campos, 2007) The process of change undergone by this particular construction has consequently become one of the most closely studied examples of grammaticalisation in the English language or even in the world.

In order to get a close account of the grammaticalisation of 'go' in English, it is helpful to start at the very beginning and define the verb's original meaning. *The Concise Oxford Dictionary of English Etymology* paraphrases 'go' as 'walk; move along; proceed'. This original meaning has since been extensively broadened. However, the paraphrase as 'move; travel' is still the most common and important one, as can be seen by its appearance as number one of 48 collected uses of 'go' in the *Longman Dictionary of Contemporary English* and equally as number one of twelve compiled uses in the *Oxford Dictionary of English*. However, in the process of semantic expansion, the concept of 'walking' appears to have weakened. It is no longer explicitly specified in the contemporary dictionaries. Nonetheless, three of the thirteen examples in *Longman* given for the 'move; travel' meaning of 'go' unambiguously denote a movement afoot. Another seven cases could be translated as either 'walk' or a more general notion of 'move'. *The Oxford Dictionary* also gives thirteen examples for this particular use of 'go', ten of which could be paraphrased as 'walk', while a more general kind of movement would also be possible. Yet, it will be important for later parts of the paper to note that the majority of the collected examples in the two dictionaries does still at least in part incorporate the aspect of 'walking' which means that 'go' can still be considered a proper mostly leg-related movement verb.

In a grammaticalisation process, English 'go' changed from andative to purposive and ultimately to a marker of future intentions. (cf. Disney, 2009) In more detail, the current English intentional future marker 'be going to' "seems to have originated from an identical structure in which *go* was the main verb followed by an infinitive functioning as an adjunct of purpose: 'I'm going to tell him' was more or less the equivalent of 'I'm going in order to tell him'." (Pertejo, 1999, p. 135) The process is approximatively reconstructed with diachronic examples in Table 2.

Tabel 2: Diachronic Process of the Grammaticalisation of English ‘be going to’

Period	Use	Example	Literature
OE	Andative	*ðu oferfærest ðone sæ 7 <u>bist gangende to</u>* you cross-2-sg the-acc sea-acc & be-2-sg going *towards* *Romesbyrig* Rome-gen-city ‘You’ll be crossing the sea and going to Rome.’ [~855]	Perez, 1990; Disney, 2009
ME	Andative	*Oure .subgettes ... having hereafter fre commyng and <u>goyng to Gene</u> yay of Gene desire to have in to oure reaume of England.* “Our subjects from hereafter have free entry and departure from Gene as those from Gene wish to have into our realm of England.” [1419]	Perez, 1990
	Purposive	*Bote God gyve [hem] grace <u>her goynge to amende</u>* “But may God give grace to her for amending the situation” [~1400]	Perez, 1990
	Intentional	*Philip (...) <u>was going too ðe</u> ouer Greece* “Philip was going to thrive over Greece.” [early 14th c]	Perez, 1990; Pertejo, 1999
EModE	Purposive/ Intentional	*… ‘sir’, quod Gerames, ‘we be frenchmen, pylgrymes, & <u>are goyng to offre</u> at ye holy sepulcre. …* [1534]	Pertejo, 1999; Disney, 2009
	Purposive/ Intentional	*Letters to my friends, And I <u>am going to deliver</u> them* [1590/1591]	Perez, 1990
ModE	Intentional	*He [Mr Pecksniff’s horse] was full of promise, but of no performance. He <u>was</u> always, in a manner, <u>going to go</u>, and never going.* [1844]	Perez, 1990

As can be seen from the examples above, in Old English (henceforth OE) the to-be-grammaticalised construction consisting of ‘be’, participle of ‘go’ and the preposition ‘to’ has already entered the stage. At this point, however, it was solely used as a progressive, indicating ongoing movement and the construction was comparatively infrequent, “despite the fact that the combination *be going* + any preposition [was] extremely common.” (Perez, 1990, p. 55) In Middle English (henceforth ME), the construction changes as the former OE participle ending ‘-ende’ is substituted by ‘-ing/yng(e)’. (cf. Disney, 2009) The slightly modified construction now more closely resembles the contemporary form.

In addition to the morphological change, the first purposive use of the ‘be going to’ construction is attested for ME. Through an expansion that allows for a combination with infinitives, the construction’s meaning changes from ‘movement to a place’ to ‘movement for a purpose’. (cf. Disney, 2009, p. 66) This is the first, important step in the grammaticalisation process of ‘be going to’.

The alleged finding of an intentional use of the construction as early as ME is highly controversial. The example given in the table above is the only one of its kind found in this early period and there is large disagreement as to whether or not the word ‘ðe’ is here to be interpreted as a form of the verb ‘thrive’.

Disregarding the controversial example in ME, the first indisputable instances of purposive-intentional uses of ‘be going to’ are found in Early Modern English (henceforth EModE). The earlier example given in Table 2 is not accepted by all linguists, as it stems from a translated text. It is often claimed that the author might just have paraphrased the form from the original language and that this example does not necessarily give any indication of whether or not the construction does indeed exist in the English language or whether it is possibly just understood as part of people’s knowledge or contact with e.g. French. (cf. Perez, 1990) The later example from EModE, however, is undoubtedly a genuine early use of the ‘be going to’ construction with a purposive-intentional meaning, as it does not stem from a translation but was used by William Shakespeare. It is virtually impossible to draw a fixed line between purposive and intentional meaning as the meaning of intention is to a large degree implicit in the purposive construction. (cf. Perez, 1990) Hence, the cases in EModE may most easily be described as purposive-intentional.

While initial instances of a comparatively strongly grammaticalised purposive-intentional construction are already found in EModE, it is not until Modern English (ModE) that they become frequent. Pertejo (1999) claims that the “original meaning of movement was lost in the course of the 17th century” (p. 137) which then allowed for a steady increase in frequency. The complete loss of the movement component becomes particularly evident as soon as the construction is used with actual movement verbs, as seen in the example for ModE given in Table 2. (cf. Perez, 1990)

Having thence significantly risen in both token and type frequency and become accepted as a marker of future intentions, the construction has arrived at its present stage where ‘be going to’ is generally seen as an auxiliary that is devoid of its original movement meaning and has turned into a purely functional construction. (cf. Pertejo, 1999)

The development, however, did not stop with the functionalisation of ‘going to’. Further grammaticalising processes like sound erosion occurred, resulting initially in the reduced form ‘gonna’ [gə̃nə̃]. ‘Gonna’, although considered casual and only possible in colloquial conversation, is well-known to and generally accepted by English speakers. More recently and only in highly casual speech, ‘gonna’ in first person singular has further experienced a reduction to [aimə̃ɾ̃ə̃]. (Bybee, 2003, p. 616-617) Characteristic of this form is the complete loss of the velar stop. Yet, there is no complete consent on the exact phonological result of the reduction. Bybee, from an American English background, gives the above used transcription or a more simplistic version thereof: [aimənə]. (Bybee, 2007, p. 13) The Australian linguist Ingram (2007), on the other hand, gives a slightly different account of the transformation of the construction featuring in particular a different nasal-combination and differently timed vowel changes: [aɪŋgənə]-[aɪŋənə]-[aŋənə]-[aŋnə]-[aŋə]. (p. 99) Without a set of underlying data, it is virtually impossible to decide which of the accounts is correct or whether they are merely distinctive regional variants of a similar sound erosion process.

Interestingly, the latest reduction of the original ‘be going to’ construction only affects the first person singular. With all other cases, the less reduced form ‘gonna’ has to be used instead and the velar stop cannot be dropped. This restriction is presumably one reason for the utmost degree of casualness that is associated with the form. The fact that the contraction can at the present point in time not be used in formal English results in an absence of a consistent written form of the construction. While this paper will subsequently refer to the strongly reduced form as ‘I’m ‘na’, the freely editable online dictionary ‘Urban Dictionary’ lists three different spelling variants: ‘I’mma’, ‘I’ma’ and ‘I’m-a’. A brief online-search with the search engine Google could confirm that these spelling variants and a number of others appeared to be frequently used in casual writing. Examples of the most frequent forms are listed in Table 3 below.

Tabel 3: Contemporarily Co-Existing Forms of English ‘be going to’ in First Person Singular

Form	Variants	Example	Source
I’m going to	<I’m going to>	I'm going to get in trouble and I don't care	Icecreamhdaches. (03.26.2011). I'm going to get in trouble and I don't care. Retrieved from http://icecreamhdaches. livejournal.com/2070184.html
I’m gonna	<I’m gonna>	Anyways, I’m gonna get some sushi and eat.	Max. (21.02.2008). Sushi Time. Retrieved from http://www.stackthefish.com /sliderblog/
I’m ‘na	<I’m ‘na>	I'm 'na get some right now!	Feanor. (25.08.2004). Pad Thai. Retrieved from http://unpasteurized. blogspot. com/ 2004/ 08/pad-thai.html
	<I’m‘na>	Okay, I'm'na get flamed, but you can use the Cool Whip if you're super set on it.	dustkitty. (03.12.2007). Whipped cream conversion. Retrieved from http://hip-domestics.livejournal.com/5448482.html
	<I’mna>	I'mna get a new account soon...	SkunkyAnnie. (12.08.2006). …new account. Retrieved from http://skunkyannie.deviantart.com/ journal/?offset=0
	<I’m na>	I wasn't thinking "cool i'm na get some attention, my user name federer007 will be famous".	federer007. (12.2007). Re: Best HU NLHE player. Retrieved from http://forumserver.twoplustwo.com /29/news-views-gossip/best-hu-nlhe-player-158878/index3.html#post3249317
	<I’mma>	I'mma get this tattooed then never close my palm so everybody can see.	Williams, J. (21.01.2010). @bigkandy. Retrieved from http://twitpic.com/z0v5n

<I’ma>	I'ma get my learners soon so I can start getting my ears gauged.	Meep. (18.09.2010). Will RS/RL Blog; I’ve been expecting you. Retrieved from http://s7.zetaboards.com/rsmdb/topic/8367704/1/
<I’m-a>	Finally, I'm-a get to move on the ground!	PentiumMMX. (04.03.2009). Mario Teaches Typing 2. Retrieved from: http://www.gamefaqs.com/pc/925214-mario-teaches-typing-2/reviews/review-133210
<I’m a>	I think I’m a get to 85 with my shammy first since he is closer to leveling.	Nitro, J. (02.02.2011). Level 80 Druid and Rising. Retrieved from http://johnnitro.com/level-80-druid-and-rising/

What can, in summary, be said for the grammaticalisation of English ‘be going to’ is that the construction changed from having a purely lexical andative meaning via a semi-functional purposive to a fully grammatical form expressing intentionality. The evolution of the functional construction was complete by the beginning of the Modern English period. In more recent years, ‘be going to’ has begun undergoing a process of phonological erosion, yielding the reduced forms ‘be gonna’ and the further first person singular reduction ‘I’m ‘na’. At present, all mentioned constructions can occur. Lexical andatives [*I’m going to Rome*.] thus co-exist with semi-functional purposives [*I’m going (there) to see Sam*.] and three different phonological forms of the fully grammatical intention marker [*I’m going to see Sam*. / *I’m gonna see Sam*. / *I’m ‘na see Sam*.].[5]

2.2.4 *Implications for Content Words and Function Words*

Having considered the English ‘be going to’ construction in detail, it is now time to turn back to the more general concepts of grammaticalisation. Let us consider the relationship that grammaticalisation theory draws between function words and content words. While it remains a fact that lexical words and grammatical words are used for entirely different purposes in language, grammaticalisation processes are proof that they are very closely related.

Evolutionarily, early human language consisted of only content words, which are the most

[5] An interesting finding which, however, exceeds the scope of this paper is the fact that the reduced construction ‘I’m ‘na’ seems to be evolving into a more general linguistic item that no longer conforms to the grammatical meaning of ‘gonna’ from which it originated. This can be seen in the emerging use of the construction ‘I’ma gonna’. A particularly prominent example for this construction is the song ‘I’m-a gonna go to hell when I die’, frequently played by Conan O’Brian in his 1993-2009 TV show ‘Late Night with Conan O’Brian’. If ‘I’ma’ in this combination was still identical to ‘I’m gonna’ then ‘I’ma gonna’ would be a bizarre case of functional reduplication. It is more likely, however, that the functional meaning of ‘I’ma’ has undergone a change process that made it diverge from the original grammatical function of ‘I’m gonna’ allowing for a nonpeculiar combination of the two. What function ‘I’ma’ has in this construction or whether it is just used for rhythmic reasons would need to be investigated in a larger study.

fundamental component of language and without which linguistic communication is not possible. Function words, which substantially facilitate but are not crucially necessary for basic linguistic communication[6], subsequently emerged in a change process in which content words took on grammatical functionality. During this universal and continuous process, function words generally split from an underlying content word in a process of abstraction and subsequent functionnalisation, leaving the original content word intact and thus resulting in a polysemous entry. The initial polysemous situation, however, may be lost over time if either the function words becomes so reduced that the relation to the original content word is no longer perceived or if the underlying content word ceases to be used. Hence, although it is not always possible to draw a connection between many contemporary function words and their underlying content words, the former stringently depend on the latter and the two categories are inevitably connected.

Considering this inherent relatedness of content and function words, the strict separating line that neurolinguistics generally draws between the two categories needs to be reconsidered in the light of grammaticalisation theory.

2.3 Grammaticalisation Theory and Neurolinguistics: Conflicting Perceptions and Consequential Conclusions

As has been argued above, the general claim that function words and content words are inherently distributed differently in the human brain is highly questionable in the light of grammaticalisation processes. Function words are immediately based on content words and many are at present still closely similar to the original content words in form, albeit not in linguistic purpose. Considering that it has been shown that abstracted content words are still capable of activating the networks pertaining to the original content words, it can be concluded that the phonological form of words has a strong impact on the activation of transcortical networks. Thus, for function words that still have the same form as the content words and even more so for words that have but very recently turned into function markers, it is not easy to argue for a complete dissociation from the transcortical networks originally associated with the underlying content words.

[6] Consider the examples of early language acquisition or the idea of being stranded in a foreign country. Babies initially learn basic words like ‘mama’ or ‘baba’ to ask for their mother’s attention or their bottle respectively. They do not need to know function words or grammar in order to communicate their most urgent needs. Similarly, a traveler, stranded in a country whose language he does not know, needs content words like ‘food’, ‘water’, ‘bus’ and ‘go’ to stay alive, rather than being aware of how to form the future perfect subjunctive or what word order is used in the foreign language.

If phonological form is just as important as semantic content for the maintenance of transcortical networks, many function words can be expected to share the networks of the content words from which they evolved.

Of course it is hardly possible to claim that all contemporary function words still activate their 'original' transcortical networks. For a great number of highly functional words, the underlying content words no longer exist. It is highly unlikely or virtually impossible that the original transcortical networks founded on the original word semantics remain in power once the content word ceases to exist. Consider the examples of the English preposition and genitive marker 'of' stemming from the OE word 'æf' meaning 'away' or the conjunction 'if', OE 'gif', presumably stemming from a word meaning 'doubt'. (cf. Harper 2001-2010). In both cases, the content word was grammaticalised and its original meaning was lost in the process. All neural associations or networks, which could have been brought along by the original semantics, are certainly lost for the present function words as it is virtually impossible that the neural networks can persist in the absence of the words that formed them. A continued existence of transcortical networks is similarly unlikely for function words that have become strongly reduced or even turned into affixes and no longer bear any recognisable resemblance to the original content words. For example, consider the English suffix '-dom' denoting a state or condition, which stems from OE 'dom', the ancestor of ModE 'doom' or the modal verb 'ought', indicating an obligation, which stems from OE 'ahte', the past tense of 'agan', the OE form of 'owe'. (cf. Harper, 2001-2010) For neither of the two contemporary morphemes it is immediately possible to draw a connection to the underlying content word. Hence, if the contemporary speaker is unaware of the relationship between content and function word, it is difficult to argue that the original cerebral networks based on the underlying content words are still active for the grammaticalised items. While the transcortical networks for the original content words do undoubtedly persist in present-day English, the functional items have become so strongly detached from the original forms both semantically and phonologically that there is no reason to believe that they still activate the original networks.

Hence, in many cases function words and content words do undoubtedly have different cerebral distributions. The important question is, at what point in their development the activation of the transcortical networks becomes so weak that it is possible to speak of a 'restriction' of function words to the perisylvian language areas.

The present paper would like to suggest two different timelines: an early and a late dissociation.

1) Early Dissociation Scenario

An early dissociation scenario for function words can be constructed to account for the prevalent neurolinguistic claims that content and function words are inherently separated. In this scenario, the transcortical associations of the original content words experience a significant weakening during the grammaticalisation process, as a consequence of the loss of lexical meaning and the emergence of functionality. The transcortical activation already weakens in the very beginning of the grammaticalisation process due to the loss of semantic content and the increase in grammaticality and as soon as words are perceived as grammatical, their cerebral activation potential has become limited to the perisylvian language areas.

Although at first sight slightly implausible given the findings for abstracted words, this hypothesis is in fact fully compatible with these findings. The transcortical activation networks for content words may persist through semantic weakening and abstraction, but disintegrate in the process of 'functionalisation'. The additional load of grammatical function might considerably weaken the association with the sensorimotor areas and in turn strengthen the links to the perisylvian cortex and thereby 'limit' the newly grammaticalised words to the primary language areas.

2) Late Dissociation Scenario

Alternatively, a late separation scenario is conceivable in which the dissociation of content and function words does not go along with the loss of lexical meaning and the acquisition of grammatical function, but is instead associated with phonological form. As long as the grammatical item has the same phonological form as the lexical item, an activation of the transcortical network associated with the original content words persists, as the phonological connections are still intact. Once sound erosion takes place, however, and the function word loses its resemblance to the original lexical item, its transcortical activation fades and restriction takes place.

This scenario is compatible with and possibly most plausible in consideration of the findings for abstracted words. As mentioned above, it might well be phonological form that is responsible for the fact that abstracted and grammaticalised words activate the networks for their original content words. In this line of thought, the phonological (or orthographic) input triggers the activation of the original transcortical activation networks whether or not the words are used in their original meaning. If this is the case, grammaticalised items will have the same cerebral distribution as the original content words as long as phonetic reduction has not yet taken place.

Although the question of how content words are processed as opposed to function words has to date not been discussed against the backdrop of grammaticalisation, both suggested scenarios could perfectly well be a description of the possible influence of grammaticalising processes in the human brain. In the preliminary absence of empirical studies, however, none of the above hypotheses can yet be confirmed or refuted.

For this very reason, the present paper strives to conduct a first empirical study on the impact of grammaticalisation theory on the processing and representation of words in the brain in order to gain a better understanding of the neural processes behind grammaticalisation and grammar in general. In a choice reaction time study similar to but significantly extending that by Boulenger, Roy, Pauligman, Deprez, Jeannerod & Nazir (2006), it attempts to gather evidence that could prove one of the proposed scenarios for the neural representation of function word in the human brain.

4 Movement Priming Abilities of Function Words: A Choice Reaction Time Experiment

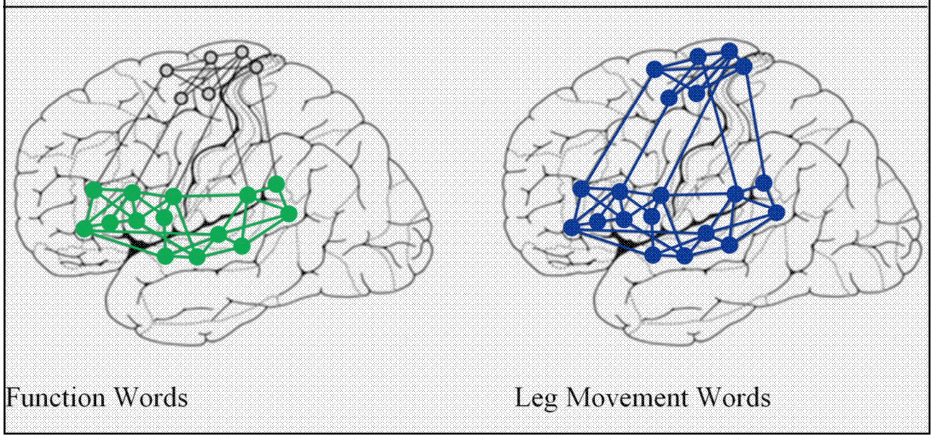
As argued in the previous sections, lexical and functional words are closely interlinked with the latter emerging from the former in the process of grammaticalisation. Although it is well known how external language is affected by the process, there is no indication as to how internal language copes with these changes. To shed some light on this question, the present paper will look at the prominent cline in grammaticalisation, described above, within which movement verbs evolve into markers of futurity and intentionality.

Function words are believed to be processed solely in the brain's language centre, i.e. the areas around the perisylvian cortex. Lexical movement verbs, on the other hand, have been shown to be more broadly distributed in the human brain. In addition to the perisylvian language areas, the processing of such action words also involves the human motor cortex. This activation has been argued to be grounded in semantic circuits resulting from a frequent co-activation of language-specific and sensory areas. Hence, lexical movement words, i.e. words with a strong semantic content, and grammaticalised movement words, i.e. words with a purely functional content, are believed to have diverging cerebral distributions. Only the former have a semantic content which allows for an association with movements and thence the motor cortex.

This results in different cerebral activation patterns for lexical and grammaticalised leg movement words, which are at the heart of this paper. The brain regions involved in the processing of lexical movement words are highlighted in blue in Figure 4 below, adapted from

Pulvermüller (2005). For function words, including those that have evolved out of leg movement words, the putative distribution is marked in green to the left.

Figure 4: Brain Activation for Function Words and Leg Movement Words



The strictly differrent cerebral distribution becomes questionable when considering findings for abstracted words and general grammaticalisation processes. Content words and functions words are closely related and a stringent separation of the two in the brain is not necessarily consequential. Taking into account, in particular, that abstracted words are able to activate the content-related networks of the words on which they are based, it is but obvious to argue that grammaticalised words may have the same abilities, at least initially. In that line of thought, it is then necessary to ask how and when the claimed restriction for function words occurs and, in consequence, which of the scenarios suggested in section 2.3 can best describe the neural change processes.

To investigate these issues, the current study will look at the English movement future ‘be going to’. The future intention marker evolved from a construction crucially including the movement verb ‘go’, which continues to be used in the English language. The fully functional construction is today used in three forms, which each display a different degree of grammaticallisation: ‘be going to’, ‘gonna’ and ‘na’. These three differently strong grammaticalised ‘go’ constructions as well as the original content word will form the basis of the present study. The characteristics and an example of each use of ‘go’ is given in Table 4 below.

Of the four forms of English ‘go’ used in the study and shown in the overview below, only the first one, labelled as ‘go’, represents a lexical word. In this use, ‘go’ denotes above all a foot and leg movement and would be expected to activate the leg motion centre in the brain in addition to the core language areas. The three other constructions are grammatical forms and have a purely functional linguistic purpose. They are thus traditionally considered to be restricted to the brain’s language centre around the perisylvian fissure.

Table 4: Four Different Contemporary Forms of ‘Go’ in English

Form	Example	Characteristic Features
go	I’m going to (the) church.	fully lexical word indicating physical or abstracted movement original meaning (physical movement, synonymous with ‘walk’) continues to exist
be going to	I’m going to sing.	fully grammatical form indicating future intention no phonetic reduction
gonna	I’m gonna sing.	fully grammatical form indicating future intention phonetic reduction, original ‘go’ in parts still discernible
‘na	I’m ‘na sing.	fully grammatical form indicating future intention extreme phonetic reduction, loss of the original ‘go’

The truth of the propositions that function words are inherently restricted to the core language areas in the brain will be questioned in a choice reaction time experiment. The methodology for this study is primarily based on a study carried out by Boulenger, Roy, Pauligman, Deprez, Jeannerod & Nazir (2006) which set out to compare the effects of movement verbs, as opposed to those of nouns on movement and acceleration times. In an experiment where participants had to react to written words with a particular hand movement, they found that “processing action verbs significantly affects overt motor performance.” (p. 1607) Based on their experiment design and the usage of written stimulus presentation, the researchers could find a priming effect that took place “at about 550-580 msec after word onset.” (p. 1612)

If a word is processed with the help of the motor cortex, immediately following movements are positively affected as the motion centre in the brain is already in a state of activation at the point the movement is initiated. Boulenger and her colleagues could prove this claim by the occurrence of earlier acceleration peaks for movement verbs compared to nouns. The researchers could not show an influence of the priming words on movement onset or movement duration, but it appears as though that was primarily based on the fact that the verbs were not matched to the required movements. All movements in their experiment were carried out with the arm. The priming verbs, however, were not strictly arm-related but referred to movements associated with different body parts, i.e. the face, legs and arms. This asymmetry might well have lessened the observable effects. Reinforcing this assumption, Boulenger, Roy, Pauligman, Deprez, Jeannerod & Nazir (2006) reported that an “interaction between language and motor tasks was strongest when words and action called the same effector.” (p. 1612) The present paper therefore sees no reason to believe that movement onset and movement duration should not be affected by movement priming if the body part carrying out the movement response is the same as the one expected to be used in the action denoted by the prime verbs.

On the basis of the above considerations, a choice reaction time experiment was conducted that set out to analyse possible priming effects of the leg movement verb ‘go’ and the grammaticalised forms thereof on the onset and duration of particular leg movements.

For the experiment, a group of test subjects were asked to listen to a number of acoustic stimuli. The stimuli had the form of short sentences, which consisted of lexical and grammaticalised movement verb constructions as well as non-movement reference verbs which were complemented with real and pseudo target words. The subjects were required to react to each stimulus with one of two different leg movements according to the nature of the target word, i.e. according to whether the target was a real or a pseudo word.

For all constructions, which are processed with activation of the motor cortex, the onset and duration of subsequent movements should be affected. Closely analysing the movement times for the non-movement reference verbs and all movement-verb constructions, it will thus be possible to determine which words and constructions activate the motor cortex and which ones do not.

4.1 Hypotheses

Given the previous findings presented above that the conduction of movements is affected if primed by movement words, a set of hypotheses emerged for the present study.

In conformance with the findings by Boulenger and Pulvermüller presented above, it is possible to assume that all the movements times for all movements that are primed by movement words will be accelerated. It is based on the assumptions that movement words activate the motor cortex in the brain and that subsequent movements will therefore be initiated sooner (i.e. have an accelerated movement onset) and will be faster (i.e. show an accelerated movement duration) than movements that are not primed.

On the basis of this general assumption, it is then necessary to further address the question of which of the employed uses of ‘go’ (i.e. content word, function word and reduced function words; cf. Table 4 above) are considered as ‘true movement words’, i.e. words which are able to function as motor primes. Based on the two scenarios for function word ‘restriction’ postulated in 2.3 above, two hypotheses are constructed for the present study:

1) Early Dissociation Hypothesis

As claimed in the early dissociation scenario above, function words might experience an early dissociation from the original networks in the process of their functionalisation. If this is the case, function words truly are processed differently than content words, as generally suggested in neurolinguistics. If, in consequence, only content words are associated with the motor cortex, then an acceleration of movement times will only take place for content words. Function words in both full and reduced forms will not produce any accelerated movements but instead be very similar to the non-movement control conditions.

2) Late Dissociation Hypothesis

The dissociation from content word networks for function words, however, may not be based on functionality but rather on phonological form. This appears particularly plausible in the light of the attested activation for abstracted words. If it is, thus, phonology that determines whether or not action verbs activate the motor cortex, it is to be expected that content words as well as their corresponding unreduced function words will lead to an acceleration of subsequent movements. Reduced function words, however, given their diverging phonological form and a consequent dissociation from the original networks, will not have an effect on the subsequent movements. The times for reduced function words will therefore resemble the times for the non-movement conditions.

4.2 Methods

For the above outlined purpose a choice reaction time experiment was constructed with the psychology experiment programme E-Prime. This was set up as a pseudo-word experiment with a lexical decision task in which the participants were required to react to a number of sentences by moving their leg from a base pedal to one of two decision pedals. The sentences they were given consisted of six different primes, re-presenting the four different forms of ‘go’ specified in Table 4 above and two control conditions. Each prime was combined with forty different target words. For task-related reasons, twenty of the targets were pseudo words and twenty were real words. The subjects were asked to move their foot to a pedal labelled ‘REAL’ to their right for real words or to a pedal labelled ‘PSEUDO’ to their left for pseudo words.

For all resulting movements, onset and duration times were measured. Movement verbs, due to their proven activation of the motor cortex, would be expected to have a visible effect on the analysed movement times. As it is not certain whether or not any of the grammaticalised forms maintained their motor cortex activation, two non-movement verbs were used as control conditions.

4.2.1 *Participants*

A total of twenty-one subjects participated in the present study. All of them were permanent residents in the UK and native speakers of English. Nineteen of the subjects were British, one participant was Northern Irish and one Australian. The two non-British subjects had both lived in Britain for more than seven years and were thus well accustomed to spoken British English. They indicated that they experienced no problems understanding British English and were in fact so habituated to the accent that they had begun using it themselves when conversing with Brits. A close familiarity with British English was of vital importance, as the speech material used in the study was recorded in British English and an unfamiliarity with the accent could have influenced the subjects' responses.

Two of the participants had to be excluded from the analysis as they displayed problems performing the experiment-related tasks. The remaining nineteen subjects consisted of eight females and eleven males and ranged in age from 23 to 40 with an average age of 28 years (SD=5.08). It was ensured that none of the subjects had any movement or hearing impairments nor linguistic or cognitive deficits. With a total of sixteen, the majority of subjects were right-handed, while two of the remaining subjects were left-handed and one was ambidextrous. Of the three non-right-handed subjects, two were left-footed. All other participants indicated that they predominantly used their right foot. All participants were in the course of the experiment asked to perform the movements with their right foot only. While this may have been an advantage for the right-footed participants, the possible impediments for the left-footed subjects were equally strong throughout conditions and would thus not have had any negative effect on the analysed results.

For the sake of completeness, a detailed overview over the individual participants with regards to the above mentioned criteria is given in Table 5 below.

Table 6: Overview over Participant Data

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
Age	26	28	28	25	35	26	25	23	24	37	40	25	26	27	25	22	36	28	27
Gender	f	f	m	m	f	m	m	m	f	f	m	f	f	f	m	m	m	m	m
Variety of English	Br	Br	Br	Br	Au /Br	Br	Br	Br	N.Ir /Br	Br	Br	Br	Br	Br	Br	Br	Br	Br	Br
Handedness	r	r	r	r	r	l	r	r	r	r	l/r	r	l	r	r	r	r	r	r
Footedness	r	r	r	r	r	r	r	r	r	r	l	r	l	r	r	r	r	r	r

4.2.2 *Conditions*

Six different conditions were used throughout the experiment. In addition to the previously specified four uses of 'go', i.e. lexical 'go' and the three differently strong grammaticalised 'be going to' constructions, two non-movement verb controls were selected.

For the lexical form of 'go' which combines with nouns, the reference verb 'be' was chosen. 'Be', with its locational meaning, can easily combine with the same complements as the movement verb 'go'. Beyond that, both verbs, in the form in which they featured in the experiment, i.e. 'go to' or 'be in/at' respectively, show a similar frequency in the British National Corpus (henceforth BNC). In the 100,000,000 word online corpus of spoken and written 20th century British English, the construction 'go to' was found 11,963 times while 'be in' and 'be at' together displayed an absolute frequency of 11,687.

In order to achieve a similar semantic structure to that of the grammaticalised 'be going to' constructions, only abstracted uses of the verb 'go' were chosen. If used in an abstracted sense 'go' does not require an article introducing the following noun phrase but can combine with the pure head noun only. Using the abstracted form, however, does not have any impact on the expected priming effect. Boulenger, Hauk & Pulvermüller (2008) successfully illustrated in an fMRI study that abstracted, metaphorical uses of movement verbs activate the motor cortex in virtually the same way as the original non-abstracted forms of those verbs which refer to actual physical movements.

The 'be going to' constructions, unlike lexical 'go', combine with verbal complements. To avoid possible effects of the different type of complement, the nominal and verbal complement conditions were considered separately.

A second non-movement control condition was therefore chosen as a reference object for the grammaticalised intention marker constructions. The best-suited verb for this condition appeared to be the verb 'try'. The form 'trying to' which was to be used during the experiment, is highly frequent in the BNC with a total of 15,563 uses. While both ‘gonna’ and ‘na’ are too casual to appear in the BNC, ‘going to’, as a grammatical construction as opposed to a lexical one, was found to be more than twice as frequent as ‘trying to’ with an absolute frequency of 32,907. It is, however, a proven fact that functional items experience a substantial rise in frequency in the process of their grammaticalisation. (cf. Bybee, 2001; 2003; 2007) Functional items have much broader fields of application than lexical items. It is therefore inevitable for ‘going to’ to be more frequent than its control construction. With an absolute frequency of 15,563, however, ‘trying to’ is remarkably prominent for a lexical construction and undoubtedly the best possible choice for a control condition.

Table 6 below gives an overview of all six conditions used in the experiment. For the sake of brevity, the condition involving abstracted, lexical ‘go’ will henceforth mostly be abbreviated as ‘go’, the nominal complement control ‘be in/at’ will be referred to as ‘be’, the unreduced form of ‘be going to’ will be labelled ‘going’ while the reduced forms will be called ‘gonna’ or ‘na’ respectively. The control condition with the verbal complement construction ‘trying to’, finally, will be referred to as ‘trying’.

Table 6: Overview of Conditions

Condition	Example	Characteristic Features
go	I’ll go to school.	abstracted leg movement verb
be	I’ll be in/at school.	non-movement verb
going	I’m going to think.	grammaticalised, unreduced leg movement verb
gonna	I’m gonna think.	grammaticalised, reduced leg movement verb
‘na	I’m ‘na think.	grammaticalised, strongly reduced leg movement verb
trying	I’m trying to think.	non-movement verb

4.2.3 *Stimuli*

A total of 300 spoken stimuli were used during the experiment, 240 of which were complete sentences, while the remaining 60 stimuli were incomplete sentences used as catch trials.

The 240 sentences recorded for the experiment for task-related reasons consisted of two main groups: sentences with real words and sentences with pseudo words. The groups were equally large with a total of 120 sentences each.

All sentences were a combination of primes and target words. The primes consisted of six different constructions: ‘I’ll go to’, ‘I’ll be in/at’, ‘I’m going to’, ‘I’m gonna’ ‘I’m ‘na’ [aɪmnə], and ‘I’m trying to’ representing the six studied conditions ‘be’, ‘go’, ‘going’, ‘gonna’, ‘na’ and ‘trying’. As previously mentioned, different pronunciations of ‘I’m ‘na’ are suggested in the literature. Before any stimulus recording could therefore take place, it was investigated which pronunciation variant was most frequent in British English, as the experiments were to take place in England. Independently of each other, five native speakers of British English indicated that the most prominent and to their knowledge only possible pronunciation of the construction in England was [aɪmnə]. This pronunciation was therefore used as a representation of the condition ‘na’.

The verbal complement control condition with ‘try’ was used in a present progressive so as to most closely resemble the grammaticalised ‘be going to’ construction. The nominal complement constructions, on the other hand, were deliberately not given in the present perfect but as a will-future construction. This was done in order to avoid a reduplication of the construction ‘I’m going to’ which might not only have had an influence on movement times due to an augmented occurrence of the construction, but also have led to difficulties in combination with pseudo targets. Distinguishing the grammaticalised intention marker and the lexical present progressive form of ‘go’ is only possible through the type of lexical complement. Intention markers combine with verbs while progressive lexical ‘go’ can occur solely with nominal compliments. Pseudo words cannot be categorised into nouns and verbs. It is therefore impossible to distinguish between intention marker or present progressive when the construction ‘I’m going to’ combines with pseudo word targets. As this combination is used for the condition ‘going’ and meant to represent the intention marker, it will in the later analysis require specific attention.

All of the prime constructions described above were subsequently completed with each twenty real and twenty pseudo target words.

For real word sentences, the target was either a noun (as a complement for ‘I’ll be in/at’ and ‘I’ll go to’) or a non-movement verb (as a complement for the remaining conditions). The nominal targets chosen for the study consisted of ten proper and ten common nouns. The common nouns were abstracted concepts for example ‘bed’ (cf. abstract ‘I go to bed.’ vs. concrete ‘I go to the bed.’). As previously mentioned, this was done to avoid the insertion of an article and thus an extra morphological and phonological unit between prime and target, which would have been necessary with concrete nouns. The proper nouns, on the other hand, consisted of place names, as for example ‘London’. The verbal complements, finally, consisted of non-movement verbs such as verbs expressing mental processes like ‘think’ or ‘believe’ or other non-movement verbs like ‘manage’ or ‘begin’.

As lexical frequency has been shown to affect the activation of the mental lexicon (cf. e.g. Pylkkänen & Marantz, 2003), particular attention was paid to the fact that the frequency not only of the individual targets, but in particular of the combination of primes and targets was not significantly different. For this purpose, a pairwise comparison with 300 factors was conducted with the online Lexical Semantic Analysis utility provided by the University of Colorado Boulder. The frequency of all prime-target combinations was assembled and an unpaired two-sample t-test could not show any significant differences for the probability of these combinations across conditions.

For pseudo word sentences, a total of twenty nonsense words were constructed according to English syllable structure rules, but without close resemblance to existing English words. The pseudo words were used as both nominal and verbal targets throughout the experiment.

In addition to the 240 experiment sentences, sixty catch trials were added, consisting of the prime construction only. This was done in order to reduce movement readiness during the experiment, as it has been suggested that the addition of catch trials leads to a decrease in movement preparation visible in an increase in mean reaction time. (cf. Alegria, 1978) The lowest possible degree of movement preparation was considered imperative despite the slightly augmented reaction times, since Neuron Theory predicts that even imagined action activates the motor cortex. (cf. Lotze, Montoya, Erb, Flor, Klose, Birbaumer & Grodd, 1999) If participants thus visualise the movements before they hear them, this might have an effect on movement times. If, however, they do not know what movement is going to be required next, the probability of visualisations is lower. Catch trials were thus added to lower movement preparation and movement readiness in order to minimise possible effects on movement times.

A summarising, simplistic overview of the stimuli used is given in Table 7 below. An extensive list of all sentences used can be found in Appendix 1.

Table 7: Overview of Stimuli

Condition	Prime	Target		
		Real	Pseudo	Catch trial
go	I'll go to	+noun	+pseudo word	ø
be	I'll be in/at	+noun	+pseudo word	ø
going	I'm going to	+non-movement verb	+pseudo word	ø
gonna	I'm gonna	+non-movement verb	+pseudo word	ø
'na	I'm 'na	+non-movement verb	+pseudo word	ø
trying	I'm trying to	+non-movement verb	+pseudo word	ø

All primes and targets were recorded in an anechoic chamber by a female speaker of British English. The primes were consequently modified with the speech analysis and manipulation programme Praat. All six constructions were cut into a uniform length of 300 msec. The constructions were subsequently joined together with the target words. In doing so, the same recording for each target word could be used throughout conditions. Target word lengths ranged from 350 msec to 550 msec with a mean of 458 msec (SD=58 msec). The differences result from the differently long targets, which resulted from a deliberate choice of most frequent prime-target combinations. Consequently, eight of the selected target words were monosyllabic and twelve disyllabic. However, the length differences between the three different kinds of critical words (i.e. pseudo, nouns and verbs) were found not to be statistically significant in an unpaired two-sample t-test. Primes and targets words were harmonised in Praat to the highest possible degree, e.g. in relation to pitch, in order to minimise their sounding unnatural.

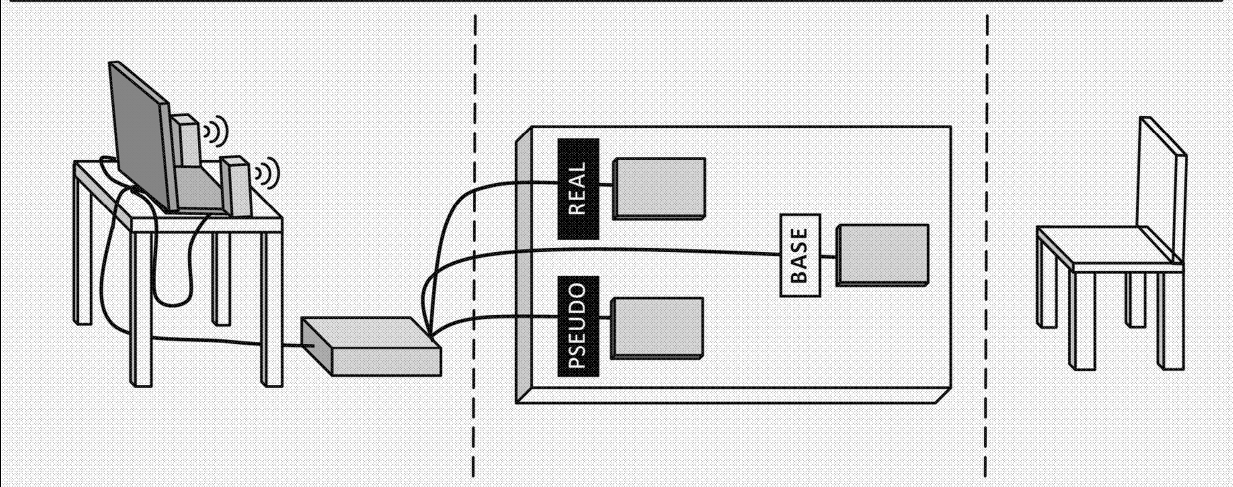
Artificial manipulation of the stimuli was purposely chosen over natural speech recording, so as to ensure the highest possible similarity of both the primes as well as the targets across conditions.

4.2.4 *Experiment Set-Up*

For the experiment, three E-Prime Foot Pedals were connected to a Serial Response Box (henceforth SRBox) and subsequently fixed to a wooden board (60cm long, 46cm wide, 0.8cm high). The base pedal was mounted one centimetre from the lower edge of the board, while the decision pedals were installed at a 40cm distance in a 20º angle from the base. The pedal for pseudo words was placed to the left and the pedal for real to the words right of the base pedal. Each pedal was labelled in large, clearly visible capital letters with its purpose in the experiment (i.e. BASE, REAL, PSEUDO).

Before each individual experiment session, the wooden board and the SRBox were placed on the floor. At the head end of the board a laptop computer was set up. The SRBox was connected to the laptop's USB port using a Serial to USB adapter, thereby enabling response recording. In addition, a pair of loud speakers was placed on the table next to the laptop computer. They were connected to the laptop's audio output to ensure the best possible sound quality. A chair, on which the participants were asked to sit during the experiment, was placed on the other side of the board. Figure 5 below illustrates this set-up visually.

Figure 5: Simplified Depiction of Experiment Set-Up



Once the equipment was properly set up, the laptop was switched on and everything was in place for the experiment session to commence.

4.2.5 *Experiment Procedure*

Prior to the experiment, the participants were informed that they would be taking part in a study that set out to test the effect of computerised speech on reaction times. This was done to ensure that the participants would not be startled by the slightly unnatural sound of some sentences, which resulted from the manipulations and merging of the sound files. Furthermore, they were told that during the experiment they would listen to a large number of sentences and react to them with different foot movements. They were warned that the sentences would be very short and at times extremely casual and they were asked to pay close attention. In this way, the participants were prepared for the casual contractions that are not usually found outside larger colloquial speech contexts.

Subsequently, the participants were informed in more detail about what they were expected to do during the experiment. They were told that most of the sentences in the experiment would end in either a real or a pseudo word and that their task was to react to each sentence by first stepping on the base pedal and subsequently on the correct decision pedal (i.e. pseudo or real). They were told that they were to conduct this sequence as quickly as possible and that intuitive reactions were more important than accuracy. That way, it was ensured that prolonged task-related contemplation periods, as experienced during preliminary testing, would be reduced to an unavoidable minimum. The participants were then informed that after each reaction sequence they were required to step on the base pedal in order to initiate the next sentence and rest their foot loosely on that pedal in anticipation of the next movement. Furthermore, they were informed that the experiment involved a number of catch trials in the form of incomplete sentences in which the decision word was missing. For these sentences, they were instructed simply to step on the base pedal to initiate the next sentence.

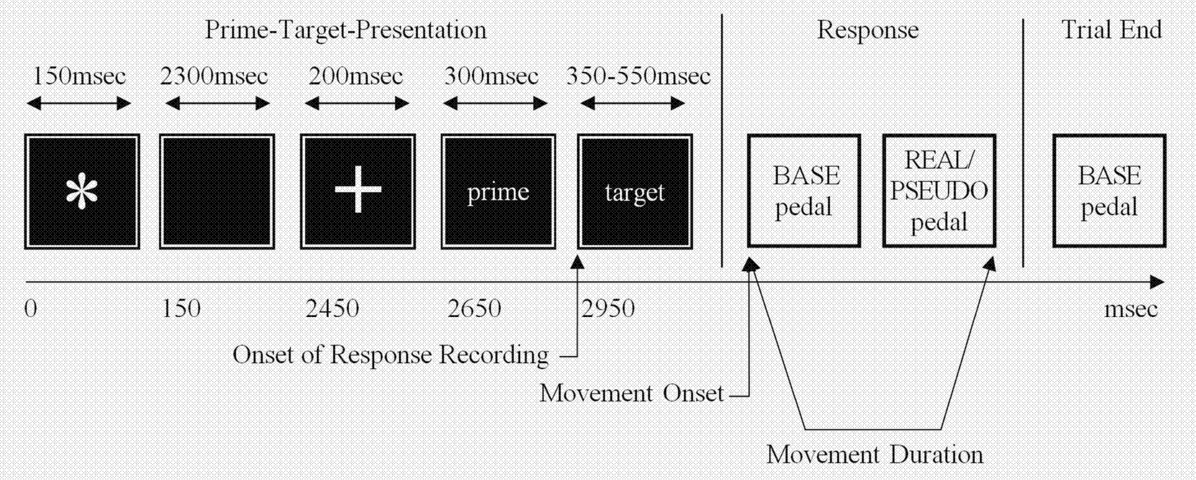
For illustration reasons and in order to facilitate the correct conduction of the required movements, the sequences for the different types of sentences (i.e. real, pseudo and catch trial) were demonstrated by the supervisor with three example sentences.

After all remaining questions were answered, the experiment, constructed with E-Prime, started with a short, guided practice phase. The participants could try out the movement sequences with twenty different sentences. The practice phase was structured in such a way that the first third of the sentences only consisted of real and pseudo sentences. Catch trials were slowly introduced in the second third to allow for an easy familiarisation with the different responses. During the practice phase incorrect order as well as incorrect execution of the movements, such as wrong placing of the foot between trials or the use of both feet, were corrected and remaining questions were answered. The practice phase included sentences from all conditions so that participants had the opportunity to ask questions if they encountered any difficulties with either of the constructions.

Once the practice phase was over, the actual experiment started. The 300 stimuli were divided into five equally large groups. Each of the groups consisted of two catch trials, four pseudo and four real sentences per condition which were randomly selected. The order of sentences within the groups as well as the order of the groups themselves were randomised. The presentation of each stimulus was preceded by a blank screen for 2300 msec and a 200 msec fixation cross. The break between trials was chosen in order to avoid possible activation or inhibition effects on the responses caused by the previous movements. The fixation cross was included as a signal for the subjects to be prepared for the next stimulus as the stimulus sentences were extremely short. At the second base activation, i.e. after the correct conduction of the required sequence, an asterisk was displayed for 150 msec indicating the successful completion of the trial. This was done to facilitate the detection of errors in the response sequence for participants and supervisor alike.

Figure 6 below is a compact, visual illustration of the above described experiment procedure.

Figure 6: Trial Procedure, Timing and Response Logging



4.2.6 *Response Recording*

For real and pseudo sentences, the first activation of the base pedal, as well as that of the decision pedals was logged in E-Prime. As the participant's foot rested on the base pedal in between trials and stepping on base was the first step in the movement sequence, its activation indicated movement onset. Movement onset was measured relative to prime offset, i.e. 300 msec after stimulus onset. Secondly, the elapsed time between movement onset and response move-ment offset was treated as movement duration. The offset of the response-related movement is given with the activation of the decision pedal.

The remaining movement (return to and activation of the base pedal) was unlogged as it was used merely as an initiation of the following sentence and therefore not part of the actual response sequence. This initiation was necessary in order to ensure that the foot and leg had re-turned to resting position 2650 msec before the onset of the next stimulus and that the leg and thus the corresponding brain areas were inactive during that time.

5 Results

Prior to all analyses, catch trials and error trials (i.e. trials in which the wrong decision pedal was chosen) were removed from the data. In addition, all trials in which movement onset or move-ment duration times were more than two standard deviations from the subject's mean times were excluded from the data set. The latter was done in order to eliminate possible outliers, i.e. responses which are slowed down as a result of e.g. inattentiveness or indecisiveness. In order to further normalise the wide-spread distribution of the participants' responses, the times were submitted to logarithmic transformation, which generally results in "distributions [which] are a little less skewed than the originals." (Ratcliff, 1993, p.518) Both methods, although not providing a guarantee that all outliers are filtered out and that the times are more evenly distributed, are comparatively powerful and "improve the power of the experimental analyses." (Ratcliff, 1993, p.511)

After the data was filtered and thus prepared for further analyses, an initial set of general analyses was carried out.

5.1 Overall Movement Times

As a very first step in the overall analysis, the overall movement times were closely looked at. It was established that the mean onset time for the chosen nineteen participants in the experiment was 952 msec (SD=229), while the mean movement duration was 621 msec (SD=142). An overview of onset and duration times for the individual participants is given in Table 8 below.

Table 8: Overview of Mean Movement Onset and Duration Times for Each Participant in Msec

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
Onset	701	840	1642	1144	1198	825	923	1052	1057	967	866	786	788	673	1108	860	1095	747	813
Duration	407	455	855	588	648	567	882	705	708	811	483	405	584	563	715	751	555	604	512

As becomes evident from the comparatively high standard deviation and the individual means in Table 1, the mean times for the subjects differed significantly. The differences, however, were analysed and proved not to be linked to either age, gender, handedness, footedness or native variety of English.

5.2 Suited and Unsuited Conditions

In a subsequent, more detailed analysis, it was then investigated whether the task-related distinction between real and pseudo words or any of the conditions had an effect on movement times.

To analyse a possible effect of pseudo sentences as compared to real sentences the mean movement times for pseudo and real sentences for the individual participants were compiled. (cf. Table 9)

Table 9: Overview of Mean Movement Times for Pseudo and Real Sentences per Participant in Msec

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
Onset	Real	686	785	1533	1079	1136	800	870	1101	995	926	817	752	760	657	1933	827	933	717	789
	Pseudo	717	894	1776	1223	1272	858	976	1103	1124	1017	916	819	816	689	1193	894	1291	782	843
Duration	Real	396	455	861	600	636	533	836	658	704	782	459	403	584	521	686	708	533	577	500
	Pseudo	419	455	848	574	662	611	929	753	712	846	509	408	584	604	748	795	593	635	527

A within-subjects repeated measures one-way ANOVA (analysis of variance) was performed on mean movement times. The analysis unveiled a significant effect of pseudo sentences compared to real sentences. Onset times for real sentences (M=905 msec, SD=207) and pseudo sentences (M=1006 msec, SD=258) significantly varied for mean movement onset ($F(1,18)=99.888, p<0.001$) with pseudo sentences invariably causing slower movement onset. Similarly, duration times for real sentences (M=602 msec, SD=137) and pseudo sentences (M=643 msec, SD=150) signify-cantly varied relative to mean movement duration ($F(1,18)=26.417, p<0.001$) with movements for pseudo sentences being considerably slower.

If the difference was only visible in movement duration, it could be argued that it might be caused by the directedness of the foot movement (i.e. real words to the right, pseudo words to the left). As, however, the slowing down effect is already discernible in movement onset in which the same initial movement is carried out for both real and pseudo sentences, it is evident that the difference is caused by the pseudo words rather than the diverging movement.

In addition to slower movement times, pseudo sentences also cause a notably higher error rate. Figures for this finding are given in Table 11 below. The effect of pseudo words on the error rate as compared to real words was found to be significant in a repeated measures one-way ANOVA ($F(1,18)=15.242, p=0.001$). This is further evidence for the impairing effect that pseudo words have on the participants' responses.

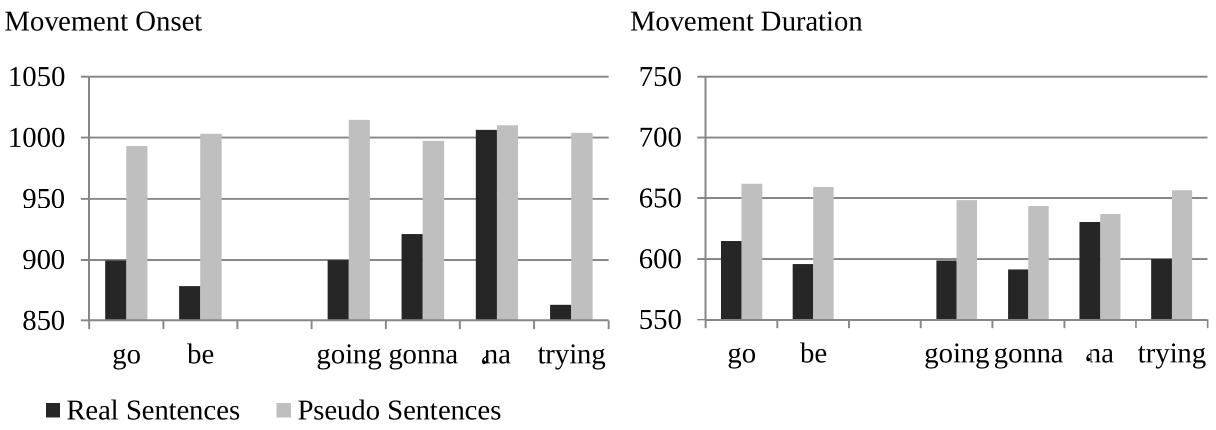
The fact that the selected pseudo words substantially slow down movement onset and movement duration and increase the number of error trials suggests that the participants had to lay special effort into their processing. This undesired extra workload and the resulting augmented time between primes and movements for pseudo words urged their being excluded from further analysis.

Subsequently, the six selected conditions were closely examined. For this purpose, the mean movement times for both real and pseudo sentences across conditions were compared. The figures are given in Table 10 and more graphically illustrated in Figure 7.

Table 10: Mean Movement Times across Conditions for Pseudo and Real Sentences in Msec

		go	be	going	gonna	‘na	trying
Onset	Real	899.25	878.25	899.65	920.86	1006.36	862.96
	Pseudo	992.98	1003.09	1014.60	997.55	1010.16	1003.83
Duration	Real	614.62	595.81	598.66	591.35	630.62	600.16
	Pseudo	661.97	659.31	648.35	643.41	637.38	656.62

Figure 7: Mean Movement Times in Msec



Not only do the above figures and the graphs give further evidence for the slowing down effect of pseudo words, but also can show a range of strikingly irregular times for the condition that features the most strongly reduced form of the future marker ‘I’m ‘na’. When occurring with real words, the condition significantly prolongated both movement onset and movement duration. The diverging movement times were analysed by means of a repeated measures ANOVA and a significant difference between the condition ‘na’ and all other constructions in the verb complement group could be found for movement onset. Pairwise comparison corrected with Bonferroni tests showed a significant difference of ‘na’ compared to ‘going’ (p=0.020), ‘gonna’ (p=0.009) as well as ‘trying’ (p=0.037). For movement duration, the mean times for ‘na’ in combination with real sentences were also slowed down as suggested by the graph in Figure 7. The differences, however, when analysed by means of a repeated measures ANOVA and subsequent Bonferroni corrected pairwise comparisons, proved to be just outside the significance margin of 0.05.[7] Another interesting, albeit statistically insignificant tendency suggested by the mean movement times was a weak speeding up effect the ‘na’ construction for movement duration in combination with pseudo sentences.

[7] ‘na’ vs. ‘going’ (p=0.065), ‘na’ vs. ‘gonna’ (p=0.117),’na’ vs. ‘trying’ (p=0.192)

All above findings for the strongly reduced construction, in agreement with the participants' later statements, suggest that 'na', when appearing outside a larger casual speech context, is perceived as incorrect. Hence, subjects are highly hesitant to classify sentences with the construction 'I'm 'na' as real, regardless of the succeeding target words, while classifying them as 'pseudo' seems to come naturally. As a result, movement times for 'na' in combination with real words are slower while those in combination with pseudo words are faster. Readiness to move their legs to the 'real' pedal is thus constrained for this condition and resulting movement times do not display influences of the neurological processing of this prime construction, but instead its perceived incorrectness in the given type of speech context.

The assumption that 'na' is perceived as incorrect is further supported by the absolute numbers of error trials and time filtered trials given in Table 11 below.

Table 11: Number of Wrong or Time-Filtered Responses across Conditions for Pseudo and Real Sentences per Participant

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	total
Real	go	1	1	1	3	0	0	1	0	1	1	2	1	1	0	1	0	0	0	2	16
	be	0	1	2	5	0	0	2	0	1	1	2	2	1	1	3	1	0	0	1	23
	going	1	0	1	0	0	0	2	0	1	1	2	0	3	1	3	1	3	4	0	23
	gonna	1	1	1	0	2	0	1	0	2	0	1	1	2	1	2	1	1	3	2	22
	'na	3	18	11	1	6	7	13	5	4	6	8	13	11	17	6	9	14	7	6	165
	trying	0	0	1	2	2	0	1	2	1	0	0	0	4	0	1	0	0	2	1	17
	total	6	21	17	11	10	7	20	7	10	9	15	17	22	20	16	12	18	16	12	266
Pseudo	go	2	1	7	5	5	7	4	1	4	5	2	3	5	6	6	2	14	5	6	90
	be	0	2	3	3	4	3	1	1	2	3	5	1	3	4	2	2	15	3	4	61
	going	1	4	5	7	3	5	8	2	3	4	0	3	4	0	5	3	15	7	6	85
	gonna	2	7	8	5	6	5	1	2	5	6	7	3	3	1	6	4	8	3	5	87
	'na	3	2	8	6	8	8	4	1	2	3	3	0	3	1	5	3	3	3	5	71
	trying	2	4	3	4	4	6	3	2	3	8	3	3	5	4	3	1	5	8	8	79
	total	10	20	34	30	30	34	21	9	19	29	20	13	23	16	27	15	60	29	34	473

Table 11 clearly attests the participants' difficulties with the most reduced construction. In a comparison of the absolute numbers of error and time-filtered trials, 'na' distinguishably protrudes as being particularly high with real sentences. All test subjects, with the exception of participant 4, were most prone to make mistakes or react particularly slowly in this condition. Some participants, like participant 2, had such great difficulties with the construction that they displayed an astonishing ratio of up to 90% of incorrect or time-filtered answers for this condition. A repeated measures ANOVA of the absolute number of error and time-filtered trials showed significant differences throughout conditions ($F(5,90)=39.337, p<0.001$). A further pairwise analysis corrected with Bonferroni tests showed that all conditions significantly differ from the strongly reduced ‘na’ as regards the numbers of error and time-filtered answers, but that the differences between all remaining conditions are statistically insignificant. Each pairwise comparison of ‘na’ and one of the remaining conditions showed a significance of $p<0.001$, while all other comparisons were non-significant.

Taken together, the prominently decelerated movement times and the distinctly elevated rate of error and time-filtered trials reveal the unsuitedness of the most reduced construction ‘I’m ‘na’ within this type of experiment. Its casualness and shortness make it appear unnatural and incorrect outside larger speech contexts. In post-experiment conversations, the participants almost uniformly confirmed this impression. They indicated being confused about the construction and uncertain about its meaning. When informed about what the construction was meant to represent, however, they declared that they would undoubtedly have understood it if it had been presented to them as part of a larger casual speech context. They even conceded that they themselves have used the reduction in casual speech countless times but had previously been unaware of this fact, as consciously reflection upon one’s own speech is rare.

As a result of the objective findings and the participants’ subjective impressions, the most reduced construction ‘I’m ‘na’ cannot be taken into account for the analyses. While grammaticalisation theory suggests that the form will over time become increasingly prominent, it is, at present, not sufficiently established and recognised to be used isolatedly as part of a linguistic experiment of this kind. Therefore, regardless of the benefit that an examination of this construction would have had, it needs to be excluded from further analysis.

Having scrutinised the most reduced form in the study, it appears necessary to briefly consider the second most reduced and casual construction ‘I’m gonna’. Although the results for ‘gonna’ show a slightly decelerated movement onset for real words and marginally accelerated movement times for pseudo words, there are no indications for this being caused by unfamiliarity with or perceived incorrectness of the construction. This is further supported by the fact that the rate of error and time-filtered trials for ‘gonna’ is not increased. Furthermore, none of the subjects reported any confusion or comprehension difficulties caused by the construction.

Thus, while ‘na’ is not yet established enough, all participants appeared to be well-acquainted with the reduced construction ‘I’m gonna’. The construction did therefore not cause any processing difficulties and can unrestrictedly be included in the analysis.

As a consequence of the above observations and resulting restrictions, all pseudo sentences and the most reduced construction ‘I’m ‘na’ had to be excluded from further analyses. This resulted in the inclusion of only five out of the initial six remaining conditions and a reduction by half of the trials, on the basis of the exclusion of all pseudo sentences. Hence, with the exclusion of pseudo sentences and the condition ‘na’, 100 sentences per participant remained for the analysis (5 conditions x 20 sentences). Of these 1900 sentences, 5.32% were excluded as error trials or due to the employed time filter of two standard deviations from the mean.

A summarising overview over the new mean movement times resulting from the remaining analysable conditions is given in Table 12 and Figure 8 below.

Figure 8: Mean Movement Times in Msec

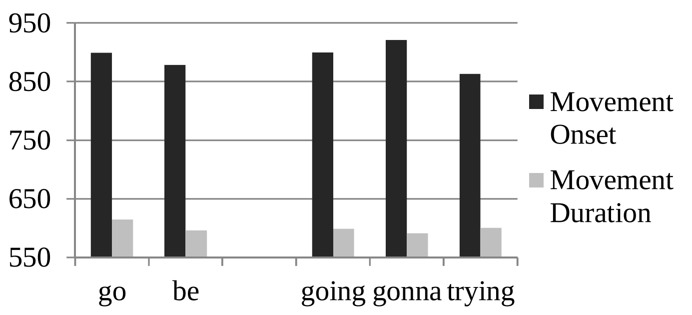


Table 12: Mean Movement Times in Msec

a) Noun Complement Constructions

	go	be
Onset	899.25	878.25
Duration	614.62	595.81

b) Verb Complement Constructions

	going	gonna	trying
Onset	899.65	920.86	862.96
Duration	598.66	591.35	600.16

5.3 Results of Real Sentence Analysis

When conducting an analysis on the real word sentences, a semantic influence of the target words on the movements is possible. A potential semantic influence would in theory occur throughout the comparable conditions, as both nominal and verbal targets are identical within the respective conditions. However, a different impact on the different conditions is in theory possible and needs to be ruled out prior to final analyses of movement times.

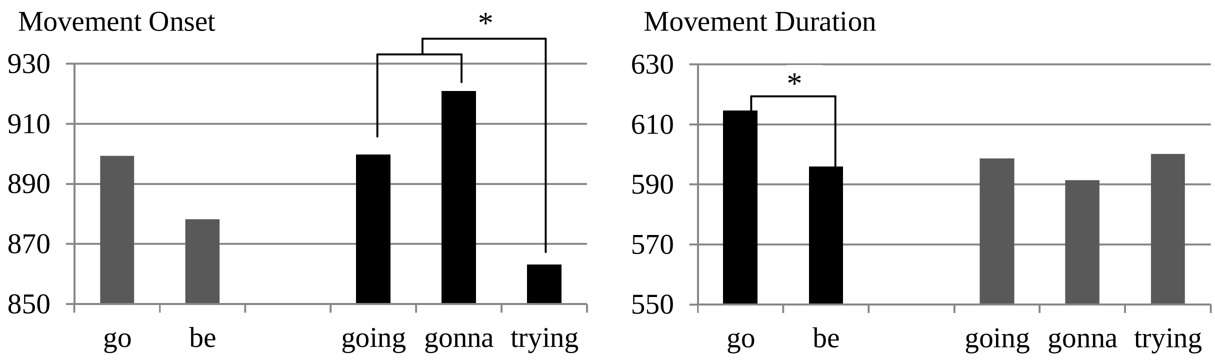
For the verbal target words, no apparent semantic effects are notable. It could have been hypothesised that impeding words like ‘stop’ or ‘pause’ would slow down movements times while inceptive words like ‘start’, ‘begin’ or ‘proceed’ would accelerate them. Such hypotheses, however, could not be supported with figures neither globally nor for individual conditions.

For nominal targets, on the other hand, a semantic effect was found according to whether the complement was a proper noun or a common noun. Common nouns showed faster movement onset times than proper nouns. Analysed with the help of a repeated measures ANOVA the effect proved to be significant for both nominal conditions, i.e. ‘go’ (F(1,9)=63.980,p<0.001) and ‘be’ (F(1,9)=9.920,p=0.012). However, since both nominal conditions are affected by this semantic influence, it has no impact on the overall results.

Having analysed and dismissed the notion of possible semantic effects influencing the movement times for real sentences, they can now be examined in more detail.

To firstly graphically illustrate the movement time differences for the five remaining conditions, a diagram of mean movement onset and movement duration is given in Figure 9. Statistically significant differences are marked with an asterisk.

Figure 9: Mean Movement Onset and Movement Duration in Msec



By means of a within-subjects (F_1) repeated measures analysis of variance (ANOVA), it was then investigated whether the time differences in mean movement onset and movement duration for the nominal and the verbal complement group were statistically significant.

Regarding the nominal complement conditions, it could be found that the onset delay for abstracted lexical ‘go’ (M=900 msec, SD=228) compared to ‘be’ (M=872 msec; SD=201) was not significant (F(1,18)=2.197,p=0.164). The slower movement duration, however, for ‘go’ (M=623 msec; SD=149) in reference to ‘be’ (M=605 msec; SD=144) was found to be statistically significant (F(1,18)=4.689,p=0.044).

For the verb complement conditions, on the other hand, the differences in movement onset time between the conditions were found to be statistically significant (F(2,36)=15.620,p<0.001= while differences in movement duration were not (F(2,36)=0.453,p=0.619). Further pairwise comparison, corrected with Bonferroni tests, revealed that movement onset differences between lexical ‘trying’ and the two grammatical ‘be going to’ constructions were statistically significant. Movement onset for ‘trying’ (M=868 msec; SD=195) was significantly faster than for ‘going’

(M=889 msec; SD=211) (p=0.002) and ‘gonna’ (M=907 msec; SD=219) (p<0.001) The differences between ‘going’ and ‘gonna’, on the other hand, were not statistically significant (p=0.307).

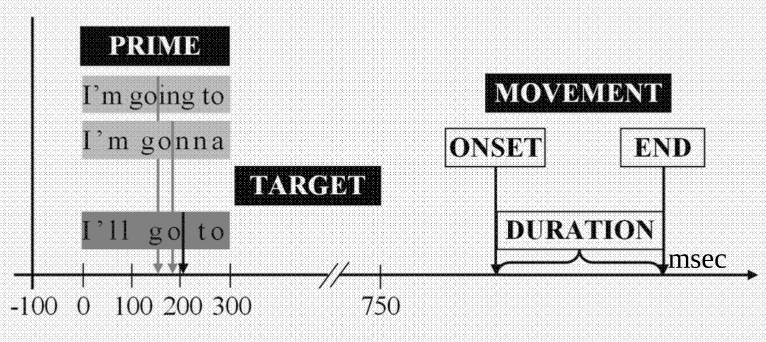
In summary, all error trials, time-filtered trials and trials with pseudo verbs as well as the condition ‘na’ were removed from the data and the remaining trials were analysed for possible semantic effects. As the semantic effects found appeared to be constant throughout the affected conditions, it was concluded that there was no apparent influence on the overall results and that no further data had to be excluded. In an analysis of the remaining, usable conditions, it was found that for the nominal complement group, only movement duration significantly differs between conditions while for the verbal complement group only movement onset shows statistically significant differences between the grammaticalised forms of ‘go’ and their control verb ‘try’. In both groups, the movements primed with ‘go’, i.e. both lexical and grammatical uses, were slower than those for the non-movement reference verbs.

6 Discussion

The results of the study, at first glance, appear somewhat inconsistent. A significant difference for movement times for the noun complement constructions and with that an effect of lexical ‘go’ is only visible for movement duration, while an effect of the grammaticalised constructions manifests itself in movement onset. Considering, however, the nature of the different prime constructions, this initially unexpected deviation becomes explicable. The nominal and verbal complement primes were presented in similar yet different constructions. While the grammaticalised forms of ‘go’ and the respective control verb were presented in the form ‘I’m VERBing to’ or reductions thereof, abstracted lexical ‘go’ and its reference verb were given in the construction ‘I’ll VERB to’ or ‘I’ll VERB in’, respectively. This was done in order to avoid the use of the construction ‘I’m going to’ to represent both the grammatical intention marker condition on the one hand and the abstracted lexical movement verb condition on the other. The two thus chosen constructions, consisting each of the pronoun ‘I’, a cliticised auxiliary, a verb and a preposition, were deemed similar enough not to have a direct impact on the participants’ responses. The fact, however, that grammatical ‘going to’ and ‘gonna’ were shown to have an influence on movement onset while abstracted lexical ‘go’ only influenced movement duration, suggests that there might indeed have been an initially unexpected influence on the overall movement times for the different constructions.

If we consider the presentations of primes, targets and the consequent responses on a timeline, as illustrated for the different forms of 'go' in Figure 10 , it becomes evident that the use of 'go' in the progressive aspect in the verb complement conditions leads to a further temporal distance between root of the movement prime word, i.e. 'go', and the response movement. There is no reason to believe that the present progressive marker 'ing' adds to the proposed effect on movement times. On the contrary, it is only the root 'go' that leads to an activation of the motor cortex. The added suffix 'ing' indicating progressive aspect bears no relation to physical movement. It is a functional affix with no direct underlying movement association which should thus not have any effect on subsequent movements. Instead, it can be considered an inserted, functional unit that further separates the movement prime from the following response. Hence, for the verbal complement constructions, i.e. grammaticalised 'go' and 'trying', the distance between the essential root of the movement word within the prime construction and movement is comparatively long, resulting in a significant difference observable in movement onset only. For the nominal complement constructions, i.e. abstracted lexical 'go' and 'be', the distance between word root and movement is shorter which brings about a later effect, now no longer visible in movement onset but movement duration.

Figure 10: Timeline for Prime-Target-Movement Sequence



While Figure 10 is only meant to show those differences in a very generalising, abstract manner, a sound file analysis of the stimuli used with the programme Praat revealed that, for the condition 'going', the offset of the root 'go' is located 152 msec from prime offset, 101 msec for 'gonna' and a mere 65 msec for 'go'[8]. These figures support the assumption that the impact on

[8] The fact that the root 'go' in the construction 'I'll go to' is followed by a voiceless alveolar stop lengthens the perceived duration of 'go'. During the occlusion phase before the release of the consonant the previous syllable (in this case 'go') lingers on for a total of 21 msec until the 't' is released and the next syllable perceivably starts. It could thus even be argued that the offset of 'go' is perceived as little as 42 msec prior to the end of the prime. As the occlusion phase, however, is generally considered part of the following consonant, the offset of the root will here be set at the above mentioned 65 msec prior to prime offset.

movement duration for the nominal complement conditions is due to a comparatively late offset of the root of the movement word, resulting in a delayed influence on the movement as compared to the verbal complement constructions.

There is thus a reasonable explanation for the seemingly inconsistent results in regards to a different influence on movement onset and movement duration for nominal and verbal complement groups. Having offered a reasonable explanation for these initially inexplicable differences, it is now time to discuss the revealed activation patterns for grammaticalised words.

The data showed that for all statistically significant movement differences, the different forms of ‘go’ were slower than their respective non-movement controls. Interestingly, not only abstracted lexical ‘go’ but also the grammaticalised ‘be going to’ construction, in both reduced and unreduced form, display these differences. Hence, movement times for lexical ‘go’ as well as grammaticalised ‘going’ and ‘gonna’, if significant, are consistently slowed down in comparison to their respective reference verbs, i.e. ‘be’ for ‘go’ and ‘trying’ for ‘going’ and ‘gonna’.

This outcome was unexpected and immediately falsified all initial hypotheses which were based on a movement priming scenario in which subsequent movements would be accelerated rather than decelerated. This assumption arose in consideration of a movement priming experiment carried out by Boulenger, Roy, Paulignan, Déprez, Jeannerod and Nazir in 2006 in which movement verbs in contrast to nouns revealed an ability of speeding up subsequent movements.

An explanation for the fact that the movement words in the present study produced decelerated movements rather than accelerated ones, however, might lie in the experiment design. In the original study carried out by Boulenger and colleagues all primes were considered as written, one-word stimuli, which directly and unintermittedly preceded the response movements. In the present study, on the other hand, the primes were imbedded in larger stimulus constructions. For task-related reasons, target words separated prime constructions and movement responses. To make matters worse, as the stimuli were presented in an acoustic rather than a written manner, the inserted target words were comparatively long. This large temporal distance between stimulus offset and response movement in the present experiment was absent in the original study by Boulenger, Roy, Paulignan, Déprez, Jeannerod and Nazir (2006) and may be the reason of the observed deceleration.

Let us consider this claim in more detail. It is reasonable to assume that the activation of the motor cortex brought about by the movement primes is only temporary and that after an initial activation phase, during which movements would potentially be faster, the brain region continues into a down state in which it is less ready to respond. If a response movement occurs during such a suggested post-activation refractory phase, it would neither be accelerated nor unaffected but rather impeded, resulting in slower movement onset and movement duration. Although not addressed in neurological literature, it is possible that an entire cerebral area descends into a post-activation refractory phase[9], where it 'recovers' from the previous activation and regenerates its action potential.

Consider in this context the example of a 100 meters runner who is held back from running at the sound of the gun and instead prompted to start running instead a second later. The sprinter's start will inevitably be slower than if he had been allowed to start at the signal. More importantly, however, the start will with high certainty also be slower than a prompted start without a prior gun shot. This suggests that if movements are initiated with a short delay after an initial start signal (or prime) they are not assisted but rather impeded instead. This easily observable impediment strongly suggests that the brain regions responsible for movements retire into a kind of regeneration phase after a period of initiated activation.

This real-life example shows why a suggested post-activation refractory phase of cerebral areas in general and the motor cortex in particular seems intuitively reasonable. Nonetheless, in the absence of previous empirical support, this assumption can be but a vague hypothesis. The fact, however, that the movements in the present study were slower when following a movement priming construction, gives preliminary support for such a claimed motor cortex refractory phase and a consequent deceleration of movements. In the absence of this claimed phenomenon, movement words could only be accelerated or remain unaffected. Acceleration would take place, as shown in Boulenger, Roy, Paulignan, Déprez, Jeannerod & Nazir (2006) when primes and movements occur in direct succession, due to a motor cortex activation by the primes. Unaffected movement times, on the other hand, could be expected for delayed movements that set in after the initial activation if previous activation did not affect the response-readiness of the motor cortex. In this study, however, all movements that occurred with a short temporal distance after the presentation of movement words were seen to slow down subsequent movements. This slowing down effect appears to only be possible if the response-readiness of the motor cortex was temporarily impaired owing to a post-activation refractory phase.

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[9] The existence of refractory phases for individual neurons is well attested. Whether, however, refractory phases can also occur for entire cerebral areas or neuron assemblies following their activation has, to my knowledge, not been discussed. Yet, a post-activation down-phase for neural areas seems intuitively plausible and given the large distance between prime and movement, this possibility will be taken into account for the present experiment.

Following the suggested explanation, it is possible to claim that movement words do not only have the ability to accelerate but also to decelerate subsequent movements, crucially depending on the temporal distance between primes and responses. The results for movement verbs in the present experiment, while initially unexpected, can be explained through the insertion of target words between priming construction and movement response.

The fact that the slowing down effect appears to be consistent for all movement words allows us to further analyse the results in spite of the falsification of the movement acceleration theory. The obtained data clearly suggests that movement words do influence subsequent movements and while the observed effect was different than initially assumed, the deceleration is highly consistent and can thus be used in order to examine how grammaticalised words are processed.

For a closer consideration of the results, it is crucial that the experiment was able to show a significant difference in movement times for the abstracted lexical movement verb ‘go’ and its reference verb ‘be’. The experiment was firmly constructed on previous findings suggesting that both lexical and abstracted movement verbs are processed with the help of the human motor cortex and are in consequence capable of affecting subsequent movements. If this claim was true and the assumed effect was measurable with the applied methodology, then movement times primed with movement words would have to significantly differ from movement times primed with non-movement words. As this is the case in the conducted experiment, it can be ascertained that the methodology is adequate to investigate the given research question and that movement verbs do indeed affect subsequent movement. The latter observation offers further support for the prevalent claim that the processing of movement words involves the brain’s motor areas.

Turning to the more innovative aspect in the study, the two grammaticalised constructions ‘going to’ and ‘gonna’, tested with the same methodology, produce results that are very similar to those of abstracted lexical ‘go’. This is a novel and highly remarkable finding which strongly suggests an involvement of the motor cortex in the processing of not only abstracted lexical ‘go’, as had been claimed in the literature, but also grammaticalised ‘go’, even in its partly reduced form.

The above findings and related general assumptions need to be further considered in reference to the above suggested scenarios for function word processing and the resulting hypotheses for the experiment. Two hypotheses were suggested above attempting to determine different possible timelines for the ‘restriction’ of function words to the perisylvian cortex: an early and a late dissociation.

Based on the data obtained in the experiment, the early dissociation hypothesis can readily be dismissed. As both grammaticalised and abstracted lexical movement verbs have an impact on movement times, it is no longer possible to argue that function and content word representations are stringently separated in the human brain, as has to the day been the predominant claim in neurolinguistics. Contrariwise, the data suggests that the processing of grammaticalised words, at least at an early stage, appears to make use of the transcortical networks associated with the underlying content words. A local confinement of function words to the perisylvian language areas does thus not appear to co-occur with the acquisition of grammatical functionality. Hence, an early dissociation scenario in which content and function words are invariably distributed differently in the brain can be clearly ruled out given the obtained data.

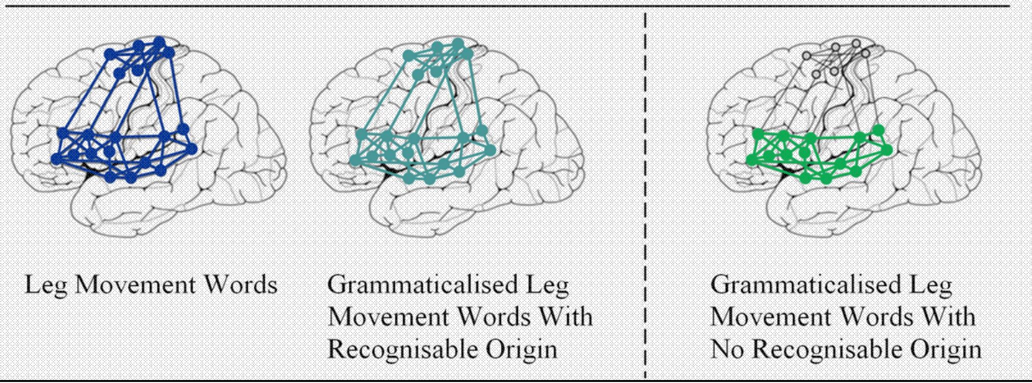
Let us then consider the late dissociation hypothesis in which it was suggested that a weakening of the transcortical associations and a resulting 'restriction' to the perisylvian areas could go along with phonetic reduction. If this hypothesis was fulfilled, only the unreduced but not the reduced forms of the 'be going to' constructions were to show an influence on movement times. Yet, there is no indication in the obtained data that the reduced form 'gonna' behaves any differently from either 'going' or 'go'. While 'gonna' is only a mildly reduced form and the original 'go' is to a large degree still discernible, phonetic reduction has undoubtedly taken place. Hence, despite a considerable weakening of the original word phonology the transcortical network remains strong enough to elicit an activation of the motor cortex. This shows that phonetic reduction, at least at a low level, cannot be the key to restrictions in the localisation of neural processing.

As, surprisingly, none of the suggested hypotheses could be confirmed, it is now necessary to reconsider the possible reasons and timeframes for a restriction of the transcortical networks for function words.

A possible and entirely plausible yet hitherto unconsidered explanation for the remaining strength of the transcortical networks even for reduced function words may lie in the obviousness or the speaker's awareness of their connectedness to the underlying content words. For the grammaticalised 'be going to' constructions the relationship with 'go' is still clearly discernible and it is more than likely that speakers of English are aware of their relatedness. Although with the emergence of 'gonna' phonetic reduction has begun and the form has by now found general acceptance, it has not replaced the unreduced construction but co-exists with it. This, together with the fact that the original 'go' is still discernible, to some degree even in the reduced 'gonna', makes it easy to draw a connection between the non-grammaticalised forms and the grammaticallised ones, unreduced as well as reduced. If this ceased to be the case as either lexical 'go' or the unreduced constructions were lost, it could by hypothesised that the neural connections for the latter became weakened and the grammaticalised item became restricted to the language specific regions. If the underlying content word ceases to exist, it is no longer possible for the individual to acquire the semantic-dependent cortical networks. A restriction would in that case be inevitable. Similarly, if there is no perceivable link that associates a function word with a particular content word, there is no logical reason why the processing of the function word should still activate its 'inherited' transcortical network. Hence, the claimed restriction of function words to the brain's core language areas, as it has been shown not to co-occur with either functionalisation or phonetic reduction, is in all likelihood connected to the loss of a consciously or semi-consciously perceived connection between content and function words.

The obtained data, suggesting that grammaticalised and reduced 'gonna' appears to have the same cerebral distribution as unreduced 'going to' and abstracted lexical 'go', strongly support the above speculation. A pattern of brain activation for lexical and grammaticalised leg movement verbs, based on the data obtained in the experiment and clearly differing from that presently suggested in neurolinguistic literature, is illustrated in Figure 11.

Figure 11: Suggested Activation for Lexical and Grammaticalised Leg Movement Words



The data obtained from the present experiment suggests that there is no stringent separation of content and function words in terms of transcortical activation. Instead, function words appear to activate the same meaning related networks as the content words from which they evolved. Their restriction to the brain's perisylvian language centre does not appear to take place before the relationship between grammaticalised form and original content word has become fully obscured.

7 Conclusion

In conclusion, the results provided by the experiment conducted for this paper strongly suggest that content words and grammaticalised words are not two strictly separated groups in the human brain. Instead, both content words and function words can have transcortical distributions, rather than the latter being restricted to the brain's language areas. If the transcortical connections for function words are eventually weakened and the claimed 'restriction' takes place, and while this is virtually certain there is no proof thereof in the present study, this happens at a very late stage in their grammaticalisation process. Based on the data collected during the experiment, it is reasonable to argue that a restriction to the perisylvian language specific areas, i.e. a weakening of the transcortical synapses, most likely occurs in combination with the native speakers' unawareness of the initial relationship of function and content word. This could be brought about by either the loss of the underlying content word or an extreme phonetic reduction of the function word.

The study furthermore gives evidence for the fact that grammaticalisation in the brain does not happen in terms of a second, separate entry for the function word in the mental lexicon. Instead, the initial content word acquires additional grammatical meaning, leading to a modification or rather extension of the primary entry rather than the emergence of a novel one. For the newly grammaticalised word, while sharing the original content word's network, the connections or synapses to the transcortical, 'meaning-related' areas will presumably experience a continued weakening while the association with the language centre, in turn, is strengthened. In this process the extended entry might eventually split into two distinct ones, but as argued above this does not happen until a very late stage in the development of function words.

The findings of this study can readily be explained through Hebbian Learning by empahsising, however, that it is not only word semantics but also phonological form that lead to an activation of transcortical networks, once they have been acquired on the basis of semantics. If a semantic entry has a certain distribution in the brain, all other entries with the same phonological form or a consciously perceptible modification thereof (as in the case of reduced grammaticalised constructions) will inevitably activate the same networks. This claim is not only supported by the presented findings but in itself generally plausible given the fact that the neural networks suggested for content words in Hebbian Learning are based on a frequent co-occurence of linguistic and sensorimotor stimuli in everyday life. Linguistic stimuli are generally presented in spoken form which implies that there must be particularly strong connections between phonological form (generally believed to be stored in the ‘phonological lexicon’ in Wernicke’s area) and the word semantics most prominently represented in the sensorimotor areas. During abstraction and functionalisation processes, the original content word is expanded with new meanings or new functions, respectively. The association between phonology and original semantic content might become weakened due to the fact that there are now words with the same phonology but different or no lexical semantics but as the original content word persists the connections between phonology and semantics continue to exist and will inherently be activated whenever the phonological form is perceived. Hence, even words with a different meaning or no lexical meaning at all activate the original meaning-associated transcortical networks. The results from the present study further showed, that the activation can even survive processes of phonetic reduction, if the reduced forms are still consciously associated with the original, unreduced words. The phonological associations for these words, however, are necessarily weakened and might eventually become too weak to evoke an activation of the transcortical networks.

It can, in summary, be said that transcortical networks for words, initially learned owing to frequent co-activation on the grounds of semantics, can be recruited for new lexical and functional items evolving out of the words on which the networks are based. The neural networks are thus activated even for words in which the original semantics are no longer present and which have acquired abstracted or even functional content. The prevalent claim in Hebbian Learning that content words and function words are inherently represented differently in the brain therefore needs to be reconsidered and modified according to the ideas of grammaticalisation theory.

The present study has fulfilled its aim to raise and investigate the question of how grammaticalisation processes manifest themselves in the human brain. It has given an initial, limited insight into the neural distribution patterns for grammaticalised words. On this basis, a scenario it suggested, according to which function words only at a very late stage in their development become so strongly associated with the brain’s core language areas and dissociated from the sensorimotor areas that their activation becomes locally restricted. Although this restriction for function words is possible at a late point in their development, the present study clearly refutes prevalent claims that function words and content words are inherently distributed and treated different in the brain. Both content words and grammaticalised words share the same transcortical activation patterns for an extended period of time[10] before the latter, due to further weakening of the neural associations as a consequence of e.g. further phonetic reduction, experiences a restrict-tion to the brain's core language areas.

In order to reinforce the present initial results, it is highly recommendable to conduct a number of large-scaled follow-up studies. Having conducted this first experiment of its kind, some suggestions for improvements in further studies arise.

First of all, in order to minimise effects of a long time-span between stimulus and response brought about by inherently long spoken target words further studies should ideally be based on written stimuli whose time can be controlled much more easily. In the present experiment, this was not possible due to the desired inclusion of the strongly grammaticalised construction 'I'm 'na' which does not have a generally accepted, uniform written representation. As the construction, however, also caused difficulties in its spoken form it became evident that it is, at this point in time, not entrenched and accepted enough to be used in a linguistic study. With the omission of this construction, however, there is no more reason to employ acoustic stimuli. The form 'gonna', albeit regarded as fairly casual and disapproved of by some, has a single, well-known written representation which can without problems be used as a written stimulus. As written stimuli can be timed more effectively and more uniformly, their use for future studies of this kind is suggested.

Secondly, although even abstracted lexical uses of 'go' could be shown to have an effect on movement times, further larger-scale experiments should for the sake of completeness include uses of 'go' in its original form, referring to bodily movement. It would similarly be recommenddable that all chosen stimuli have the same temporal or spatial distance between offset of the root 'go' and stimulus offset, yet ideally avoiding identical forms.

Aside from modifications of the experiment in the English language, it would be highly rewarding to conduct similar experiments in other related and unrelated languages which have movement futures. Differently strong degrees of grammaticalisation and differences in the perceptibility of the relationship between function word and original content words might give further insight into the changes and pathways of the storage of grammaticalised words in the human brain.

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[4] Remember that the first unambiguous grammatical uses of 'going to' appeared in the early 16th century, i.e. roughly 500 years ago, and that the construction has been used as a future intention marker ever since.

Finally, of course, the use of more advanced equipment is strongly recommended. While the given choice reaction time study could provide acceptable results, the use of brain scanning equipment like an fMRI scanner would be able to substantially and indisputably reinforce the given findings. The reported reaction time differences are readily refutable as side effects of semantic influences or byproducts of the frequency or probability of occurrence of the selected conditions. Brain imaging equipment could unambiguously disprove such objections by physically showing the alleged activation in the leg part of the motor cortex.

Bibliography

Abdoulaye, M. L. (2001). The grammaticalisation of Hausa zâa ‘be going’ to future. *Journal of African Languages and Linguistics 22*(1), 1–32.

Alegria, J. (1978). Sequential Effects of Catch Trials on Choice Reaction Time. *Acta Psychologica 42*, 1-6.

Bergs, A. (2010). Expressions of futurity in contemporary English: a Construction Grammar perspective. *English Language and Linguistics 14*(2), 217-238. doi:10.1017/S1360674310000067

Boulenger, V., Hauk, O. & Pulvermüller, F. (2008). Grasping Ideas with the Motor System: Semantic Somatotopy in Idiom Comprehension. *Cerebral Cortex*, 19(8), 1905-19014. doi:10.1093/cercor/bhn217

Boulenger, V., Roy, A. C., Pauligman, Y., Deprez, V., Jeannerod, M. & Nazir, T. A. (2006). Cross-talk between Language Processes and Overt Motor Behavior in the First 200 msec of Processing. *Journal of Cognitive Neuroscience*, *18*(10), 1607-1615.

Bybee, J. (2007). *Frequency of Use and the Organization of Language*. Oxford: Oxford University Press.

Bybee, J. (2003). Mechanisms of Change in Grammaticalization: The Role of Frequency. In B. D. Joseph & R. D. Janda (Eds.), *The Handbook of Historical Linguistics* (pp. 602-623) Malden: Blackwell.

Bybee, J. & Hopper, P. (Eds.) (2001). *Frequency and the Emergence of Linguistic Structure*. Amsterdam: John Benjamins.

Disney, S. J. (2009). The Grammaticalisation of “Be Going To”. *Newcastle Working Papers in Linguistics 15*, 63-81.

El-Chaar, C. (1994). It’s No Go for the Italian Future. *La Trobe Papers in Linguistics 7*. Retrieved from http://www.latrobe.edu.au/linguistics/LaTrobePapersinLinguistics/Vol%2007/Contents.htm

Fischer, O., Norde, M. & Perridon, H. (Eds.). (2004). *Up and down the Cline: The Nature of Grammaticalization*. Amsterdam: John Benjamins.

Hauk O., Johnsrude I. & Pulvermüller F. (2004). Somatotopic representation of action words in human motor and premotor cortex. *Neuron 41*(2), 301–307. doi:10.1016/S0896-6273(03)00838-9

Heine, B. (2003). Grammaticalization. In B. D. Joseph & R. D. Janda (Eds.), *The Handbook of Historical Linguistics* (pp. 575-601). Malden: Blackwell.

Heine, B. & Kuteva, T. (2007). *The Genesis of Grammar: A Reconstruction*. Oxford: Oxford University Press.

Heine, B. & Kuteva, T. (2002a). *World Lexicon of Grammaticalization*. Cambridge: Cambridge University Press.

Heine, B. & Kuteva, T. (2002b). On the Evolution of Grammatical Forms. In A. Wray (Ed.), *The Transition to Language* (pp. 376-397). Oxford: Oxford University Press.

Hilpert, M. & Koops, C. (2008). A quantitative approach to the development of complex predicates: The case of Swedish Pseudo-Coordination with *sitta* “sit”. *Diachronica* 25(2) ,240–259. doi:10.1075/dia.25.2.06hil

Hopper, P. J. & Traugott, E. C. (2003). *Grammaticalization* (2nd ed.). Cambridge: Cambridge University Press. (Original work published 1993).

Ingram, J. C. L. (2007). *Neurolinguistics: An Introduction to Spoken Language Processing and its Disorders*. Cambridge: Cambridge University Press.

Kuteva, T., (2001). Auxiliation: An Enquiry into the Nature of Grammaticalization. Oxford: Oxford University Press.

Lotze, M., Montoya, P., Erb, M., Huelsmann, E., Flor, H., Klose, U., Birbaumer, N. & Grodd, W. (1999). Activation of cortical and cerebellar motor areas during executed and imagined hand movements: an fMRI study. *Journal of Cognitive Neuroscience 11*, 491-501.

Norde, M. (2009). *Degrammaticalization*. Oxford: Oxford University Press.

Perez, A. (1990). Time in Motion: Grammaticalisation of the *be going to* construction in English. *La Trobe University Working Papers in Linguistics 3*, 49-64.

Pertejo, P. N. (1999). *Be Going To* + Infinitive: Origin and Development. Some Relevant Cases from the *Helsinki Corpus*. *Studia Neophilologica 71*, 135-142.

Pulvermüller, F. (1995). Neurobiologie der Wortverarbeitung. *Naturwissenschaften 82*, 270-287.

Pulvermüller, F., Hauk, O., Nikulin, V. & Ilmoniemi, R. J. (2005). Functional links between motor and language systems. *European Journal of Neuroscience, 21*(3), 793-797.

Pylkkänen, L., & Marantz, A. (2003). Tracking the time course of word recognition with MEG. *Trends in Cognitive Sciences*, 7, 187-189.

Ratcliff, R. (1993). Methods for Dealing With Reaction Time Outliers. *Psychological Bulletin 114*(3), 510-532.

Torres-Cacoullos, Rena. (2011). Variation and grammaticalization. In. M. Díaz-Campos (Ed.), *The Handbook of Hispanic Sociolinguistics*. Oxford: Blackwell.

Traugott, E. C. (2003). Constructions in Grammaticalization. In B. D. Joseph & R. D. Janda (Eds.), *The Handbook of Historical Linguistics* (pp. 624-647) Malden: Blackwell.

Van Olmen, D. & Mortelmans T. (2009). Movement futures in English and Dutch: A contrastive analysis of *be going to* and *gaan*. In A. Tsangalidis & R. Facchinetti (Eds.), *Studies on English modality: In honour of Frank Palmer* (pp. 357-386). Bern: Peter Lang.

Véliz Campos, L. (2007). Grammaticalization: The development of some English modal auxiliaries. *Literatura y Lingüística 18*, 213-318. doi:10.4067/S0716-58112007000100011

Dictionaries and Corpora

Harper, D. (Ed.). (2001-2010). *Online Etymology Dictionary*. Retrieved from http://www.etymonline.com

Hoad, T. F. (Ed.). (1996). *The Concise Oxford Dictionary of English Etymology*. Oxford: Oxford University Press. Retrieved from Oxford Reference Online Premium database.

Longman Dictionary of Contemporary English Online. (1999-2010) Pearson Education Limited. Retrieved from http://www.ldoceonline.com.

Stevenson, A. (Ed.). (2010). *Oxford Dictionary of English*. Oxford: Oxford University Press. Retrieved from Oxford Reference Online Premium database.

The British National Corpus (3rd edition). (2007). Oxford University Computing Services on behalf of the BNC Consortium. Retrieved from http://www.natcorp.ox.ac.uk/

Urban Dictionary. (1999-2011). Urban Dictionary LLC. Retrieved from http://www.urbandictionary.com/

Appendix I

Overview of Sentences Used for the Experiment

Condition 1: go as content word

real		pseudo	
1	I'll go to bed.	121	I'll go to drin.
2	I'll go to school.	122	I'll go to soat.
3	I'll go to hell.	123	I'll go to neaf.
4	I'll go to jail.	124	I'll go to nop.
5	I'll go to town.	125	I'll go to riss.
6	I'll go to church.	126	I'll go to zolk.
7	I'll go to Leeds.	127	I'll go to teab.
8	I'll go to Prague.	128	I'll go to coss.
9	I'll go to uni.	129	I'll go to tosark.
10	I'll go to heaven.	130	I'll go to deskiece.
11	I'll go to prison.	131	I'll go to steantle.
12	I'll go to college.	132	I'll go to fortull.
13	I'll go to Stansted.	133	I'll go to inthall.
14	I'll go to Gatwick.	134	I'll go to atrean.
15	I'll go to Tesco.	135	I'll go to cratter.
16	I'll go to Derby.	136	I'll go to deprut.
17	I'll go to Chester.	137	I'll go to ameef.
18	I'll go to Paris.	138	I'll go to rehorve.
19	I'll go to London.	139	I'll go to unwilk.
20	I'll go to Houston.	140	I'll go to botrat.

Condition 2: control I: be

real		pseudo	
21	I'll be in bed.	141	I'll be in drin.
22	I'll be in school.	142	I'll be in soat.
23	I'll be in hell.	143	I'll be in neaf.
24	I'll be in jail.	144	I'll be in nop.
25	I'll be in town.	145	I'll be in riss.
26	I'll be in church.	146	I'll be in zolk.
27	I'll be in Leeds.	147	I'll be in teab.
28	I'll be in Prague.	148	I'll be in coss.
29	I'll be at uni.	149	I'll be at tosark.
30	I'll be in heaven.	150	I'll be in deskiece.
31	I'll be in prison.	151	I'll be in steantle.
32	I'll be in college.	152	I'll be in fortull.
33	I'll be at Stansted.	153	I'll be at inthall.
34	I'll be at Gatwick.	154	I'll be at atrean.
35	I'll be in Tesco.	155	I'll be in cratter.
36	I'll be in Derby.	156	I'll be in deprut.
37	I'll be in Chester.	157	I'll be in ameef.
38	I'll be in Paris.	158	I'll be in rehorve.
39	I'll be in London.	159	I'll be in unwilk.
40	I'll be in Houston.	160	I'll be in botrat.

Condition 3: go as function word, unreduced

real		pseudo	
41	I'm going to think.	161	I'm going to drin.
42	I'm going to stop.	162	I'm going to soat.
43	I'm going to start.	163	I'm going to neaf.
44	I'm going to dream.	164	I'm going to nop.
45	I'm going to pause.	165	I'm going to riss.
46	I'm going to feel.	166	I'm going to zolk.
47	I'm going to fit.	167	I'm going to teab.
48	I'm going to count.	168	I'm going to coss.
49	I'm going to surprise.	169	I'm going to tosark.
50	I'm going to forget.	170	I'm going to deskiece.
51	I'm going to manage.	171	I'm going to steantle.
52	I'm going to believe.	172	I'm going to fortull.
53	I'm going to promise.	173	I'm going to inthall.
54	I'm going to begin.	174	I'm going to atrean.
55	I'm going to impress.	175	I'm going to cratter.
56	I'm going to agree.	176	I'm going to deprut.
57	I'm going to approve.	177	I'm going to ameef.
58	I'm going to proceed.	178	I'm going to rehorve.
59	I'm going to deny.	179	I'm going to unwilk.
60	I'm going to accept.	180	I'm going to botrat.

Condition 4: go as function word, reduced

real		pseudo	
61	I'm gonna think.	181	I'm gonna drin.
62	I'm gonna stop.	182	I'm gonna soat.
63	I'm gonna start.	183	I'm gonna neaf.
64	I'm gonna dream.	184	I'm gonna nop.
65	I'm gonna pause.	185	I'm gonna riss.
66	I'm gonna feel.	186	I'm gonna zolk.
67	I'm gonna fit.	187	I'm gonna teab.
68	I'm gonna count.	188	I'm gonna coss.
69	I'm gonna surprise.	189	I'm gonna tosark.
70	I'm gonna forget.	190	I'm gonna deskiece.
71	I'm gonna manage.	191	I'm gonna steantle.
72	I'm gonna believe.	192	I'm gonna fortull.
73	I'm gonna promise.	193	I'm gonna inthall.
74	I'm gonna begin.	194	I'm gonna atrean.
75	I'm gonna impress.	195	I'm gonna cratter.
76	I'm gonna agree.	196	I'm gonna deprut.
77	I'm gonna approve.	197	I'm gonna ameef.
78	I'm gonna proceed.	198	I'm gonna rehorve.
79	I'm gonna deny.	199	I'm gonna unwilk.
80	I'm gonna accept.	200	I'm gonna botrat.

Condition 5: go as function word, strongly reduced

real		pseudo	
81	I'm 'na think.	201	I'm 'na drin.
82	I'm 'na stop.	202	I'm 'na soat.
83	I'm 'na start.	203	I'm 'na neaf.
84	I'm 'na dream.	204	I'm 'na nop.
85	I'm 'na pause.	205	I'm 'na riss.
86	I'm 'na feel.	206	I'm 'na zolk.
87	I'm 'na fit.	207	I'm 'na teab.
88	I'm 'na count.	208	I'm 'na coss.
89	I'm 'na surprise.	209	I'm 'na tosark.
90	I'm 'na forget.	210	I'm 'na deskiece.
91	I'm 'na manage.	211	I'm 'na steantle.
92	I'm 'na believe.	212	I'm 'na fortull.
93	I'm 'na promise.	213	I'm 'na inthall.
94	I'm 'na begin.	214	I'm 'na atrean.
95	I'm 'na impress.	215	I'm 'na cratter.
96	I'm 'na agree.	216	I'm 'na deprut.
97	I'm 'na approve.	217	I'm 'na ameef.
98	I'm 'na proceed.	218	I'm 'na rehorve.
99	I'm 'na deny.	219	I'm 'na unwilk.
100	I'm 'na accept.	220	I'm 'na botrat.

Condition 6: control II: try

real		pseudo	
101	I'm trying to think.	221	I'm trying to drin.
102	I'm trying to stop.	222	I'm trying to soat.
103	I'm trying to start.	223	I'm trying to neaf.
104	I'm trying to dream.	224	I'm trying to nop.
105	I'm trying to pause.	225	I'm trying to riss.
106	I'm trying to feel.	226	I'm trying to zolk.
107	I'm trying to fit.	227	I'm trying to teab.
108	I'm trying to count.	228	I'm trying to coss.
109	I'm trying to surprise.	229	I'm trying to tosark.
110	I'm trying to forget.	230	I'm trying to deskiece.
111	I'm trying to manage.	231	I'm trying to steantle.
112	I'm trying to believe.	232	I'm trying to fortull.
113	I'm trying to promise.	233	I'm trying to inthall.
114	I'm trying to begin.	234	I'm trying to atrean.
115	I'm trying to impress.	235	I'm trying to cratter.
116	I'm trying to agree.	236	I'm trying to deprut.
117	I'm trying to approve.	237	I'm trying to ameef.
118	I'm trying to proceed.	238	I'm trying to rehorve.
119	I'm trying to deny.	239	I'm trying to unwilk.
120	I'm trying to accept.	240	I'm trying to botrat.