Priming and unidirectional language change

Anette Rosenbach	Gerhard Jäger
University of Paderborn	University of Bielefeld
Institut für Anglistik und Amerikanistik	Department of Linguistics and Literature
Warburger Str.100	PF 10 01 31
33098 Paderborn	33501 Bielefeld
Germany	Germany
email: anette.rosenbach@upb.de	email: Gerhard.Jaeger@uni-bielefeld.de

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Abstract

In this paper we argue that the psycholinguistic mechanism of PRIMING may account for the empirical observation that grammaticalization processes typically proceed in one direction only. It is shown how two well-known unidirectional changes, i.e. the development from spatial to temporal expressions and phonological reduction, may be connected to cases of ASYMMETRIC PRIMING as reported in the psycholinguistic literature. In these cases a form or concept *A* primes a form or concept *B*, but not *vice versa*, and this cognitive asymmetry corresponds precisely to the observed unidirectional pathway from *A* to *B* in diachronic change. Ultimately, then, we argue that what appears as diachronic trajectories of unidirectional change is decomposable into atomic steps of asymmetric priming in language use. More generally, we also suggest that priming is the 'missing link' in evolutionary models of language change in that it provides for a plausible linguistic replicating mechanism, i.e. an 'amplifier' of linguistic units.

This is a programmatic paper which should bring to attention the potential of fruitfully applying insights from psycholinguistic research to some central issues of historical linguistics. Specifically, our approach allows for the formulation of falsifiable predictions that can be tested with present-day speakers, under the uniformitarian assumption that the same cognitive mechanisms that we find to be operating in present-day speakers also have operated in past speakers of a language.

*Priming and unidirectional language change**

1. Introduction

In this paper we connect two strands of research which have so far run in parallel in the linguistic literature, largely ignoring each other in the past, i.e. psycholinguistic research on priming and research on language change.[1] In so doing we hope to shed light on some notorious issues in theories of language change. First and foremost, we offer a psycholinguistic explanation for the empirical observation that (most) grammaticalization processes are not reversible, based on the results from previous psycholinguistic research. We also suggest that priming may provide a key to the understanding of what has been called 'the problem of linking', i.e. the puzzle of how performance preferences may come to be encoded in grammars (i.e. on the competence level) over time. We finally argue that priming is the 'missing link' in evolutionary models of language change in that it provides for a plausible linguistic replicating mechanism. This is a programmatic paper in which we try to demonstrate that combining psycholinguistic considerations with issues of language change opens up for a promising research programme that will ultimately allow us to test present-day speakers for mechanisms that have driven past changes. Note from the outset that the goal of this paper is to outline a – as we believe – promising new research programme, rather than giving all answers already at this stage. Note further, that grammaticalization receives special attention in this paper for the simple fact that it is in this framework that the issue of unidirectional change has been particularly highlighted in recent years. Apart from that, the empirical evidence presented touches on processes typically observed in grammaticalization. In principle, however, our claims hold for unidirectional change in general rather than being restricted to grammaticalization processes (which represent only a subset of language change). Neither do we claim that we present an account for *all* unidirectional grammaticalization (or change, for that matter). It is well possible (very well, indeed) that there are grammaticalization processes and/or cases of unidirectional change which cannot be captured by our approach. This will essentially remain an empirical question. The advantage of our proposal, as we see it, lies then in the fact that we turn the issue of unidirectionality into

[1] For some exceptions see section 3 though.

an empirical question, i.e. that we specify ways of how the (possible) mechanisms for unidirectionality may be empirically tested.

In the following we first briefly contextualize our work within the current debate on the unidirectionality of grammaticalization processes (section 2) and then characterize priming (section 3). In section 4 we report two case studies on priming from the psycholinguistic literature which, as we will argue, may account for two well-known unidirectional pathways, namely the development from spatial to temporal expressions and phonological reduction. We then show how the short-lived mechanism of priming can account for long-term change (section 5), and finally discuss the role of priming within an evolutionary approach to language change (section 6). Section 7 concludes with an outlook of the potential of this approach.

2. Grammaticalization and the hypothesis of unidirectionality

Grammaticalization is, very generally speaking, the process by which grammatical elements evolve out of lexical elements (or less grammatical elements). A typical example for a grammaticalization process in English is the development of the *going-to* future. Originally, *going to* could only be used in contexts expressing locomotion as in (1a). Today it has however clearly developed a future meaning, as most evident in example (1d), where there is no longer somebody going anywhere but where we exclusively get the temporal meaning, and where *going to* is now also reduced to *gonna*. Typical in this development is a stage where both the locative and the temporal meaning may be co-present, as in (1b). Thus, what we see here then is a change both in form and in meaning: A lexical main verb expressing locomotion becomes an auxiliary verb expressing futurity. Phonetic reduction as in the change from *going to* to *gonna* is typical (though not necessary) in grammaticalization.

(1)   a. I'm going to London to visit my friend.
        b. I'm going to read.
        c. It's going to rain.
        d. It's gonna rain.

Grammaticalization is a gradual process, and the goal of research on grammaticalization is to reconstruct all the 'minimal steps' in this process of formal and semantic change and to find, ultimately, the mechanisms and principles underlying this form of language change. One

overarching principle that has been put forward in this framework is the hypothesis of unidirectionality, which says that grammaticalization proceeds in one direction only and is not reversible. This predicts for the example in (1) above that the locative meaning of *going to* may develop into the temporal *gonna*, but temporal *gonna* should never change again into locative *going to.*

The hypothesis of unidirectionality is presumably one of the most central – and most hotly debated – hypotheses of the grammaticalization framework. While it is still a matter of considerable debate to what extent it is empirically valid and/or plausible (see e.g. the contributions in *Language Sciences* 23, Lass 2000, Hopper & Traugott 2003:§5, or Haspelmath 2004), it is generally agreed on that the majority of observed changes are irreversible, and that (potential) exceptions to unidirectionality are extremely rare. However, only few linguists have addressed the question of *why* there is such a tendency in language change. One noteworthy exception is Haspelmath (1999a), who proposes a user-based account of unidirectionality, couched within Keller's (1994) invisible-hand approach. In particular, he argues that the maxim of extravagance, i.e. speakers' attempt to be particularly expressive, is a driving force in grammaticalization and that cases of degrammaticalization, i.e. counter-examples to unidirectionaliy, do not occur because there is no counter-acting principle of anti-extravagance. In contrast, Janda (2001) argues that unidirectionality as a diachronic constraint cannot exist in the light of the individual speaker, because current speakers do not have any awareness of a language's history and for them, therefore, grammaticalization processes are always, in principle, reversible. Interestingly, both Haspelmath and Janda advocate a user-based account to language change, though coming to very different conclusions with respect to unidirectionality. We agree with these authors that it is essentially people who are using and changing language. At the same time we think, however, that there are ways to reconcile, and in fact, complement, their (opposing) positions. We will evoke a user-based account of unidirectionality, which is based on a very common psycholinguistic mechanism, namely priming. We will show how speakers, even if they do not 'know' the supposed pathway of forms/constructions, may still come to follow grammaticalization pathways in a natural way, contra Janda (2001).[2] And while the general idea underlying our approach is well compatible with Keller's invisible-hand approach (as evoked by Haspelmath 1999a), it will draw on a specific cognitive user-mechanism, namely priming, which allows us to formulate testable and falsifiable claims.

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[2] Also, Janda argues mainly from a sociolinguistic angle, while our perspective is a psycholinguistic one, but essentially both perspectives focus on the role of the individual language user in language change.

3. What is 'priming'?

PRIMING is both a phenomenon as well as a method in psycholinguistics that can tested empirically.[3] As a phenomenon priming basically means 'preactivation' in the sense that the previous use of a certain linguistic element will affect (usually in the sense of facilitating)[4] the subsequent use of the same or a sufficiently similar element (i.e. the 'target'). As such, priming is an extremely pervasive phenomenon that is not restricted to language but also found in other cognitive domains. Within language, it has been shown to be operating on all linguistic levels; it can affect both the repetition of linguistic form (on the phonological, morphological, lexical, and syntactic level) as well as the repetition of meaning. Repetition (and its avoidance) can also be employed in a very conscious way, for stylistic reasons (e.g. Tannen 1987). This process is, however, distinct from priming, which is a largely unconscious and automatic cognitive process, operating without speakers' awareness. Within language processing, priming has been shown to be operative in language production (e.g. Bock 1986, and subsequent work), language comprehension (e.g. Luka & Barsalou 2005) as well as in dialogue (Pickering & Garrod 2004).[5]

Usually, priming affects the subsequent processing of *the same* element. So, for example, in an experimental study Levelt & Kelter (1982) were asking Dutch shopkeepers (the Dutch equivalents of) either

(2)   a.   *At what time does your shop close?* or

        b.   *What time does your shop close*?

Their results show that subjects were more likely to repeat the preposition *at* in their answer when it was present (*at six*) in the question as in (2a), while answers to (2b) usually lacked the preposition (*six*). However, there is also evidence that the two items involved do not need to be identical but just sufficiently similar to cause priming. Bock & Loebell (1990), for example, showed that both the previous presentation of a passive (3a) and an intransitive locative (3b), which superficially share the same overt structure, could prime a passive target structure.

(3)   a.   *The 747 was alerted by the airport's control tower*

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[3] Priming is also a neuronal activation state, as e.g. modelled in connectionist spreading-activation models (e.g. Dell 1986) and approaches to a 'neuronal grammar' as in Pulvermüller (2002). However, it is not quite clear yet to what extent priming at the behavioural level can be equated with priming at the neuronal level, especially at the syntactic level, although it is well possible that the neuronal mechanism is the cause of the behavioural phenomena (Pulvermüller 2002:170; see also Tulving & Schacter 1990).

[4] Priming can also have an inhibitory effect in the sense that the repetition of a linguistic element is avoided or delayed.

[5] The literature on priming is huge. For the sake of exposition we will mainly focus on structural priming here to illustrate the range of application and the basic mechanisms.

b.   *The 747 was landing by the airport's control tower*

Likewise, in an experiment by Flores d'Arcais & Schreuder (1987) subjects were more likely to name a violin when previously having seen the picture of a guitar than if they had seen the picture of a table. These two examples illustrate that similarity may suffice for priming to occur.

While the *potential* of relating priming to language change has already been pointed out in psycholinguistic work on priming (see Bock & Kroch 1989:187; Loebell & Bock 2003 and Luka & Barsalou 2005; Ferreira 2005),[6] so far there are no psycholinguistic approaches which have explicitly tested for specific language change phenomena or connected priming with unidirectional change.[7] In historical linguistics priming has gone altogether unnoticed in the literature so far, let alone been used to apply to past changes.[8] Neither has priming been evoked to date in evolutionary approaches to language change. The present paper will therefore connect the three disciplines of psycholinguistics, historical linguistics and evolutionary theory in a novel and original way. The phenomenon of priming will be used to account for directional change, thereby trying to gain more insights into the microstructure of linguistic change on the level of language processing in individual speakers. Moreover, integrating priming into an evolutionary approach of language change may add an interesting new perspective to such approaches.

4. Case studies

As outlined in section 1, the goal of this paper is to show why there should be unidirectionality in language change in the first place. That is, rather than addressing the status and/or empirical validity of the hypothesis of unidirectionality in general, which is not our concern here, we will focus on cases which are sufficiently well empirically supported. In the following we will address two well-known unidirectional pathways, i.e., the development

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[6] Bock & Kroch (1989:187) mention priming as a possible source for analogical change. Luka & Barsalou (2005) suggest that structural priming may be connected to contact-induced change. Ferreira (2005) investigates markedness effects in structural priming, showing how uncommon (i.e. dispreferred, 'marked') constructions exhibit a stronger priming effect than common (i.e 'unmarked') structures. Ferreira argues that this may account for the fact why dispreferred structures do not eventually drop out of the language. Most recently, priming (or 'persistence') has also come to be studied by corpus linguists outside psycholinguistics; see most prominently Szmrecsanyi (2006), who suggests at the end of his monograph that persistence phenomena may be related to issues regarding language change (in particular, the s-curve pattern of linguistic change).
[7] Note, however, that recently the theoretical approach of Dynamic Syntax (Kempson & Cann 2006) has started using the notion of syntactic alignment to account for specific cases of syntactic change (the emergence of clitic pronouns in medieval Spanish). 'Syntactic alignment' refers to the phenomenon that speakers and hearers tend to re-use the linguistic tools used by the other interlocutor in dialogue (cf. Pickering & Garrod 2004) and thus may be regarded as syntactic priming in dialogue.
[8] Though see very recently Fischer (2007) for mentioning syntactic priming in the context of analogical models of language change.

from spatial to temporal expressions (§4.1) and phonological reduction (§4.2). We will report evidence from two empirical studies from the psycholinguistic literature that may account for these directional changes.

4.1 From space to time: Boroditsky (2000)

It is well-known that we tend to conceptualise time in terms of space; see the examples in (3), where the temporal expressions are all derived from corresponding spatial ones.

(3)   *Space-time correspondences in English (adapted from Deutscher 2005: 134)*

spatial expressions	temporal expressions
from London to Paris	*from Monday to Friday*
in England	*in January, in time of war*
at the door	*at noon*
the king rode before the army	*before the battle started*
they are a mile behind us	*they are an hour behind us*
sit by the window	*arrive by tomorrow*
within the prison	*within a year*

As previous research has shown, diachronically the development is always from spatial expressions to temporal ones, but not vice versa. Such unidirectional development is by no means restricted to English but also found in many other languages (e.g. Heine et al. 1991, Svorou 1994, Haspelmath 1997, Heine & Kuteva 2002, Hopper & Traugott 2003: 85). That is, there is presumably a universal unidirectional pathway from space to time, i.e. from spatial to temporal expressions.[9]

In some very interesting and cleverly constructed experimental studies Boroditsky (2000) tested in how far spatial expressions may prime temporal expressions, and vice versa.[10] In her studies Bordoditsky distinguishes two basic spatial conceptualisations of time, which are commonly assumed in the literature (e.g. Clark 1973, Lakoff & Johnson 1980), i.e. the (a) EGO-MOVING METAPHOR, and (b) the TIME-MOVING METAPHOR. In the ego-moving metaphor, "the 'ego' or the observer's context progresses along the time-line toward the future"

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[9] Note that the development from spatial to temporal expressions does not necessarily need to involve grammaticalization though, as pointed out to us by Roula Svorou.

[10] Boroditsky's (2000) main concern was to test the psychological reality of the claim that abstract conceptual domains are structured through metaphorical mappings from more basic experiential concepts/domains (Lakoff & Johnson 1980). In particular, she was investigating what she calls the METAPHORIC STRUCTURING VIEW, i.e. the claim that "abstract conceptual domains such as time are structured by metaphorical mappings from more concrete experiential domains such as space" (3).

(Boroditsky 2000:5). Thus, 'front' is assigned here to the future, as in *We are coming up on Christmas* , as illustrated in figure 1. In contrast, in the time-moving metaphor temporal events are relative to each other and the time-line proceeds in the opposite direction, with front now being assigned to an earlier event, as in *Christmas is coming up,* as shown in figure 2.

(a)

ego-moving metaphor

PAST   FUTURE

We are coming up on Christmas.

(b)

PAST   FUTURE

time-moving metaphor

Christmas is coming up.
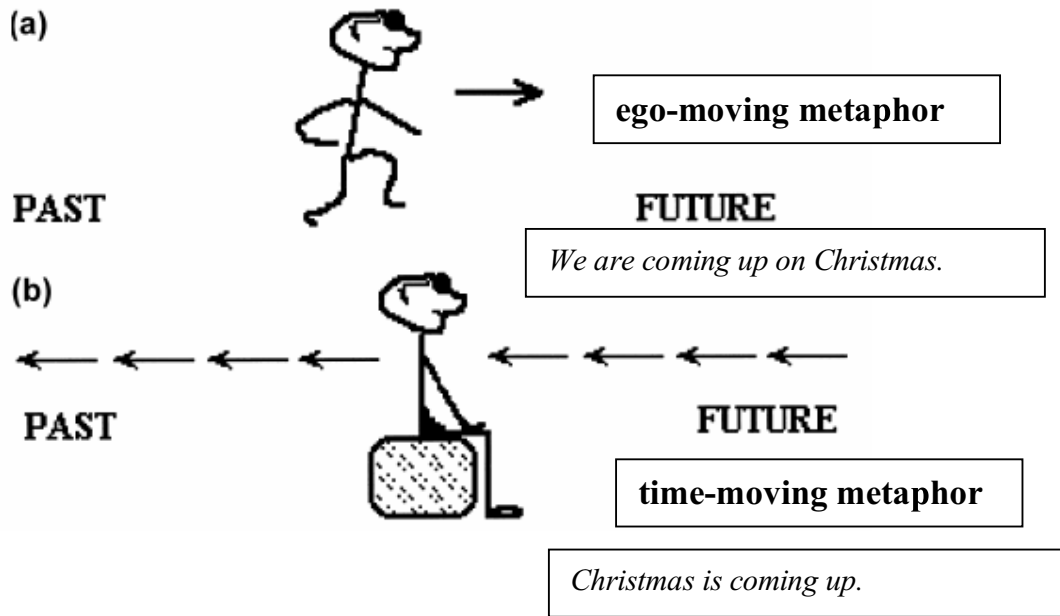
Figure 1: Temporal metaphors in English *(adapted from Boroditsky 2000: 5)*

Compare now these two conceptualisations of time to the two corresponding spatial metaphors as illustrated in figure 2 below, i.e. (a) the EGO-MOVING METAPHOR, with objects being relatively to 'ego' (as in: *The dark can is in front of me*), and (b) the OBJECT-MOVING METAPHOR, with objects being in relative position to each other (as in *The light widget is in front of the dark widget*).

(a)   **ego-moving metaphor**

The dark can is in front of me.

(b)   **space-moving metaphor**

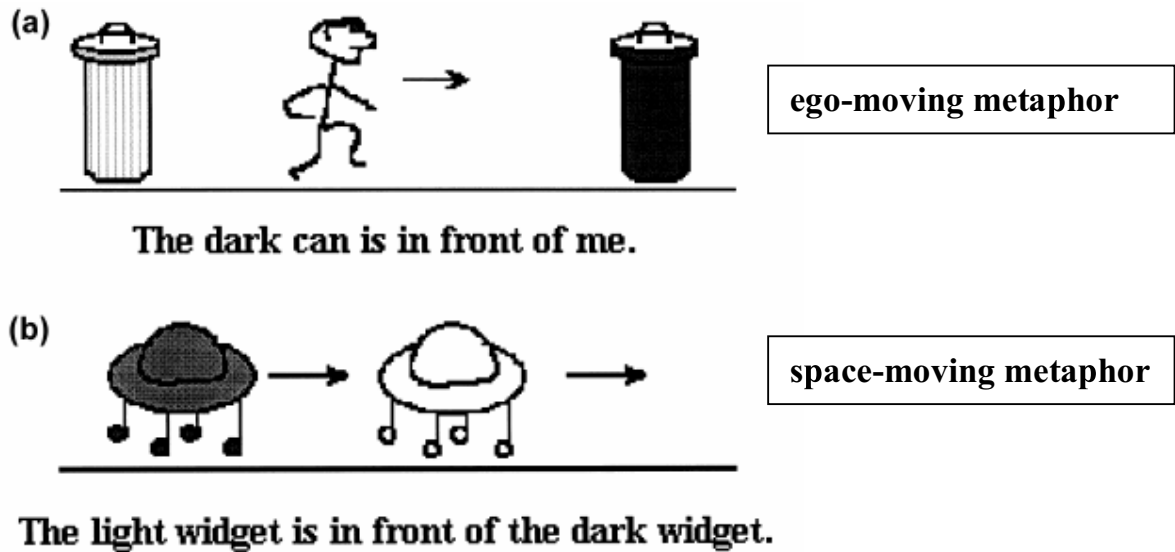The light widget is in front of the dark widget.

Figure 2: Spatial metaphor in English (cf. Boroditsky 2000: 6)

Now, in a first experiment subjects got spatial primes; these were spatial scenarios consisting of a picture and a sentence description, which either contained an ego-moving spatial frame or an object-moving frame. They then had to interpret an ambiguous temporal statement such as *Next Wednesday's meeting has been moved forward 2 days.* Under the ego-moving interpretation the meeting has been moved to Friday, while under the time-moving interpretation the meeting has been moved to Monday. Boroditsky's (2000) results show that when previously being presented with a spatial ego-moving prime (that is, something like *The dark can is in front of me*), subjects were more likely to think that the meeting has been moved to Friday (in 73.3% of all cases), while after a spatial object-moving prime (as *The light widget is in front of the dark widget*) they usually thought the meeting was moved to Monday (in 69.2% of all cases). The rationale of this experiment is illustrated in figure 3 below. This shows that spatial terms can prime temporal interpretations in on-line processing.

ambiguous   temporal   sentence

(e.g. *Next Wednesday's meeting has moved forward 2 days*.)

ego-moving interpretation   time-moving interpretation

(i.e. meeting is on Friday)   (i.e. meeting is on Monday)

↑   ↑

primes   primes

| |

ego-moving spatial frame   object-moving spatial frame

(e.g. *The dark can is in front of me*.)   (e.g. *The dark widget is in front of the light widget.*

Figure 3: *Illustration of experiment 1 in Boroditsky (2000)*

But what about the other way round? Can temporal terms also prime spatial interpretations? To test for this question, Boroditsky (2000) conducted two further experiments, in which she was now using both spatial and temporal primes (in the respective 2 frames) as well as ambiguous questions about spatial and temporal targets. Her results very clearly show that while spatial primes could prime the respective spatial interpretations as well as the respective temporal interpretations, temporal primes could only prime the respective temporal interpretations but not the corresponding spatial ones.[11] According to Boroditsky (2000: 20) this demonstrates that while people use spatial primes to think about time, they don't use temporal primes when thinking about space. Thus, this study shows two things. First, the metaphorical mapping from space to time is indeed psychologically real (and not a 'dead' metaphor; see also Gentner et al. 2002 and Givón 2005: 79-81), and second, that priming between space and time is asymmetric, with only spatial expressions priming temporal interpretations but not vice versa; see also Boroditsky (2000: 22):

> *Apparently, space and time can share structured relational information on-line, but this sharing is asymmetric; spatial schemas can be used to think about time, but temporal schemas cannot be used to think about space.*

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[11] In experiment 2, space-to-time priming resulted into 63.9% consistent responses, while time-to-space priming only revealed 47.2% consistent responses. ('Consistent response' in this case means that the two respective schemas primed each other across domains.) The results of this second experiment was backed up by converging evidence from a third experiment that tested the effects of consistent mapping in an on-line task.

4. 2 Phonological reduction: Shields & Balota (1991)

Another case of asymmetric priming reported in the psycholinguistic literature may account for the well-known unidirectional tendency of words to be phonologically reduced in the process of language change. It is commonly observed that linguistic expressions typically become shorter when they undergo change, while the reverse process generally does not occur. For example, *hiu dagu* ('on this day') became *hiutu* in Old High German, *hiute* in Middle High German and is *heute* ('today') in Modern German (see Keller 1994:110). It is however not to be expected that *heute* develops back again into *hiu dagu*. The process of phonetic reduction is also typically involved in the process of grammaticalization; see e.g. the development from *going to* to *gonna* mentioned in section 2 above or the grammaticalization of *let us* to *let's*.

Hopper & Traugott (2003:154) summarize the two versions of phonological reduction under historical change in the following way:

> *"In the process of phonological attrition and selection […], we can identify two tendencies:*
> - *A quantitative ('syntagmatic') reduction: forms become shorter as the phonemes that comprise them erode.*
> - *A qualitative ('paradigmatic') reduction: the remaining phonological segments in the form are drawn from a progressively shrinking set."*

This asymmetry in historical change has its counterpart in an asymmetry regarding phonological priming. Briefly put, a full form is more likely to prime a phonetically reduced form than the other way round. This is demonstrated for instance in a psycholinguistic study by Shields & Balota (1991). In their experiment, test persons read certain sentences in present tense and were asked to repeat them from memory in past tense (thus ensuring that the sentences were fully grammatically processed). Typical sentences were the following:

(4)   a.   Her **cat** chases our *cat* under the table.

        b.   Her **dog** chases our *cat* under the table.

        c.   Her **son** chases our *cat* under the table.

Each sentence contains a prime (indicated above in bold) and a target (written in italics). Prime and target were either identical (as in (4a)), semantically related (as in (4b)) or

completely unrelated (as in (4c)). The phonetic realization of the target was acoustically analyzed with regard to duration and amplitude.

It turned out that both identity and semantic relatedness lead to a reduction in duration, and this effect is strongest under identity. For the example given above, the values are

(5)   a.   (cat) … *cat:*   329 msec

        b.   (dog) … *cat:* 340 msec

        c.   (son) … *cat:* 350 msec

Both the difference between (5a) and (5b) and between (5b) and (5c) are statistically significant.

Identity priming furthermore leads to a significant reduction in amplitude. The difference in amplitude between the vowel of the target and a reference vowel were:

(6)   a.   (cat) … *cat:* -1.62 dB

        b.   (dog) … *cat:* -0.11 dB

        c.   (son) … *cat:*   0.23 dB

The difference between (6b) and (6c) is not significant, but the difference between (6a) and the other two values is. In words, identity priming (but not semantic priming) leads to a significant reduction in amplitude.

Similar results are reported by other authors. For instance, Fowler & Housum (1987) conducted an experiment where subjects were asked to spontaneously produce narratives. They found that on average, repetition leads to a reduction in duration. 71 percent of second occurrences of nouns in such narratives where shorter than the corresponding first occurrence. Likewise, Gregory et al. (1999) found in a corpus study that there is a positive correlation between the duration of a word token and the frequency of the corresponding type in the preceding discourse.

There are essentially two ways to relate these findings to priming. One way is to say that phonetic priming is in fact asymmetric – a phonetic full form has a stronger priming effect on the corresponding reduced form than the other way round. Alternatively, one might argue that phonetic reduction is rather a side effect of genuine identity priming. Various authors (Fowler and Housum 1987, Gregory et al. 1999, Jurafsky et al. 2001 and Lindblom 1990, *inter alia*) have pointed out and presented evidence that there is a relation between

phonetic reduction and expectedness. Probable or expected words are more likely to be phonetically reduced than unexpected or unlikely ones. Priming may therefore be related to phonetic reduction via probability, as it has an impact on probability. If for instance the word *cat* occurs in a discourse, it is more likely to be repeated in the immediately following stretch of discourse than without its being previously mentioned. If it is in fact repeated, this second occurrence constitutes a case of identity priming. That is, this second occurrence is more expected than the first occurrence, and therefore more likely to be phonetically reduced.

This issue, though interesting, is of minor importance for our proposal, however. What does matter is (a) that prime targets are more likely to be phonologically reduced than primes, and (b) that this asymmetry is skewed into the same direction as frequently observed unidirectional pathways of language change.

5. A usage-based account of directional change (based on priming)

5.1 Stating the problem

So far we have shown that there are two unidirectional changes which have a correspondence in synchronic asymmetric priming. The question remains, however, how such priming effects should account for long-term diachronic change. After all, priming is typically regarded as a a very short-lived phenomenon, which increases the likelihood for a certain form/construction to occur in a specific context rather immediately and locally. So, the question remains how such priming effects can be 'registered' in grammar. This actually relates to a central question (or rather problem) in approaches to variation and change: We know *that* preferences in language usage may become grammaticalized (see e.g. the work by John Hawkins and most functionalist work on language change) but we don't know *how*.[12] Kirby (1999) calls this 'THE PROBLEM OF LINKAGE' and offers a computational model to account for the fact how frequency in usage may lead to entrenchment in grammar. In his account, however, language usage only very indirectly plays a role, acting as a filter on the input children encounter in first language acquisition, on the basis of which they then construct their grammars. In so doing, Kirby (1999) follows the usual separation of performance and competence, with relegating changes in the latter to first language acquisition. However, Bresnan and colleagues (see e.g. Bresnan et al. 2001, Aissen & Bresnan 2002, Bresnan & Aissen 2002) have recently argued for a stochastic grammar (following Boersma's 1998 proposal for phonology), in

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[12] Keller (1994) offers an 'invisible-hand' account of language change which can account neatly for the fact why language changes unintentionally by the accumulated actions of individual speakers. One drawback of Keller's approach, however, is that it does not lead to empirically testable claims but rather provides a very general philosophical meta-framework.

which the difference between categoricity in competence and optionality in performance is not a qualitative one but only a quantitative one. Under this view, grammar does not become totally fixed after first language acquisition but can also be adapted in adults (in the form of changes in constraint weights) and thus remain essentially 'plastic' throughout the lifetime of speakers. That is, adult speakers' grammars can change, too, in this formal account.

In the following we will discuss how priming effects may become entrenched in grammars. We will first introduce the notion of IMPLICIT LEARNING which can, very generally, account for the fact that individual instances of language use (i.e. tokens of use) have an immediate impact on grammar. In a second step we will then say, more specifically, how the observed asymmetric priming effects in the studies reported above may accumulate into (uni)directional change.

5.2 Implicit learning

The account of implicit learning of language we would like to present here has been developed within the research paradigm of syntactic priming and is primarily based on the empirical observation that structural priming may persist over various trials, indicating that priming effects do not always immediately decay the moment the target is produced (e.g. Bock & Griffin 2000; Hartsuiker & Kolk 1998). Bock & Griffin (2000) also provide evidence for a qualitative difference between mere lexical repetition, which they attribute to memory effects, and structural priming, which they attribute to learning.[13] In addition, there is evidence for cumulative priming effects in that with repeated trials there is an increased preference for a certain structure (see e.g. Luka & Barsalou 2005: 438-439 for a succinct summary of the literature). Among other things, this finds expression in the well-known fact that speakers tend to judge odd structures as increasingly better after repeated exposure (e.g. Luka & Barsalou 2005), actually a common observation in grammaticality judgement studies (see e.g. Schütze 1996). It has therefore been suggested to consider structural priming as a form of IMPLICIT LEARNING (Bock & Griffin 2000), which has been modelled in a connectionist neural network (Chang et al. 2000; and see particularly Chang et al. 2006 for an

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[13] In addition, Tulving & Schacter (1990:302) provide evidence from various kinds of dissociations for the existence of two different kinds of memory. For example, amnesic patients are reported to show the same priming effects as normal patients, although they fail to remember the primes and/or the whole priming event. Also, there is a developmental dissociation: while recognition memory increases in children with age, priming effects remain basically constant between infants (3-year-olds, according to the authors) and an adult control group. Furthermore, there are drug-induced dissociations in the form that subjects show a reduced performance in explicit recall when drugged (e.g. by alcohol) while having no problems with priming. All this suggests (at least) two different kinds of memory systems behind, one for consciously accessible (i.e. explicit) knowledge for recognition and one for consciously not accessible (i.e. implicit) knowledge for priming. See also Tunney (2003), *inter alia*, for converging evidence for these two types of memories from artificial grammar learning.

in-depth account).[14] Simply put, the idea expressed in this model is one of error-based learning as equally underlying first language acquisition and later adaptations of structural representations. That is, the authors suggest that the same learning mechanism that drive the acquisition of syntax in children also drives the (implicit and continuous) learning of syntax in adults in language use. Thus, via implicit learning the effects of structural priming may become entrenched in speakers' grammars over time. It is not difficult to see the appeal of implicit learning for theories of language change, as it provides a usage-based model of how performance changes in the lifetime of speakers may come to have an immediate effect on their grammars (see particularly Chang et al. 2006), thereby challenging the assumption of formal models of grammar that competence change is restricted to the process of first language acquisition only.[15]   Note that this view on language processing and grammar is well compatible with the view of a plastic grammar in recent theoretical work on syntax, as mentioned above (e.g. Aissen & Bresnan 2002).

Implicit learning is certainly essential to understand the connection between asymmetric priming effects and unidirectional language change, but questions remain. There are especially two questions that need to be addressed to solve the problem of linkage:

- Phonetic reduction of the kind investigated by Shields and Balota (1991) is a quantitative phenomenon. While a second occurrence of *cat*, say, may have a reduced duration and amplitude, it still consists of the three segments /k/, /æ/ and /t/. This is still a far cry from **phonological** reduction like for instance the final b-deletion in the pronunciation of *bomb*.

- Even if the previous question can be answered satisfactorily, this would only help to explain the historical pathways of **forms**. Meaning change, like the emergence of a temporal interpretation of an originally spatial expression is not accounted for in this way.

In the remainder of this section we will address these questions in turn.

5. 3 From phonetic to phonological reduction: Exemplar dynamics

[14] Note that implicit learning is a general notion that has been put forward in the psychological literature and from there applied to the learning of language (e.g. Ellis 1994). The connectionist model as introduced by Chang and colleagues is only one way of implementing this idea, though it is the only model so far we are aware of that explicitly models the impact of linguistic priming in terms of implicit learning.

[15] The idea that priming/persistence may become entrenched can also be found in Szmrecsanyi (2006) who, though somewhat tentatively, suggests that "the cognitive mechanism of entrenchment is one long-term manifestation of persistence, and that persistence is among one of the short-term mechanisms which relate to entrenchment in the long run" (211).

The way the first question above is stated, it presupposes an ontological distinction between phonetics (as an aspect of linguistic performance) and phonology (as a part of competence). This assumption is not uncontested. Bybee (2002) argues convincingly that phonetic variation is part of lexical knowledge. For instance, she reports findings from Losiewicz (1992) according to which "monomorphemic /t/ or /d/ is shorter in duration than regular past tense /t/ or /d/. […] In addition, Losiewicz found that a final past tense /t/ or /d/ is longer in low-frequency verbs than in high-frequency verbs" (Bybee 2002: 265).

So according to Bybee, phonetic characteristics of a word (like the length of a final obstruent) are part of the lexical knowledge of speakers. How is this possible? To explain this fact, she assumes an exemplar-based representation of lexical items (see for instance Johnson 1997 or Pierrehumbert 2001, 2002). According to this approach, each exemplar, i.e. token of a lexical item that a language user processes, is stored in memory. Each of these memorized tokens has a certain strength that decays over time. These exemplars are organized in a similarity space, i.e. similar items are located close to each other and vice versa. The cognitive representation of a lexical entry is simply the collection of all memorized tokens of it. In production, a speaker strives to imitate the exemplar of a lexical item that is close to the weighted average of all its stored tokens. This process may be subject to some random perturbation, which accounts for variation.[16]

One might wonder why words are perceived as being phonetically composed out of smaller units like syllables and sounds at all, if each lexical unit is just a collection of holistic exemplars. This question is orthogonal to our concern here; it is addressed in Pierrehumbert (2001).

Since each usage of a lexical item adds an exemplar to its cognitive representation, this representation undergoes a constant continuous dynamic. The complete disappearance of a "segment" is just an extreme case of such a process. Both Bybee (2002) and Pierrehumbert (2001) have pointed out that a directed bias in language production (like a tendency to reduce sounds) ultimately leads to a trajectory of phonological reduction, and they invoke this idea to explain unidirectionality in language change. The main innovation of the present approach is to account for the observed frequency effects and the bias to reduction by linking these effects to the psycholinguistic mechanism of priming in a unified approach to unidirectional change

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[16] Note the differences to the model of implicit learning as advocated by Chang et al. (forthc.): In Chang et al's model it is violations of an expected probability for a form to occur which leads to the immediate adjustment of this expected probability (or, more precisely, its internal weight). In exemplar theories as advocated by Bybee and Pierrehumbert every token occurrence gets stored and thereby adds to its holistic representation.

that accounts for various (and, ideally, all) types of unidirectional changes, not only phonological reduction.

5.4 Entrenchment of semantic priming: Co-activation

Like form priming, semantic priming (i.e. the priming of meanings/concepts) has long term effects that may be observed as pathways of language change, as evidenced in the development from spatial to temporal expressions discussed in §4.1. The mechanism here is slightly more complicated though. To account for the problem of linkage here, we make two additional assumptions. They are in principle testable though, and thus open to empirical inquiry. The assumptions are:

1. The stronger the activation of a concept is, the more likely this concept is to be expressed by a speaker.
2. If a concept can be expressed in more than one way, the activation level of a form is positively correlated with its likelihood to be chosen.

Let us illustrate the first point with a simple example. As mentioned above, the usage of a concept primes, i.e. activates, related concepts. For instance, the concept "guitar" primes the concept "violin" (see §2 above). As a consequence of the first claim, we expect that speakers are more likely to talk about violins if the immediately preceding discourse mentioned, say, "guitar". A more subtle prediction is that semantic priming should have an impact on word order. Suppose a speaker wants to express the proposition "John arrived with a backpack and a violin". This can be expressed as (5a) or (5b).

(5)   a.   John arrived with a backpack and a violin.
       b.   John arrived with a violin and a backpack.

The prediction would be that the relative probability of (b) compared to (a) is increased if the immediately preceding sentence mentioned a guitar.

The second claim above relates to competing ways to express the same concept. Recall that (sufficiently) similar or identical forms can prime each other. That is, all other things being equal, a certain token will raise the probability of the occurrence of the same or similar token to occur. For example, if a speaker has the choice to refer to a house either by using *house* or by using *building*, the form *house* can be primed by an immediately preceding usage of either the same form *house* or, for instance, the (phonologically) similar form *mouse*.

How do these assumptions relate to meaning change? For the purpose of illustration, consider the preposition *within*. In present day English it is lexically ambiguous between a spatial and a temporal reading, but suppose, for the sake of the argument, that its only literal meaning is something like "spatially included by", while the temporal interpretation is only available via active metaphor.[17] Suppose furthermore that there are competing expressions like *during* that unambiguously express the concept of temporal inclusion.

If, in such a scenario, a speaker uses *within* in its spatial meaning, our assumptions above lead to two consequences:

1. Boroditsky's findings indicate that spatial concepts prime homomorphic temporal concepts. The usage of spatial *within* thus activates the concept of temporal inclusion. According to the first assumption, this increases the likelihood that the speaker will express temporal inclusion in the immediately following discourse.

2. If the speaker does indeed want to express temporal inclusion immediately following the usage of spatial *within*, she is more likely to use the very same form, *within*, in its metaphorical, temporal meaning, than in a neutral context. This follows from the second assumption, because the form *within* is still activated.

The crucial aspect here is that a form (like [within]) and an originally non-literal meaning (like "temporal inclusion") are frequently activated simultaneously, due to simultaneous form priming and semantic priming. This mechanism can thus be dubbed "co-activation. It is schematically depicted in Figure 4.

In more general terms, the two assumptions above lead to the prediction that semantic priming facilitates semantic change. If a concept *A* primes a concept *B*, an expression denoting *A* is a candidate to acquire the additional meaning *B*. If this priming effect is asymmetrical, i.e. if *A* primes *B* stronger than the other way around, we predict the historical pathway to be asymmetrical, as in the development from spatial to temporal expressions.

To summarize, the idea we are advocating in this paper is the following: Unidirectional change ultimately goes back to the fact that a form or a concept/meaning *A* primes the use of a form or concept/meaning *B* if it is sufficiently similar to it, but that *B* doesn't prime *A*. Via repeated usage and implicit learning *B* will become entrenched over time. That is, what appears as diachronic trajectories of unidirectional change is ultimately decomposable into atomic steps of asymmetric priming in language use. It is in this way that

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[17] In Present-day English this is however not (or rather no longer?) the case. As shown in Boroditsky's (2000) studies, spatial primes are not necessary to prime temporal interpretations – the latter can also be primed directly by a temporal expression. This indicates at least some degree of autonomy of the derived temporal form, at least in present day English. But, for the sake of the argument, we simply suggest here that in a previous stage the temporal meaning of *within* could only be activated via the corresponding spatial expression.

the actions of individual speakers may come to have a long-term impact on the shape of a grammar, without speakers consciously conspiring to change language in a certain direction. In this respect, our user-based account is well compatible with Keller's (1994) invisible-hand approach to language change.
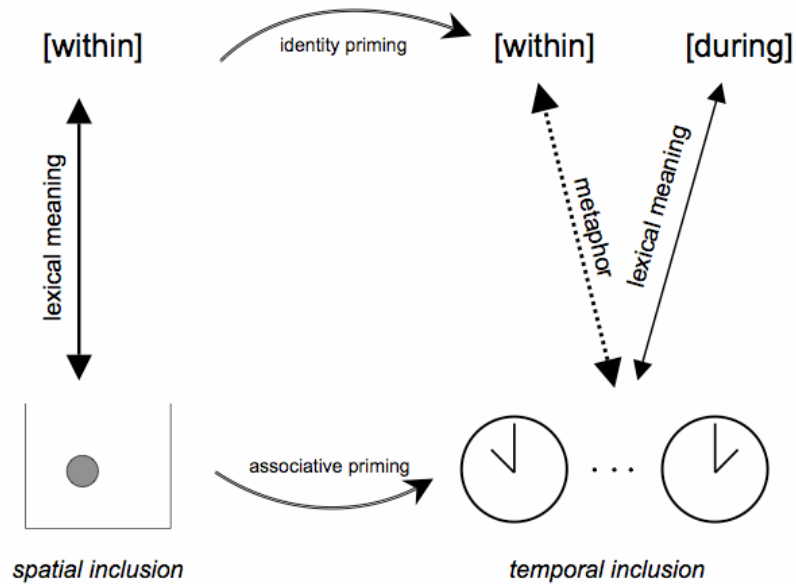

Figure 4: *Schematic representation of the co-activation mechanisms*

Note, finally, that it is precisely the fact that *A* and *B* are not identical but similar which brings in the dynamics into this account.[18] If there was only identity (repetition) priming, there wouldn't be room for change. It is an open (and essentially empirical) question what precisely constitutes sufficient similarity in such cases. In our approach, similarity can be operationalized by 'primeability': Under this view similarity means primeability. If it can be shown that two forms/concepts prime each other, they are sufficiently similar, whatever constitutes this similarity in the first place.

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[18] See also Givón (2005: 69-89) for endorsing a view of metaphorical change (as the one from spatial to temporal meaning) in terms of similarity rather than Lakoff & Johnson's (1980) conceptual-mapping approach, which assumes a mapping between two distinct cognitive domains. Givón also envisages the gradual shift towards a conventionalised metaphorical use as shifts in co-activation patterns (see particularly pp. 84-88).

6. Priming in an evolutionary approach to language change

It has been claimed that general evolutionary processes (such as variation, selection and replication) may underlie just *any* historically-evolved, complex system, subsuming both biological and cultural evolution – although of course operating quite differently in the respective domains (e.g. Dawkins 1986; Dennett 1996). Language is such a culturally evolved complex system and evolutionary approaches to language change have recently become popular in linguistics (e.g. Lass 1990, 1997; Haspelmath 1999b; Croft 2000, Ritt 2004). The challenge however is to find linguistic analogues for the evolutionary processes of variation, selection and replication. The process of selection in language change is already relatively well understood (although there is still some controversy as to the role of functional versus social factors in linguistic selection). It is however yet unclear by which mechanism linguistic elements should be replicated and how variation may arise in language, as there is no natural counterpart in linguistic evolution to the replication of genes in sexual reproduction and to mutation in biological evolution. We may assume with Croft (2000) that the units of linguistic evolution are pieces of linguistic structure like phonemes, morphemes, words, idioms, or constructions (possibly including concomittant semantic units). According to Croft (2000) the basic linguistic replicators are 'linguemes', comparable to Dawkins' (1986) concept of 'meme', which is also adopted in Ritt's (2004) approach. However, it is not clear by which mechanism precisely such linguemes or linguistic memes should get replicated. Priming provides a natural cognitive mechanism by which linguistic items are replicated in language use, as the previous use of an element *A* will enhance the likelihood of the same element *A* to occur in discourse, hence acting like an amplifier of *A*. As priming does not require total copying fidelity, it may also provide a possible – and in fact quite natural – mechanism for creating variation in language. To the extent that similarity suffices for the replication of utterances, priming may account for the extension of forms/constructions to new contexts (see also Bock & Kroch 1989: 187). It is well known from biology that mutation presupposes replication; transferred to language it may be argued that replication (i.e. repetition) is a precondition for the rise of new variants (cf. also Haiman forthc.). It remains to be seen, however, to what extent priming may also account for the rise of new grammatical categories and constructions, i.e. reanalysis.[19]

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[19] It is well possible that there is no real difference between analogy and reanalysis, and that new structures may arise via many small steps of analogical extensions, which may all be captured by similarity-based priming. See also Hopper & Traugott (2003), who tentatively ask "whether everything is not reanalysis". Especially in approaches which assume gradual adaptations of cognitive representations such as Bybee's (2002) , Pierrehumbert's (2001) or Chang et al.'s (2006) this seems to be a plausible scenario, though this question needs to be addressed in more detail.

7. Conclusion and outlook

In this paper we have argued that the psycholinguistic mechanism of priming may account for the fact that grammaticalization processes typically proceed in one direction only. In particular, we have shown how two such unidirectional changes, i.e. the development from spatial to temporal expressions and phonological reduction, may be connected to cases of asymmetric priming as reported from the psycholinguistic literature. In these cases a form or concept *A* primes a form or concept *B*, but not *vice versa*, and this cognitive asymmetry corresponds precisely to the observed unidirectional pathway from *A* to *B* in diachronic change. In order to account for the diachronic transition of synchronic priming effects in language usage to the grammar of a language we have referred to the concept of implicit learning, as for example recently implemented for structural priming (e.g. Chang et al. 2006), complementing it by further assumptions. In particular, we have referred to work on exemplar dynamics, which can account for the fact that phonetic reduction on the level of usage can ultimately lead to phonological reduction on the competence level. We have also proposed a way of how priming and implicit learning may account for long-term unidirectional *meaning* change, as evidenced in the pathway from spatial to temporal expressions.

We are aware that our approach is still considerably simplified in many ways and leaves various questions open. So, for instance, we have focussed solely on the change-accelerating function of frequency, but it is well-known that frequency may also be change-inhibiting. Note also that our account does not ultimately explain unidirectionality – it still begs the question of *why* there should be such asymmetries in priming in the first place. It does, however, push the explanation considerably back to the cognitive domain, and is therefore to be seen as a step further in terms of 'explanatory ascent' (see e.g. Eckman 2004 for a recent discussion of this concept).

In general, the present article is first and foremost supposed to be a think-piece which should bring to our attention the potential of fruitfully applying insights from psycholinguistic research to central issues of historical linguistics. What makes such an approach particularly appealing, as we see it, is the fact that (a) falsifiable predictions fall out from it, and (b) that we can test these predictions with present-day speakers. Under the uniformitarian assumption that "the same principles governing the world (= domain of enquiry) were the same in the past as they are now" (Lass 1997:25) we may assume that whatever psycholinguistic mechanisms we can find to be operating today, must also have been operating in the past (under the

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For more in-depth treatments of the relation between priming and evolutionary accounts of language change see also Jäger (2007) and Rosenbach (forthc.).

assumption that these mechanisms themselves have not changed, but this seems unlikely given the time-span we are talking about). Thus, investigating psycholinguistic mechanisms with present-day speakers may shed light on processes guiding language change.[20] Under this view it is then possible to test *any* unidirectional changes that has been put forward in the literature (see most prominently the list given in Heine & Kuteva 2002) with respect to asymmetric priming. Very generally, the prediction is that in any reported case of change, where the development goes unidirectionally from *A* to *B*, *A* should prime *B*, but not vice versa. Admittedly, this sounds simpler than it might be in practice. Note, for instance, that not all grammaticalization pathways are equally well attested. While some have a very robust empirical basis (such as the ones discussed in this paper), other pathways still stand on relatively weak empirical pillars. Note also, that a crucial prerequisite for testing for asymmetric priming in such cases is the co-existence of the older form/concept *A* with the later form/concept *B* for present-day speakers. For example, the direction of priming from spatial to temporal could only be tested in Boroditsky's (2000) experiments because present-day speakers have both the spatial and the homomorphic temporal expressions at their disposal. But not in every case will the source form/concept be retained in present-day language.

Another open question is whether the stages on the clines proposed in grammaticalization research (or rather the notations chosen for them) will precisely correspond to some cognitively real counterparts that can prime each other. Apparently, the main data source of historical linguists is the text material from earlier stages of the language. But the textual evidence available to use will not always give us the full picture of the various steps involved in a change and there will be (often considerable) gaps. Under the uniformitarian assumption, priming may help us find the 'minimal steps' underlying the gradual process of formal and semantic change as typical in grammaticalization. In this respect, then, priming may serve as a complementary tool in the reconstruction of grammaticalization pathways.

It also remains to be seen whether really *all* cases of unidirectional change can be accounted for in terms of asymmetric priming or only certain classes of changes. At this stage we simply do not know. It may be speculated, however, that our priming account only holds for special changes, namely those involving a certain kind of inclusion relation. Note, for example, that a movement in space always includes a movement in time (but not *vice versa*).

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[20] This idea has been very successfully applied in sociolinguistic research to historical change, but, surprisingly, it has so far barely been transferred to psycholinguistic research, for exceptions see Stein (1988), Tabor (1994), Berg (1998), or Rosenbach (2002).

The change from spatial to temporal meaning may thus be regarded as a loss of a semantic feature rather than a genuine innovation (cf. also the idea of semantic bleaching underlying such changes, e.g. Givón 1979). Likewise, a full form necessarily includes the phonetically reduced form (but not *vice versa*). Seen in terms of features, then, it is obvious that the fully specified forms/meanings prime the forms/meanings lacking a feature but not the other way round in asymmetric priming. At the same time, however, prime and target still share enough features to be similar enough for priming to occur. Under such a view priming does not 'add' any novel meaning/form – and thus does not create new meanings/forms – but only reduces features of forms/meanings already there.

But, repeat, which instances and types of unidirectional change may be captured by our hypothesis of asymmetric priming is an empirical question and we hope to have shown a way of how to test for this.

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