

The rise and preservation of argument indexing systems

Bachelor's thesis premaster Linguistics

Sebastian Collin (s4400097)
Under the supervision of dr. S. Lestrade
August 2015

Abstract

This paper explores the question why core arguments are indexed on the verb. Two perspectives are taken: firstly on the origins of indexing systems, secondly on the preservation of such systems. The origins are argued to be in free pronominal expressions. Grammaticalization of free pronouns gradually changed them into bound pronominal indexes and later into grammatical argument indexes. Taking two different pronominal sources as the origins of indexing systems, two cross-linguistic tendencies are accounted for: the prevalence of subject indexing and the prevalence of first and second person indexing. The diachronic preservation of argument indexing systems may be accounted for by means of the indexes high frequency of occurrence: children may learn indexing easily since they are often exposed to it. Additionally it is argued that the diachronic stability of argument indexing may be an effect of their contribution to parsing performance.

Contents

1. On the redundancy of argument indexing.....	4
2. The development of argument indexing	6
2.1 Argument indexes: phenomena sui generis	6
2.2 Grammaticalization theory and the historic origins of argument indexing	7
2.2.1 Grammaticalization Theory	8
2.2.2 From topic-shift marker to argument indexing.....	11
2.2.3 From higher accessibility marker to argument indexing	12
2.3 Conclusion	13
3. The stability of argument indexing systems	15
3.1 Cultural transmission and the dual-nature of frequency	15
3.2 Parsing performance	17
3.3 Conclusion	20
4. Conclusion	22
5. References.....	23

1. On the redundancy of argument indexing

The roles of the arguments in a transitive clause need to be distinguishable in order for the listener to understand the intended meaning. There are several ways to make apparent what the intended role distribution is. If a grammatical strategy is used, the arguments' syntactic relations to the verb (e.g. subject, object) are expressed and used by listeners to retrieve the intended semantic roles (e.g. agent, patient). For instance in English word order is used to express the arguments' grammatical relations to the verb.

(1) John_{subj} hits Mary_{obj}

Traditionally three grammatical argument marking strategies are distinguished. Besides word order, there are also dependent-marking and head-marking strategies (cf Nichols 1986). In a dependent-marking strategy, the arguments (the dependents) themselves are marked for grammatical case (e.g. accusative or ergative). English has remnants of such a system, visible in pronominal expressions.

(2) He_{nom} hits her_{acc}.

In a head-marking strategy, the finite verb (the head) indexes properties of one or more dependents by means of an agreement affix. In English there is person/number agreement with the subject, though only if the subject is third person singular.

(3) He hit-s her
 3sg.m.nom hit-3sg 3sg.f.acc

What should be noted is that the subject indexing in (3) is inept to independently distinguish subject from object. Since both arguments are third person singular, the 3sg-agreement marker could index either of them. It is therefore needed to rely on other means to disambiguate between the arguments. This also holds true for languages with a richer verbal argument marking paradigm. That is, if core arguments are similar with respect to the properties indexed on the verb, a listener would need other cues than just the index to fully distinguish between these arguments (Nichols, 1986). Argument indexing thus seems ineffective as an argument marking strategy compared to word order and case marking.

It should also be noted that subject indexing is obligatory, whether the clause is transitive or not. In other words, even if there is only one argument and no need to distinguish between semantic roles, the argument's syntactic relation to the verb is still overtly marked. This seems somewhat wasteful compared to case marking systems, in which the core argument of an intransitive verb often remains unmarked. Considering also the fact that object arguments are already marked by word order and sometimes case, the indexing of the subject could be considered to be redundant. This again is not unique to English: obligatory subject indexing is common to Indo-European languages (Haspelmath, 2013) and many languages use both head- and dependent-marking (Nichols, 1986).

The observations raise the question why languages mark the verb at all. In this work I will explore precisely that question. Formulated more concretely: how can we functionally account for the existence of verbal head-marking? Within a broader framework of usage-based linguistics two perspectives on this question will be taken. Firstly, how can we functionally explain the emergence of verbal head-marking? And secondly, how can we functionally explain the continuing existence of verbal head-marking?

In chapter two, before answering the first question, I will review a paper by Haspelmath (2013) in which he argues that the concepts of pronouns and agreement are problematic in the analysis of verbal head-marking phenomena. I will adopt Haspelmath's view and – as I have already done, will in this paper speak of argument indexing rather than of verbal agreement. Importantly the review of Haspelmath's paper is more than a matter of definition. Firstly, Haspelmath points out that the redundancy in core argument marking strategies may be seen as a “distributed expression of meaning”. I will adopt this view too. Secondly and directly related to the central topic of chapter two, I will suggest that Haspelmath's paper also shows that free pronouns are the historic source of bound argument indexes.

I will then review grammaticalization theory (Heine & Kuteva, 2007) to explain the general process which may turn free morphemes into bound ones. I will also explain why the grammaticalization of a morpheme can be considered functional. Then I will review two accounts with different hypotheses on the specific pronominal source of argument indexing: anaphoric topic-shift markers (Givón, 1976) and reduced referential pronouns (Ariel, 1999). Following Ariel I will suggest that these views can together account for the cross-linguistic prevalence of subject indexing (rather than that of object indexing) and that of first and second person indexing (rather than that of third person indexing).

In chapter three I will look into the diachronic stability of argument indexing systems. To that end I will first discuss the role of frequency in the later stages of the grammaticalization process. Then I will also look in what way the index could be useful in terms of parsing performance.

2. The development or argument indexing

In this chapter I will try to give a functional account of the development of verbal agreement – or rather, argument indexing. To clarify why I wish to avoid term “agreement” in giving this account, I will first discuss Haspelmath’s view (2013) on the problems with the notion of agreement. This review is also important to notion of the redundancy involved in argument indexing: in line with Haspelmath I will consider it a “distributed expression of meaning”. Haspelmath’s observations are also relevant to the central theme of this chapter, namely that free pronouns are the historic origins of bound argument indexes. I will turn to this topic after the review of Haspelmath’s paper.

2.1 Argument indexes: phenomena sui generis

Haspelmath (2013) proposed to do away with the terms and concepts of pronouns and agreement for the analysis of verbal head-marking phenomena. He argued that these notions are Eurocentric and that therefore a more generic framework of *argument indexing* is needed (Haspelmath, 2013). To clarify Haspelmath’s issue, consider first the following (modified) example from his paper.

- (1) *English*
a. Mary come-s
b. she come-s
c. *come-s

What (1) shows is quite familiar. Because in (a) the verb is marked for its third person argument, “Mary”, we say that it agrees with its subject. We can readily replace “Mary” with the pronoun “she” (b), but we cannot omit the subject all together like in (c). What’s important here is that in English there is a clear distinction between pronouns and verbal affixes and that we indeed can speak of agreement: the inflexion on the verb must agree with something, an obligatory conominal as Haspelmath calls it.

Now compare this system of *grammatical indexing* (or gramm-indexing), with the system of *pronominal indexing* (or pro-indexing) in (2).

- (2) *Oko*
a. Àde cìna óbín
 Ade become king
 ‘Ade has become a king.’

b. è-cìna óbín
 3SG.SUBJ-become king
 ‘He has become a king.’

c. *Àde ècìna óbín

(2) demonstrates that though “Ade” in (a) can be replaced with the pronoun “è” (b), this time the pronoun is affixed. (c) shows that we should indeed think of it as a pronoun: the affix fully replaces the nominal expression and does not function as an agreement marker. Now consider the system of *cross-indexing* as in (3).

(3)	<i>Latin</i>	<i>Italian</i>
a.	Marcus veni-t Marcus come.PRS-3SG 'Marcus/Marco comes'	Marco vien-e Marco come.PRS-3SG
b.	veni-t come.PRS-3SG 'he comes'	vien-e come.PRS-3SG

This example reveals that though we can speak of marking or indexing, we cannot really speak of agreement. We could imagine a phonologically empty pro-form in (b), but such an analysis would precisely be what Haspelmath means when he says '[...] squeezed into the European mould'. On the solution of viewing the cross-index as either an agreement marker or pronoun depending on the context, he says the same. His issue is that grammatical indexing as in (1) is rather typical of European languages, while cross-indexing like in (3) appears to be much more common. He instead proposes is that argument indexes are phenomena sui generis, meaning that they should not artificially be treated as a special case of agreement or pronouns. Importantly, he concludes that some languages just doubly express their arguments and that there is nothing strange about expressing one meaning distributed over more than one form. (Haspelmath, 2013)

What Haspelmath demonstrates is precisely what one would expect if argument indexes are indeed remnants of free pronouns, a notion that will be central to this chapter. Free person forms and bound indexes are not readily distinguishable precisely because of their diachronic relation. Note that this is *not* contrary to Haspelmath's claim about argument indexes being phenomena sui generis – he is not concerned with the historical source of indexes. Rather he treats them as synchronic explananda, of which he says that they form a category on their own. Importantly, Haspelmath views doubly expressed items as a distributed expression of information, rather than necessarily wasteful: '[...] the index and its conominal jointly constitute the subject nominal. Thus, arguments may be doubly expressed [...] In general, distributed expression of meaning is not unusual in languages' (p. 13). Since I will adopt this view too, and thus assume that the joint expression of meaning is not unusual, I will also try to account for how such a distributed system may arise during the development or argument indexing strategies.

2.2 Grammaticalization theory and the historic origins of argument indexing

Above I have pointed out that we should not define – and thus not try to explain – the rise of verbal head-marking systems in terms of agreement markers on the finite verb. To reiterate the problems with this view (Haspelmath, 2013):

- (i) pronouns, clitics and affixes cannot always be functionally demarcated: they can at best be delimited in terms of morphological boundedness;
- (ii) there is not always a controlling conominal, so it is problematic to (always) speak of agreement.

The question now is how free pronouns sometimes end up as bound argument indexes. What I should therefore account for is the rise of a bound morpheme, which bears or reflects the properties of a verb's dependent.

To explain the rise of the bound person morpheme, the index, I will first turn to grammaticalization theory to explain the general processes which may turn free morphemes into bound ones. By applying grammaticalization theory I will also show why it is that a controlling conominal may not always be needed and additionally how the expression of an meaning may get distributed over more than one item.

To explain the development of argument indexing specifically, I will review two accounts that have the basic premise that argument indexing strategies have their diachronic origins in pronouns. Though they have in common that they can account for the close relation between pronouns and indexes, they differ in their views on the precise pronominal source of argument indexing. Crucially, they are both meritorious, because they together explain two cross-linguistic prevalent indexing patterns. I will first review Givón's (1976) account which holds that argument indexing is the end result of the grammaticalization of anaphoric topic-shifting markers. The merit of this view is that it accounts for the fact that cross-linguistically, subject indexing is more common than object indexing, and definite object indexing more common than indefinite object indexing (Givón, 1976, p. 151). Then I will review Ariel's (1999) account in which argument indexing is viewed as the diachronic outcome of the marking of the high salience of speech act participants. The value of her view is that it accounts for the fact that first and second person indexes are cross-linguistically more common than third person indexes (Ariel, 1999, pp. 213-221).

2.2.1 Grammaticalization Theory

Though there are many views on (and terms for) grammaticalization, most theorists ascribe to the view in which grammaticalization '[...] is defined as the development from lexical to grammatical and from grammatical to even more grammatical structures' (Heine, 2003, p. 577). Simply put: grammatical items once started their lives as lexical items. To identify and describe instances of grammaticalization, Heine and Kuteva (2007, p. 34) have proposed a model of four interrelated parameters:

- (i) Extension:
The rise of new grammatical meanings when linguistic expressions are extended to new contexts (context-induced reinterpretation)
- (ii) Desemanticization:
Loss or generalization in meaning content
- (iii) Decategorialization:
Loss in morphosyntactic properties characteristic of lexical or less grammaticalized forms
- (iv) Erosion:
Loss in phonetic substance

To clarify these parameters, we can briefly reconstruct the grammaticalization cline of the lexical verb *willan* – *to want* in Old English, which became a modal auxiliary expressing

intention in Middle English (Aitchison, 2001, p. 114) and now serves as the future tense auxiliary *will*. That is, it became used in a more general sense (viz. expressing intention by using a word which denotes desire), which made it applicable and used in more contexts. This resulted in the loss of more and more concrete meaning aspects, including the later loss of the modal aspect of intention (cf. (i) and (ii)). It lost its inflectional paradigm as well (thus, the properties characteristic of a verb) and is as of current often used as clitic rather than as word, e.g., *He'll do it*, rather than *He will do it* (cf. (iii) and (iv)).

Now according to Heine (2003), grammaticalization theory is based on the assumption that:

The main motivation underlying grammaticalization is to communicate successfully. To this end, one salient human strategy consists in using linguistic forms for meanings that are concrete [...] to also express less concrete [...] meaning contents. To this end, lexical or less grammaticalized linguistic expression are pressed into service for the expression of more grammaticalized functions. (p. 578)

It should be noted however that the above should not have a too teleological reading, in the sense that it is not the case that grammaticalization happens on purpose, with some predefined goal. Rather, grammaticalization is highly gradual and emerges from language use in many different contexts. Heine & Kuteva (2007) propose the term “context-induced reinterpretation”: before an item’s grammatical meaning is conventionalized (when desemanticization has occurred) that item was already taken to convey a more general meaning many times during its gradual extension to other contexts (pp. 36–37). One way to explain grammaticalization is therefore to view it as a product of (many gradual) pragmatic inferences (Heine, 2003, p. 580). Heine proposes that also conceptual or metaphorical transfers take place, wherein shifts occur from anthropocentric ontological domains to increasingly abstract ones (p. 586). (Cf. also Dahl, 2008, who argues that the pervasiveness of animacy in grammar can also be explained by in such a way.) I suggest that one functional aspect of grammaticalization lies here, namely that language adapts to its users’ needs over time.

Crucially, grammaticalization is in itself not caused by an independent increase of an item’s occurrence. Rather, an item’s frequency of occurrence increases as a result of the item’s extension and desemanticization, which then in turn may lead to decategorialization and erosion (Heine, 2003, p. 583). I will later return to both frequency and the latter two parameters, when I will account for affixation and will also highlight other functional aspects of grammaticalization.

The gradual nature of grammaticalization is also reflected by the grammatical patterns it shapes. Below are two of the principles of grammaticalization mentioned by Heine (2003, p. 589) originally described by Hopper:

- (i) Layering, whereby older layers of language use are not necessarily discarded when new layers emerge, but may remain to coexist and interact with the newer layers;
- (ii) Divergence, results when a form undergoes grammaticalization and the original form continues to be used as an autonomous element so that the grammaticalized and ungrammaticalized forms coexist side by side;

- (iii) Persistence, some of the traces of earlier meanings of an item undergoing grammaticalization are likely to survive in the form of the grammatical distribution of the item concerned.

Note that the difference between (i) and (ii) is that layering concerns multiple patterns that perform one function (i.e., distributed expression of meaning) while divergence concerns one form that has multiple patterns of use. Hopper's principles are relevant because they show how the expression of meaning could get spread out over more than one item or pattern. This is so because it is not the case that an older pattern that performs some linguistic function fully disappears before the genesis of a new patterns starts. Rather, an item's grammaticalization results in its gradual loss of semantic, morphosyntactic and phonetic content (Heine, 2003, p. 579) and during this loss it gradually becomes inept to independently perform its original function. A new item may therefore be recruited to assist it, which crucially does not mean that the older one will then disappear completely.

To clarify, consider colloquial French, in which the original grammatical indexes are not pronounced anymore and a new argument indexing system is developing from clitization of the former nominative personal pronouns (Ariel, 1999, p. 202). The former accusative personal pronouns on the other hand are occasionally used as new nominative ones (Givón, 1976, p. 155). Thus, Hopper's principle of persistence lies in the fact that the former nominative markers can still perform their former function – at least partially so. The principle of layering lies in the employment of the accusative markers while the nominative markers are also still in use. This employment also relates to the principle of divergence, in that the accusative pronouns sometimes also function as nominative pronouns.

I argue that this example makes very clear how shifts can occur from one argument indexing system to another and also why it is problematic to make clear distinctions between pronouns, clitics and affixes. We should also note how the gradualness involved can give rise to a distributed way of expressing meaning: if a clitized pronoun still has some referential power at the start of a grammaticalization cycle, it may well stand on its own to properly refer in some contexts, though other contexts might warrant more elaborate references. In such contexts new free pronouns may be needed to jointly express the argument. (Cf. Hopper's principles above, cf. also Ariel, 1999 and Givón, 1976).

A crucial question now is which mechanics are responsible for the decategorialization and erosion of an item. In terms of the development of argument indexing strategies: how can we explain the affixation of an erstwhile unbound pronoun and how do we end up with obligatory indexing systems? As I will show, this is essentially a question of what precisely the effects are of an item's extension and hence, its increased frequency.

On erosion it has been suggested that its origins '[...] are in the automatization of neuro-motor sequences which comes about with repetition.' (Bybee & Hopper, 2001, p. 11) According to Dahl on the other hand, reduction is a result of a decrease in an item's informational value (Dahl, 2004, p. 173). To reconcile these suggested procedural and informational aspects involved, we can turn to so-called chunking phenomena '[...] which causes frequently-used sequences of lexical matter to acquire lexical storage as single, agglutinated mental representations' (Bush, 2001, p. 256). To explain these phenomena, we must first realize that reduction is shown to be governed by more elaborate probabilistic dynamics, rather than being only an effect of absolute frequency: items are reduced when they have a high predictability given their context, for instance in the sense of their neighbouring words (Jurafsky, Bell, Gregory, & Raymond, 2001). Secondly, and along the same line, it has been shown that probabilistic dynamics are at work in word-boundary palatalization (Bush, 2001). (Cf. also Bybee's Linear Fusion Hypothesis: items that are used together, fuse together. Bybee, 2002, p. 112.) We thus arrive at a view in which both

reduction and agglutination are governed by context-dependent probabilities. Such a view obviously fits well with the earlier observation that the *start* of grammaticalization is a matter of context-induced reinterpretation. (Also, note the gradualness involved here too, in the sense that the parameters do not constitute distinct phases.) I also suggest that these processes highlight another aspect of the functional characteristic of grammaticalization: it reduces the amount of resources needed for production, both in terms of raw production costs (i.e., a reduction of phonetic load) and perhaps more importantly, in terms of processing costs (i.e., a reduced attentional load) due to the automatization or proceduralization of grammatical knowledge. As for obligatorification, viz. an item becoming obligatory in *all* contexts that warrant – though not necessitate – its use, I argue the same. Though there is some redundancy involved, it seems to greatly simplify the general procedure which maps meaning to form.

2.2.2 From topic-shift marker to argument indexing

Having seen how free pronouns can in principle become bound argument indexes as a result of chunking, we should explore the question what first initialized the grammaticalization of pronouns. In Givón (1976) the grammaticalization cline is argued to have its origin in ‘[...] topic-shifting constructions in which the topicalized NP is co-referential to one argument of the verb’ (p. 151). (Note that the topic is what the discourse is about at any given moment.) In his view the contexts that warranted a more grammatical pronominal use were those wherein a topic-shift had occurred. To prevent ambiguous references in such contexts, a superfluous anaphoric pronoun was used in dislocated NP constructions to overtly mark or re-establish the topic. According to Givón, over-use of such constructions then lead to a reinterpretation of the topic-marker as being part of the verb’s inflectional paradigm.

To clarify this developmental path, consider first an outline of Givón’s own example in which two anaphoric discourse devices are contrasted: anaphoric pronominalization (AP) and topic-shift (TS) (Givón, 1976, p. 153, abbreviated):

(1)	Context	Once there was a wizard.
	AP	He lived in Africa.
	TS	? Now the wizard, he lived in Africa.
(2)	Context	Once there was a wizard who had two sons. The first was tall and brooding and spent his days in the forest hunting snails. The second was short and vivacious, but always game.
	AP	? He lived in Africa.
	TS	Now the wizard, he lived in Africa.

In (1) there can be no question as to whom “he” refers to. Unambiguous reference is therefore possible with a minimal amount of information, namely by means of AP. Though using TS would be redundant in this context, Givón remarks that the extra information provided by TS could also have a function at signal-level. That is, if the communication channel is noisy the redundancy could aid the hearer in receiving the message properly, which helps explain the eventual over-use of the construction in marked contexts. (p. 154). (Cf. also Dahl on the function of redundancy at signal-level 2004, pp. 9-11.)

(2) demonstrates that since the wizard’s second son was the last topic, AP would lead to an interpretation wherein that son is the intended referent. More information is thus needed to re-establish the topicality of the wizard, which is provided by using TS.

To motivate the construction's extension, Givón argues that an overuse of TS is natural under communicative stress. He supports this claim by pointing to research on early child-language by Gruber and Keenan and early syntax acquisition in Pidgins and Creoles by Limber (p. 156). Then, according to Givón, if TS is overused in marked contexts, the construction eventually gets reinterpreted as being the neutral syntax. That is, the topic-agreement anaphoric pronoun ultimately gets reinterpreted as an argument index which 'agrees' with subject or object, rather than the topic. (Note that this also constitutes a simplification of the grammar in the sense that indexing an argument is a simpler procedure than marking a topic *if* a topic-shift has occurred.)

Importantly, Givón's view accounts for the fact that argument indexing occurs more often for subjects than for objects, and more so definite objects than for indefinite ones (p. 151). This is so because under this account argument indexing '[...]' is governed by the universal hierarchy of *topicality*, i.e., the likelihood of various NP arguments being the *topic* of sentences, and more particularly the topic in topic-shift constructions' (p.152, original stress). Because definite NPs pertain to given information, they are more likely to be topics than indefinite NPs are. Therefore, if definite NPs occur more frequently as topics than indefinite ones, grammaticalization of definite object indexes should occur more often. The prevalence of subject indexing can be explained on the basis of animacy and anthropocentric principles. Firstly, humans are more likely topics than non-humans are, because we speak more of ourselves than of other things. Secondly, humans are more likely actors than non-humans are, because they are more involved and more intentional. (Put differently, non-humans are more likely to be undergoers or grammatical objects.) Thirdly then, we tend to express the frequently occurring human actor as subject, to also express in a grammatical way our human perspective on things (cf. Dahl 2008). Thus, if humans topics occur most often, while humans are more likely subjects and non-humans are more likely objects, we can easily see why subject indexing would develop more often than object indexing.

Now, there is one problem with Givón's account, namely that it explicitly relies on an over-use of topic-*shifting* markers, rather than an overuse of topic markers. Again, such a construction is needed, at least initially, if the intended referent is not predictable enough to refer to it only by means of AP. However, as Givón also remarks himself: '[...] the speaker tends to be the universal point of reference and the *most highly presupposed* argument' (p. 153, original stress). As Ariel notes, it would be very unlikely for first persons and second persons to be overtly marked as a re-established topic (Ariel, 1999, p. 249). Taking topic-shifting constructions as the source of argument indexing, we would therefore expect third person indexing to be the prevalent indexing pattern – which is empirically contradicted (Ariel, 1999, p. 213). Thus we need another account to explain how references to “highly presupposed arguments” could still lead to the prevalence of first and second person argument indexing. Givón's account is still important however. As I will discuss below, Ariel's account is less successful in explaining why third person indexing would develop.

2.2.3 From higher accessibility marker to argument indexing

In Ariel (1999) the cline from pronoun to argument index is seen as '[...] the result of speakers' intention to mark some referents as extremely accessible, even more accessible than regular pronoun antecedents are' (p. 198). The contexts that led to argument indexing were those situations wherein “highly accessible mental entities” (analogous to Givón's “highly presupposed arguments”) were referred to by attenuated pronunciation of pronouns to mark the intended referent's high predictability. Frequent occurrence of such attenuated pronouns

then led to their reinterpretation as being part of the verbs inflectional paradigm. (Cf. the chunking phenomena as described above.)

The general idea is that varying amounts of attentional resources are needed to retrieve or access mental representations of referents from working memory: if a referent's representation is readily retrievable, we say that it is highly accessible. According to Ariel speakers' referring expressions depend on their gauge of the intended referent's accessibility in listeners' minds. Those that are easily accessible need few attentional resources and hence less informative linguistic items (e.g., pronouns, demonstratives) to be retrieved. Those that are less accessible on the other hand, need more informative references to be retrieved from memory and are thus referenced as such (e.g., by means of full NPs or proper names). Therefore in Ariel's view, speakers' ways of referring also serve as a cue for listeners; in essence an accessibility marker.

As to what determines the accessibility of a referent Ariel's main focus is on '[...] the degree of salience of the potential antecedent (linguistic or non-linguistic) [...]' (p. 205). That is for instance: speakers are more salient than addressees, who are more salient than non-participants; humans are more salient than non-human animates, which are more salient than inanimates; repeated references are more salient than few previous references; and so on (p. 206). (Note that the factors that determine an antecedent's salience largely converge with the factors that determine the antecedent's likelihood of being a topic.) Now as already mentioned, speech act participants (viz. speaker and addressee or first and second person), are highly salient, more so than third person antecedents. Their very high level of accessibility then, argues Ariel, is marked by speakers by attenuating the pronunciation of pronouns (e.g., by destressing them). Crucially, speech act participants are continuously more accessible than other referents (p. 221): they are physically present, they are a point of reference in the discourse, they are very often mentioned, etc. Thus, since first and second pronouns are very often reduced, they develop into argument indexes more often than third person references (cf. chunking phenomena described above). The accessibility route to argument indexing can therefore account for the cross-linguistic prevalence of first and second person argument indexing (pp. 213-221). By contrast, Givón's account has the merit that it can better account for the development of third person indexing. His account would actually predict the development of third person indexing, given the premise that marking the topic-shift to first and second persons is unlikely.

2.3 Conclusion

In this chapter I have tried to give a functional account of the development of argument indexing systems. In line with Haspelmath I have considered indexing systems to be phenomena *sui generis*, since free pronouns, clitics and agreement affixes cannot always be functionally demarcated and also because it is problematic to (always) speak of agreement. By placing Givón's and Ariel's accounts in the general framework of grammaticalization theory, we can see why these problems might arise. If all argument indexing systems have developed from free pronouns, they would form a continuum of various degrees of grammaticalization. Because of the gradualness involved in grammaticalization it is then only expected that agreement affixes and free pronouns cannot always be clearly separated. We could imagine how a pro-indexing system would develop from a free pronominal system, which grammaticalizes up to the point of becoming a bound index system. The reason why cross-indexing is forbidden in such a system may then be that the indexes still have too much semantic or morphosyntactic content for them to co-occur with a conominal. From this system, a cross-indexing system may then develop if the indexes undergo further

grammaticalization. The indexes would then become obligatory and low enough on semantic and morphosyntactic content to occur with conominals. However, since their original referring function still lingers on, they would also be able to act as arguments independently. Importantly we can also imagine how at this point pattern layering may start to arise. For instance new, free pronouns may be recruited to jointly refer to antecedents together with the index. Then, in yet a later stage of grammaticalization, a gramm-indexing system would develop out of the former cross-indexing system, when the index would have lost so much of its properties that its independent use is not possible anymore in any context.

3. The stability of argument indexing systems

In the previous chapter I have shown how a pronoun's extension increases its frequency, thereby leading to its increasing loss of semantic and morphosyntactic properties and phonetic substance. I have also shown how an index's further grammaticalization would lead to a shift from a pro-indexing to cross-indexing and finally a gramm-indexing system. As a consequence, the index becomes increasingly inept to independently refer to an antecedent. Assuming no decrease in the index's frequency, one may therefore expect an exponential rate of loss, in the sense that index starts to lose its properties ever more quickly when its grammaticalization continues. However, this does not turn out to be true. For instance the indexing systems in Germanic languages are assumed to date back to Proto-Germanic, suggesting an age of some 2000 years (Dahl, 2004, pp. 269). Despite the layering involved in grammaticalization, this seems surprising after the observation that an item's high frequency constitutes its loss of properties. Additionally, as highlighted in chapter one, the index also does not seem to be very functional or even redundant as an argument marker. The question thus is: why do argument indexing systems exhibit such great diachronic stability? In this chapter I will therefore try to give a functional account for their diachronic preservation. To that end I will first look at the role of frequency in the later stages of grammaticalization. Then I will also look in what way the index could be useful in terms of parsing performance.

3.1 Cultural transmission and the dual-nature of frequency

Many authors suggest a dual-nature of frequency in the process of grammaticalization (cf. Bybee & Hopper, 2001; Bybee & McClelland, 2005; Dahl, 2004; Diessel, 2007). A surprising effect of the high frequency involved in grammaticalization is that while highly frequent items more easily undergo reductive changes on the one hand, they are at the same time more resistant to change (Dahl, 2004, p. 159). One way to account for this dual-nature of the role of frequency is to say that frequent patterns are in general acquired more easily by children (Dahl, 2004, p. 159). An interesting example of this comes from Kirby (2001) who simulated the cultural evolution of linguistic behaviour using an iterative learning model. In his model, a speaking agent was given a random set of meanings from a pre-defined meaning space¹. This agent then tried to express the meanings using his knowledge of the language. If the agent did not have a (complete) mapping scheme to express a meaning, he randomly invented (part of) an expression and also tried to learn from this invention. A learning agent took these expressions as a learning set and consequently became a speaker itself. Then a new learning agent was created and a new simulation cycle would be started.

Importantly, the first speaker did not have any grammar and therefore initially only produced non-compositional strings. Assume for instance that this speaker needed to express *rides (john, bike)* and randomly produced the string *jrj*. He then learned one rule, which idiosyncratically mapped the meaning to form. To express *rides (mary, bike)* he would invent a new string, say *ns*, for which he would then also create a new idiosyncratic mapping rule. If now a pattern was created, the agent would start to analyse it in a compositional way. (Note that in the beginning of the simulation it would take a while for this to happen: a pattern would have to be created by "accident".) Assuming that he would produce *rprb* to express

¹ Following Shannon (1956): 'Messages and the corresponding signals are points in two "function spaces" and the modulation process is a mapping of one space into the other.' In other words, messages (meanings), signals (forms) and the mapping between them (modulation in signal theory, or syntax in linguistics) are pictured as points on Cartesian planes to abstract away from their content. This may be done for computational reasons or for instance for the sake of argument.

rides (john,horse), the speaker would now have learned the mapping rules below (S/ denotes the special category of well-formed expressions):

(1)	<i>Unanalysed grammar</i>		
	S/rides(john,bike)	→	jrb
	S/rides(john,horse)	→	rprb
	S/rides(mary,bike)	→	ns

Due to both the similarity and the dissimilarity between *j-rb* and *rp-rb*, the rules below could be created. In these rules A/ represents a new category or set, whose members can be used in any rule which can take them as ‘arguments’. Importantly, nothing can be said about the “mary-rule” yet.

(2)	<i>Analysed grammar</i>		
	S/rides(mary,bike)	→	ns
	S/rides(john, x)	→	A/x rb
	A/bike	→	j
	A/horse	→	rp

Now over time this model only generated maximally compositional languages, which evidently would not correspond with the evolution of natural languages. Kirby therefore included random erosion in his model, meaning that speakers could fail to produce some characters in an utterance string. Crucially, if *rides(mary,bike)* would be pronounced as *n* instead of *ns*, no compositional analysis would be possible anymore, thereby introducing true irregularity into the mapping space. However, since learners were not exposed to the entire meaning space, the lifetime of non-compositional rules were generally very short. Analogous to natural acquisition, this is so because such a rule can only be acquired if the specific, corresponding utterance is heard. Compositional rules on the other hand, can emerge from exposure to various sorts of utterances. Thus, *n* for *rides(mary,bike)* would disappear if the meaning did not get expressed, to eventually be replaced by compositional rules. Therefore, to generate more natural states of stable linguistic regularity and irregularity, Kirby’s solution was to model a non-uniform frequency distribution in the meaning space, i.e. increasing the likelihood of some utterances to be produced, acquired and be produced again. The result was that in an overall compositional mapping and signal space, some non-compositionality got preserved over time. As Dahl argued, this would suggest that frequent patterns can more easily be acquired by children than less frequent patterns. This is so because children are more frequently, or perhaps necessarily, exposed to them. The exposure to low frequent items on the other hand, occurs less often or perhaps not at all. This may then result in their replacement by more frequent patterns.

It could be argued that the acquisition and preservation of grammatical irregularity is different from the stability of argument indexing systems, since the latter involves the acquisition of compositional rules. However, Bybee & McClelland (2005) argue that the distinction between regular and irregular forms is gradual, rather than categorical. Crucially, one of their arguments comes from experiments with connectionist models (models that do not rely on rules but on a series of weighted nodes in the mapping space), which have shown that children’s acquisition of both regular and irregular verbs can be modelled without using rules (p. 391). They therefore hold all patterns to be processed by the same underlying mechanism, namely one that is sensitive to a pattern’s frequency, increases fluency of production and processing after frequent exposure to it and subsequently reduces any compositional analysis between the items in the pattern (p. 396). Note that these are the same

mechanisms involved in linguistic chunking (cf. chapter 2) and that chunking does away with the distinction between regularity and irregularity in the sense that all frequent patterns are processed holistically.

The view above would belong to the so-called single mechanism paradigm to verbal inflection. Theories on the processing of regular and irregular verbs can be roughly divided into two views, namely the single mechanism and the dual mechanism account. The former holds that all frequent surface forms (i.e., inflected forms) are stored lexically and that the productivity of inflectional paradigms is an emergent property of the associative nature of the lexicon. In the latter view only irregular surface forms are stored lexically, while regular forms are produced online from lexically stored stems and a rule-based grammar (Hare, Ford, & Marslen-Wilson, 2001, pp. 182-185).

Assuming a single mechanism account, I suggest that we can account for the dual nature of high frequency in the following way. During the initial stages of a pronoun's grammaticalization, it frequently appears adjacent to a verb. The verb's frequency at this point does not matter, what matters is that the probability that the verb is followed by this pronoun is relatively high. Then, precisely because this pronoun is so predictable in all those contexts, there is a gradual loss of compositional analysis and the pronoun thus becomes a part of many lexicalized verbal surface forms. What now crucially changes is that the verb's frequency, or rather the frequency of the surface form, *does* start to matter. Since it is less predictable in its context than the original pronoun was, the chances are smaller for reduction to occur. Importantly, frequent words (including verbal surface forms) are still prone to reduction (Bybee & McClelland, 2005, p. 390): '*just, went or don't* are more likely to have a final /t/ or /d/ deleted than lower frequency words such as *innocent, interest, or attract*'. In other words, there would be no dual-role of frequency, because the reduction process involved in highly frequent items does not change. Rather, it is the item itself that changes, since it becomes part of an emergent pattern. Since it is also true that the pattern as a whole can easily be acquired by children (cf. Kirby and Dahl), the combined effect of cultural transmission and chunking phenomena would indeed account for an index system's great stability.

It should be noted however that it is not entirely clear whether the single or dual mechanism account is true. There are results in favour of both the single mechanism account (cf. Bybee & McClelland 2005; cf. also Hare, Ford, & Marslen-Wilson, 2001) and the dual mechanism account (cf. Newman, Ullman, Pancheva, Waligura, & Neville, 2007, which also includes reviews of other studies). Additionally it should be noted that holistic processing is a product of a pattern's high frequency, suggesting that compositional processing does take place for patterns of a lower frequency. Though more research is needed, I suggest that under both accounts we can imagine the pronoun to be changing in nature. Assuming a dual mechanism account, the conventionalization of the bound index would mean that it becomes part of a morphosyntactic rule. The bound morphemes involved in these rules may then be less prone to reduction or interact differently with frequency than regular lexical items do. In fact Diessel (2007, p. 214) 'emphasize[s] that frequency is not the sole factor affecting the emergence of linguistic structure.' Rather he argues that cross-linguistic tendencies are also motivated by pressures from syntactic parsing and information processing. I will turn to this notion below.

3.2 Parsing performance

Though a grammatical index may not independently be used anymore to refer to an antecedent, it may still perform some function(s) in its interaction with other patterns. For instance, Nichols (1986) argues that argument indexes signal the grammatical relations early

on in verb-initial sentences. Suggestions can also be found in Lehman (1988) who argues that agreement in general assists in (re)identifying antecedents. In Dahl (2004) there is the notion of redundancy management, which entails the use of error detecting or error correcting mechanisms during communication. The idea is that to compensate for the possible distortion of a message during noisy communication, one could express more than informationally necessary (cf. also Givón on the over-use of topic-shift). This can be done either as a “data integrity check” (do the index’s features agree with the nouns features?) or even as a means to reconstruct the signal altogether. As I will explain, my suggestion is that the proposals above may be related to parsing performance.

Hawkins (2010, p. 206) proposes the Performance-Grammar Correspondence Hypothesis (PGCH): ‘grammars have conventionalized syntactic structures in proportion to their degree of preference in performance, as evidenced by patterns of selection in corpora and by ease of processing in psycholinguistic experiments’. Hawkins’s idea is that the human parser operates on principles of efficiency and that linguistic patterns that lead to more efficient parsing will get conventionalised. He proposes three principles, namely Minimize Domains (MD), Minimize Forms (MF) and Maximize On-line Processing (MaOP). The first entails that parsing distances in general are preferred to be kept short, especially between two elements that are semantically or syntactically related (pp. 209-210). The second means that elements are preferred to be kept short and low on formalized semantic or grammatical properties (e.g., a pronoun would be preferred over a full NP). The latter means ‘[...] that it is preferable to be able to recognize syntactic and semantic properties efficiently throughout the processing of a sentence [...]’ (p. 219). To clarify MaOP, when an element *e* is processed it must be semantically and syntactically integrated in the parse structure. The properties needed for correct integration may not be formalized properties of the item itself (cf. MF), but may need to be assigned to *e* when it is processed. Its integration would then depend on contextual information or on the parsing of other elements. The properties that need to be assigned to *e* should be readily retrievable, so that it in turn can get integrated efficiently. This is to avoid a heavy burden on working memory or to reduce the chances of faulty property assignments, potentially leading to reanalyses (i.e., rebuilding the parse structure altogether). Note how the three principles are related: short forms will keep parsing distances low, which will in turn prevent long delays in property assignments. On the other hand: forms should not be too short or low in distinctions, since this can increase the chance of misassignments (cf. Givón on using only AP after a topic-shift has occurred) or delays. Such a delay could occur, for instance, in a VSxO clause if there are no prior expectations about the verb’s valency and neither the verb nor the subject would be marked for the transitive nature of the clause. This is so because a correct parse structure can only be built after the correct valency property has been assigned to the verb, which can only be done after the object has been parsed.

Now, due to the reversed word order in non-declarative sentences, we can also think of concrete examples of the early signalling of grammatical relations in English. Compare for instance (3) and (4) below:

- (3) Were your brothers crying when you got home?
- (4) Was your brothers’ crying bothering you?

The difference between “were” in (3) and “was” in (4) is that the latter prevents a subject interpretation of “your brothers” and subsequently signals that the sentence does not start with the matrix clause. Importantly, under a V/2-constraint like in many Germanic languages, the verb can occur prior to the arguments even in declarative sentences. Therefore, though an

argument index cannot always discern subject from object or indeed could seem redundant if a language also has a case marking system, it may well increase the parsing performance by preventing parsing ambiguities or reanalyses. (Cf. also Gibson, Pearlmutter, Canseco-Gonzalez, & Hickok, 1996 on how number indexing can help disambiguate between NP attachment sites in sentence processing.)

Suggestions on how an argument indexes could function as error checking mechanisms during processing come from studies in the event related brain potential (ERP) paradigm. In ERP studies, the brain's electrical activity is measured to capture its responses to experimental stimuli. A host of studies have been done (cf. Molinaro, Barber, & Carreiras, 2011, for a review of 30 ERP studies on agreement errors) and several ERP-signals have been identified and linked to specific parsing difficulties, namely (Mancini, Molinaro, Rizzi, & Carreirasa, 2011, p. 1362):

- (i) LAN (left anterior negativity), a negative response between 200 and 500 ms after the stimulus, which is seen as morphosyntactic anomaly detection
- (ii) N400, a negative response peaking at around 400 ms after the stimulus, which is seen as an effect of difficulties in lexical-semantic processing;
- (iii) P600, a positive response arising after about 500 ms which has been interpreted as a signal of increased syntactic processing or reanalysis processes.

I suggest that especially (i) and (iii) could be taken to indicate that the argument index functions (also) as an error checking mechanism, in that the parser cannot only detect morphosyntactic errors but can also attempt repairs if such errors are found.

Interestingly, there is also an ERP study suggesting that the argument index is more than just a formal copy of the properties of the argument it indexes (Mancini et al., 2011). Mancini et al. used an indexing construction in Spanish called unagreement. This construction allows for person incongruence between plural third person arguments and plural argument indexes, for instance (p. 1363):

- (5) *El cocinero cocinaste un pescado muy rico
The cook_{3.sg} cooked_{2.sg} fish very tasty
*The cook cooked very tasty fish.
- (6) Los cocineros cocinamos un pescado muy rico.
The cooks_{3.pl} cooked_{1.pl} a very tasty fish.
We cooks cook/cooked a very tasty fish.

In (5) both the subject and the index are singular, but they are incongruent on the category of person. This sentence is ungrammatical. However (6) is considered to be grammatical, despite the person incongruence between subject and argument index. This is so because a plural third person subject may be followed by a first or second person plural index, resulting in a we/you_{pl} reading of the subject.

Mancini et al. argued that most processing models have emphasized morphosyntactic aspects of processing and have assumed formal feature-checking operations, independently from the pragmatic functions of the agreeing elements. However, the unagreement condition

would question such a formal view: the fact that the person feature on the verb forces a reinterpretation of the person feature of the argument suggests that the argument index is not just a formal feature copy of the properties of the argument. Using a sentence acceptability task Mancini et al. measured participants' ERP-responses to normal agreement (control), unagreement (6) and agreement errors (5). Relative to the control condition, the agreement errors showed both strong N400 and P600 effects, suggesting both increased lexical-semantic and syntactic processing, and attempts at reanalyses. Interestingly, the unagreement relative to the control showed a stronger N400 effect, but a weaker P600 effect between 500 – 800 ms, though a similar P600 effect between 800 – 1000 ms. Mancini et al. suggested that the initially reduced positivity could be due to the absence of the usual costs involved in syntactic integration. The parser instead relied on the person information retrieved from the verb, thus indeed suggesting that the index is more than a formal feature copy of the argument. The lack of a difference in the later P600 window was interpreted as a result of the grammaticality of both the constructions: no attempt at reanalysis was made since it was not necessary.

Though the unagreement construction may be typical for Spanish, I suggest that we can take the following from these results. Firstly, Hawkins's suggestion that the parser disprefers misassignments and reanalyses seems to be corroborated by these results. It in fact seems to be the case that the parser is actively engaged in preventing any such operation: integration of the conominal's person information is not attempted after the detection of the unagreement condition and no reanalysis is attempted later on. (However, as also suggested above, reanalysis are in fact done if true errors are detected. I interpret this in a Dahlian fashion, namely that grammar also has an error checking function.) Secondly, while in this example the index's properties are used reactively, the conominal's properties first lead to the prediction of a third person index (evidenced by the N400 effect). Similarly we can imagine how in a verb-initial sentence the index's properties would lead to predictions about the parsing structure. In this sense also Nichols suggestion on the early signalling of syntactic relations seems plausible. Lastly though perhaps not directly related to parsing performance, these results seem to corroborate Haspelmath's notion of the distributed expression of meaning (and also Hopper's principle of layering). At least in Spanish the index seems to be more than an agreement marker, in the sense that it also has a pragmatic function. In fact the notion of agreement seems particular inappropriate in this example. Thus in Haspelmath's words (2013, p. 13): 'the index and its conominal jointly constitute the subject nominal.' Either way, in the light of the observations above and in line with Hawkins's PGCH my suggestion is that we could indeed view the conventionalisation and, importantly, *the conservation* of argument indexes (partly) as a result of their contribution to parsing performance.

3.3 Conclusion

Argument indexing systems are apparently very stable. This is surprising because of earlier observations: a pronoun's increased frequency leads to its increasing loss of properties and an index becomes increasingly inept to independently refer to antecedents. Additionally, as observed in chapter one, argument indexing seems somewhat poor as an argument marking strategy. The question thus was: why do argument indexing systems exhibit such great diachronic stability? In this chapter I have therefore tried to give a functional account for the diachronic preservation of argument indexing systems.

I have firstly looked into the seemingly dual-nature of the frequency involved in grammaticalization: while highly frequent items more easily get reduced, they also become more resistant to change. Language acquisition could play an important part here, in the sense

that children may more easily acquire patterns that occur frequently. I have also suggested that the index changes in nature, rather than that the role of frequency changes. Under an account that emphasizes holistic processing, I suggested that the index becomes part of many lexicalized surface forms. The productive nature of the indexing pattern would then emerge from the associative nature of the lexicon. Under this account it should still be true that highly frequent (surface) forms are subjective to reduction, as is indeed suggested by experimental results. Though a strictly holistic view is problematic, I have also suggested how under an account that emphasizes compositional processing the item may change in nature. The index may change from a lexical pronoun to a morpheme subjective to conventionalized, morphosyntactical rules. These morphemes may then interact differently with frequency than regular lexical items do.

My second line of inquiry followed from this notion. Adopting Hawking's position on the conventionalization of patterns as a result of their contribution to parsing performance, I have suggested a few ways in which an argument index may contribute to parsing performance. The index could for instance signal grammatical relations early on in the sentence, thereby assisting in correct predictions of the parse structure and reducing the chances of property misassignments, or faulty parse analyses. I have also suggested how the index may serve as an error checking mechanism, on the basis of studies within the ERP-paradigm. The conclusion from this line of inquiry was that the preservation of argument indexes could indeed be linked to its contribution to parsing performance.

Because of the observations made in this chapter, I would therefore like to conclude that though frequency plays an important role in grammatical preservation, it is not the only factor to take into account.

4. Conclusion

Argument indexing seems ineffective as an argument marking strategy compared to word order and case marking. Indexing could also be considered to be redundant, considering the fact that it may be obligatory even in intransitive clauses, or the fact that a language may also mark core arguments by different means. These observations raised the question why languages mark the verb at all. Two perspectives on this question were taken: firstly, how can we functionally explain the emergence of verbal head-marking, and secondly, how can we functionally explain the continuing existence of verbal head-marking?

Following Haspelmath I have avoided the notion of agreement markers as much as possible in answering these questions. Problems with this notion are that there is not always a controlling conominal, making it problematic to always speak of agreement, and additionally that pronouns, clitics and affixes cannot always be functionally demarcated.

In chapter one I tried to give a functional account of the development of argument indexing systems, including Haspelmath's observations about them. The central conclusion of this chapter was that indexing systems may have their origins in free pronouns and that further grammaticalization of the index could lead to shifts from one indexing system to another. In other words, if all argument indexing systems have developed from the grammaticalization of free pronouns, they would form a continuum of various degrees of grammaticalization. Because of the gradualness involved in grammaticalization it is then to be expected that agreement affixes and free pronouns cannot always be clearly separated.

Furthermore, I discussed two different accounts that support the view that free pronouns are the source of argument indexes: in Givón's view the origins of argument indexes are anaphoric topic-shift markers, whereas in Ariel's account the source of these indexes lies in reduced referential pronouns. Together they can account for different cross-linguistic patterns.

Importantly, we have also observed how pattern layering may be introduced into an indexing system. Due to the gradual nature of grammaticalization, new patterns may emerge while older patterns are still in use. Together they can distributedly express meanings. For instance new, free pronouns may be recruited to jointly refer to antecedents together with the index.

In chapter two I tried to account for the stability of argument indexing systems. Argument indexing systems are apparently very stable, which is surprising because of earlier observations about the index's loss in properties and functionality due to its high frequency. I have therefore looked into the seemingly dual-nature of the frequency involved in grammaticalization: while highly frequent items more easily get reduced, they also become more resistant to change. Language acquisition could play an important part here, though I have suggested that the item changes in nature – rather than that the role of frequency does. I have also suggested a few ways in which an argument index may contribute to parsing performance. The index could for instance signal grammatical relations early on in the sentence or serve as an error checking mechanism. The conclusion of this chapter was that though frequency plays an important role in grammatical preservation, it is not the only factor to take into account. The preservation of indexing systems may also be linked to parsing performance.

In terms of giving a functional account of the existence of argument indexing strategies, my main conclusion would be that both the emergence and preservation of argument indexing systems have their basis in language use.

5. References

- Aitchison, J. (2001). *Language change, progress or decay?* Cambridge: Cambridge University Press.
- Ariel, M. (1999). The development of person agreement markers: From pronouns to higher accessibility markers. In M. Barlow, & S. Kemmer (Eds.), *Usage based models of language* (pp. 197-260). Stanford: CSLI Publications.
- Bush, N. (2001). Frequency effects and word-boundary palatalization in English. In J. Bybee, & P. Hopper (Eds.), *Frequency and the emergence of linguistic structure* (pp. 255-280). Amsterdam: John Benjamins Publishing Company.
- Bybee, J. (2002). Sequentiality as the basis of constituent structure. In T. Givón, & B. Malle (Eds.), *The evolution of language out of pre-language* (pp. 109-134). Amsterdam: John Benjamins Publishing Company.
- Bybee, J., & Hopper, P. (2001). Introduction. In J. Bybee, & P. Hopper (Eds.), *Frequency and the emergence of linguistic structure*. Amsterdam: John Benjamins Publishing Company.
- Bybee, J., & McClelland, J. (2005). Alternatives to the combinatorial paradigm of linguistic theory based on domain general principles of human cognition. *The linguistic Review*(22), 381-410.
- Dahl, Ö. (2004). *The growth and maintenance of linguistic complexity*. Amsterdam: John Benjamins Publishing Company.
- Dahl, Ö. (2008). Animacy and egophoricity: Grammar, ontology and phylogeny. *Lingua*(118), 141-150.
- Diessel, H. (2007). Frequency effects in language acquisition, language use, and diachronic change. *New Ideas in Psychology*(25), 108-127.
- Gibson, E., Pearlmutter, N., Canseco-Gonzalez, E., & Hickok, G. (1996). Recency preference in the human sentence processing mechanism. *Cognition*(59), 23-59.
- Givón, T. (1976). Topic, pronoun and grammatical agreement. In C. Li (Ed.), *Subject and topic* (pp. 151-188). New York: Academic Press.
- Haspelmath, M. (2013). Argument indexing: A conceptual framework for the syntactic status of bound person forms. In D. Bakker, & M. Haspelmath (Eds.), *Languages across boundaries: Studies in memory of Anna Siewierska* (pp. 197-226). Berlin: De Gruyter Mouton.
- Hawkins, J. (2010). Processing efficiency and complexity in typological patterns. In *Oxford Handbook of Language Typology* (pp. 206-226). Oxford: Oxford University Press.
- Heine, B. (2003). Grammaticalization. In B. D. Joseph, & R. D. Janda (Eds.), *The handbook of historical linguistics* (pp. 575-601). Malden: Blackwell Publishing.
- Heine, B., & Kuteva, T. (2007). *The genesis of grammar: A reconstruction*. Oxford: Oxford University Press.
- Jurafsky, D., Bell, A., Gregory, M., & Raymond, W. (2001). Probabilistic relations between words: Evidence from reduction in lexical production. In J. Bybee, & P. Hopper (Eds.), *Frequency and the emergence of linguistic structure* (pp. 229-254). Amsterdam: John Benjamins Publishing Company.
- Kirby, S. (2001). Spontaneous evolution of linguistic structure: An iterated learning model of the emergence of regularity and irregularity. *IEEE Transactions on evolutionary Computation*, 5(2), 102-110.
- Lehmann, C. (1988). On the function of agreement. In M. Barlow, & C. Ferguson (Eds.), *Agreement in natural languages: Approaches, theories, descriptions* (pp. 55-65). Chicago: CSLI Publications.

- Mancini, S., Molinaro, N., Rizzi, L., & Carreirasa, M. (2011). When persons disagree: An ERP study of Unagreement in Spanish. *Psychophysiology*(48), pp. 1361-1371.
- Molinaro, N., Barber, H., & Carreiras, M. (2011). Grammatical agreement processing in reading: ERP findings and future directions. *Cortex*(47), 908-930.
- Newman, A., Ullman, M., Pancheva, R., Waligura, D., & Neville, H. (2007). An ERP study of regular and irregular English past tense inflection. *NeuroImage*(34), 435-445.
- Nichols, J. (1986). Head-Marking and Dependent-Marking Grammar. *Language*, 62(1), 56-119.
- Shannon, C. (1998). Communication in the presence of noise. *Proceedings of the IEEE*, 86(2), 447-457.