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AGREEMENT PROCESSING IN HUNGARIAN APHASICS*

BRIAN MACWHINNEY – JUDIT OSMAN-SÁGI

Abstract

Crosslinguistic studies of sentence processing in aphasia in the Competition Model framework emphasize the extent to which strong cues are preserved in aphasia, while weak cues are lost. In addition, these studies have indicated that cues expressed by morphological markings, such as case and agreement cues, are particularly vulnerable to damage. The processing of agreement cues in Hungarian is an interesting further test of this “selective vulnerability” of morphological marking, since Hungarian has a rich and complex system of agreement-marking coupled with a remarkably simple system for case-marking. In addition, aphasics may rely on cues such as animacy and word order when they are not able to process the more grammaticalized case and agreement cues. This study examines the relative cue strength of each of these four cues for aphasics in a simple sentence interpretation task. The results provide further support for the importance of cue strength in aphasic processing, as well as pointing to the selective vulnerability of morphological cues, particularly in Wernicke’s aphasia.

1. Introduction

The expression of grammatical role is one of the most central functions conveyed by language. In every clause, we need to be able to identify the subject or actor. If the verb is intransitive, this is an easy matter. But when the verb is transitive, we may often find two or even three nominals that are potential candidates for the role of subject. In order to select among these possibilities, we use a series of cues, including word order, case-marking, animacy, and verb agreement-marking. Of these various cue types, the ones that involve the most elaborate type of processing are the agreement cues, since they require us to process morphological markers on the verb and the various nouns and then to compare these two sets of markings in terms of a possibly complex conjugational paradigm. In English, the conjugational paradigm is not very complex. Consider the English sentence *It was the dogs that*

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were chased by the cat. Here we must process the number marking on the verb *were*, interpret the number on the nominals, *the dogs* and *the cat*, and link these two sets of results in terms of the agreement rules of English. Despite the formal simplicity of the English system, the processing of agreement in English is still a difficult matter (Bock–Miller 1991).

In Hungarian, the situation is even 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. In a sense, this might make Hungarian agreement-marking a more powerful and reliable cue, since it not only tells us the grammatical number of the subject, but also its grammatical person. What makes the situation particularly complicated in Hungarian is the fact that these markers 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.

Crosslinguistic studies of sentence processing in the Competition Model framework (Bates–Wulfeck 1989; MacWhinney–Osman–Sági–Slobin 1991; Smith–Bates 1987; Smith–Mimica 1984) have emphasized the extent to which strong cues are preserved in aphasia, while weak cues are lost. In addition, these studies have indicated that agreement cues are particularly vulnerable to damage. The processing of agreement cues in Hungarian is an interesting further test of this “selective vulnerability” of agreement marking, since Hungarian has a particularly complex, but reliable, system of agreement-marking coupled with a remarkably simple system for case-marking. In addition, we know that aphasics may rely on cues such as animacy and word order when they are not able to process the more grammaticalized case and agreement cues. MacWhinney–Osman–Sági–Slobin (1991) showed that, when the Hungarian case-marking cue is clearly detectable, aphasics rely on it with fair consistency. However, that study did not examine the use of the agreement-marking cue. Therefore, we do not know whether Hungarian aphasics are able to make full and integrative use these two reliable grammatical cues. This study examines the relative cue strength of each of the four cues for aphasics in a simple sentence interpretation task.

2. Cues to grammatical role identification in Hungarian

Before presenting out experiment, it will be helpful to review the ways in which grammatical roles are marked in Hungarian. Hungarian has five major cues that help the listener identify the subject of a transitive: (1) case marking, (2) subject–verb number agreement, (3) word order, (4) animacy, and (5) object–verb def-

initeness agreement. In this report, we will only focus on the use of the first four cues, since research with normal subjects (MacWhinney–Pléh 1997) has shown that object–verb agreement plays a minimal role in sentence interpretation.

In 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* ‘apples’ 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 subject.

2. **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–verb agreement.** The same suffix on the verb that indicates a third person singular subject also indicates that the object of the verb is definite. Since *fiú* 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.

5. **Word order.** Finally, *fiú* precedes the verb and *almákat* does not. This positional placement of *fiú* provides further evidence that *fiú* is the subject. Thus, the five cues of case, number agreement, definiteness agreement, animacy, and word order all point toward the selection of *fiú* as the subject and agent.

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 directions. For example, the free word order of major elements in a Hungarian sentence (see below) makes it so that the word order cue often conflicts with the case cue. 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). This model holds that the cues which have the strongest effect on sentence processing are those with the highest cue reliability. In order to understand the predictions that arise from the Competition Model for Hungarian in general and for aphasia in particular, we need to examine the relative reliabilities of the five major cues to subject identification.

2.1. Reliability of the case-marking cue

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 with transitive verbs and two NPs in which the presence of the accusative is misleading. However, there are a few cases in which the cue is not **available** because the accusative case marker is optional. 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.
 see-1.sg the dog-2.sg.poss
 'I see your dog'.
- (3) Lát-om a kutyá-d-at.
 see-1.sg the dog-2.sg.poss-acc
 'I see your dog'.

Both sentences mean "I see your dog". In (2) the accusative suffix on *kutyádat* is optional. When the first person singular or second person singular possessive is not present, every object of a transitive verb must have the accusative suffix. 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 recognize both regularly and irregularly inflected accusatives. For children, this task is not so easy (MacWhinney 1985; MacWhinney *et al.* 1985), because they have not yet learned to control the various morphophonological irregularities involved. Moreover, auditory detection of the accusative suffix can be difficult for children in forms where the *-t* directly follows a dental obstruent (MacWhinney *et al.* 1985). Aphasics have particular trouble detecting the accusative marker (MacWhinney *et al.* 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. A noun that appears without any case suffixes or postpositions is, by default, placed into the nominative case. The absence of any form of case marking or postpositional marking is an extremely reliable cue for the subject of the verb. Since there is no true passive in Hungarian, the subject is also easily identified as the actor or agent with a transitive verb.

2.2. Reliability of the subject–verb agreement cue

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 neutralization and is relatively clear and unambiguous. For example, the verb *fut* ‘run’ has these forms.

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

Note that each of these forms is distinct and there is virtually no neutralization anywhere in the conjugational paradigm. This is generally true for Hungarian verbs.

In the terms of the Competition Model, this means that the agreement cue on the verb is completely **reliable**, despite its high level of **formal complexity**. Although this cue is extremely reliable, it is not as generally **available** 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. Of course, in those cases where the subject–verb agreement cue is not available, the accusative case cue is usually available. There are no cases in which the case cue and the agreement cue point in opposite directions. In Competition Model terms, this means that the **conflict validities** of both the case cue and the subject–verb agreement cue are very high.

There are two ways in which the number agreement cue in Hungarian differs from number agreement in languages like English, German, or Spanish. One difference involves the way in which agreement interacts with ‘plural’ quantifiers. In Hungarian, one says *öt férfi* ‘five man’ instead of *öt férfiak* ‘five men’. 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 “plural” subject noun phrase is treated as singular. In this sense, a referent that is conceptually plural (Pollard–Sag 1988) is treated as grammatically singular. If sentence processing relies more on underlying form than on superficial syntactic form, these two mismatches between conceptual number (Pollard–Sag 1988) and grammatical number could serve to weaken the subject–verb agreement cue. Alternatively, as Bock–Miller (1991) and Bock–Loebell–Morey (1992) have suggested, syntactic processing may rely initially more

on surface syntactic structure than on underlying conceptual structure. In that case, the strength of agreement marking should be influenced only by reliability and other processing factors.

2.3. Reliability of the word order cue

When the verb is in the definite conjugation, the usual word order is SVO. Hungarian permits all six word orders in transitive clauses (SVO, SOV, VSO, VOS, OSV, OVS). However, the SOV and SVO orders are the unmarked (Dezső 1972; 1982). When there is a definite noun in postverbal position in an NVN clause, then it is fairly likely that the preverbal noun is the subject. This cue is fairly high in availability, but rather low in reliability. In sentences with OVS order, the case marking and agreement cues inevitably dominate over the word order cue. Similarly, in NNV clauses with an articleless preverbal noun, it is fairly likely that the first noun is the subject. In both word order types the basic cue is that the first noun is probably the subject (MacWhinney *et al.* 1985).

2.4. Reliability of the animacy cue

As in other languages that have been investigated within the Competition Model framework (MacWhinney–Bates 1989), Hungarian makes use of animacy contrasts to determine 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 (4) listeners tend to take *fiú* ‘boy’ as the subject that is also supported by the conceptual representation of verb semantics.

- (4) *A labda fog-ja a fiú.
 The ball grab-3.sg.def the boy
 ‘?The boy grabs the ball’

2.5. Cue reliability: Summary

According to the Competition Model (MacWhinney–Bates 1989), the strength of the four cues should be determined first 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 in this set of four cues. For the other two cues, the major determinant of their relative strength should be **availability**. In this regard, the accusative suffix is more highly available than the agreement cues, since agreement is sometimes neutralized. Therefore, case-marking should be the strongest of the four cues, although the difference in strength between case-marking and agreement-marking should not be large.

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There are two additional factors which could further limit the strength of the agreement cues. First, agreement cues place a greater 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–MacWhinney (in preparation) have shown that formal complexity is not a major determinant of sentence interpretation. Therefore, we would be inclined to attribute any additional problems found in processing agreement cues not to formal complexity, but to processing costs.

3. Methods

3.1. Subjects

Our subjects included 10 Broca's aphasics, 11 Wernicke's aphasics, 9 anomics, 4 conduction aphasics, and 15 normal control subjects. The aphasics were tested by the second author at the Rehabilitation Institute in Budapest where they were recovering. The control subjects were matched to the aphasic subjects in terms of age and educational level.

3.2. Materials

The stimulus sentences in this experiment were all composed of two simple nouns and one verb. The verbs used were 'push away', 'hit', 'beat', 'jump over', and 'step over'. The nouns were all common animal names such as 'lizard' or 'pig'. The order of the nouns and the verb was always NVN.

The shape of the two noun phrases was specified by the systematic variation of three factors: case marking, number, and animacy. For each of these three cues, there were three levels in a fully crossed $3 \times 3 \times 3$ design. On the first level, the cue favored the choice of the first noun. On the second level, it favored the choice of the second noun. On the third level, the cue was the same for both of the two nouns. For example, the three levels of the case cue were (1) the cue favors first noun, (2) the cue favors second noun, and (3) the cue is neutralized. In addition to the three noun cue factors, there was a fourth factor that varied the number of the verb. This factor was added to see if the effects for singular verbs were the same as the effects for plural verbs. Thus, the complete design of the experiment was:

case marking	(3)
noun number	(3)
animacy	(3)
verb number	(2)

This leads to a total of 54 possible cells. One sentence was constructed for each of the possible cells. In order to further control for possible order effects, three different versions of the test were constructed in which combinations of nouns and verbs and the order of stimuli were further counterbalanced.

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 (5):

- (5) *Egy kutya el-kerget-i egy csacsi-t.
 a dog away-chase-3sg.def a donkey-acc.
 'A dog chases away a donkey'

The verb was always a third person singular definite verb with an unseparated verbal prefix of the type given in (5). The use of prefixed verbs had two advantages. First, prefixed verbs usually denote a specific rather than habitual action. Therefore the reading of the definite article as denoting the generic could be avoided. Second, sentences with unseparated verbal prefixes have a straightforward topic-comment structure, since it is the prefix itself which takes the focus slot, thereby allowing the listener to treat the preverbal noun as given information (É Kiss 1981).

3.2.1. Case-marking variation

The following three sentences illustrate the three basic patterns for case marking, when both nouns are animate, definite, and singular.

- (6) *First noun nominative* (cue favors first noun choice; Nom-Acc)
 A csacsi meg-üt-i a krokodil-t.
 the donkey pref-hit-3.sg.def the crocodile-acc
- (7) *Second noun nominative* (cue favors second noun choice; Acc-Nom)
 A csacsi-t meg-üt-i a krokodil.
 the donkey-acc pref-hit-3.sg.def the crocodile
- (8) *Both nouns nominative* (cue favors neither noun; Nom-Nom)
 *A csacsi meg-üt-i a krokodil.
 the donkey pref-hit-3.sg.def the crocodile

We will refer to these three sentence types as Nom-Acc (Nominative-Accusative), Acc-Nom (Accusative-Nominative), and Nom-Nom (Nominative-Nominative), respectively. For the first two types of sentences we would expect the unmarked

nominative noun to be chosen as the agent. When both nouns are nominative, interpretation would rely on the use of other cues. Note that, whereas (6) and (7) are grammatical sentences in Hungarian, (8) is not. However, as demonstrated in MacWhinney–Pléh–Bates (1985), the interpretation of sentences like (8) follows the same principles as those followed in the interpretation of fully grammatical sentences like (6) and (7).

3.2.2. Number-marking variation

The next three sentences provide examples for the three levels of the factors of number. For clarity of illustration, the cues of definiteness and case marking are balanced in these sentences.

- (9) *Both nouns singular* (cue favors neither noun)
 *A csacsi meg-üt-i a krokodil.
 the donkey pref-hit-3.sg.def the crocodile
- (10) *First noun singular* (cue favors first noun choice)
 *A csacsi meg-üt-i a krokodilok.
 the donkey pref-hit-3.sg.def the crocodile-pl
- (11) *Second noun singular* (cue favors second noun choice)
 *A csacsik meg-üt-i a krokodil.
 the donkey-pl pref-hit-3.sg.def the crocodile

We will refer to these three noun number patterns as Sg-Sg (Singular-Singular), Sg-Pl (Singular-Plural), and Pl-Sg (Plural-Singular), respectively.

3.2.3. Animacy variations

The next three sentences illustrate the three levels of animacy, which we will call Anim-Inan (Animate-Inanimate), Inan-Anim (Inanimate-Animate), and Anim-Anim (Animate-Animate).

- (12) *First noun animate* (cue favors first noun choice; Anim-Inan)
 *A csacsi meg-üt-i a kocka.
 the donkey pref-hit-3.sg.def the block
- (13) *Second noun animate* (cue favors second noun choice; Inan-Anim)
 *A kocka meg-üt-i a krokodil.
 the block pref-hit-3.sg.def the crocodile

(14) *Both nouns animate* (cue favors neither noun; Anim-Anim)

*A csacsi meg-üt-i a krokodil.
 the donkey pref-hit-3.sg.def the crocodile

3.3. Procedure

Pairs of objects were placed in front of the subject. Then a sentence was read aloud and the subject's task was to enact the activity described by the sentence. For example, given a sentence such as 'the cows are hitting the dog', the subject could either pick up the dog and use it to hit the cows or else pick up the pair of cows and use it to hit the dog. Pairs of objects, such as a pair of cows, were mounted together on a small board to facilitate handling. The second author, a native speaker of Hungarian, read the test sentences in a clear normal voice. The full set of 54 test sentences were administered one after another—usually in a single experimental session.

4. Results

4.1. Word order

As in earlier experiments with normals (MacWhinney–Pléh 1997; MacWhinney *et al.* 1985), there was a general tendency to take the first noun as agent. Normals chose the first noun 55% of the time in this experiment, closely matching the 54.3% level of choice for normals found in a parallel study with similar materials by MacWhinney–Pléh (1996). The patient groups all showed higher levels of first noun choice, $F(4,44) = 2.94$, $p < .03$. The levels were 56% for anomics, 57% for Broca's, 60% for Wernicke's, and 75% for Conduction. This marked elevation in the use of the first-noun-as-agent strategy for Wernicke's was also observed in MacWhinney–Osman-Sági–Slobin (1991).

4.2. Case

As in earlier experiments with normals (MacWhinney–Pléh 1997; MacWhinney *et al.* 1985), the main effect of case was highly significant across all five groups, $F(2,88) = 83.77$, $p < .00001$. However, the magnitude of this effect varied greatly across the five groups, $F(8,88) = 14.51$, $p < .00001$. The sharpest use of the cue was in the normal group. Following the normals, come the anomics, the Broca's patients, and finally the Wernicke's and Conduction patients. Figure 1 displays the shape of this interaction. This pattern of sharply diminished use of the case-marking cue in Wernicke's aphasics tightly replicates the similar pattern reported in MacWhinney–Osman-Sági–Slobin (1991).

4.3. Animacy

There was a significant main effect for animacy, $F(2,88) = 6.82, p < .005$. In Anim-Inan (animate first, inanimate second) orders, the percentage choice of the first noun as agent reached 65%. In the Anim-Anim and Inan-Anim orders, choice was at 62% and 55%, respectively. There were no significant differences between the groups in the use of the animacy cue, although the use in the Broca's group had the weakest level of use of the cue.

4.4. Subject-verb agreement

As in earlier experiments with normals (MacWhinney-Pléh 1997; MacWhinney *et al.* 1985), the main effect of agreement between the noun and the verb was highly significant, $F(2,88) = 22.73, p < .00001$. When the agreement cue favored the first noun, choice of the first noun was at 67%. When it favored the second noun, choice of the first noun was reduced to 54%. This overall effect of agreement was modified by three significant interactions. First, there was a significant interaction of subject group with the agreement cue, $F(8,88) = 2.28, p < .03$. The essence of this interaction was that the agreement cue was used more by the normal and Broca's groups than by the other three groups, as is indicated in Fig. 2. As with the processing of the case cue in Fig. 1, the Wernicke's patients show the most severe loss of this grammatical cue.

There was also a significant interaction of case with agreement, $F(4,88) = 6.92, p < .0001$ which is parallel to the one found in MacWhinney-Pléh (1997) with normals. When the case marking cue was absent in the Nom-Nom sentences, the effect of agreement was much stronger. However, this was not true across all of the subject

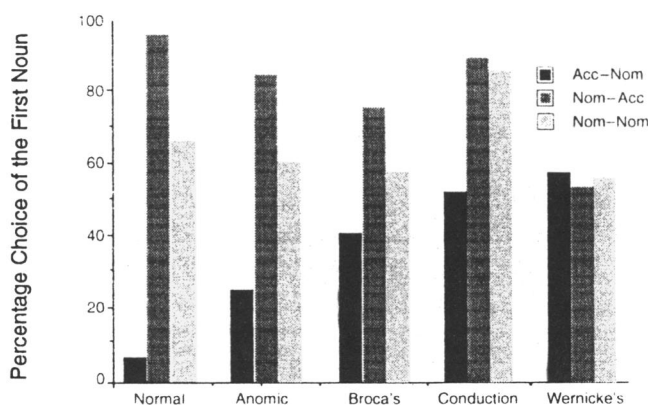


Fig. 1
Differences between subject groups in the use of case marking

groups. Even when there was no case cue, the Wernicke's group differed significantly from the other groups in failing to pick up on this cue, $F(16,176) = 2.28$, $p < .005$.

4.5. Cue convergence

Smith and Bates (1987) found that their Serbo-Croatian aphasic subjects tended to rely on morphological cues primarily when several cues pointed in the same direction. The Broca's subjects in this experiment showed a similar effect. When the animacy and agreement cues were neutral, the presence of an accusative case marker on the first noun led to a 55% level of choice of the first noun as actor.

When the agreement and animacy cues both pointed toward the second noun as actor, this level of choice dropped to 15%. However, a similar pattern did not appear when the case marker was on the second noun. In such sentences, choice of the first noun as actor by Broca's aphasics remained around 75%, even when animacy and agreement cues were added to the case cue. For Wernicke's aphasics, the addition of more cues made no difference, since choice was generally at chance in all conditions.

5. Summary

This study provides further support for the finding from previous research (Bates–Wulfeck–MacWhinney 1991; MacWhinney *et al.* 1991) that morphological

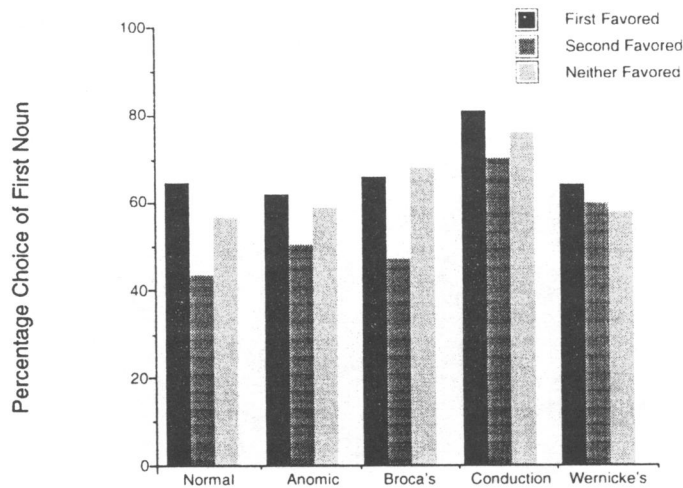


Fig. 2
Use of the agreement cue across groups

cues are particularly vulnerable to loss in aphasia. Overall, the patterns of preservation and loss support the Competition Model notion that strong cues are preserved over weak cues. For the normals and the anomics, the case cue was stronger than the number agreement cue. For the Broca's group, both cues were weakened, but still somewhat operative. Finally, the Wernicke's patients appear to have almost totally lost their ability to use either the case marking cue or the agreement cue. As subjects lose control of these morphological markings, they rely increasingly on animacy and word order strategies.

These data suggest that Wernicke's aphasics may be suffering from a general inability to process morphological markings. However, there is little evidence in this particular study that aphasia damages the agreement cue more than the case marking cue. The greater complexity of the agreement-marking paradigm and the higher level of processing complexity for agreement might have led us to expect to find a higher level of damage of the agreement cue than the case-marking cue. But no such differences were reported. Instead, the most dramatic result of the study is the nearly total loss of both of the grammatical morphological cues in Wernicke's aphasics. It is possible that this extreme loss of ability in the Wernicke's group reflects the loss of some basic ability to process grammatical markers as phonological appendages of stems. Thus, the vulnerability of morphological markings in these patients appears to focus on the basic detection and use of the suffix, rather than on higher-level syntactic processing.

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