



Sentence Parsing in a Morphologically Rich Language – Finnish

Jukka Hyönä* and Seppo Vainio

University of Turku

Abstract

We review evidence on how sentences are parsed in Finnish – a morphologically rich language. The reviewed studies focus on effects of word order, morphological agreement, and morphological complexity. As regards word order, it has been shown that infrequent word orders are more difficult to process than frequent word orders. Moreover, pragmatic constraints can wipe out the effect of structural frequency, although the pragmatic influence is non-immediate. Morphological agreement in modifier–head noun phrases facilitates their processing. The effect is delayed in nature, which (in combination with other evidence) suggests that facilitation operates at the level of syntactic integration. Finally, evidence is reviewed that demonstrates an effect of morphological complexity and density in the processing of complex verb constructions, but only when the complex and less complex constructions are equally frequent. This is not the case when the complex construction is more frequent, suggesting the structural frequency can override a morphological complexity effect.

In this article, we review empirical evidence collected on parsing written sentences in Finnish. Finnish is an agglutinative, morphologically rich language that uses case endings in noun phrases to mark the syntactic status of sentence constituents. A total of 15 cases exist in the language, of which 13 are in active use. Verb constructions may also be morphologically complex; for example, so-called converb constructions are used to replace a full subclause. Morphological marking of sentence constituents in turn goes hand in hand with flexibility in ordering sentence constituents. In principle all possible constituent orders exist, although the SVX (S = subject, V = verb, X = object, adverbial, or predicative) order, the canonical order in Finnish (and many other languages), is the most frequent one (Hakulinen et al. 1980). Finnish belongs to a small Finno-Ugric language family. About 23 million people in the world speak a language that belongs to this language family. Finnish is relatively closely related to Estonian and more distantly related to Hungarian. Finnish resembles Estonian both in vocabulary and syntax, whereas the family resemblance between Finnish and Hungarian is primarily restricted to syntax.

We review here all existing studies conducted in Finnish on written sentence parsing by adult readers. Given the heavy use of morphology in marking grammatical roles, the Finnish studies have focused on the effects of morphology on sentence parsing. Apart from morphological marking, we also review studies on effects of structural frequency and morphological complexity. The emphasis significantly departs from parsing studies of English – the most studied language in psycholinguistics – which have made use of frequently appearing local syntactic ambiguities in the language, such as garden-path sentences like *Since Jay jogs a mile seems like a long distance to him* (Frazier and Rayner 1982). The underlying idea here is that by leading the human parser down the garden path, typical parsing strategies will be revealed. The Finnish studies depart from this line of research in focusing on the processing of syntactically unambiguous structures. The working hypothesis in our own studies has been that as long as morphological markers are available in the surface structure of the text and they also reliably cue the sentence structure (Bates and MacWhinney 1989), they will be readily utilized by written language comprehenders.

In our studies, we have primarily used the eye-tracking method that has been proven to be a very fruitful measure to study online written language processing (see Carreiras and Clifton 2004, for further details on sentence comprehension methodologies). The attractiveness of this method is that it provides an online record of the reading process without a need to use other tasks extraneous to the actual processing (such as button pressing or oral response) that may potentially contaminate the natural parsing process as it evolves over time. The application of the method makes recourse to the eye-mind hypothesis (Just and Carpenter 1980), according to which there is a close relationship between what a reader looks at in the text and what his/her mind is engaged with. Not only does the eye-tracking method allow for natural, uninterrupted processing, but it also provides a detailed record of the time course of processing. The most informative measures are the durations of eye fixations made during reading. Eye fixations are typically grouped into fixations made during the first-pass versus second-pass reading of a word or phrase. First-pass fixations are made during the initial encounter with each sentence constituent (or some other text region of interest), while second-pass fixations are looks that are directed back to an already processed constituent. Thus, first-pass fixations index more immediate parsing decisions, while second-pass fixations reveal relatively more delayed effects, for example, in the form of reanalyses (for a review, see Clifton et al. 2007). Typically researchers sum up the durations of fixations made on the critical text region to derive a measure of first-pass and second-pass fixation time. These processing time measures are then used to index the relative processing difficulty of different sentence constructions (i.e. by assuming that short fixation durations imply ease of processing).

In our review, we deal with the following questions related to sentence parsing in Finnish: (1) how variation in word order affects online sentence

processing; (2) whether comprehenders make use of morphological agreement present in Finnish noun phrases when assigning grammatical roles to noun phrases; and (3) whether morphological complexity and density influence sentence parsing. The choice of topics is dictated by the availability of evidence (for which the present authors bear a significant responsibility). The common thread that ties these studies together is the use of morphological marking in sentence parsing.

Effects of Word Order in Sentence Parsing

Hyönä and Hujanen (1997) conducted a study on effects of word order on processing sentences in Finnish (for a review of word order effects across a range of languages, see Gibson 1998). As noted above, the order of sentence constituents in Finnish is basically free, as all possible combinations of major sentence constituents can be used. This flexibility of word order is associated with marking the sentence constituents with case inflections (see Gerdts 1990). However, case marking is not always completely unambiguous. Even though sentence subjects are typically zero-marked (they appear in the nominative case without any suffix attached to them), they can also appear in the partitive case (see, for example, Kaiser and Trueswell 2004, for further details), which is the most frequent case ending of sentence objects. Sentence objects can also appear in the accusative (identical in form to genitive) or nominative case. The choice between the partitive versus accusative/nominative case for objects is made depending primarily on the completeness of the act denoted by the main verb (partitive is used for incomplete acts). Adverbial phrases, on the other hand, are always marked unambiguously with one of six locative cases (e.g., *pöydällä* = on the table, where the locative case ending *-llä* corresponds to the English preposition *on*).

Effects of word order variation were examined by Hyönä and Hujanen (1997) by comparing the processing of subjects, objects, and adverbials when they appeared sentence-initially. As noted above, the SV order is canonical, whereas the OV and AV orders are non-canonical in Finnish. Following type of sentence constructions we used:

- 1a. *Subject*: Lopulta *politiikka* tuhoaa joustavuuden päätöksenteossa.
(Finally politics (nom.) destroys flexibility (acc.) decision-making (iness.))¹
'Finally the politics destroy the flexibility in decision-making.'
- 1b. *Object*: Lopulta *politiikan* tuhoaa jatkuvasti kasvava nukkuvien puolue.
(Finally politics (acc.) destroys continuously growing body of non-voters (nom.))
'Finally the politics are destroyed by the continuously growing body of non-voters.'
- 1c. *Adverbial*: Lopulta *politiikassa* tuhoaa moni poliitikko kansansuosionsa.
(finally politics (iness.) destroys many politician popularity-his (acc.))
'Finally in the politics many politicians destroy their popularity.'

The target phrase [presented above in italics; (*in*) *the politics* in English] appeared sentence-initially preceded only by an adverb (*lopulta* = finally). The target phrase was either the sentence subject, object, or an adverbial. The participants read these sentences silently for comprehension, while their eye fixation patterns were registered. The results on the first-pass fixation time showed a reliable effect of word order. The two non-canonical orders (sentences starting with an adverbial or an object) received reliably longer first-pass fixation times than the canonical order. However, the AV and OV orders did not differ from each other, which suggests that ambiguity in morphological marking seemed irrelevant (ambiguity exists in marking objects but not adverbials). Thus, frequency of occurrence seems to be at stake here, as SV sentences are much more frequent in Finnish than OV or AV sentences. An analogous effect was also obtained in second-pass fixation time, which suggests that even though the effect of word order was immediate (appeared when first encountering the sentence constituent), it lingered on during later processing as well.

The subject preference effect is consistent with the active filler hypothesis of Frazier (1987) as well as exposure-based models of parsing (e.g., Bates and MacWhinney 1989; MacDonald et al. 1994; Trueswell et al. 1994; Mitchell et al. 1995), which all assume parsing decisions to be based, among other things, on the relative frequency of exposure to different sentence structures. It is also in line with Gibson's (1998) SPLT theory, which explains the processing cost observed for non-canonical orders (in our case OV and AV sentences) as a working memory effect. When a sentence starts with an object or an adverbial, an expectation is created that a subject will appear later in the sentence, which increases working memory load and subsequently slows down processing. On the other hand, the data speak against the notion of head licensing (Abney 1989; Pritchett 1991), which assume grammatical relations not to be disambiguated locally by case marking but only by the main verb of the sentence (i.e., at the time the main verb is encountered). A highly reliable effect of morphologically marked grammatical role observed in the first-pass fixation time is clearly inconsistent with the notion of head licensing but consistent with the view that grammatical roles are assigned incrementally.

Kaiser and Trueswell (2004) have questioned the previous interpretations proposed for the subject preference effect by suggesting that the effect merely reflects an out-of-context effect, that is, the target sentences were presented without a fitting context. Their reasoning is based on the fact that, at least in Finnish, non-canonical word orders serve pragmatic functions (Vilkuna 1989). More specifically, for the sentence object to appear prior to the main verb, its referent is typically known from previous discourse (i.e., it contains old information).

In their first experiment, Kaiser and Trueswell (2004) compared the processing of OVS and SVO sentences that were presented after a short, two-sentence discourse context. Both word orders were presented both in

a supportive and a non-supportive context. For OVS, the supportive context mentioned the object referent prior to the target sentence but not the subject referent; in the non-supportive context the object referred to a new entity while the subject referred to an old, already mentioned discourse entity. For SVO, on the other hand, the situation was reversed: in the supportive context subject referred to old information and object to new information, while in the non-supportive context subject referred to new and object to old information. The structure of the target sentences was Noun (subject/object)–Verb–Noun (subject/object)–Filler word–Filler word.

Kaiser and Trueswell (2004) employed a self-paced reading method to collect reading times for each word in the target sentence. In this method, readers present the text one word at a time by pressing a button. The word reading time is the time elapsed between two subsequent button presses. The main prediction was that the structural complexity effect (OVS being more difficult to process than SVO) is wiped out or diminished when a supportive context is provided. Such an effect (i.e. an interaction between structure and context) was indeed observed for the processing of the second noun and the two filler words succeeding it, but not for that of the first noun or the verb. In other words, in the latter part of the target sentence, an effect of word order was not obtained in the supportive context but only in the non-supportive context. These results are taken to suggest that the word order effect observed by Hyönä and Hujanen (1997) for isolated sentences may be of pragmatic origin, related to the distribution of old and new information in a sentence, rather than reflecting the infrequency or complexity of non-canonical word orders.

This pragmatic hypothesis was put to a further test in our unpublished eye-tracking study, where we examined whether the presence of contrastive focus modulates word order effects. Similarly to Kaiser and Trueswell (2004), we compared the processing of object-fronted (non-canonical) word order to that of subject-fronted (canonical) word order. The target sentence was the second sentence in short, three-sentence stories. However, unlike Kaiser and Trueswell we did not manipulate the givenness/newness of the sentence-initial noun (subject/object); instead we inserted contrastive markers in the first sentence and in the beginning of the target sentence to signal a contrastive discourse structure. The following example exemplifies the type of stories used (the target sentence 2b appears in the OSV order):

- 2a. Opiskelijamielenosoittajia vastassa olikin yllättäen huligaanijoukko.
 (Student-protesters (acc.) up against was-however surprisingly
 hooligan-group (nom.))¹
 ‘Student protesters were in fact surprisingly faced by a group of
 hooligans.’

- 2b. Sen sijaan poliiseja opiskelijat eivät olleet nähneet lähimaillakaan.
(Instead policemen (acc.) students (nom.) not had seen
at-close-quarters)
'On the other hand, students had not seen policemen at close
quarters.'
- 2c. Tilanteen saama ennakoimaton käänne hämmensi monia
mielensoihtajia.
(Situation (gen.) gotten unexpected turn-of-events confused many
(acc.) protesters (acc.))
'The unexpected turn of events confused many protesters.'

In this story, contrast is expressed in the first sentence by the clitic-*kin* that may be translated to English by *in fact* (although it does not provide a particularly good translation). Moreover, the contrastive structure of the story is amplified by the first word of the target sentence (2b), which also signals contrast (the English translation of the contrastive structure may sound somewhat strange, which is not the case in Finnish). Thus, both contrastive markers cue the reader to expect to encounter a new discourse entity at the beginning of the target sentence (the contrastive structure in 2a signals that some other people than hooligans were expected). If so, encountering a new discourse entity sentence-initially may not slow down processing even when it is a sentence object. Thus, a reduced word order effect (a difference between OSV and SVO) was predicted in the presence of contrastive focus compared to a story version where the contrastive structure is not readily apparent (not presented here).

The preliminary results provide evidence for the aforementioned prediction. A reliable interaction emerged between word order and presence of contrastive focus in the second-pass fixation time on the first noun of the target sentence. The presence of contrastive focus did not affect the second-pass fixation time for the sentence subject but did so for the sentence object (fixation time was shorter when contrastive structure was signaled). These results provide support for Kaiser's and Trueswell's (2004) contention that pragmatic constraints significantly modulate word order effects in Finnish. However, it should be noted that the first-pass fixation time was only affected by word order: the noun was fixated for longer time when it was an object than a subject, regardless of previous story context.

The above-cited evidence bearing on pragmatic influences is consistent with interactive accounts of sentence parsing (e.g. MacDonald et al. 1994). These interactive accounts assume multiple sources of information (also non-syntactic) to contribute to immediate parsing decisions. However, the results do not refute the rival account (e.g., Frazier and Clifton, 1996), which assumes syntactic information to be consulted first, while other, non-syntactic (lexical-semantic and pragmatic) information is utilized only later. Neither in the study of Kaiser and Trueswell (2004) nor in our unpublished study was the effect of context immediate, as it did not show up during the initial

encounter with the first noun of the target sentence. Thus, the syntax-first theory may account for these results by arguing that context influences a later processing stage where syntactic and semantic information are integrated, but not the immediate parsing decision.

Morphological Agreement and Grammatical Role Assignment

We now turn to a second typical feature of Finnish: all constituents of complex noun phrases typically agree in case and number. For example, in a noun phrase *suurissa taloissa* (= in big houses) plurality is denoted by *-i* which is attached not only to the head of the noun phrase but also to the adjective modifier. The same is true of the locative case ending *-ssa* (corresponds to the English preposition *in*) that is repeated both in the modifier and the head. Do Finnish speakers make use of this redundancy when assigning grammatical roles to sentence constituents during sentence processing? Our working hypothesis was that as morphological marking is completely reliable and also salient, readers will make use of this readily available redundancy. If so, during the processing of complex noun phrases they would assign a grammatical role to the whole noun phrase already when encountering the modifier (modifier always precedes its head in Finnish), which would speed up the processing of the head in comparison to a situation where a non-modifier precedes the head noun. This prediction was put to a test in a series of eye-tracking experiments (Vainio et al. 2003, 2008), where native Finnish speakers read silently such noun phrases embedded in sentence contexts. These experiments differ from previous studies on modifier-head agreement conducted in Serbo-Croatian (Gurjanov et al. 1985; Lukatela et al. 1987), Spanish (Barber and Carreiras 2005), and Russian (Akhutina et al. 1999) in that non-grammatical agreement violations were not used. Thus, observed agreement effects are readily interpretable as facilitatory agreement effects.

We started the series of experiments with two transparent cases (i.e., exactly the same inflection is attached to the modifier and the head regardless of the word stems). These morphologically transparent cases were chosen as they were the most likely to reveal an agreement effect in processing. An agreeing modifier-noun condition (*suureksi taloksi* = for a big house; *-ksi* marks a translative case denoting transmutation or transition) was compared to a non-agreeing adverb-noun condition (*monesti taloksi* = often for a house). As expected, a reliable agreement effect was observed. However, the delayed nature of the effect came to us as a surprise. We never observed it on the head noun itself, but depending on the experiment, either on the word following the head or in the second-pass fixation time of the head noun (or in the probability of looking back to the head). The nature of the effect was always the same: the agreeing condition resulted in smoother processing than the non-agreeing condition, which confirmed our working hypothesis.

The delayed agreement effect turned out to be highly generalizable as it was observed for all tested cases. Subsequent experiments demonstrated that the effect was observed equally for a purely syntactic case (nominative denoting sentence subject) as well as semantic cases (locative cases). Moreover, morphological transparency in agreement did not seem to matter, as an agreement effect was also obtained for a morphologically opaque case inflection (for which the inflectional variant depends on the word stem). Finally, the observed agreement effect could not be explained as a modifier presence effect (Rayner et al. 1989), that is, as the mere presence of a modifier predicting the next word to be a noun and thus speeding up processing, in comparison to the adverb–noun condition where an adverb does not strongly constrain the grammatical category of the following word. The evidence came from an experiment where, instead of the adverb–noun condition, a restricted set (about 10) of adjectival modifiers was used that do not agree with their heads but always appear non-inflected. These modifiers never appear isolated but are always followed by a head noun. Thus, they predict the grammatical category of the next word even more strongly than regular, agreeing adjectives. Nevertheless, a reliable agreement effect was observed: the agreeing modifier–head condition resulted in smoother processing than the non-agreeing modifier–head condition.

The fact that, across four different experiments, we never found an agreement effect during the first encounter with the head noun speaks against the view that the effect would manifest at the lexical level. In other words, our data do not support the idea that morphological agreement would help accessing the lexical form of the head noun. We do not know of a single eye movement study, where a lexical effect would have manifested as a purely lagged effect (no effect on the word itself but only after fixating away from it). This suggests that the lagged effect is unlikely to be lexical in nature. Instead, the delayed nature of the effect suggests that it is likely to operate at the level of syntactic integration, that is, when the parser integrates a combination of successive words into a complete phrase. Our data suggest that this integration process is fully completed only after the reader has progressed with his/her eyes to the next phrase. The timing of the effect accords roughly with the P600 effect observed in studies examining agreement effects via brain potentials (Barber and Carreiras 2005; Coulson et al. 1998; Deutsch and Bentin 2001; Gunter et al. 2000; Kaan et al. 2000; Osterhout and Mobley 1995). We have estimated our effect to materialize about 500–700 ms after the onset of the first fixation on the head noun.

According to an alternative interpretation, initial structure building is achieved without recourse to morphological information, which is consulted later as a feature-checking confirmation process (Chomsky, 1995). Although we cannot refute such an account, we consider it an unlikely processing strategy in Finnish (or other morphologically rich languages), where most words are morphologically complex. Ignoring morphological information during the initial parse would not be a smart and efficient strategy.

Morphological Complexity in Sentence Comprehension

In the previous section, we provided evidence demonstrating a facilitatory effect of morphological marking. However, morphological marking may not always come as a blessing for a language comprehender, as it may sometimes result in a complex word form that can be difficult to parse. Being a morphologically rich language, Finnish contains morphologically complex expressions that may comprise 4–5 morphemes (for a review of processing two-noun compound words in Finnish, see Pollatsek and Hyönä 2006). Such expressions may be cumbersome to process, as the morphemes are glued together into a single word unit (i.e., morpheme boundaries are not visually marked, for example, by spaces or hyphens). One such expression is the so-called converb construction (Haspelmath 1995) – a complex verb construction that may be used in place of a multiword subclause. For example, a temporal converb construction *uidessani* corresponds to an English subclause *when I was swimming*. This converb construction may also be expressed more transparently as a temporal subclause (*kun olin uimassa*), which corresponds to the structure of the English translation given above. Historically, converb constructions appeared earlier in Finnish than full subclauses (Itkonen 1966); however, in the present-day Finnish, their use is largely restricted to written language, while full subclauses are typically used in colloquial speech.

Hyönä and Vainio (2001) compared the processing of such converb constructions to that of their subclause equivalents in two eye-tracking experiments. The target constructions were embedded in sentences and participants were asked to read them silently for comprehension. Two types of converb constructions, temporal and final, and their subclause equivalents were employed. Temporal converbs (see the example above) can be used to replace a temporal subclause in sentences that conform to the following structure: ‘When X happened /did something, Y happened/did something else’, while final converbs typically convey intentionality (they are used to replace the subclause in sentences like ‘In order for X to happen, X needs something / something has to happen to X’). The converb constructions were morphologically more dense and complex than their subclause equivalents in two respects. First, the converb construction is marked by short bound morphemes, which makes it less transparent. Second, typically the total number of morphemes in the converb phrase is greater than in its subclause equivalent.

For the temporal constructions (Experiment 1), a reliable complexity effect was observed in the first-pass fixation time. Converb constructions were read with longer fixation time than their subclause equivalents (the effect was replicated in the second experiment). On the other hand, no complexity effect was apparent for final converb constructions (Experiment 2). In fact, the subclause equivalent was read with significantly longer first-pass fixation time than the final converb construction. The opposite pattern of results for the two types of constructions is readily explained by the differences in the

relative frequency of converb and subclause constructions. For the temporal construction, the converb and subclause constructions were equally frequent in a written language corpus (Lauseopiston arkisto, University of Turku), whereas for the final construction the converb construction was nine times more frequent than its subclause equivalent. Hence, the results suggest that when a morphologically more complex and less transparent construction is clearly more common, structural frequency can overrule a complexity effect, which is observed when the two corresponding structures are equally frequent. In other words, frequent exposure to a linguistic structure results in the corresponding mental structure becoming more easily accessible, which in turn will speed up its processing. In sum, it is concluded that structural frequency plays a relevant role in parsing and comprehending unambiguous but morphologically complex structures in Finnish. Although our structural frequency account bears resemblance to other frequency-based accounts of parsing (Mitchell et al. 1995; Gibson 1996; Jurafsky 1996; Hale 2001; Levy 2008), it departs from them in applying the principle to the processing of syntactically unambiguous structures, whereas the previous models provide an account for how structural frequency is utilized in resolving local syntactic ambiguity.

Another way to override a morphological complexity effect in processing is to provide a syntactic context that makes the morphologically more and less complex expressions equally plausible. This was demonstrated by Hyönä et al. (2002). They first established a morphological complexity effect for nouns presented in isolation using the lexical decision paradigm (participants are asked to press a yes or no button as soon as they know whether a letter string is an existing word in the language). They compared the recognition of inflected nouns to that of non-inflected nouns. Two inflections were employed, partitive and accusative (identical in form to genitive), which are both syntactic cases, as they are used to mark the syntactic object (see above the discussion of word order variation). The lexical decision experiment showed that when presented in isolation, inflected nouns take reliably longer to recognize than their length- and frequency-matched non-inflected counterparts. This is taken as evidence for a morphological complexity effect (i.e., a word that contains two morphemes takes longer to identify than a single-morpheme word), which is a cornerstone of the SAID model (Niemi et al. 1994) put forth as an account of the recognition of morphologically complex words in Finnish. In the two subsequent experiments, the target nouns were placed in a sentence context where both forms fit equally well syntactically (the context was semantically non-constraining); all target nouns appeared as the clause object, which may be marked either by an inflection (partitive or accusative) or appear in a non-inflected form (nominative). Now a morphological complexity effect was no longer obtained. This was true both when participants read the sentences for comprehension while their eye fixations were registered, as well as when they performed a lexical decision task in a sentence context.

We argue that the pattern of results suggests that the morphological complexity effect obtained for nouns presented in isolation does not reflect processing at the level of lexical access but instead at the level of assigning a syntactic status to the noun. We follow Taft's (1994) reasoning, according to which an inflection is stripped off from its stem and fed into a syntactic module. Syntactic processing is then facilitated by the previous sentence context that makes the morphologically more complex inflected form equally plausible to the less complex form, thus wiping out the complexity effect observed in isolation. As argued above, this syntactic integration account is also able to explain the delayed morphological agreement effects.

Summary and Conclusions

Finnish is an agglutinative language with a rich morphology that serves not only syntactic but also semantic (particularly locative cases) functions. Heavy morphological marking is associated with flexibility in clause-level word order. Basically all possible word order combinations exist, although their usage may be pragmatically constrained. In the present article, we set out to review the existing literature on factors governing sentence parsing in Finnish. We concentrated on three issues: (1) influences of word order variation on sentence parsing, (2) the extent to which morphological marking is utilized in online sentence processing, and (3) whether morphological complexity and density affect the processing of clauses and clause constituents.

Despite the great flexibility in word order in Finnish, the study of Hyönä and Hujanen (1997) demonstrated that non-canonical, less frequent word orders pose a processing disadvantage over the canonical and more frequent word order. Kaiser and Trueswell (2004) provided evidence demonstrating that pragmatic constraints bearing on the distribution of old and new information in a sentence alleviate the processing difficulty often ascribed to non-canonical word orders (for word order effects in German, see, for example, Hemforth et al. 1993; in Hungarian, see MacWhinney and Pléh 1988). Thus, Kaiser and Trueswell propose that instead of (or in addition to) structural frequency (or syntactic complexity) word order effects may reflect pragmatic constraints. However, more evidence needs to be accumulated to determine whether the pragmatic modulation is immediate as suggested by interactive models of sentence parsing, or whether it operates later in the processing timeline, as claimed by the syntax-first approach.

We reviewed evidence suggesting that, perhaps not surprisingly, Finnish speakers make use of morphological agreement present in modifier-head constructions in assigning grammatical roles to these noun phrases. The reviewed evidence demonstrates that they use it to the same extent regardless of whether agreement is transparent or opaque or whether agreement is related to a syntactic or a semantic case. Agreement effects did not appear to operate at the lexical level of processing (morphological agreement between modifier and head did not facilitate the lexical access of the head's

full form) but at a later stage. We interpret it to index syntactic integration where a grammatical role is fixed for the encountered noun phrase, but we admit that an alternative structure-building-first-feature-checking-second account cannot be refuted by the present data. It remains for the future studies to sort out, which one of the two accounts should be preferred.

We also reviewed evidence showing that morphological complexity (relative transparency and morpheme density) affects online sentence processing in Finnish. However, the complexity effect was only obtained when the more complex and the less complex construction were equally frequent. When the more complex construction was more frequent than the less complex one, structural frequency was able to reverse the complexity effect (a more complex construction became easier to process). This is taken as further evidence for the view that structural frequency plays a relevant role in sentence parsing in Finnish.

Finally, we reviewed evidence demonstrating that a morphological complexity effect obtained for lexical processing of nouns presented in isolation (inflected nouns harder to recognize than non-inflected ones) is wiped out when the nouns are processed in a proper syntactic context. This suggests that case marking (at least for syntactic cases) is processed at the level of syntactic integration and not at the level of lexical access. This conclusion bears close resemblance to our conclusion reached for processing morphological agreement in Finnish. The reviewed study (Hyönä et al. 2002) also points to the importance of studying morphological processing at the sentence level and not restricting it to experimenting with isolated words – a tradition that has prevailed in the field of morphological processing.

In the present article, we have shown that structural frequency, morphological agreement and morphological complexity all play a significant role in sentence processing in Finnish. Perhaps the most newsworthy aspects of the reviewed studies concern the effects of structural frequency and morphological complexity, as different types of agreement effects have previously reported for a number of languages (for a review, see Vainio et al. 2008). It remains to be seen whether effects of structural frequency and morphological complexity can be observed in parsing of other languages bearing resemblance to Finnish.

Short Biographies

Jukka Hyönä holds a PhD degree in psychology from the University of Turku (Finland), where he works currently as the senior lecturer. His research uses the eye-tracking method to study online processing of written language. His studies tap into different levels of written language comprehension – from word recognition via sentence parsing to comprehension of long expository texts. He has also applied the method to study attentional processes and eye guidance during reading. His research has been published in journals such as *Journal of Memory and Language*, *Psychological Science*, and *Cognitive Psychology*.

Seppo Vainio received his PhD degree in the general linguistics from the University of Turku (Finland). His thesis examined how syntactic and semantic predictability influence online sentence processing in Finnish. He has a keen interest to extend the findings observed in Finnish to other languages resembling Finnish to varying degrees.

Notes

* Correspondence address: Jukka Hyönä, Department of Psychology, University of Turku, FI-20014 Turku, Finland. Email: hyona@utu.fi.

¹ nom., nominative (the base form of Finnish nouns); acc., accusative; iness., inessive (one of six locative cases in Finnish; it is equivalent to the English preposition *in*).

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