LANGUAGE AND COGNITIVE PROCESSES, 1997, *12* (1), 67–102

Double Agreement: Role Identification in Hungarian

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In Hungarian, distinguishing subjects and objects in transitive clauses requires the processing of five major types of cues: subject–verb agreement-marking, object–verb agreement-marking, case-marking, animacy and word order. Two studies examined the relative strength of these cues in a sentence interpretation task. Because Hungarian has a "double agreement-marking" system, it was possible to compare the relative strengths of the two types of agreement-marking. Despite the fact that object–verb agreement is a fully deterministic grammatical marker, the studies showed that this type of agreement has a very weak impact on sentence processing. This weakness is demonstrated in two experiments, the first using only sentences with definite objects and the second varying the definiteness of the object. The weakness of the object–verb cue is attributed to its lower contrast availability. The preservation of this marking in the Hungarian language is testimony to the diachronic tenacity of morphological markings when they become embedded in complex grammatical paradigms.

INTRODUCTION

In every clause that we encounter, we need to identify one nominal that will play the role of subject or actor. If the verb is intransitive, this is an easy

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Our thanks to Ferenc Dudás and Miklos Kovács for their assistance in running the experiments and to Károly Halmai for technical assistance. This work was supported by Grant HD17790 from the National Institute of Child Health and Human Development to Brian MacWhinney and Elizabeth Bates and by Grant 24–02–84 from the Hungarian Ministry of Education to Csaba Pléh.

matter. But when the verb is transitive, we may find two or even three nominals that are potential candidates for the role of subject. To select among these possibilities, we use a series of cues, including word order, case-marking, animacy and verb agreement-marking. The cues that involve the most complex interrelations between sentential elements are the agreement cues, since these cues require us to decode morphological markers on the verb and on the various nouns that might agree with the verb, and then to compare these two sets of markings in terms of the formal markings of the conjugational paradigm.

In English, the verb agreement paradigm is exceedingly simple. Consider the sentence "The dogs were chasing the cat". To use the agreement cue, we first must process the number marking on the verb "were" and the two noun phrases "the dogs" and "the cat". Then we must link these two sets of results in terms of the agreement rules of English. Despite the formal simplicity of the English system, errors in agreement are often observed during sentence production (Bock & Miller, 1991).

In Hungarian, the situation is more complicated. Like English, Hungarian has agreement between the subject and the verb. However, unlike English, the markers in Hungarian fully distinguish all persons and all numbers in all tenses. This makes Hungarian agreement-marking a pivotal cue, since it tells us not only the grammatical number of the subject, but also its grammatical person. A further complication is the fact that the same set of verbal suffixes not only indicate the person and number of the subject, but also the definiteness of the object. In other words, a single suffix on a Hungarian verb is used to mark both subject–verb agreement and object–verb agreement. We will call a system of this type a "double agreement-marking" system, since a morphologically unitary verbal agreement suffix is used to mark agreement with two different noun phrases.

Typologically speaking, languages which mark agreement between the verb and the object are rather less common than languages that mark agreement between the verb and the subject. Hopper and Thompson (1980, 1984) found that languages that mark object–verb agreement tend to code for the definiteness or animacy of the object, whereas languages that mark subject–verb agreement tend to code for the person and number of the subject. They argue that this asymmetry reflects the fact that the object is relatively more involved in the activity of the verb and the features of animacy and definiteness that are involved in this relation.

Both types of agreement-marking can be used as good cues to sentence interpretation. When a sentence has one definite NP and one indefinite NP and the verb is marked as indefinite, then we have a strong cue that the object is the indefinite NP, rather than the definite NP. Similarly, when a sentence has one plural NP and one singular NP and the verb expresses plural subject agreement-marking, then we have a strong cue that the

subject is the plural NP and not the singular NP. Thus both types of agreement-marking provide potentially deterministic cues to sentence interpretation.

In this study, we examine the two cue types in an attempt to evaluate their relative contributions to sentence processing. Anticipating the empirical results we will present here, we will see that the subject agreement-marking cue is fairly strong in Hungarian, whereas the object agreement-marking cue is hardly used at all. In an attempt to better understand how it can be that a fully grammaticalised cue can have such a minimal impact on sentence processing, we will then examine certain additional synchronic and diachronic facts about the object agreement-marking system. In particular, we will argue that object agreement-marking is preserved because of the way it has become embedded in the complex grammatical paradigm of the Hungarian verb.

CUES TO ROLE IDENTIFICATION IN HUNGARIAN

Hungarian has five major cues that help the listener to identify the subject of a transitive clause: (1) case-marking, (2) subject–verb agreement-marking, (3) object–verb agreement-marking, (4) animacy and (5) word order. To see how these cues interact, consider a Hungarian sentence such as (1):

1.	Egy	fiú	szeret-i	az	almá-k-at.
	a	boy	like-3.Sg.Def	the	apple-Pl-Acc
	"A boy likes the apples".				

The listener's decision to treat *fiú* ("boy") as the subject and *almákat* ("apple") as the object is influenced by each of these five cues. In this particular case, all five cues point in the same direction.

1. *Case-marking*. *Fiú* has zero case-marking, which makes it a good candidate for the actor/subject. *Almákat* has accusative case-marking, which blocks it as a possible candidate for actor.
2. *Subject agreement-marking*. *Fiú* is singular and therefore agrees with the third-person singular marking on the verb, whereas *almákat* is plural and does not agree properly with the number of the verb. Therefore, *fiú* is a better candidate for actor.
3. *Object agreement-marking*. The same *-i* suffix on the verb that indicates a third-person singular subject also indicates that the object of the verb is definite. Since "boy" is marked by an indefinite article, it cannot be the object of the verb and must be the subject.
4. *Animacy*. Furthermore, *fiú* is animate and *almákat* is not, and this further supports the choice of *fiú* as the subject. It is important to note that the concept of an "animacy cue" is really just a placeholder for a

broader set of selectional constraints. Corrigan (1986) has shown that some verbs have strong expectations for animate subjects, whereas others place somewhat different requirements on the subject. For example, the verb "flood", when used in a sentence such as "The river flooded the bank", does not require that the subject be animate, but rather that it be a liquid. However, in the study reported here, the verbs being studied are ones that place a strong animacy constraint on the subject.

5. *Word order*. Finally, *fiú* precedes the verb and "apple" does not. This positional placement of "boy" provides further evidence that "boy" is the subject.

Thus the five cues of case, number agreement, definiteness agreement, animacy and word order all point towards the selection of "boy" as the agent or actor.

Not all sentences work out so nicely. In some sentences, several cues may be ambiguous. It can even turn out that cues point in opposite, competitive directions. For example, the free word order of major elements in a Hungarian sentence often makes the word order cue conflict with the case cue.

THE COMPETITION MODEL

A model that has been formulated to deal with cue competitions of this type is the Competition Model (MacWhinney & Bates, 1989; MacWhinney, Pléh, & Bates, 1985). The Competition Model adopts a lexicalist, functionalist approach to language structure and function (MacWhinney, 1997). It relies on connectionist modelling and parameterised mathematical modelling as tools to account for input-driven learning during language acquisition and cue interaction during processing.

The Competition Model uses two very different measures of processing effects. The first of these measures—percentage choice of first noun—is viewed as reflecting off-line processes of cue integration. The second measure—choice reaction time—is viewed as reflecting on-line processes of cue competition. When we look at the off-line agent choice measure, the standard finding has been that cues combine in terms of a simple multiplicative model (Massaro, 1987; McDonald & MacWhinney, 1989) in which cue strength is determined primarily by cue reliability. As explained in detail by McDonald and MacWhinney (1989), equations used to estimate parameters in this model take the general form of the Luce choice ratio:

$$\Pi S_{ij} / (\Pi S_{ij} + \Pi (1 - S_{ij}))$$

The S_{ij} parameter values estimated in these equations are then matched up with the reliability levels of the cues as estimated from text counts. Cue reliability is defined as the proportion of times the cue leads to the correct choice over the total number of occurrences of the cue. For a particular cue, such as the agreement cue, its reliability is the probability of choosing the subject as agent, given the presence of the cue. Simple reliability is calculated against only those cases in which the cue is both present and contrastive.

The observed cue interaction effects for the off-line choice measure are extremely uniform. The strongest cues are always the most reliable cues. When all cues favour a given interpretation, choice behaviour is fully consistent with the cues. When cues conflict, choices become split. Strong cues tend to mask patterns of interactions between weaker cues. The effects of convergence and conflict between weak cues can only be observed clearly when the strongest cues are neutralised.

When we turn to the effects of cue competition on the reaction time measure, the most obvious predictions of the Competition Model are that the fastest responses will occur when cues do not compete and that the slowest responses will occur when cues are in competition. Furthermore, when competitions are resolved early in the sentence, responses are faster than when they are resolved only towards the end of a sentence. Recent work using the Competition Model framework (Hernandez, Bates, & Avila, 1994; Kilborn, 1989; Li, Bates, & MacWhinney, 1993; McDonald & MacWhinney, 1995; Mimica, Sullivan, & Smith, 1994) has supported both of these predictions.

However, there are two other effects found in these on-line studies that point towards the need for a more complicated model. First, strong cues tend to saturate the on-line processing system, so that providing additional evidence when a strong cue is already present has little additional effect on reaction times. Second, there is reason to believe that the frequency of a syntactic structure has a stronger effect upon on-line role assignment processes than on off-line interpretation. In the Competition Model framework, these frequency effects are discussed in terms of cue *availability*. Frequency effects have been demonstrated for relative clause attachment (Cuetos & Mitchell, 1988; Mitchell, Cuetos, & Zagar, 1990; Mitchell et al., 1990), as well as for the processing of syntactically ambiguous lexical items under the influence of verb frame structures (MacDonald et al., 1994; Trueswell and Tanenhaus, 1994; Trueswell, 1996). This literature would lead us to suspect that frequency might also play a major role in determining agent role assignment. Indeed, data from both simulations and modelling of role assignment in German and Russian (Kempe & MacWhinney, submitted) indicate that both reliability and availability make unique contributions to reaction time data.

APPLYING THE COMPETITION MODEL TO HUNGARIAN

To understand the predictions that arise from the Competition Model, we need to examine the reliability and availability of the five major cues to subject identification.

Case-marking

The direct object of the Hungarian verb is marked by a final *-t* accusative suffix. In Competition Model terms, this marker is considered to be an extremely reliable cue to role identification. There are no cases in which the presence of the accusative is misleading. In other words, the conditional probability of the accusative, given the presence of the cue (p(Acc)|Cue), is close to 1.0. However, there are a few cases in which the cue is not available because it can be optionally deleted. These optional deletions occur when a noun has a first-person singular or second-person singular possessive suffix. For example, one can say either (2) or (3):

2.	Lát-om	a	kutyá-d-at.
	see-1.Sg.Def	the	dog-2.Sg.Poss-Acc
	"I see your dog".		
3.	Lát-om	a	kutyá-d.
	see-1.Sg.Def	the	dog-2.Sg.Poss
	"I see your dog".		

Both sentences mean "I see your dog". In (3), the accusative suffix *-at* is not present in the form *kutyád*, despite the fact that *kutyád* is the object. When the first-person singular or second-person singular possessive is not present, every object of a transitive verb must have the accusative suffix. This means that, although (4) is grammatical, (5) is not:

4.	Lát-om	a	kutyá-d.
	see-1.Sg.Def	the	dog-2.Sg.Poss
	"I see your dog".		
5.	*Lát-om	a	kutya.
	see-1.Sg.Def	the	dog
	"I see the dog".		

Thus although the accusative is fully reliable, it is not always available.

There is a complex set of morphophonological patterns that alters the actual shape of the linking vowel and the stem itself. However, none of these morphophonological processes alters the shape of the final *-t*. Because of this, adult speakers can easily recognise both regularly and irregularly inflected accusatives. For children, this task is not so easy (MacWhinney, 1985; MacWhinney et al., 1985). Detection of the suffix is particularly

difficult in forms where the *-t* directly follows a dental obstruent (MacWhinney et al., 1985). Aphasics also have trouble detecting the accusative marker (MacWhinney, Osman-Sági, & Slobin, 1991), and this problem appears to be more severe for Wernicke's aphasics than for Broca's aphasics.

The other major case-marking cue in Hungarian is the "zero" marking cue on nouns. Nominative nouns may have plural or possessive suffixes, but they cannot have case suffixes or postpositions. The absence of any form of case-marking or postpositional marking is an extremely reliable cue for the subject of the verb. The one exception to this rule is for the case of the object modified by a possessive suffix, as illustrated in example (3) above. Since there is no true passive in Hungarian, the subject is also easily identified as the actor or agent with a transitive verb.

Subject–Verb Agreement

Hungarian verbs agree with their subjects in person and number. As in languages like Spanish and German, the Hungarian verb is conjugated for three persons and two numbers. The paradigm for subject–verb agreement marking has very little neutralisation and is relatively clear and unambiguous. For example, the intransitive verb *fut* ("run") has the following forms:

		Present Ind.	*Past*	*Conditional*	*Imperative*
Singular	1st	*futok*	*futottam*	*futnék*	*fussak*
	2nd	*futsz*	*futottál*	*futnál*	*fuss*
	3rd	*fut*	*futott*	*futna*	*fusson*
Plural	1st	*futunk*	*futottunk*	*futnánk*	*fussunk*
	2nd	*futtok*	*futottatok*	*futnátok*	*fussatok*
	3rd	*futnak*	*futottak*	*futnának*	*fussanak*

Each of these forms is distinct and there is virtually no neutralisation anywhere in the conjugational paradigm. This is generally true for Hungarian verbs. In Competition Model terms, this lack of neutralisation or omission means that the agreement cue on the verb is completely reliable, despite its high level of formal complexity. In the Competition Model, it is the reliability of the cue and not the formal complexity of the paradigm that determines cue strength and cue processing. Empirical support for this claim comes from an analysis of the use of the case-marking cue in Russian and German (Kempe & MacWhinney, submitted). Despite the higher formal complexity of the Russian paradigm, the greater reliability of the Russian

case-marking cue leads to stronger use of case-marking in Russian than in German.

Although the Hungarian subject–verb agreement cue is extremely reliable, it is not as high in *contrast availability* as the case-marking cues. When there are two or more third-person singular nouns in a clause, agreement-marking alone cannot tell us which is the subject and which is the object. In such cases, the cue is present and available, but not contrastive. Fortunately, in those cases where the subject–verb agreement cue is not available, the accusative case cue is usually available. There are no sentences in which the case cue and the agreement cue point in opposite directions. In Competition Model terms, this means that the *conflict reliability* of both the case cue and the subject–verb agreement cue is very high.

There are two ways in which the subject–verb number agreement cue in Hungarian differs from subject–verb number agreement cues in languages like English, German or Spanish. One difference involves the way in which agreement interacts with quantifiers. In Hungarian, one says *öt férfí* ("five man") instead of *öt férfiak* ("five men"). The singular noun is also used with other quantifiers such as "many", "some" and "all". Whenever the quantifier expresses inherent plurality, the marking of plurality on the noun is considered redundant and is suppressed. Furthermore, for the purposes of agreement with the verb, a quantified subject noun phrase is treated as singular, even when the noun is conceptually plural (Pollard & Sag, 1988). Second, this treatment of a plural subject as singular can also arise with coordinated subjects. For example, Hungarians can say either *Mari és Feri jön* ("Mari and Feri comes") or *Mari és Feri jönnek* ("Mari and Feri come"). When the coordinated subject is treated as singular, one gets the sense of the two people coming as a unit. When the verb is plural, one gets the sense that two different people are coming perhaps from different places at slightly different times. If processing of the agreement cue relies heavily on conceptual form, these two mismatches in Hungarian between conceptual number (Pollard & Sag, 1988) and grammatical number could serve to weaken the uniform application of the subject–verb agreement cue.

Object–Verb Agreement

There are two major conjugations of the verb in Hungarian. It is important not to confuse the type of conjugation we find in Hungarian with the type that one finds in a language like Latin. In Latin, each verb is assigned to one of four conjugations and appears only in that conjugation. In Hungarian, each transitive verb has a full set of forms in both of the two conjugations. The placement of a verb into one of the two conjugational paradigms in a given sentence depends on certain properties of the direct object. The two

conjugations for the present tense indicative mood of the transitive verb *lát* ("see") are as follows:

		Indefinite		*Definite*	
Singular	1st	*lát-ok*	("I see")	*lát-om*	("I see it")
	2nd	*lát-sz*	("you see")	*lát-od*	("you see it")
	3rd	*lát*	("it sees")	*lát-ja*	("sees it")
Plural	1st	*lát-unk*	("we see")	*lát-juk*	("we see it")
	2nd	*lát-tok*	("you see")	*lát-játok*	("you see it")
	3rd	*lát-nak*	("they see")	*lát-ják*	("they see it")

Both conjugations also have a complete paradigm for the past, the conditional and the imperative. Each of the 46 verbal suffixes in this paradigm expresses both subject–verb agreement and object–verb agreement at the same time. Here, the usually agglutinative nature of Hungarian morphology has given way to a more fusional marking pattern reminiscent of the markings found in Latin. The nearly complete morphological fusion of the two agreement cues has important psycholinguistic consequences, both synchronically and diachronically. The crucial point is that there is no obvious way in which one of these cues could be levelled out from the paradigm without simultaneously affecting the marking of the other cue as well as parts of the paradigms for tense and mood.

The intransitive/indefinite conjugation is used whenever there is no overt object or when the object is perceived to be indefinite. The transitive/definite conjugation is used when there is a definite object. For example, the marked conjugation is used in sentences such as (6) and the unmarked intransitive/indefinite is used in sentences such as (7). In sentence (7), the zero marking on the verb is indicated with a -0 and morphemicised as 3.Sg.Indef:

6. János lát-ja a fiú-t.
   John see-3.Sg.Def the boy-Acc
   "John sees the boy".
7. János lát-0.
   John see-3.Sg.Indef
   "John sees".

These two types of sentences map clearly onto the transitive/intransitive distinction. However, there is a third type of sentence that shows the relation of the unmarked conjugation to indefiniteness. These are sentences with indefinite objects, such as (8):

8. János lát-0 egy fiú-t.
   John see-3.Sg.Indef a boy-Acc
   "John sees a boy".

The unmarked indefinite/intransitive conjugation is used in (8) despite the fact that there is actually an overt object. Because of this, it is important not to think of the unmarked conjugation as the "intransitive" conjugation, but rather as the indefinite/intransitive conjugation.

When there is an inherently intransitive verb, such as the verb *fut* ("run"), the choice of conjugation is simple. Inherently intransitive verbs can only be conjugated in the unmarked conjugation. There are many inherently intransitive verbs that take particular oblique second arguments. These verbs, despite their semantic similarity to verbs with direct objects, are still treated as intransitives. Constructions like (9)–(11) all have the verb in the intransitive conjugation form, despite the fact that the obligatory second argument is definite. Only full transitives with the second argument in the accusative can take the definite/transitive conjugation.

9. Gondol-0 a lány-ra.
   think-3.Sg.Indef the girl-SUBLATIVE
   "He thinks about the girl".
10. Csalód-ott-0 a fiú-ban.
    deceive-Past.3.Sg.Indef the boy-INESSIVE
    "He became disappointed in the boy".
11. Gondolkoz-ott-0 az ajánlat-on.
    thought-Past.3.Sg.Indef the offer-SUPERESSIVE
    "He thought about the offer".

Within the framework of the Competition Model, the choice in sentence production between competing grammatical forms is based upon the validity with which a given form maps particular communicative functions. There are a variety of functions that cue the selection of the definite/transitive conjugation (Moravcsik, 1983):

1. For common nouns, the basic functional cue is the presence of definiteness on the object. Definiteness can be evidenced in several ways. If there is a definite article, the transitive/definite conjugation is selected. The definite article *az* or *a*, which is derived from the distal demonstrative pronoun "that", can be used with either the singular or the plural form of the noun and always precedes the noun.
2. Direct objects that are proper nouns are also treated as definite and always require use of the definite conjugation.
3. Possessively modified nouns are considered to be definite, even if the noun phrase has an indefinite article, as in *elvitte egy macskámat* ["(he) carried away one my-cat"], where "one my-cat" is treated as definite.

4. Verbs that take a complement introduced by the word *hogy* ("that") always require the definite conjugation, even when the word *hogy* is optionally omitted. Such verbs often have as their overt object in the matrix clause the deictic definite pronoun *az* ("that"). The deictic serves as a pointer tag to the presence of the complement. Sentences (12) and (13) provide two examples for the verb *akar* ("want") with the deictic pronoun either present or omitted. Although the pointer tag is missing in (13), it is "understood" to be there and the verb is still in the definite:

12. Kati az-t akar-ja, hogy ül-j-ek.
    Kati it-Acc wants-3.Sg.Def that sit-IMP-1.Sg.Indef
    "Kate wants me to sit".
13. Kati akar-ja, hogy ül-j-ek.
    Kati want-3.Sg.Def that sit-IMP-1.Sg.Indef
    "Kate wants me to sit".

Selection of the intransitive/indefinite does not simply involve looking for the absence of one of the four cues for the transitive/definite. There is another set of cues or functions that supports selection of the intransitive/indefinite conjugation:

1. If there is no object, the intransitive/indefinite is selected.
2. If the object is modified by an indefinite article, the intransitive/indefinite is selected, except as noted in point (3) above.
3. If a bare common noun appears as the direct object without any article, the intransitive/indefinite is used. Articleless common nouns occur in two ways. First, since the indefinite article "one" cannot be pluralised, all plural indefinite objects must occur without articles. Second, even in the singular, an indefinite object noun can occur without an article. However, the articleless singular noun takes on the meaning of something non-specific.
4. When the object is a first- or second-person pronoun, the indefinite/intransitive is used. For example, in *szeretsz engem*? ("love-you me?"), the verb *szeretsz* is in the indefinite, because the object *engem* ("me") is in the first person. There is also a special form of the indefinite that applies only when the subject is in the first-person singular and the object is in the second person. This form expresses both persons in a single suffix, as in *lát-lak* "see-1.Sg.2.Sg" ("I see you"). In all other persons, however, first- or second-person objects take the standard indefinite conjugation forms.
5. The indefinite conjugation can also be used when there is an implicit direct object. Thus, *lát* ("sees") can mean "he sees me", "he sees you", or sometimes even "he sees something", in example (7) above. The definite can also be used with implicit object, but in that case the object must be in the third person. Thus the definite form *lát-ja* expresses a third-person object

and a third-person subject, the definite form *lát-od* expresses a third-person object and a second-person subject, and so on.

6. In object relatives, the verb is placed into the intransitive even when the head is definite, as in (14):

14. El-ment a fiú, aki-t a lány szeret-0.
AWAY-went the boy, who-Acc the girl love-3.Sg.Indef
"The boy the girl loves left".

An exception to this pattern occurs with the deictic relative pronoun *amelyik*, which requires the transitive conjugation in the relative clauses. In subject relatives, on the other hand, the selection of a conjugation for the verb depends on the same basic principles that operate in a matrix clause.

We have discussed only the most important cues to choice of the conjugation for the verb. Further detailed discussion of additional factors can be found in Moravcsik (1983) and MacWhinney (1989). It should be clear from this discussion that the choice between the two conjugations is motivated by an exceedingly complex set of disparate factors.

Animacy

As in other languages that have been investigated within the Competition Model framework (MacWhinney & Bates, 1989), Hungarian makes use of the animacy cue as one way of determining the subject of the sentence. The real effect of the animacy cue is only evident when case-marking and agreement cues are removed. For example, in a sentence like (15) with no case-marking present, listeners tend to take *fiú* ("boy") as the subject:

15. *A labda fog-ja a fiú.
the ball grab-3.Sg.Def the boy
"?The boy grabbed the ball".

As we noted earlier, reference to an "animacy cue" is really just a placeholder for a broader set of selectional constraints that verbs place on their subjects and objects. However, in the study reported here, the verbs being studied are ones that place a strong animacy constraint on the subject.

Word Order

Hungarian permits all six word orders in transitive clauses (SVO, SOV, VSO, VOS, OSV, OVS), with the SOV and SVO orders as the unmarked options (Dezső, 1972, 1982). When the verb is in the definite conjugation, the usual word order is SVO (subject–verb–object). Although SOV and SVO are unmarked, the OSV and OVS orders are common. This extreme word-order variability makes the Hungarian word-order cue a highly

unreliable guide to sentence processing. Because previous work (MacWhinney et al., 1985) has shown that this cue is weaker than other cues in the language, we chose not to vary word order in the two experiments we report here. Instead, we look only at sentences with NVN (noun phrase–verb–noun phrase) word order.

Cue Reliability: Summary

According to the Competition Model (MacWhinney & Bates, 1989), the strength of the five cues we have discussed should be determined primarily by their relative *conflict reliability*. In sentences where two cues point in opposite directions, the one that wins should have the greatest individual strength. Reliability considerations make it so that the animacy cue and the word-order cue should be the weakest. For the other three cues, the major determinant of their relative strength should be *availability*. In this regard, the accusative suffix is more readily available than the agreement cues, since agreement is sometimes neutralised. Therefore, case-marking should be the strongest of the five cues, although the difference in strength between case-marking and agreement-marking should not be great.

There are three additional factors that could further limit the strength of the agreement cues. First, processing of agreement-marking requires the listener to match up markers between verbs and nouns across arbitrary distances. The processing of these non-local cues can place a great strain on the language processor and could therefore be somewhat weaker than local cues, such as case-marking cues. Second, although agreement marking is reliable, the paradigm is formally quite complex. However, in a comparison of Russian and German, Kempe and MacWhinney (1995) have shown that formal complexity of the paradigm underlying particular grammatical markers is not a major determinant of sentence interpretation. Based on these empirical findings, we would be inclined to attribute any additional problems found in processing agreement cues not to formal complexity of the grammatical paradigm, but to processing costs. Third, we have shown that the semantics underlying definiteness agreement is quite complex. This could also serve as a factor limiting the reliance on the object–verb agreement cue.

Cue Competition and Ungrammaticality

To measure the relative strength of the three morphological cues, we asked subjects to listen to sentences in which these cues were placed into competition. Doing this leads inevitably to ungrammatical sentences. However, our previous work in Hungarian (MacWhinney et al., 1985) has shown that there is no discontinuity or asymmetry between the processing of grammatical sentences and closely matched ungrammatical sentences. The

comparison we used to examine this was between sentences of the types given in (16) and (17):

16. Lát-om a kutyá-d-at.
see-1.Sg.Def the dog-2.Sg.Poss-Acc
"I see your dog".

17. Lát-om a kutyá-d.
see-1.Sg.Def the dog-2.Sg.Poss
"I see your dog".

18. *Lát-om a kutya.
see-1.Sg.Def the dog
"I see the dog".

We found that grammatical sentences of the type given in (17) were processed in the same way as ungrammatical sentences of the type given in (18). Both (17) and (18) have missing accusative markers, but have identical configurations in terms of the other cues of word order, animacy and agreement-marking. MacWhinney et al. (1985) present further details regarding the reaction time data supporting these claims. These data indicate that there is no processing discontinuity between grammatical and ungrammatical sentences in Hungarian Competition Model experiments.

The three morphological cues may be placed into competition in a variety of ways. Consider an NVN sentence with a singular definite verb:

19. *A kutyák kergeti a macskát.
the dog-PL chase-3.Sg.Def the cat-ACC
"*The dogs chases the cat".

Here the first noun is plural, nominative and definite, and the second noun is singular, accusative and definite. This means that the number cue points towards the second noun as the subject and the case cue points towards the first noun as the subject. The definiteness cue is neutralised and does not participate in the competition. By placing cues into competition in this way, we can estimate the relative strength of each cue during actual sentence processing (MacWhinney & Bates, 1989; Massaro, 1987). In our first experiment, verbs were always in the definite/transitive conjugation and were always singular in number. What we varied was the placement of the accusative marker, the definiteness of the nouns and the number of the nouns.

EXPERIMENT 1

Methods

Subjects. The subjects in this experiment were 24 college students enrolled in the Loránd Eötvös University in Budapest. We will refer to the subjects as "listeners" to avoid confusion with the grammatical notion of "subject".

Materials. All of the stimulus sentences in this experiment were composed of two simple nouns and one verb. The order of the nouns and the verb was always NVN. Since the verbs were all formed with a verbal prefix, and since both nouns had articles, the actual order of elements was: (article + noun) + (prefix + verb) + (article + noun). For example, one of the stimulus sentences was sentence (20):

20. *Egy kutya el-kerget-i egy csacsi-t.
a dog AWAY-chase-3.Sg.Def a donkey-Acc
"A dog chases away a donkey".

In this sentence, the verb *elkergeti* is marked as definite, even though the object *egy csacsit* is indefinite.

In this first experiment, the verb was always a third-person singular definite verb with an unseparated verbal prefix. For example, in sentence (20), the verb *elkergeti* has the prefix *el-*, which is not separated from the stem. We used this form of the verb because it has a fairly straightforward topic-comment structure (É.-Kiss, 1981).

The shape of the two noun phrases was specified by the systematic variation of four cues: case-marking, number, definiteness and animacy. For each of these four cues, there were three levels in a fully crossed design. On the first level, the cue favoured the choice of the first noun. On the second level, it favoured the choice of the second noun. On the third level, the cue was the same for both of the two nouns. Sentences (21), (22) and (23) illustrate how the case-marking cue was varied:

21. A kutya elkergeti a macskát.
the dog AWAY-chase.3.Sg.Def the cat-Acc
"The dog chases the cat".
22. A kutyát elkergeti a macska.
the dog AWAY-chase-3.Sg.Def the cat-Acc
"The cat chases the dog".
23. *A kutya elkergeti a macska.
the dog AWAY-chase-3.Sg.Def the cat-Acc
"The dog chases the cat".

Sentence (21) illustrates the cell in which the case-marking cue favours the selection of the first noun as agent, following an SVO interpretation. Sentence (22) illustrates the cell in which the case-marking cue favours the selection of the second noun as agent, following an OVS interpretation. Sentence (23) illustrates the cell in which the case-marking cue is absent. Because we found in our earlier work (MacWhinney et al., 1985) that sentences without case-marking provide the most detailed information on sentence processing, we added a fourth level to the case-marking factor to double the number of stimuli without case-marking. This fourth level simply doubled the number of sentences in the design of the type of sentence (23) that had no case-marking. Thus the complete design of the experiment was: 4 (case-marking) $\times$ 3 (number) $\times$ 3 (definiteness) $\times$ 3 (animacy). This yielded a total of 108 sentences in the full design. The form of the verb itself was constant in all of the sentences. It was always a third-person singular definite verb with a verbal prefix.

Recording of Stimuli. The 108 sentences were tape-recorded by the second author, a native speaker of Hungarian, using a standard unmarked intonational pattern in which the main stress falls on the verbal prefix. From the master recording, three duplicate tape-recordings were created, in which the order of sentences was varied in a systematic stratified fashion across each of the levels of the four factors. The sentences were recorded onto the first track of a stereo tape using an AKAI reel-to-reel tape-recorder. The sentences were separated by 8 sec of pause. On the second track of the tape, a 100 Hz, 50 msec pulse marked the end of the sentence. This pulse started a clock counter which was stopped by a voice key when the listener began a verbal response.

Procedure. The listeners heard the 108 sentences in sequence with a short rest after sentences 36 and 72. The listeners' task was to listen to each sentence and to name as quickly as possible the participant who carried out the action described in the sentence. Because most of the sentences were ungrammatical, the listeners were told that the purpose of the experiment was to investigate the interpretability of errors made by foreigners in their learning of Hungarian. Reaction times were measured from the end of the sentence to the beginning of the listener's verbal response.

Results

The design included structurally identical sets of sentences without case-marking. Since the results for these two levels of the case-marking factor were identical, we report the average for these two levels in the text and in the figures. The two dependent variables in this experiment were choice and

reaction time. First let us examine the effects for noun choice. We report the results for F_1 analyses only, since all of the results that were significant in the F_1 analyses were also significant in the F_2 analyses.

Noun Choice

Although word order was not a separate factor in the study, we were able to get an overall measure of word-order effects by looking at the grand mean. Across all stimuli, the percentage choice of the first noun as agent was 52.6%. This indicates that there was a general first noun bias, but only a fairly weak one.

Case. As in previous studies (MacWhinney et al., 1985), the effects of case-marking were extremely strong [$F(3,69) = 108.93$, $P < 0.0001$], accounting for 29.7% of the variance out of a total of 48% of the variance accounted for by the experimental variables in this study.

Number. The main effect of subject–verb number agreement was quite strong [$F(2,46) = 50.61$, $P < 0.0001$], accounting for 4.5% of the variance. For singular–singular (Sg-Sg) and singular–plural (Sg-Pl) configurations, the average selection of first noun was 60%, whereas for plural–singular (Pl-Sg) configurations it dropped to 35%. As Fig. 1 shows, the strongest effect of case appeared in those sentences in which there was no number cue (three Sg-Sg bars). Figure 1 also indicates that the strongest effects for number occurred when the case cue was neutralised (three centre bars).

In a separate analysis of sentences with no case, number accounted for 22.3% of the variance, whereas in an analysis of sentences with case, number accounted for only 0.3% of the variance. Thus it is clear that listeners are only making use of number when they cannot make use of the preferred case cue.

Definiteness. Just as the effect of number agreement only appears when there is no case, so the effect of definiteness agreement only appears when case is not marked. Although the main effect of definiteness was significant [$F(2,46) = 20.67$, $P < 0.001$], it accounted for only 2.5% of the variance. Thus definiteness was the weakest of the three grammatical cues.

Definiteness played an important role only when the two stronger cues—case and number—were both neutralised. Indefiniteness of the second noun is a good cue for selection of the first noun as actor, since an indefinite noun should not be the object of a definite verb. The significant interaction of definiteness with case [$F(6,138) = 4.66$, $P < 0.0001$] was due to

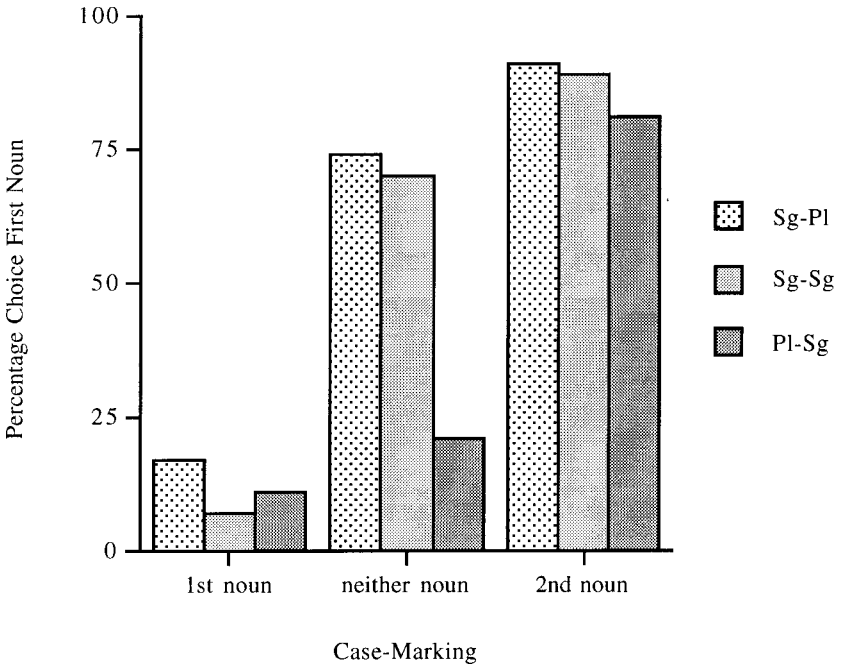

FIG. 1. The effects of case and number contrasts on percentage first noun choice in Experiment 1.

the fact that, in sentences without case-marking, the presence of an indefinite second noun increased first noun choice from 49 to 63%. When both number and case cues were neutralised, the presence of an indefinite second noun increased first noun choice from 54 to 80%. This showed up as a significant three-way interaction of case, number and definiteness [$F(12,276) = 3.62$, $P < 0.0001$].

Animacy. The main effect of animacy was also significant [$F(2,46) = 8.67$, $P < 0.001$], accounting for 1.9% of the variance. In Anim-Inan (animate first noun, inanimate second noun) sentences, the animate noun was selected 63% of the time. Animacy interacted with number [$F(4,92) = 6.26$, $P < 0.001$], as can be seen in Fig. 2. If the first noun was animate and singular, and the second noun was inanimate and plural, there was strong cue convergence, since the verb was always singular, and the first noun was chosen 74% of the time. If the first noun was inanimate and plural, and the second noun was animate and singular, the situation was reversed and the first noun was chosen only 24% of the time.

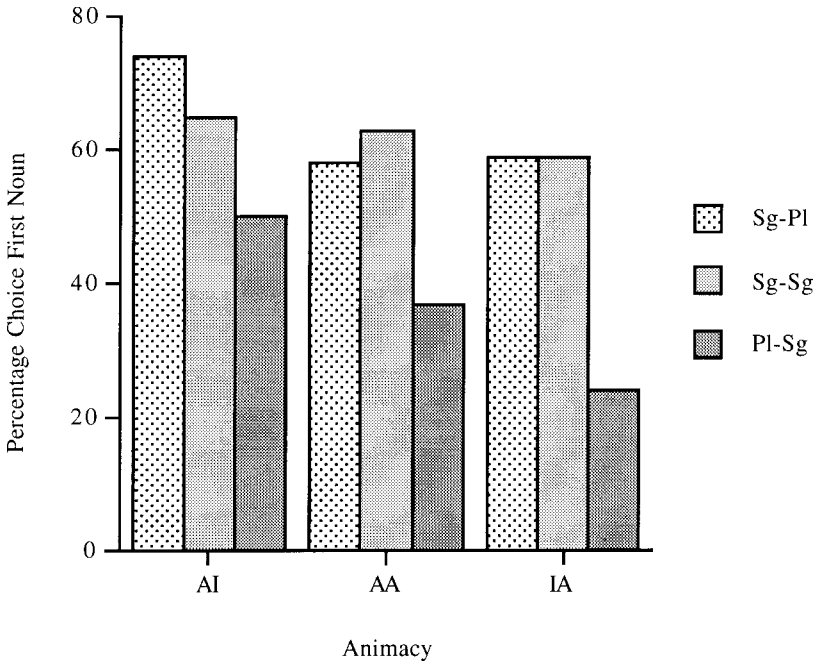

FIG. 2. The effects of animacy and number contrasts on percentage first noun choice in Experiment 1.

Reaction Times

For the choice judgements, case-marking emerged as the strongest cue, followed by subject–verb agreement, definiteness and then animacy. When we turn to the reaction time results, we find a very different pattern. For choice, the Competition Model predicts main effects for the strongest cues and interactions in terms of the patterns of cue convergence and conflict. For reaction times, however, the model does not predict main effects, only interactions. Specifically, the model predicts significant interactions for those cases in which cues conflict, particularly when the interaction is not resolved until near the end of the sentence.

Whereas case was the major determinant of choice, there was no significant main effect for either case or definiteness on reaction times. Both number and animacy had significant main effects on reaction times, but these effects were qualified by additional interactions. However, there were several strong interactions between the various factors, indicating a complex pattern of cue use during on-line processing.

Number. The main effect of number agreement was highly significant [$F(2,46) = 20.29$, $P < 0.0001$]. However, this effect must be interpreted in the light of a strong [$F(6,138) = 14.27$, $P < 0.0001$] interaction of case with number. This interaction is shown in Fig. 3.

To understand this interaction, we need to remember that the marking on the verb leads the subject to look for a singular subject. When the first noun has both accusative and plural marking, both cues combine immediately to support an OVS interpretation. When the first noun is marked as plural without any case-marking, the listener also often hypothesises an OVS interpretation, but this can then be reversed when an accusative marker is encountered on the second noun. It is sentences of this type, indicated in the seventh bar in Fig. 3, that contributed most to this interaction. Because all of the verbs in this study were singulars, it is possible that listeners use this number cue strategically. However, a corpus analysis of Hungarian (Papp, 1969) showed a nearly 2:1 ratio of singular verbs to plural verbs. Thus the expectations manifested in this study may reflect those found in the language more generally.

The other sentence type contributing to this significant interaction was the Sg-Pl sentence with an initial accusative noun. In this type of sentence, the presence of the accusative on the first noun makes that noun a poor candidate for a subject. However, when the final noun fails to agree with the verb, the listener is left with no good subject. The choice data show that listeners uniformly favour the case cue over the agreement cue and select the last noun as agent. While case is the basic cue for distinguishing subject and object in transitive clauses, the conflict between case and agreement exacts its toll in terms of a delay in the decision. Crucially, the processing of the agreement cue occurs right at the end of the sentence and resolution of the conflict must add directly to post-sentence reaction times.

It is not the case that reaction times increase with increasing numbers of contrasts to be attended to. Consider a sentence like (24):

24.	Egy	csacsi	meg-üt-i	a	kocká-k-at.
	a	donkey	PRE-hit-3.Sg.Def	the	block.Pl.Acc
	"A donkey hits the blocks".				

In such sentences, there are contrasts in animacy, number, case and definiteness. In other words, each of these cues points to one of the two nouns. But none of these contrasts conflict. These fully contrastive, non-conflict sentences took only 1349 msec to process—the shortest reaction time in the entire experiment. As long as cues work convergently, there is no reaction time cost associated with having more contrasts to process.

Definiteness. Although the main effect of definiteness on reaction times was not significant, there was a highly significant interaction of definiteness

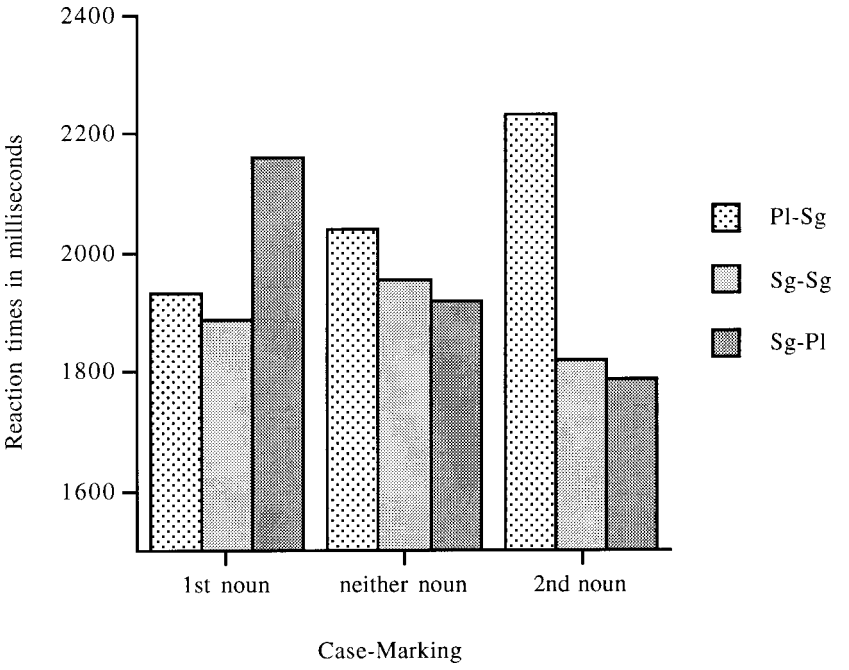

FIG. 3. The effects of case and number contrasts on reaction times in Experiment 1.

with number [$F(4,92) = 9.71$, $P < 0.0001$]. Reaction times slowed down markedly when the plural noun was definite and the singular noun was indefinite. Thus in sentences like (25), the mean reaction time was 2079 msec, and in sentences like (26) it was 2114 msec:

25.	*Egy	csacsi	meg-üt-i	a	krokodil-ok.
	a	donkey	PRE-hit-3.Sg.Def	the	crocodile-PL
	"A donkey hits the crocodiles".				
26.	*A	csacsi-k	meg-üt-i	egy	krokodil.
	the	donkey-PL	PRE-hit-3.Sg.Def	a	crocodile
	"A crocodile hits the donkeys".				

Although this effect showed up both for sentences with and without case-marking, it was strongest for sentences without case-marking, such as (25) and (26). In sentence (25), the choice of the first noun as actor is secure until the very last moment. Listeners then hear a second noun which at first seems like a good candidate for the object because it matches the requirements of the verb for a definite object. However, this final noun is missing the crucial case cue. Although they end up choosing the first noun as actor, the absence of the expected case cue slows processing markedly. In

sentence (26), the first noun is acceptable as an actor until the verb is heard and the violation of number agreement is detected. As in sentence (25), the listener waits until the end of the sentence for the deciding case cue. However, in this particular sentence type, case is not marked and the listener must depend instead on the number agreement cue. This forces a shift from a default SVO interpretation to an OVS interpretation. These effects are specific to particular sentences types, such as (25) and (26); they are not general effects of definiteness. A more general definiteness effect would have involved a major slowdown for an initial accusative indefinite noun. However, this effect did not occur.

Animacy. The main effect of animacy was barely significant [$F(2,46) = 4.15$, $P < 0.02$]. However, there was a strong interaction of animacy with case [$F(6,138) = 8.67$, $P < 0.0001$] and a three-way interaction of animacy with number and case [$F(12,276) = 6.48$, $P < 0.0001$]. Figure 4 displays the shape of the interaction of animacy with case. When the animacy and case cues converged, reaction times decreased. The fastest reaction times (1824 and 1899 msec, respectively) appeared in sentences that had a first noun that was either inanimate and case-marked for object or animate and case-marked as subject. When these two cues were set into competition, reaction times increased. Sentence-initial animate objects and inanimate subjects both slowed down processing. In all cases, listeners expected the actor to be animate.

The strong interaction of animacy with number and case was concentrated on those sentences where the initial animate noun had a conflict between case and number cues. In sentence (27), the selection of the first noun as actor is favoured by animacy and number, but not case. In sentence (28), the selection of the first noun as actor is favoured by animacy and case, but not number.

27.	*A	csacsi-t	meg-üt-i	a	kocká-k.
	the	donkey.Acc	PRE-hit-3.Sg.Def	the	block-PL
	"The blocks hit the donkey".				
28.	*A	csacsi-k	meg-üt-i	a	kocká-t.
	the	donkey.PL	PRE-hit-3.Sg.Def	the	block.Acc
	"The donkeys hit the block".				

In (27) the reaction time rose to 2526 msec and in (28) it rose to 2371 msec. The reaction times for these two cells were among the highest in the entire study. In both cases, the final choice of an agent was contingent on information that was not available until the very end of the sentence.

Animacy displays a similar pattern of additive cue interaction in relation to number and definiteness. We saw in our discussion of Fig. 4 that reaction times slow down when the cues for number and definiteness conflict. Figure

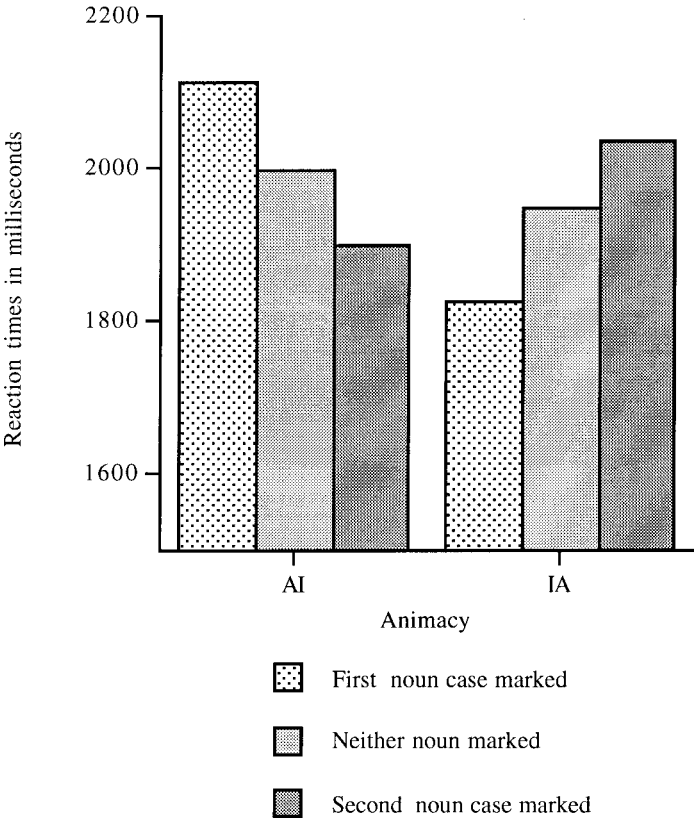

FIG. 4. The effects of animacy and number contrasts on reaction times in Experiment 1.

5 shows that listeners were 100 msec faster to respond when the indefinite noun was also animate. When this occurred, the combination of animacy and definiteness worked to overcome the number cue. However, both the animacy and definiteness interaction and the animacy and number interaction must be interpreted in the light of the strong and significant three-way interactions of these factors with case. Case-marking on the first noun is particularly effective in decreasing reaction times when the first noun is both definite and not the only animate noun. When the first noun was singular, case-marked and definite in animate–inanimate sentences such as (29), reaction time went up to 2693 msec—the highest reaction time in the entire experiment:

29. A csacsi-t meg-üt-i a kocká-k.
the donkey.Acc PRE-hit-3.Sg.Def the block-PL
"The blocks hits the donkey".

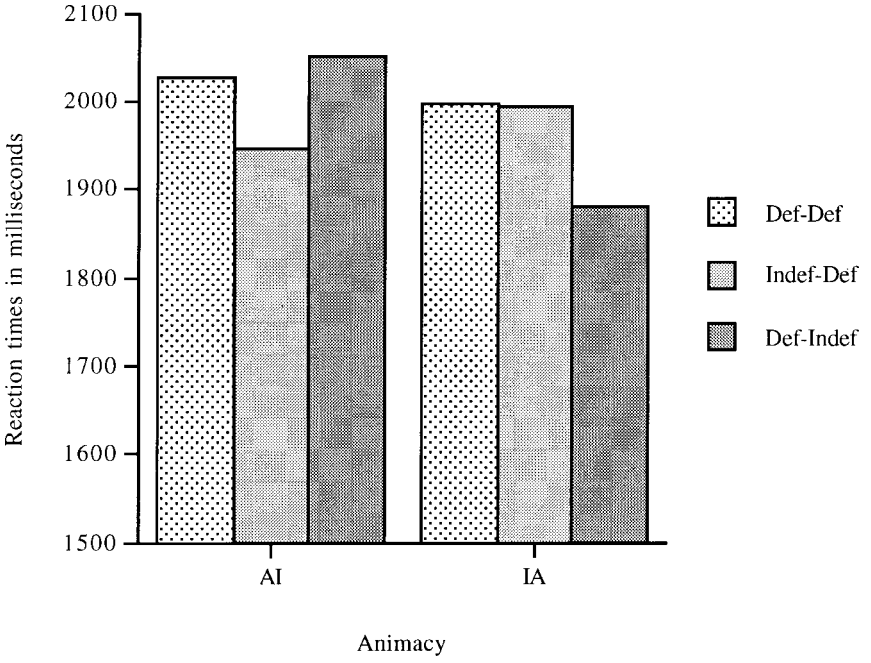

FIG. 5. The effects of animacy and definiteness contrasts on reaction times in Experiment 1.

Discussion

This study used two very different dependent variables—choice and reaction time. The standard finding of earlier work with the Competition Model for the off-line choice measure was that cues combine in terms of a simple multiplicative model (Massaro, 1987; McDonald & MacWhinney, 1989) in which cue strength is determined primarily by cue reliability. Cue reliability, in turn, can be estimated from text counts as the proportion of times the cue leads to the correct choice over the total number of occurrences of the cue. The observed pattern of cue interactions is extremely uniform in this work. When all cues favour a given interpretation, choice behaviour is consistent and reaction times are fast. When cues conflict, choices become split between alternatives and reaction times slow down. Strong cues tend to mask patterns of interactions between weaker cues. The effects of convergence and conflict between weak cues can only be observed clearly when the strongest cues are neutralised. The current study provides further evidence of the pervasiveness of these basic cue interaction patterns.

The second measure used in this study, choice reaction time, reflects on-line processes of cue competition. The Competition Model account for

the reaction time variable focuses primarily on ways in which cue competition leads to increases in reaction times in non-canonical sentences. The current work on Hungarian agreement is particularly useful in demonstrating particular instances of strong interpretation reversals. As the discussion of examples (25)–(29) has shown, the slowest reaction times occur in those sentences which have major cue conflicts and which are not resolved until the final word of the sentence.

Some studies conducted in the Competition Model framework have reported that increases in the number of cues available in a sentence can actually lead to a slowdown in processing, even when these cues are not in competition. For example, Kail (1989) found that, in both Spanish and French, the presence of clitic markers and agreement cues had a slight tendency to slow down processing of simple sentences, even when these cues matched up well with the overall word order and object-marking cues. In Serbo-Croatian, Mimica et al. (1994) also found that presence of additional grammatical cues can slow processing.

In the current study, on the other hand, having additional contrasts to pay attention to did not increase reaction times. Sentences in which all five cues were available, contrastive and non-conflicting were the fastest of all. We believe that this difference between the Hungarian results and those for Spanish, French and Serbo-Croatian reflects real cross-linguistic differences in the languages involved. Hungarian does not have a nominal gender system (MacWhinney, Leinbach, Taraban, & McDonald, 1989) of the type found in these other languages. As a result, cues are processed directly, rather than through the complexities and irregularities of gender categories. Because the grammatical markings in Hungarian for case and subject–verb agreement are so clear, transparent and reliable, and because word order is so flexible, it makes good practical sense for Hungarians to pay attention to these markings all of the time. Although the object–verb agreement cue is semantically complex, it is not possible to ignore it, since it is always combined morphologically with the subject–verb agreement cue and always agrees with that cue. Therefore, the best strategy for a listener to assume when processing Hungarian is to pay attention to all of the grammatical endings on words, since they typically provide useful and easily accessible information.

The second major finding in this study was the fact that the non-grammaticalised animacy cue was about as strong in absolute terms as the fully grammaticalised object–verb agreement cue. Although the object–verb agreement cue was potentially just as important in this experiment as the subject–verb agreement cue, it had a much weaker impact on the overall results. The fact that this cue was so weak is a finding that demands explanation. One possible explanation focuses on limitations in the design of the materials in Experiment 1. We used only third-person singular verbs in

the definite conjugation, and this may have allowed listeners to expect the object to be definite, somehow ignoring instances of non-agreement between the verb and the object. Such a strategy could then, in turn, lead to an underestimation of the importance of the verb–object agreement cue in Hungarian.

EXPERIMENT 2

A potential limitation of Experiment 1 was the fact that the verb was always kept in the third-person singular definite. This may have led subjects to adopt a strategy of ignoring violations of verb–object agreement. In Experiment 2, both the number and the conjugation of the verb were varied, thereby removing the confound and blocking the potential for use of this strategy. Besides excluding a possible confound in the results of Experiment 1, the inclusion of number and conjugation in Experiment 2 also allowed us to place a new set of cues into contrast, allowing us to detect possible violations of the basic predictions of the Competition Model.

Methods

Subjects. The subjects in this experiment were 24 college students enrolled in the Loránd Eötvös University in Budapest.

Materials. The general design of the materials was similar to that in Experiment 1. Simple sentences with NVN word order were used. The animacy factor was dropped from this experiment and all of the nouns were always the names of animal species, such as "tiger" or "bird". The factors of case-marking, noun definiteness and noun number were varied exactly as in Experiment 1.

Two factors were added to permit a variety of conflicts between agreement in number and the other factors: the first was the number of the verb (singular or plural) and the second was the conjugation of the verb (transitive/definite or intransitive/indefinite). Varying the dimensions of noun number and verb number made it so that the verb could agree with the first noun on both, one or neither of the dimensions of number and definiteness. Similarly, the verb could agree with the second noun on both, one or neither of these dimensions.

Altogether, the crossing of the factors of case (3 levels), noun number (3 levels), noun definiteness (3 levels), verb number (2 levels) and verb definiteness (2 levels) made a $3 \times 3 \times 3 \times 2 \times 2$ within-subjects design with 108 sentences. Actual experimental lists were produced out of these materials the same way as in Experiment 1.

Procedure. The procedure was the same as in Experiment 1.

Results

As in Experiment 1, the two dependent variables were noun choice and reaction times. We report the results for F_1 analyses only, since all of the results that were significant in the F_1 analyses were also significant in the F_2 analyses.

Noun choice

Case was again the most important determiner of the interpretation of the clause [$F(2,46) = 114.79$, $P < 0.0001$], accounting for 41.3% of the total variance. However, this main effect is qualified by additional interactions discussed below. These interactions represent cue summation effects of the standard Competition Model type.

Bias Effects. No other main effect accounted for more than 1% of the variance. However, this is a bit misleading, since use of the agreement cues requires interactions between two factors. Specifically, to evaluate subject–verb agreement, we must look at the interaction between the factor of noun number and the factor of verb number, and to evaluate object–verb agreement, we must look at the interaction between noun definiteness and verb definiteness.

Given this, main effects for the individual factors must be understood as representing biases towards certain sentence configurations, rather than cue effects. The two number cues had highly significant main effects, although neither of these effects approached the magnitude of the effect for case. The main effect of noun number was significant [$F(2,46) = 7.19$, $P < 0.002$]. Overall, the first noun was chosen as the subject more often in the Sg-Pl pattern than in the Pl-Sg pattern (54 *vs* 47%). This means that listeners are somewhat more willing to decide that a singular noun is the subject, even when half of the time this decision fails to agree with the number of the verb. For the verb number cue, the opposite was true. When the verb was plural, the chances of the first noun being selected as subject increased from 48 to 55% [$F(1,23) = 38.52$, $P < 0.0001$]. There were also significant interactions between case and noun number [$F(4,92) = 9.96$, $P < 0.0001$] and between case and verb number [$F(2,46) = 11.73$, $P < 0.0001$]. In the cells where case-marking was absent, the bias effects noted above were magnified.

Neither of the definiteness factors—noun definiteness and verb definiteness—had a significant main effect on choice. As noted above, the absence of a main effect for these cues only means that there is no overall bias towards a particular sentence gestalt that favours one definiteness configuration over others. However, if we look only at the sentences with no case-marking, we do see that the main effect of noun definiteness was significant [$F(2,46) = 7.65$, $P < 0.001$], while the main effect of verb

definiteness barely reached significance [$F(1,23) = 4.29$, $P < 0.05$]. The direction of the effect for noun definiteness was that, in the absence of case-markers, definite nouns had more chance of being selected as agents.

Number Agreement. The analysis of the use of the agreement cues depends upon an examination of the interaction effects. There was a strong interaction between noun number and verb number [$F(2,23) = 23.61$, $P < 0.0001$]. However, this effect was modulated by a significant interaction of noun number and verb number with case [$F(4,46) = 17.72$, $P < 0.0001$]. When the first noun was marked as accusative, the presence of a plural suffix had an interesting effect. It drove the choice of the initial noun as agent down to almost 2%. An example of a form of this type is *csacsikat* ("donkey-Pl-Acc"), where the stem *csacsi* has first the plural *-k* and then the accusative *-at*. It appears that the combination of the plural marker with the accusative marker produces a form in initial position that is very clearly accusative and not available for choice as the agent. A similar effect appeared in Experiment 1. This effect provides further evidence for the role of perceptual factors in Hungarian affix processing that was noted in earlier research (MacWhinney et al., 1985, 1991). Although it is sometimes possible to confuse a lone accusative marking with a plural marking or some other suffix, the combination a plural with an accusative is unmistakable.

The interaction between case, noun number and verb number also involves differential effects that occur when case is either marked or not marked. These effects are displayed in Fig. 6. What stands out in Fig. 6 is the low first noun choice (20%) for the Pl-Sg pattern with a singular verb. This is not too surprising, since, for this cell, the plurality of the first noun violates subject–verb agreement. However, when the verb is plural and the first noun is singular, there is an unexpectedly high level of choice of the first (singular) noun as agent. This goes directly against the basic rules of Hungarian grammar. There is no case-marking here that requires choice of the first noun. Nonetheless, listeners pick the first noun as agent and simply disregard the plurality of the verb, despite the presence of a plural noun after the verb. Sentence (30) illustrates a stimulus of this type:

30.	*A	macska	kerget-ik	a	kutyá-k.
	the	cat	chase-3.Pl.Def	the	dog-PL.

"*The cat chase the dogs".

In other words, singular verbs work strongly to pick out singular subjects, but plural verbs do not pick out plural subjects with the same clarity. We will discuss this result in further detail later.

Definiteness Agreement. The rather strong effects for number agreement contrast with decidedly less powerful effects for definiteness

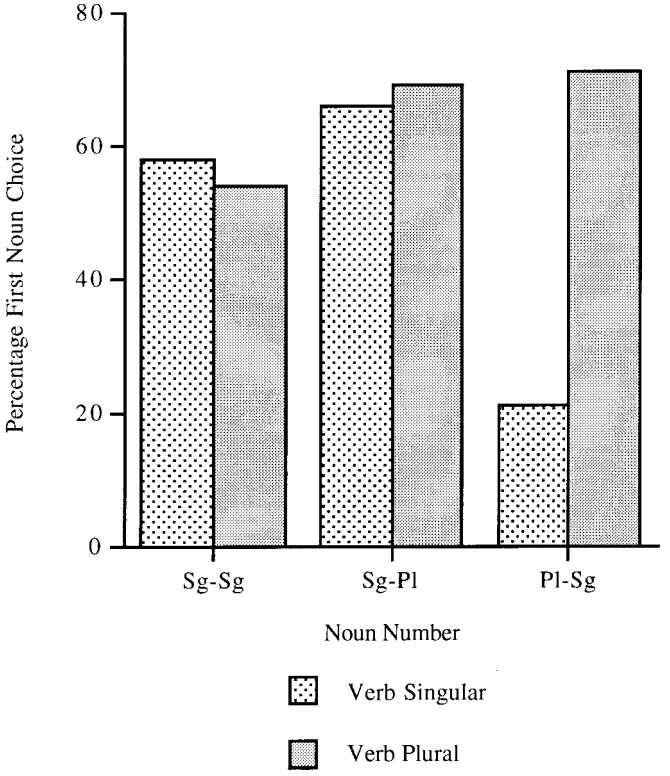

FIG. 6. The effects of verb number and noun number contrasts on percentage first noun choice in Experiment 2.

agreement. The interaction between noun definiteness and verb definiteness was only just significant [$F(2,46) = 4.69$, $P < 0.01$], indicating a weak overall use of definiteness agreement. However, in the analysis of just those sentences with no case-marking, this interaction was not significant.

Reaction Times

Case. For response reaction times, case-marking had a significant main effect [$F(2,46) = 4.65$, $P < 0.01$]. The fastest responses were for Acc-Nom structures (1894 msec), while both Nom-Acc (1943 msec) and Nom-Nom (1985 msec) orders slowed processing down.

Number Agreement. The factor to have the strongest main effect on reaction times was verb number [$F(1,23) = 18.69$, $P < 0.0001$]. Plural verbs were about 100 msec slower than singular verbs. This effect was mostly due

to the fact that the plural verbs were one stop consonant longer in the definite conjugation and an entire syllable longer than their singular counterparts in the indefinite conjugation. However, the interactions of number-marking with other factors cannot all be accounted for in terms of length differences. One significant interaction was between verb number and noun number [$F(2,46) = 6.26$, $P < 0.005$]. This interaction was due to the fact that, if both nouns were singular (Sg-Sg), the presence of a plural verb slowed down decisions considerably (1823 *vs* 2010 msec), while in the other two noun number configurations reaction times were basically the same. These findings indicate that the fast reaction times for singular initial nouns in Experiment 1 were partly strategic. However, the preference for singular verbs over plural verbs in Experiment 2 indicates that there is also a general non-strategic preference for a canonical sentence form in which a singular subject combines with a singular verb.

The interaction between the two number cues has to be interpreted in the light of a strong three-way interaction between noun number, verb number and case-marking [$F(4,92) = 7.94$, $P < 0.0001$]. In the sentences with no case-marking, there was no significant interaction involving noun number. Figure 7 displays the shape of the effect, but only for cells in which case is marked—Nom-Acc and Acc-Nom. In Fig. 7, all of the fastest reaction times occurred when the agreement cue matched the number of the nominative noun. This occurs in bars 1, 3, 5, 8, 10 and 11 reading from left to right across the graph. The other cells all involved cue conflicts and these conflicts all appeared to slow down decisions. These results show that listeners definitely pay attention to the number agreement cues and that violations of number agreement slow down decision times.

Definiteness Agreement. When we turn to an examination of the effects of definiteness agreement, we see much weaker effects. There was a significant interaction of case with noun definiteness [$F(2,46) = 5.98$, $P < 0.005$]. This interaction was mainly due to the fact that, for indefinite subjects, Nom-Acc sentences were slower (2036 msec) than Acc-Nom sentences (1836 msec). This can be interpreted as evidence for a definite subject preference, but not as evidence for the importance of the definiteness agreement cue.

There was a significant interaction between verb definiteness and noun definiteness [$F(2,46) = 7.41$, $P < 0.002$]. In the definite–definite noun configuration, definite verbs gave faster interpretations than indefinite verbs (1885 *vs* 1953 msec), while in indefinite–definite noun configurations, the reverse picture was obtained—sentences with an indefinite verb were over 100 msec faster (1911 *vs* 2042 msec). This suggests that the listener waits for the second noun as a candidate for the object if the first one does not agree with the definiteness of the verb.

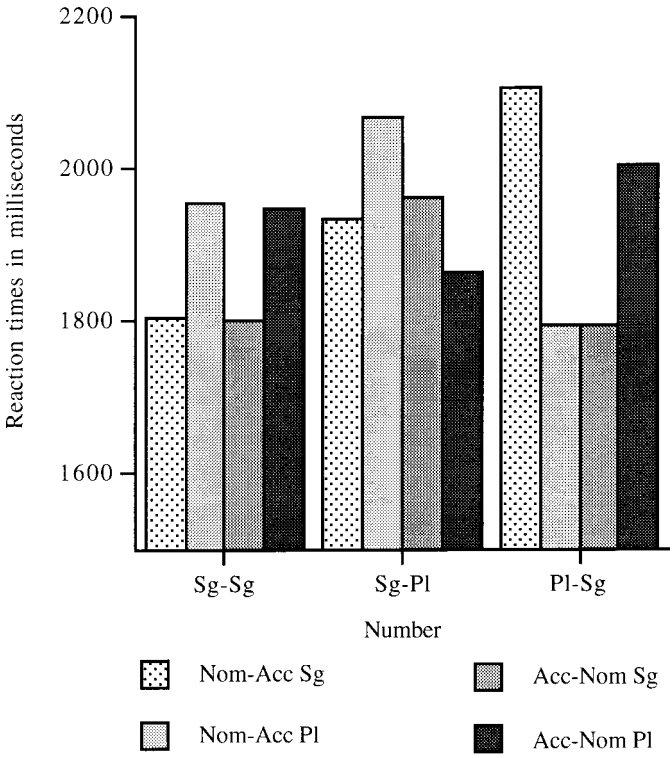

FIG. 7. The effects of case-marking, noun number and verb number contrasts on reaction times in Experiment 2.

This interpretation is supported by the three-way interaction between case, noun definiteness and verb definiteness. In sentences with case-marking, there was a significant interaction between verb definiteness and noun definiteness [$F(2,46) = 4.82$, $P < 0.01$]. The three-way interaction with case [$F(2,46) = 3.84$, $P < 0.05$] was mainly due to the strong facilitating effect of definiteness agreement between an initial accusative indefinite noun and an indefinite verb in Acc-Nom sentences, such as (31):

31.	Egy	macská-t	kerget-0	a	medve.
	a	cat.Acc	chase-3.Sg.Indef	the	bear

"The bear is chasing a cat".

The reaction times for this sentence type are given in the second bar in Fig. 8. When an initial accusative also agreed with the verb in definiteness, listeners decided that it could not possibly be a subject and that the final noun must be the subject. By being able to exclude any competition, they were able to respond more quickly.

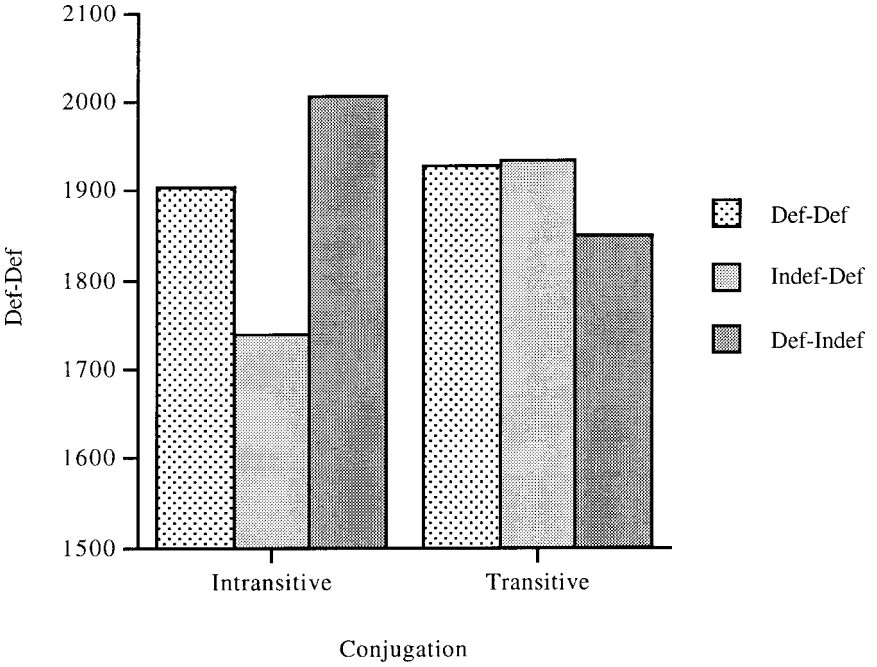

FIG. 8. The effects of verb conjugation and noun definiteness on reaction times for sentences beginning with accusative nouns in Experiment 2.

DISCUSSION

Experiment 2 helped to clarify and solidify the results of the first. The basic Competition Model pattern of cue interactions appeared again, both for choices and reaction times. Although this pattern involves many significant main effects, two-way interactions and three-way interactions, the shape of these effects is always the same. Strong cues dominate over weak cues and the effects of conflicts between weak cues can only be seen in those cells of the design in which the strong cues are neutralised. As in the first study, the strongest cue was case-marking, followed by subject–verb agreement and then object–verb agreement. This ordering corresponds to the relative cue validity of the three cues in the language.

Experiment 2 showed that failure to vary verb definiteness and number was not the reason for a weak use of object–verb definiteness agreement in Experiment 1. In fact, definiteness agreement seemed to play an even more marginal role in Experiment 2 than in Experiment 1. Why is it that this cue has such a weak impact on sentence processing?

One possible account of this finding would argue that the agent identification task tends to place subject–verb agreement-marking into

focus, while downplaying the importance of object–verb agreement-marking. For Hungarian speakers, who use object case-marking as their primary cue to agent identification, this may seem like a rather curious suggestion. However, the current study does not rule out this possibility. It would be possible to run a version of these studies in which subjects are asked to identify not "who chased the bear" but "whom did the bear chase?". Indeed, we hope to test out this possibility in future work. However, the emphasis that Hungarian already places on attention to the case-marking of the direct object makes it unlikely that this additional extra-grammatical manipulation will alter the finding that subject–verb agreement is stronger than object–verb agreement.

A second possible account would focus on the difficulties involved in the processing of agreement markings. Work by Bock and Miller (1991) for English, by Mimica et al. (1994) for Serbo-Croatian and Bates et al. (1984) for Italian has demonstrated a specific weakness for agreement cues. In Hungarian, there are two agreement cues which place virtually identical information-processing and cognitive demands on the language processor, but one of these two cues is fairly strong and the other has virtually no impact at all. Why is this so?

Perhaps the most straightforward answer to this question is that the object–verb agreement cue is lower in contrast availability (McDonald & MacWhinney, 1989). If you use the number agreement cue to pick out the subject, you will typically find that only one of the nouns in the sentence agrees with the verb. This is because the subject will often be in the first or second person. In fact, there are six possible person–number combinations, all recognised by the paradigm. Only when there are two nouns in the third person and both have the same number will use of the subject–verb agreement cue be non-contrastive. On the other hand, for definiteness agreement there are only two possible values for nominals. They may be either definite or indefinite. Often, both nouns are definite or both are indefinite, which means the object–verb agreement cue is rendered non-contrastive.

This cue validity account seems to explain our synchronic psycholinguistic findings, but it begs a further diachronic question. Why is this relatively useless marking preserved in the language? Given the fact that the object is so easily identified by the accusative suffix, and given the fact that the definiteness of the direct object can easily be marked by the definite article, why does Hungarian maintain two full conjugations to mark a distinction that can be more readily indicated by much simpler devices? The answer to this question lies in the historical development of the language.

In early Proto-Uralic (Bárczi, Benkö, & Berrár, 1980; Horger, 1931; Klemm, 1928), the language from which Finno-Ugric derives, the genitive and accusative cases were used with definite nouns; indefinite nouns took no

marking. This kind of pattern of marking definiteness only for the object has also arisen in other languages. For example, Turkish (Erguvanli, 1984) allows for omission of the accusative marker when the object is indefinite.

The addition of markers to the verb began during the Finno-Ugric period with the attachment of the third-person pronoun to the verb. This deictic pronoun originally served not as a subject agreement-marker, but as a marker of the definite object of the verb. From this agglutinated morpheme, we can trace the morphological origins of the definite conjugation. By the time of the early Hungarian period, the complete set of two conjugations had emerged. The first "toehold" of the new conjugation was in the third-person singular, where the intransitive/indefinite conjugation uses zero-marking. Because the other cells of the definite paradigm arose from the possessive markers, suffix combinations were not created by agglutination. Instead, a whole new set of affixes arose in the present tense, parallel to the earlier set.

During the time of the formation of the two conjugations, there was still no separate marking of the definiteness of the noun. During the fourteenth century, the deictic pronoun *az* ("that") started to function as a definite determiner. During subsequent centuries, it became fully reinterpreted as a definite article. Despite the emergence of a transparent definite article, the contrast between the two conjugations has remained entrenched in the morphology of the language.

The end result of these historical processes is a system that is not optimally functional. During sentence production, speakers must continually pay attention to the definiteness of the object so as to select the correct set of suffixes for the verb. This involves processes that we do not find in English, but which are quite natural in many other languages. During sentence comprehension, the availability of the definite article, a reliable accusative case-marker, and a clear system of subject–verb agreement makes use of the contrast between the two conjugations relatively unimportant. Thus this contrast is preserved in production, despite its low functional utility for comprehension. The preservation of this marking in the Hungarian language is testimony to the diachronic tenancity of morphological markings when they become embedded in complex grammatical paradigms. Such situations demonstrate clear limits to the extent to which we can argue that the morphosyntax of language is always fully functionally determined.

Manuscript received June 1996
Revised manuscript received November 1996

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