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Cue Validity and Sentence Interpretation in English, German, and Italian

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Linguistic and psycholinguistic accounts based on the study of English may prove un-reliable as guides to sentence processing in even closely related languages. The present study illustrates this claim in a test of sentence interpretation by German-, Italian-, and English-speaking adults. Subjects were presented with simple transitive sentences in which contrasts of (1) word order, (2) agreement, (3) animacy, and (4) stress were systematically varied. For each sentence, subjects were asked to state which of the two nouns was the actor. The results indicated that Americans relied overwhelming on word order, using a first-noun strategy in NVN and a second-noun strategy in VNN and NNV sentences. Germans relied on both agreement and animacy. Italians showed extreme reliance on agree-ment cues. In both German and Italian, stress played a role in terms of complex interactions with word order and agreement. The findings were interpreted in terms of the "competition model" of Bates and MacWhinney (in H. Winitz (Ed.), *Annals of the New York Academy of Sciences Conference on Native and Foreign Language Acquisition.* New York: New York Academy of Sciences, 1982) in which cue validity is considered to be the primary determinant of cue strength. According to this model, cues are said to be high in validity when they are also high in applicability and reliability.

Linguistic and psycholinguistic accounts based on the study of English may prove unreliable as guides to sentence processing in even closely related languages. There is a danger that we may find ourselves proposing generalizations about language as a whole that turn out to be nothing more than facts about English. One highly effective antidote to this particular form of overgeneralization is cross-linguistic psycholinguistic research. However, in order to conduct such research, we must be able to devise techniques that will yield data that are comparable across languages. In addition, we must have access to a theoretical perspective that allows us to compare results across languages.

In the present study, we asked subjects to listen to sentences with two nouns and a verb such as *the dog the cat chases* or *the eraser chases the pig* and say who was the actor. Because our stimuli were simple sen-

tences and because the three languages we studied—English, Italian, and German—were closely related, we were able to achieve reasonable comparability of stimuli across languages. To make theoretically interesting comparisons between subjects' responses in the three languages, we utilized a model of sentence processing called the "competition model" (Bates & Mac-Whinney, 1982a, 1982b; Bates, McNew, MacWhinney, Devescovi, & Smith, 1982; MacWhinney, 1983). Because the main hypotheses being tested derive from this model, it will be helpful to give a brief view of the model by way of background.

THE COMPETITION MODEL

The competition model holds that "the forms of natural languages are created, governed, constrained, acquired and used in the service of communicative functions." The model is being proposed as a means of organizing our understanding of cross-linguistic differences in sentence processing, while focusing our attention on important and researchable issues in this field. The model is a *performance grammar* or a theory of language use. As such, it may bear only an indirect relation to theories of linguistic competence based on very different kinds of data (Bever, Fodor, & Garrett, 1974).

The competition model makes a series of fairly strong claims about the control of sentence processing. For our present purposes, the most important claims are the six discussed below. Of these, the first four are presented as background assumptions—they are not being directly tested in this experiment. It is the last two claims that are the main focus of the experiment. However, to correctly explain the force of the last two claims, it is best to present the full set of six claims.

1. Direct mapping. Only two levels of processing are specified in the model: a functional level (where all the meanings and intentions to be expressed in an utterance are represented) and a formal level (where

the surface forms appropriate for a given meaning/intention configuration are represented). Mappings between the formal and functional levels are said to be direct. This notion of direct mapping means that we are claiming that it is possible for languages to integrate semantic contrasts on an equal footing with syntactic cues in a parsing system. This is a very strong claim. If we were to discover evidence for a separation of cues by linguistic levels, we would have evidence against direct mapping. At the same time we would then be in a position to suggest certain constraints on the form of universal grammar.

2. Multiplicity of form–function mappings. In natural languages, mappings of a single form onto a single function are quite rare. Rather, languages make extensive use of polysemy, thereby producing grammatical systems in which a given form maps onto several functions and a given function maps onto several forms. An extremely strong version of the functionalist position would hold that each form maps onto a single function. However, as discussed in detail in Bates and MacWhinney (1982) and MacWhinney (1982, 1983), this strong claim cannot be right. Rather, it must be the case that a single form can map onto several functions and that a single function can map onto several forms. For example, in the present study, we find that, in sentence comprehension, the listener may make use of a variety of cues to identification of the "actor."

3. Coalitions and the breakdown of coalitions. The mappings between forms and functions are not chosen randomly. Instead, they reflect the fact that certain things tend to go together "naturally." For example, in the three languages we are considering here, the functions of agent, actor, and topic prototypically map onto the set of devices that constitute the "subject." This is to say that a coalition of functions is mapped onto a coalition of forms. Although language is structured to maximize coalition, it also can happen that functions

that prototypically "go together" are split apart and assigned to different items. Consider what happens when the coalition between agency and topicality breaks down. This can occur when we need to topicalize "the ball" even though "John" did the hitting. In such cases the grammar has to determine which of the two elements should "win" access to the device of preverbal positioning. At the same time, it must have a default mapping available for the item that loses in the competition. If the topic wins out, the agent must be placed in a "by clause." Note that a functionalist model of this type holds that constraints on the form of universal grammar derive, in large measure, from facts about the ways in which things go together in the world and ways in which the human information-processing system interacts with the conversational task.

4. Competition. The model assumes dynamic control of the mapping of form onto function in comprehension and of function onto form in production. This mapping is understood to ge governed by a system of parallel activation with strength-based conflict resolution much like that found in Thibadeau, Just, and Carpenter (1982) or McClelland and Rumelhart (1981).

5. Cue strength. Having reviewed these first four background assumptions, we now come to the two claims that are being tested in this study. The first is the notion of cue strength which holds that, in the set of many-to-many mappings, each link between a form and a function is given a weight or strength. No sharp line is drawn between probabilistic tendencies and determinate rules. Rules and mappings that have become fully determinate are simply understood as patterns whose strength begins to approach unity. As the strength of rules approaches unity, the likelihood that they will apply when their conditions are matched (Anderson, 1983) also approaches unity. This assumption is similar to that made in variation theory (Sankoff, 1978). This view of determinate rules as rigidifi-

cations of tendencies provides advantages in describing transitional stages in language acquisition (MacWhinney, 1978), speech errors in both children and adults (Menn and MacWhinney, in press), and various aspects of language change (Andersen, 1980; Chen & Wang, 1975; Givón, 1979; Holden, 1976). In contrast to more deterministic models of language change, in which rules are either present or absent (e.g., Wexler and Culicover, 1980), the competition model permits apparent rules or conventions to emerge gradually, through a continuous increase in the determining force of probabilistic form–function mappings. The view of cue strength being claimed here could be falsified by a variety of data. If it could be shown that determinate cues operate in a clearly different fashion from probabilistic cues, there would then be reason to believe that something more than mere strength was coded for cues. If it could be shown that cues interact in a way that is not general, but somehow idiosyncratic to particular combinations of cues, there would be a need to either reject the notion of cue strength or make fundamental changes in the claims of the model. If, for example, two cues were shown to add strength in one discourse context, but subtract strength in another, and if no third cue were operative, it would be clear that the notion of cue strength was not working. Similarly, if it could be found that, after a certain point, adding further positive cues not only failed to increase certainty, but even started to lead to decrements in reaction time and certainty, then it would also be necessary to develop a new formulation. These claims of the model regarding the importance of cue strength are extremely strong and easily falsified. If it could be shown that, because of factors such as processing limitations, certain otherwise strong cues were not being fully exploited, this claim regarding cue validity would have to be weakened. A possible example of this type is reported by McDonald (1982) in a study of relative clause comprehension

in adult German–English bilinguals. In that study, native-born speakers of German failed to pay attention to the case of the relative pronoun and interpreted sentences with relative clauses by relying on lexical semantic strategies. It may be the case that speakers have difficulty processing case clues of this type when they are separated from the nouns to which they refer. Further tests of such possible limitations to the notion of cue validity must be conducted.

6. *Cue validity.* Extrapolating from some ideas proposed by Brunswik (1956), we argue that the weights of cues in a particular language are reflections of their relative "cue validity" in that language. According to this assumption, one can look at an array of form–function mappings, derive estimations of their relative cue validity, and then use these estimates to predict both order of acquisition and relative usage in adult processing. Of course, this enterprise depends entirely on being able to devise some relatively objective characterization of "cue validity." Following MacWhinney (1978), we do this by distinguishing "cue applicability" and "cue reliability." In comprehension, cues are high in applicability if they are "available" when you need them and cues are high in reliability if they are never misleading or ambiguous. Cues that are high in both applicability and reliability are the most valid cues. Cues that are low in applicability and high in reliability are still fairly high in validity, although one cannot rely on them as much as on cues that are always there when you need them. Cues that are unreliable are the lowest in validity. However, in the absence of more valid cues, even unreliable cues will be attended to.

The main hypothesis being tested in the current experiment is that cue validity is the primary determinant of cue strength and, hence, certainty of choice in sentence interpretation. To evaluate this hypothesis, we must have a way of objectively assessing the validity of cues to sentence interpretation. First, let us consider how this

was done in MacWhinney (1978). Since that study looked at production and not comprehension, the validity being examined was "device validity," rather than "cue validity." However, the notions of applicability and reliability apply equally well in each case. The device validity of 13 morphophonological rules was assessed in MacWhinney (1978) by first determining the percentage of total nouns in the lexicon that had the shape required in the structural description for the rule. This was done by using frequency lists and an *a tergo* dictionary. The result was a measure of the relative "device availability" for the 13 rules. Then, the percentage of candidate bases that were exceptions was determined for each rule. This provided a measure of the "reliability" of the device. With device validity defined in this way, the order of acquisition of the 13 rules of Hungarian phonology showed a rank order correlation of 0.83 with cue validity.

In Bates et al. (1982), these ideas were extended to the acquisition of the use of a series of cues to sentence interpretation by English- and Italian-speaking children. In general, we found that cue validity was also a remarkably powerful determinant of the order of acquisition of cues to sentence interpretation. In the next sections, we provide a detailed examination of the role of four types of cues in English, Italian, and German. By examining in somewhat greater detail the exact applicability and reliability of the cues in each language, we can make somewhat more precise estimates of cue validity.

For other devices, such as grammatical markings, the best way of estimating applicability and reliability is by text counts. For example, in German, masculine singular nouns are marked in a way that distinguishes the subject (nominative) from the object (accusative). For feminine and neuter nouns, this contrast is not marked. Looking then at the cue validity of marking of the masculine nominative (through either articles or pronouns), we find that such

marking is available in about 50% of the transitive clauses in German. Thus, the availability of some form of nominative case marking is 0.50. If one wishes to consider the availability of each separate cue, this is still lower. For example, the availability of the article *der* as a cue to subject is around 0.25, since it occurs in about half of the transitive clauses in German. The reliability of the various markings also varies somewhat. The pronoun *er* "he" is 100% reliable, but the definite article *der* is only about 65% reliable, since it also means "singular feminine genitive," "singular feminine dative," and "plural genitive." In general, one can use text counts in this way to obtain objective estimations of the applicability (i.e., availability) and reliability of cues.

To derive cue validity from cue applicability and cue reliability, one must make an additional assumption regarding the relative importance of applicability vs reliability. In the computational simulation of the acquisition of morphophonology, MacWhinney (1983) assumed that one correct use of a cue increased its strength by 0.1, whereas one incorrect use decreased its strength by 0.2. Empirical tests of these parameters have not yet been conducted. Whatever the best values for these parameters turn out to be, the evidence to data indicates that cues that are not reliable will not be strong, no matter how high they are in availability.

The present study places four major cue types into competition. These cues are (1) word order, (2) agreement marking, (3) stress, and (4) animacy. In German, it would have been possible to have added a fifth important cue to this list, since German marks the case of the noun on the preceding article. However, in pilot work we found that, in simple clauses, when Germans were provided with unambiguous case-marking cues, their responses were entirely determinate. Therefore, we concentrated our efforts on finding out what would happen in German when case-

marking cues were ambiguous. Following the competition model in general and claims (5) and (6) above in particular, we would expect that the extent to which a given cue is used in any one of these languages should be a direct reflection of its availability and reliability. To derive predictions for the use of these cue types in the current experiment, we need to turn now to a detailed analysis of the use of these four cue types in each of the three languages.

WORD ORDER

English

The vast majority of English sentences use subject–verb–object order as basic. Except in clauses in the passive voice, this SVO order is also agent–verb–patient order. Thus, in NVN (noun–verb–noun) sequences, the first noun is almost always the actor/agent. (For a discussion of the role of certain apparent exceptions to this principle, see Bates and MacWhinney, 1982.) If the sentence is intransitive, the SV fraction of SVO order is still preserved. To further preserve the SV segment of the SVO pattern, English makes extensive use of dummy subjects and pronominal subjects, avoiding subject deletion wherever possible. Subject deletion is only permitted where strong grammatical patterns such as the equi-NP constraint allow unique recoverability. In interrogatives, the rules of do-insertion and subject–auxiliary inversion also serve to keep the subject in front of the lexical verb. The exceptions to this rule are as follows.

1. Although passive sentences have SVO order, semantically they resemble OVS sentences in that the first noun is the object and the second is the actor. Passives also exist in Italian and German. In all three languages, passivization is fairly rare and has clear morphological marking.

2. OSV sequences can arise in at least four ways:

    a. OSV sentences like *The red one I want* are often said to be produced by

topicalization or "Yiddish movement" (Postal, 1971). The resulting OSV sentence can be called a "left dislocation." Such sentences are quite rare.

b. OSV sequences can also arise when the head of a relative clause is also the object of that clause, as in *I saw the dog the cat chased.*

c. OSV structures are clearly present in questions like *What do you eat?*

d. OSV sequences are approximated in left dislocations such as *My dog, John likes him.*

3. VOS sentences are even rarer.

a. Occasionally, speakers produce "afterthought" (Hyman, 1975) topicalizations such as *Makes a mean apple pie, my old lady.* These VOS structures can be called "right topicalizations."

b. VOS structures can also arise in imperatives, such as *Get the ball, Billy* where the inclusion of a vocative produces a surface structure resembling a VOS right topicalization.

c. VOS structures are approximated in right dislocations such as *She makes a mean apple pie, my old lady.*

4. SOV orderings are extremely rare. This is particularly interesting when one considers that SOV was once the basic order in English. Its traces remained in poetry up to the last century. Consider the line from Coleridge's *Xanadu,* "In Xanadu did Kubla Khan a stately pleasure dome decree."

These facts about English can be easily summarized by first noting that the "canonicality" of SVO order in simple sentences is supported in terms of its two components: the SV unit and the VO unit. The SV unit is in turn supported by (1) the use of devices that force subject insertion, (2) basic SV and SVO orders, (3) several OSV structures, and (4) avoidance of OVS, VSO, and SOV options. The VO unit is supported—somewhat less extensively— by (1) basic SVO order, (2) several uses of VOS order, and (3) avoidance of OVS, VSO, and SOV orders. Thus, positioning

before the verb is a reliable cue for the actor and positioning after the verb is a reliable cue for the patient. Both cues are very high in availability. However, the VO cue is not applicable in NNV structures and the SV cue is not applicable in VNN structures. But note that where one cue is missing, the other is present and applicable. From this analysis, the clear prediction of the competition model is that *English speakers should pay a great deal of attention to both the SV unit and the VO unit as cues in sentence perception.* Evidence in support of just this claim has already been presented by Carroll (1978).

It is important to realize that, by viewing SVO order as derivative of SV and VO patterns, we are somewhat downplaying the centrality of "canonicality" (Slobin & Bever, 1982) as an explanatory principle in sentence processing in English. We are not assuming that, when processing sentences, subjects necessarily first attempt a match to a specific canonical template. Rather, we believe that subjects are using a variety of cues when processing sentences, and that these clues include intonation, markers, and order. Order patterns of two types can play a role in sentence processing. Both local orderings such as SV and VO, and canonical patterns such as SVO can have an impact on sentence processing. As we will see, there is reason to believe that English relies somewhat more on local orderings, whereas Italian and German make more use of possible canonical patterns.

Italian

Unlike English, Italian permits a wide array of word order variations. All possible word orders can and do occur in informal Italian conversation, in main and subordinate clauses, in actives and in passives, and in questions and declaratives. The following hypothetical passage of restaurant conversation (from Bates et al., 1982) illustrates how such variations work in simple sentences. (In all examples, italics represents intonational stress. The variety of

Italian being considered here is that spoken in Rome.)

1. SVO Io mangerei un primo. (I would eat a first course.)

2. OSV La pastasciutte Franco la prende sempre qui. (Pasta Franco it orders always here.)

3. VSO Allora, mangio anche *io* la pastasciutte. (Well then, am eating also *I* pasta.)

4. VOS Ha consigliato la lasagna qui Franco, no? (Has recommended the lasagna here Franco, hasn't he?)

5. OVS No, la lasagna l'ha consigliata *Elizabeth*. (No, the lasagna it has recommended *Elizabeth*.

6. SOV Allora, *io* gli *spaghetti* prendo. (In that case, *I* the *spaghetti* am having).

In addition, Italian also permits extensive subject NP omission—Bates (1976) found that up to 70% of the subjects in informal conversation are subjected to omission. As a result, the statistically most frequent form in Italian discourse is not SVO, but (S)VO or O(S)V. Given the combination of order variation plus ellipsis, the identity of subject and object is not at all predictable in Italian by word order information alone. Although word order is highly applicable, it is also very unreliable, and the competition model predicts that *Italians should not rely on word order as a major cue in sentence interpretation.*

In a study that was the direct predecessor of the current study, Bates et al. (1982) found major differences between English and Italian speakers in their processing of sentences like the ones in the current experiment. English speakers relied almost exclusively on word order, whereas Italian speakers relied far more on lexical animacy and complex combinations of topicality and stress. Together, stress, dislocation, and order constitute definitions of canonicality in Italian sentences.

German

While permitting a variety of alternative word orders, German tends to condition se-

lection of a given word order on strict grammatical criteria. One major division in German is between main and subordinate clauses. In *nonrelative* subordinate clauses, German word order is strictly NNV and almost always SOV. However, OSV order can occur if the subject is a noun and the object is a pronoun. In the case of a passivized subordinate clause, the first noun can be a patient rather than an agent. In *relative* clauses, both SOV and OSV orders can appear. If the head of the relative is the subject of the verb in the embedded clause, SOV order occurs. If it is the object of the embedded verb, OSV order occurs. In other words, the preference for SOV order in subordinate clauses is absolutely overruled by the requirement that a relative clause must begin with its head noun. It is also invariantly true that both the main verb and the modal verb must be placed at the end of any subordinate clause. In written texts, Zubin (1979) has shown that subject relatives are six times more frequent than object relatives. Thus, when case marking is ambiguous, Germans would be expected to interpret relative clauses as SOV sequences.

Word order in main clauses follows quite different rules. If there is no auxiliary verb, the following possible orders occur.

1. SVO order is the standard pattern for transitive active declarative main clauses. Intransitive main clause use SV order. As in English, the use of dummy subjects (*es regnet* "it rains") and avoidance of subject omission leads to a high frequency of SVO and SV ordering.

2. VOS and VO ordering is the main pattern for imperative, as in English. VOS order also arises when there is some reason to focus an adverbial phrase. Consider this sentence pair: *Hans besucht Tom im Krankenhaus. Morgen besucht ihn Maria.* A word-by-word translation of this is *Hans visits Tom in hospital. Tomorrow visits him Maria.* In such cases of double contrast, the adverbial occurs in focus position before the verb and the subject is postposed.

3. OVS order can arise when the object

is being contrasted. This requires not only contrastive stressing of the object, but also a somewhat "afterthought" status for the subject. When the contrastivity of the object is to be expressed, the preferred option is SVO. OVS order is used somewhat more extensively in literature, particularly when the identity of the subject and object can be established by case-marking clues. OVS order also arises in "wh" questions with "what?" as in *Was sieht Peter?* "What sees Peter?"

4. OSV orders can arise in conversation, although they are rare and often said to be ungrammatical.

5. SOV and VOS orders almost never occur in normal conversation. However, in yes–no questions with auxiliary verbs, the auxiliary is fronted and the main verb postposed, as in *Hat Peter die Tür geöffnet?* "Has Peter the door opened?" The resultant order is AuxSOV.

6. VS(O) is the standard order in yes–no questions, as in *Öffnet Peter die Tür?* "Opens Peter the door?" In colloquial German it is also common to make an imperative emphatic by leaving in the pronominal subject. When this occurs, the order is VSO, as in *Iss du den Reis!* "Eat you the rice!"

In declaratives, when there is an auxiliary verb, the only change from the above patterns is that the auxiliary takes the place of the verb in basic SVO order and the main verb is extraposed to the end of sentence. In a sense, then, when there is an auxiliary, the basic order in German is SOV rather than SVO.

Like English, German has a strong tendency to resist omission of the subject. In the next section we will see that morphological marking on the verb often permits recoverability of the subject in both German and Italian. However, because German does not omit the subject even where it could, the SV order retains a certain probabilistic strength. In general, neither the SV unit nor the VO unit are preserved as strictly in German as in English.

However, both units are stronger in German than in Italian. On the other hand, except where there is morphological marking to the contrary (as in relative clauses), there is a preference for treating the first noun before the verb as the subject. Because the absolute position of the subject is more reliable as a cue than its position vis-à-vis the verb, the competition model would predict that Germans would use absolute position rather than the SV and VO cues used in English. However, Germans should rely on these units more than Italians.

VERB AGREEMENT AND CASE MORPHOLOGY

English

Because of the consistency with which English maintains SVO ordering, English speakers have been able to tolerate a relatively degraded system of bound morphology. Case distinctions are marked only in personal pronouns and even there the subject/object contrast is beginning to erode. Agreement marking on the verb is of four types.

1. When the verb is a simple past or if it includes any type of modal, there is no marking of agreement *The dog ate, The dogs ate, I ate*, etc.

2. When the verb is a simple present or tense with the auxiliaries *have/has* or *do/does*, the use of the -s suffix marks a third person singular subject, but none of the other person/number alternatives are distinguished (*The dog eats, The dogs eat, I eat, You eat, The dog has eaten, The dogs have eaten, I have eaten, You have eaten*, etc.).

3. When the copula/auxiliary is used in the form *was* or *were*, there is a binary marking of the distinction between the first person singular and third person singular and the other four person/number alternatives (*The dog was hungry, The dogs were hungry, I was hungry, We were hungry*).

4. When the copula/auxiliary is used in the forms of *am, are,* or *is,* there is a unique

marking of both the first person singular and the third person singular; the other person/number alternatives are not distinguished (*I am hungry, You are hungry, We are hungry, They are hungry,* etc.).

Thus, bound morphology is an unreliable source of information about sentence relations in English. Word order, on the other hand, is reliable and omnipresent. Given this, it is not surprising that English researchers have concentrated on the role of word order in sentence processing, while having little to say about the use of morphological markings as cues to comprehension.

Up to this point, we know of no other research setting order and morphology into competition in English. However, there is some evidence suggesting that English speakers do, in fact, pay remarkably little attention to agreement marking. Keeney and Wolfe (1972) examined the development of subject–verb agreement in English and found virtually no sensitivity to this form of grammatical marking up through five years of age. However, there is no reason to believe that these findings for English are in any way general across languages. Studies setting word order and morphology into competition in Hebrew (Frankel, Amir, Frenkel, & Arbel, 1980; Frankel & Arbel, 1981) and Turkish and Serbo-Croatian (Slobin & Bever, 1982) have shown that, where morphological cues are high in applicability and reliability, they can clearly dominate over word order cues. Since morphological cues in English are low in reliability, the competition model would predict that *English speakers should rely much more on word order cues than on agreement cues in interpreting sentences.*

Italian

Like English, Italian has allowed a full system of case marking to erode to the point where case is only marked by personal pronouns. However, these pronouns serve a more important disambiguating role

in Italian than in English. For example, in sentences (2) and (5) above, the pronoun *la* occurs before the verb where it must be the object. Since the only feminine noun in the sentence is *la pastasciutte,* it must be the case that *la pastasciutte* is also the object. In effect, the Italian object clitic can be viewed as an object agreement marker much like the object agreement markers found in Bantu languages.

In Italian, as in English, the subject must agree with the verb in person and number. However, the Italian agreement system is much richer and more informative, as can be seen in the following examples (the German examples will be discussed later).

	English	Italian	German
Singular			
1st pers (I)	buy	compro	kaufe
2nd pers (you)	buy	compri	kaufst
2nd pers formal	—	compra	kaufen
3rd pers (he/she/it)	buys	compra	kauft
Plural			
1st pers (we)	buy	compri-amo	kaufen
2nd pers (you)	buy	comprate	kauft
2nd pers formal	—	comprano	kaufen
3rd pers (they)	buy	comprano	kaufen

This system still leaves room for ambiguity. For example, agreement will not distinguish between two third-person nouns if both are singular or if both are plural. Also the ending on the verb is identical in all instances for third person singular and formal singular "you." Subject pronouns, since they are case marked, may help to clarify matters in situations like these. However, subject omission is so common in Italian that subject pronouns are generally not applicable. Clitic pronouns, which are marked for gender, also help out. However, if there are no clitics, or if both subject and object agree with the clitics in gender, clitic gender agreement may not be a sure cue. The best cue overall is likely to be the verb ending, even though it is not an infallible guide. Although the endings of

Italian verbs vary across conjugation, tense, and mood, contrasts of person and number are always maintained. Because of its high availability and reasonably high reliability (particularly in comparison to the other cues available in Italian), the competition model must predict that *Italians will place a great deal of reliance on verb agreement as a cue to sentence interpretation.*

German

German morphological marking provides an interesting contrast to English and Italian. Unlike these other two languages, German has a full system of case marking on both nouns and pronouns. In this regard, German makes more use of morphology to mark grammatical contrasts than either English or Italian. The case, gender, and number of the noun is marked by the shape of the preceding article or adjective. The four cases are nominative, genitive, accusative, and dative. The genders are masculine, feminine, and neuter. In the masculine singular, all four cases are given different markings by the article. For example, the nominative of the masculine noun "apple" is *der Apfel,* whereas the accusative is *den Apfel.* In the feminine and neuter, the distinction between the nominative and accusative is neutralized. Thus, the accusative of woman is *die Frau* and the nominative is also *die Frau.* In the plural, the contrast between the nominative and accusative is leveled in all three genders. Thus, while German uses case marking on the noun to distinguish subject from object, this works only when at least one of the nouns is in the masculine singular. In an analysis of written text, David Zubin (personal communication) found that about 30% of transitive clauses had no masculine singular noun and therefore failed to use case to distinguish the subject from the object. Thus case marking is fairly high in availability. Where case marking appears to be ambiguous, often the ambiguities can be resolved in various ways. For example, a

genitive reading of *der* requires (usually) that there be a noun both in front of and after the *der.* If this is not the case, the *der* is more likely to be a subject marker. It is clear that case marking, although complex, is a highly reliable cue to sentence interpretation in German and the competition model predicts that *Germans should rely on this cue wherever possible.* However, this particular prediction will not be further tested in the current study, since pilot testing has already indicated unequivocably that case marking is a fully determinate cue to the interpretation of simple sentences.

In addition to this well-developed system of case marking, German also makes use of subject–verb agreement marking. The German present tense verb paradigm was displayed above next to the English and Italian paradigms. Although the German paradigm seems almost as unambiguous as that of Italian, there are some problems in German that are not present in Italian. Except for certain verbs that have umlauting vowels (like the /a/ of *lauf-*), the contrast between the third person singular and the second person plural disappears. Second, unlike Italian, the singular formal is identical to the plural formal. Third, the first person plural is the same as the third person plural. Finally, in the past tense, the first person singular becomes the same as the third person singular.

However, there is another problem involved in making efficient use of verb agreement as a cue to subject indentification in German. This problem is the complexity of plural marking on the German noun. Nouns may be pluralized by adding *-s, -en, -er,* or *-e,* by umlauting the stem, or by adding nothing. Moreover, the rules governing the selection of one of these alternative pluralization techniques are complex and not fully predictive. To make effective use of agreement in German one cannot rely on a single morpheme as in English or Italian. Rather the agreement marker on the verb must be coordinated with a variety of markers on the noun. Al-

though adult native speakers have complete control over this system for real nouns and surprisingly complete control even for nonce nouns (Walter, 1975), the complexity of the system may increase the "cost" of these cues (Carroll, Tanenhaus, & Bever, 1978). If further research should continue to demonstrate the importance of "cue cost," the competition model would be required to consider its impact upon cue strength. Even in its present form, however, the competition model predicts that *Germans will rely less on subject–verb agreement than will Italians.*

ANIMACY

The psycholinguistic literature is rich in studies demonstrating a probabilistic relation between animacy and agency in English. This relation involves a tendency to perceive the more animate of two nouns as the agent of an action, as well as a tendency to prefer animate agents as subjects (for reviews, see MacWhinney 1977, 1982). The existence of this tendency is widely recognized, but it remains to be seen whether semantic cues of this type should be regarded as a systematic part of the grammar. There are certainly examples of natural languages in which some kind of an abstract animate/inanimate distinction *must* be included if the grammar is to be descriptively adequate. For example, in Navajo, nouns are ordered before the verb in terms of a strict hierarchy of animacy levels (Perkins, 1978). In Russian and Serbo-Croatian, the nominative/accusative contrast exists for animate masculine nouns but is leveled for inanimate masculines. In languages with systems of "split" marking of ergativity (Silverstein, 1976; DeLancey, 1981), marking generally falls on inanimate objects and animate subjects. The fact that animacy plays such an obvious role in the grammar of some languages should at least leave us open to the possibility that a similar semantic distinction could operate in a less absolute way in other languages.

In the current study, the competition

model predicts that *Italian speakers should show more reliance on animacy than English speakers,* largely because the other cues that Italians have to depend are not as reliable as word order in English. We would also predict that *German speakers should show more use of animacy than English speakers* in the current experiment. This is because, in this experiment, Germans are deprived of the case cues upon which they usually rely.

STRESS

English

The basic rule of sentence stress in English is that the last content word in the sentence is stressed (Halliday, 1967). Apart from this default use, stress is used most commonly to mark newness and contrastivity—particularly when contrastivity involves refential "shifting." For example, in a sentence like *John kicked Paul, and then HE punched Tom* the stressed pronoun refers not to the default referent "John," but to the other plausible referent "Paul" (Maratsos, 1973).

Italian

In Italian, the pragmatically neutral word order is SVO, and this is also the order in which default, pragmatically neutral stress is usually observed. Marked stress (either *S*VO or SV*O*) is possible within NVN orders, but in many cases such stress marking is also used to indicate a reassignment of roles (either *O*VS or OV*S*). In the alternative word orders NNV and VNN, the marked nature of the ordering is usually accompanied by some kind of marked stress pattern. However, all possible default and marked stress configurations can occur under certain conditions (Antinucci, 1977). Perhaps the best summary statement is that Italians must use intonational cues to interpret word order configurations. That is, stress indicates that "something unusual is going on"—and that "something unusual" may involve assignment of basic semantic–

syntactic roles as well as default pragmatic expectations.

German

German uses stress to switch pronominal reference in a way much like English. We are not aware of any studies of the use of stress in case-role assignment. However, we might expect a language with at least some word order variation like German to use contrastive stress to suspend the default interpretation of a given word order.

Given these analyses of the role of stress in the three languages, we see that the competition model must predict that *stress should function in German and Italian to reverse normal interpretations with secondary interpretations, particularly when the secondary interpretations are supported by additional sources of data.*

METHOD

Subjects. There were 68 middle-class adult subjects who participated in the experiment: 24 native speakers of English, 24 native speakers of Italian, and 20 native speakers of German. The majority of the subjects were university students in their 20's, although some postgraduate adults were included in the Italian sample. All English-speaking participants were residents of the Denver area and spoke standard American English. All Italians were residents of Rome, and the majority spoke a dialect typical of educated adults in that city. The German subjects were all residents of Regensburg, and most spoke a variety of Southern German typical of that region.

Design. The five factors manipulated as independent variables included languages (English, Italian, and German), word orders (NVN, VNN, and NNV), animacy contrasts (animate first noun with animate second noun = AA, animate first noun with inanimate second noun = AI, and inanimate first noun with animate second noun = IA), stress contrasts (neutral stress = St0, first noun stressed = St1, and

second noun stressed = St2), and agreement contrasts (ambiguous agreement = Ag0, first noun agrees with the verb = Ag1, and second noun agrees with the verb = Ag2). For the full analysis across languages, we dealt with the problem of unequal sample size (24 subjects in English and Italian, 20 in German) by randomly excluding the data for 4 subjects in English and Italian, retaining 20 subjects in each language. For analyses within each of the three languages, we utilized the data for all subjects.

Materials. There were a total of 81 test sentences for each subject. Each sentence was composed of a verb in the third person, plus two third person common nouns with definite articles. The sentences were constructed by selection out of a pool of 15 animal names and 9 inanimate object names. Because English and Italian do not mark case on the noun, we could not include case agreement as a factor and had to select German nouns to be ambiguous as to case. We were forced to use a group of feminine nouns that did not fully match the nouns used in English and Italian. The nine verbs all described concrete transitive activities. Table 1 lists the words used in the three languages and gives sample sentences for each language.

Because individual lexical items might be biased in terms of the plausibility of their combinations (e.g., lions are perceived as more ferocious and active than turtles), different combinations of nouns and verbs were assigned randomly to each sentence type for each of 12 protocols. This extensive randomization guarantees that the only lexical effect that could plausibly emerge would be one based on a more abstract animate/inanimate contrast. For one-third of the items, all nouns and verbs were given in the singular. For these items, verb agreement marking was ambiguous. On the remaining morphologically contrastive items, subjects received half of their verbs in the singular, and half in the plural, with noun agreement conditions adjusted accordingly.

TABLE 1
Object Names and Verbs

Italian	English	German	Gloss of German
ANIMATE OBJECTS			
gatto	cat	Katze	cat
cavallo	horse	Henne	hen
cammello	camel	Ente	duck
giraffa	giraffe	Giraffe	giraffe
capra	goat	Ziege	goat
vitellino	calf	Amsel	blackbird
scimmia	monkey	Ratte	rat
orso	bear	Gans	goose
maialino	pig	Gemse	chamois
mucca	cow	Kuh	cow
zebra	zebra	Schlange	snake
agnellino	lamb	Sau	sow
tartaruga	turtle	Schildkröte	turtle
cane	dog	Maus	mouse
asinello	donkey	Eidechse	lizard
VERBS			
mangia	eat	fressen	eat
annusa	smells	schnüffeln	sniff
lecca	licks	lecken	lick
bacia	kisses	küssen	kiss
morde	bites	beissen	bite
guarda	watches	beobachten	watch
carezza	pats	streicheln	stroke
afferra	grabs	ergreifen	grab
saluta	greets	grüssen	greet
INANIMATE OBJECTS			
palla	ball	Kugel	ball
penna	pen	Zange	tongs
sasso	rock	Schachtel	box
temperino	sharpener	Kerze	candle
gomma	eraser	Schere	scissors
cubo	cube	Gabel	fork
bastone	stick	Stange	pole
matita	pencil	Lampe	lamp
sigaretta	cigarette	Zigarette	cigarette

SAMPLE SENTENCES
The eraser the pig chases.
La gomma il maialino bacia.
Die Gabel küsst die Sau.

Licks the cow the goat.
Lecca la mucca la cabra.
Leckt die Kuh die Ziege.

The dog grabs the pencil.
Il cane afferra la matita.
Die Maus ergreift die Lampe.

Thus an agreement-first item for one subject might be "The dogs are kicking the horse," while another subject would hear something like "The dog is kicking the horses," in the same condition.

The decision to use verbs in the present progressive in English was based on the low perceptual salience of agreement marking in the English present tense. For most English verbs, the marking of the number of the subject on the verb uses a single final consonant, -z or -s, as in "hits" versus "hit." Italian, on the other hand, marks this contrast with a full syllable -no (as in picchia vs. picchiano). In German, the singular adds the suffix -t and the plural adds the full syllable -en. To avoid any potential confounding of grammatical and phonological differences between the languages, we decided to increase the perceptibility of the English contrast by presenting all English verbs in the present progressive form (e.g., "is hitting" versus "are hitting"). This decision does not introduce a semantic bias, since the English present progressive is correctly translated in most cases by a simple present tense verb in Italian and German.

A total of 12 unique quasi-random sentence orders were constructed with the constraint that the same lexical item could not appear in adjacent items. Certain further constraints on the randomization procedure that are described in Bates et al. (1982) were repeated here to preserve comparability with those results. In each language, each of the 12 protocols was given to two subjects.

Procedure. Subjects were tested individually by graduate students who were native speakers in the respective languages. The instructions and test sentences were all read aloud to each subject. The experimenter explained the nature of the experiment, emphasizing the fact that the same items were being used in different languages. This explanation was included to justify the fact that so many items would seem "odd" in the listener's own language.

(For evidence regarding the extent to which this task is treated in a natural fashion by adults please see Bates et al. (1982).) Great care was taken not to bias the listeners toward a syntactic versus a semantic strategy, by essentially asking for both:

I will read you a series of very simple sentences. After I read each sentence, you will have to interpret it: you should tell me which one of the two nouns in the sentence is (the subject of the sentence), that is, (the one who does the action).

Half the subjects were given these instructions with "subject" first; half received the same instructions with "one who does the action" first. The experimenter also emphasized that different ways to interpret the sentences were possible, and that there was no "right" answer that had been decided on in advance. At that point, the factors that would be varied from one sentence to another were listed and explained (i.e., "the order of the words," animacy, contrastive or emphatic stress, and agreement between the noun and verb in singular and plural). These factors were always listed in one of several randomized orders, which were in turn assigned randomly to subjects, to avoid indicating that any one of them was "the" important factor. The sentences were read in as standard a fashion as possible, with very clear distinctions between the default stress and contrastive stress sentences. It is true that default stress patterns often contain a certain difference in amount of stress between the two nouns. Thus, in English, default stressing places more stress on the second noun in NVN orders. However, the stressing of the second N in default NVN was very much less than the stressing it received when given contrastive stress. In other words, contrastive stress was clearly and consistently contrastive. As we will see later, it is unlikely that slight variations within these three stress levels (no stress, first noun stressed, second noun stressed) could have affected results in any systematic way.

Scoring. The dependent variable in this experiment was choice of one of the two nouns as the actor. For each item, subjects were given a 1 for choosing the first noun and a 2 for choosing the second noun. These were the scores entered into analyses of variance. However, to maximize comparability with related cross-linguistic studies (e.g., Slobin, & Bever, 1982), these scores ranging from 1 to 2 have been translated into percent choice of first noun in all figures and tables of cell means.

RESULTS

Four mixed-model ANOVA's were conducted with subjects as random and the other factors or contrasts as fixed. The results of the three ANOVA's for English, Italian, and German are summarized in Tables 2, 3, and 4. The complete analysis is presented in Table 5. The overall analysis is particularly useful in evaluating the significance of interactions involving the Language factor. In all of the tables, we have included information about the amount of variance accounted for by each significant main effect and interaction. Although it is not traditional to include these statistics, we feel that information about the *magnitude* of effects is just as important and often more illuminating than reports on their *reliability*. Because of the design only provided a small number of stimulus sentences per subject at the level of the five-way and four-way interactions, it would be risky to try to interpret interactions at these levels. However, in fact none of the five-way interactions are significant and only one four-way interaction is significant and this problem does not arise in these data.

Word Order

The main effect of the word order contrast reached significance in both English and Italian, but not in German. Furthermore, there was also a significant interaction of Language and Word Order, as displayed in Figure 1. The first noun was chosen as the actor in English 39% of the time, in Italian about 55% of the time, and in German about 62% of the time. It is im-

TABLE 2
RESULTS OF THE ANOVA FOR ENGLISH

Effect	df	F ratio	p <	MS error	% Variance accounted for
Animacy (AN)	2,46	5.42	0.008	0.4698	1.0
Word order (WO)	2,46	110.58	0.000001	1.065	50.00
Agreement (AG)	2,46	5.54	0.008	0.3816	0.9
Stress (ST)	2,46	1.87	0.16	0.1922	—
AN × WO	4,92	1.78	0.14	0.0898	—
AN × AG	4,92	1.27	0.28	0.0634	—
AN × ST	4,92	2.03	0.10	0.0671	—
WO × AG	4,92	4.31	0.004	0.0808	0.2
WO × ST	4,92	0.23	0.91	0.0495	—
AG × ST	4,92	0.79	0.53	0.0733	—
AN × WO × AG	8,184	1.23	0.27	0.0599	—
AN × WO × ST	8,184	0.17	0.99	0.0459	—
AN × AG × ST	8,184	0.87	0.54	0.0653	—
WO × AG × ST	8,184	1.30	0.24	0.0664	—
Four-way	16,368	0.55	0.91	0.0604	—

portant to keep these fundamental baseline differences in mind during our presentation of the results.

The English results were identical to those for two separate experiments that are reported in Bates et al. (1982). There was a strong tendency to select the first noun on NVN sentences along with a tendency to choose the second noun on VNN and NNV sentences. This powerful effect accounted

for 50% of the variance in the English data. Since this is the third experiment reporting robust VOS and OSV biases in English, we must conclude that the strategies that lead to processing of NNV as OSV and VNN as VOS constitute an important component of English sentence processing.

The Italian results are also similar to those reported by Bates et al. (1982): there was a weak bias toward SVO and NVN

TABLE 3
RESULTS OF THE ANOVA FOR ITALIAN

Effect	df	F ratio	p <	MS error	% Variance accounted for
Animacy (AN)	2,46	73.79	0.000001	0.1404	4.2
Word order (WO)	2,46	20.11	0.00002	0.1787	1.4
Agreement (AG)	2,46	850.80	0.000001	0.1544	54.0
Stress (ST)	2,46	2.42	0.09	0.1118	—
AN × WO	4,92	1.80	0.13	0.0763	—
AN × AG	4,92	60.88	0.000001	0.1059	5.3
AN × ST	4,92	1.34	0.25	0.0658	—
WO × AG	4,92	10.76	0.00001	0.0858	0.7
WO × ST	4,92	2.38	0.06	0.0637	—
AG × ST	4,92	6.57	0.0003	0.0745	0.4
AN × WO × AG	8,184	1.15	0.33	0.0775	—
AN × WO × ST	8,184	1.65	0.11	0.0766	—
AN × AG × ST	8,184	1.47	0.17	0.0782	—
WO × AG × ST	8,184	4.16	0.0003	0.0746	0.5
Four-way	16,368	0.74	0.74	0.0636	—

TABLE 4
RESULTS OF THE ANOVA FOR GERMAN

Effect	dg	F ratio	p <	MS error	% Variance accounted for
Animacy (AN)	2,34	37.24	0.000001	1.0397	20.2
Word order (WO)	2,34	0.97	0.61	0.1557	—
Agreement (AG)	2,34	21.46	0.00001	0.9335	10.4
Stress (ST)	2,34	4.32	0.019	0.0857	—
AN × WO	4,68	0.30	0.87	0.1160	—
AN × AG	4,68	5.28	0.001	0.1792	1.0
AN × ST	4,68	1.37	0.25	0.0964	—
WO × AG	4,68	2.59	0.042	0.1279	—
WO × ST	4,68	1.00	0.41	0.0963	—
AG × ST	4,68	2.75	0.033	0.1268	—
AG × ST	8,136	1.68	0.106	0.1061	—
AN × WO × AG	8,136	0.74	0.64	0.0886	—
AN × WO × ST	8,136	0.47	0.87	0.1212	—
AN × AG × ST	8,136	3.88	0.00054	0.0991	0.8
WO × AG × ST Four-way	16,272	1.72	0.040	0.1036	—

sentences and random performance on VNN and NNV stimuli. As a whole, word order accounted for only 1.4% of the variance in Italian.

The fact that there was no main effect of the word order contrast in German does not mean that German performance is random with respect to word order. Rather, these subjects demonstrate a general tendency to choose the first noun as subject in all three word orders. They choose the first noun about 62% of the time, irregardless of the word order of the stimulus. Since there were no word order differences across word order types, this across-the-board first-noun strategy does not show up in the analysis of variance as a word order effect.

Agreement

Although the main effect of Agreement was significant in each of the languages, there was also a strong interaction of Language with Agreement. The shape of this interaction is displayed in Figure 2. In all cases, the direction of the effect is the same: choice of the noun agrees with the verb as actor. However, the magnitude of this effect is radically different across languages. Just as Word Order played a predominant role in English, so Agreement

played a determining role in Italian—accounting for fully 54% of the variance, compared with 10.4% in German and only 0.9% in English.

Animacy

Animacy also had a significant effect in each of the three languages (see Tables 2, 3, and 4) and the interaction of Language with Animacy was also highly significant (Table 5). Figure 3 displays the shape of this interaction. As expected, each language showed a preference for animate actors. However, this preference was stronger in Italian than in English and stronger in German than in Italian. In fact, the animacy factor accounted for 20.2% of the total variance in German—almost twice the variance accounted for by the grammatical cue of subject–verb agreement.

On the basis of the strength of the main effects, we can rank order cues within languages as follows:

English	Word Order > Agreement, Animacy
Italian	Agreement > Animacy > Word Order
German	Animacy > Agreement > Word Order.

However, the way that these cues are used together becomes clearer when we examine the interactions.

TABLE 5
RESULTS OF THE ANOVA FOR ALL THREE LANGUAGES

Effect	df	F ratio	p <	MS error	% Variance accounted for
Language	2,57	37.66	0.000000	0.5078	3.2
Animacy (AN)	2,114	67.08	0.000000	0.5276	5.8
Word order (WO)	2,114	110.19	0.000000	0.4391	8.0
Agreement (AG)	2,114	168.74	0.000000	0.5068	14.1
Stress (ST)	2,114	3.29	0.039	0.1324	—
LA × AN	4,114	13.57	0.000001	0.5276	2.4
LA × WO	4,114	67.30	0.000000	0.4391	9.7
LA × AG	4,114	41.62	0.000000	0.5068	7.0
LA × ST	4,114	0.76	0.22	0.1324	—
AN × WO	4,228	1.81	0.17	0.0957	—
AN × AG	4,228	33.48	0.000000	0.1179	1.3
AN × ST	4,228	2.03	0.088	0.0747	—
WO × AG	4,228	6.26	0.00021	0.1001	—
WO × ST	4,228	0.71	0.58	0.0728	—
AG × ST	4,288	5.42	0.00057	0.0854	—
LA × AN × WO	8,228	0.68	0.70	0.0957	—
LA × AN × AG	8,228	10.89	0.000000	0.1179	0.9
LA × AN × ST	8,228	0.67	0.71	0.0747	—
LA × WO × AG	8,228	3.36	0.0014	0.1001	—
LA × WO × ST	8,228	1.10	0.36	0.0728	—
LA × AG × ST	8,228	2.31	0.0205	0.0854	—
AN × WO × AG	8,456	1.23	0.2767	0.0828	—
AN × WO × ST	8,456	1.33	0.16	0.0695	—
AN × AG × ST	8,456	0.86	0.61	0.0868	—
WO × AG × ST	8,456	4.10	0.00022	0.0810	—
LA × AN × AG × ST	16,456	2.05	0.0096	0.0810	—

Note. Other four- and five-way interactions all nonsignificant.

Interactions of Word Order with Agreement

The two-way interaction between Word Order and Agreement reached significance within each of the three languages. In addition, however, there was also a significant three-way interaction of Language with Word Order and Agreement, as displayed in Figure 4. This interaction reflects very different patterns of results within each language.

First, in English the effect of agreement was slightly larger on the two non-NVN word orders, particularly NNV, where English listeners show somewhat less consistency in choice of actor. Nevertheless, the most striking result was that the conventional grammatical cue of subject–verb agreement was decisively overridden by word order—including two non-SVO word

order strategies that have only recently been described in the literature (Bates et al., 1982).
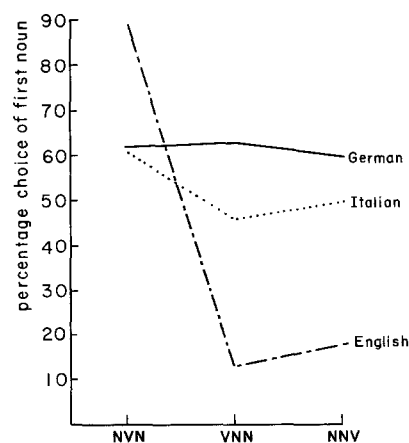
In Italian, the effects of the agreement
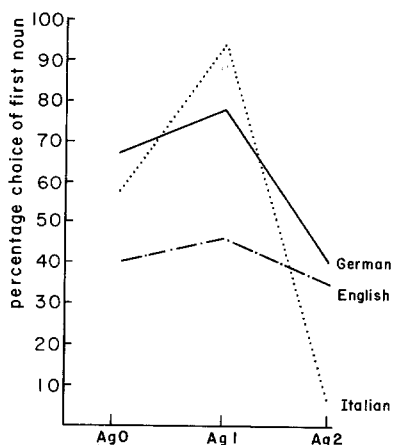

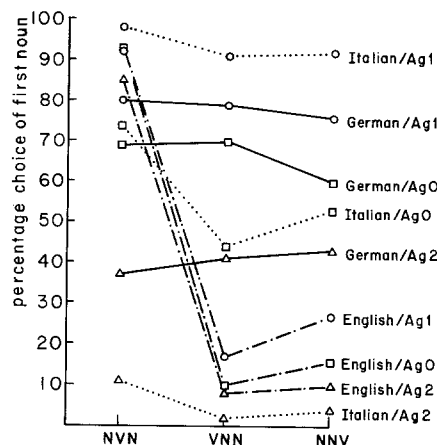FIG. 1. Language by word order.

FIG. 2. Language by agreement.

FIG. 4. Language by word order by agreement.

contrast were so strong that the difference between SVO and the other two orders was barely perceptible. When given a sentence like "The pencil are kicking the cows," English and Italian listeners make their decisions in entirely opposite directions. However, when agreement was ambiguous, the Italian bias toward SVO emerged more strongly. Still, SVO interpretations of sentences with ambiguous agreement averaged only 73%, as compared with 93% in English.

Like Italians, Germans showed a differentiation between word orders only when agreement cues were ambiguous (Ag0). This involved slightly more first noun choice on NVN and VNN orders compared

with NNV. The relative lack of consistency on NNV orders may reflect the fact that both SOV and OSV are possible in relative clauses, so that choice of interpretations depends crucially on agreement cues and the structure of the matrix clause.

Interactions of Animacy with Agreement

Within languages, the two-way interaction between Animacy and Agreement reached significance only in Italian and German. There was also a significant interaction of Language with Animacy and Agreement, as displayed in Figure 5. The
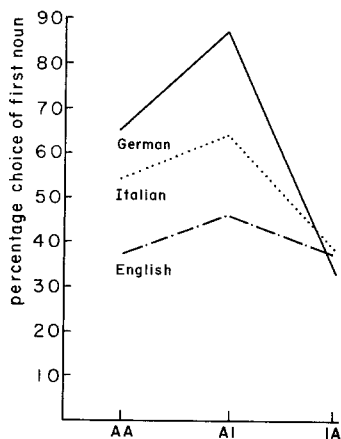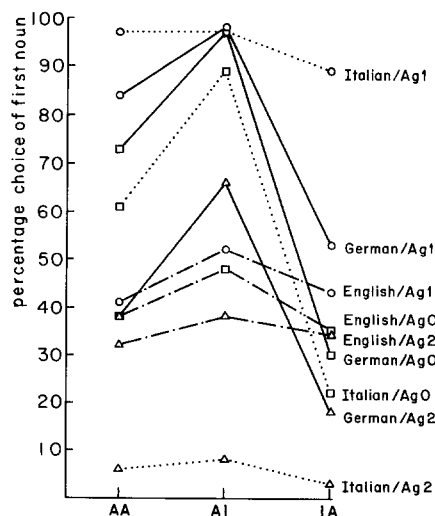

FIG. 3. Language by animacy.

FIG. 5. Language by animacy by agreement.

basic direction of the interaction is easily summarized. In English, Animacy and Agreement had no effect on each other. In Italian, Animacy had its strongest effect when agreement was ambiguous. Hence, the large Italian animacy effects reported by Bates et al. (1982) are replicated here, but only when morphological cues fail to provide an interpretation. In German, animacy had a major impact on all three agreement types—although the magnitude of the effect was larger when morphology is ambiguous. Comparing Figure 5 with Figure 3 for German, we see that agreement in German increased the chances of picking the agreed-with noun as actor by roughly 15% (from a baseline of 62%).

Comparing the results in Figures 4 and 5, we have further support for the rank orderings of cues suggested simply on the basis of the main effects. Word order is the strongest cue in English, where both animacy and agreement play very minor roles. Agreement is the major determinant of sentence interpretation in Italian, but animacy overwhelms word order when morphological cues are ambiguous. Since case marking was not available to the Germans as a cue in this experiment, Animacy emerged as the major remaining cue, followed then by Agreement and a general tendency to choose the first noun as subject.

English Stress Effects

In the results reported by Bates et al. (1982), there were slight effects of contrastive stress in English but significantly larger stress effects in Italian. In the present experiment, none of the effects involving stress reached significance within the English sample alone (Table 2). This fact gives us a simple interpretation of the interactions involving Language and Stress in Table 5: contrastive stress does not play a role in the English data, but it does have effects in both German and Italian. This should be particularly clear in Figure 6, in
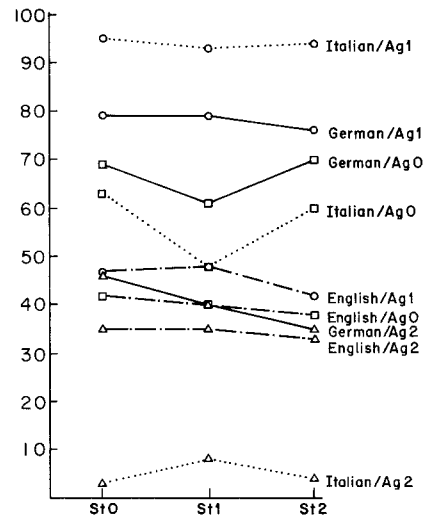

FIG. 6. Language by stress by agreement.

which a significant interaction Language by Agreement by Stress is displayed.

Italian Stress Effects

Several of the interactions involving Stress reached or barely missed significance in the Italian sample (Table 3). The most complex of these is an interaction of Stress with Agreement and Word Order, illustrated in Figure 7.

One obvious conclusion suggested by Figure 7 is that, in Italian, stress has an effect almost exclusively on items in which
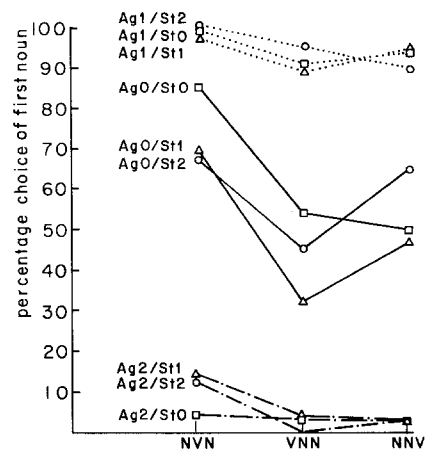

FIG. 7. Italian word order by stress by agreement.

the predominant agreement cue is unavailable. When agreement is absent, stress then plays an important role in the interpretation of word order configurations.

First, on the NVN items, contrastive stress serves to reduce first noun choice. That is, an interpretation in terms of default SVO order seems to hinge on the presence of default stress patterns. Note that although overall choice of the first noun as actor in NVN sentences is only 60%, Figure 7 shows that, when both agreement and stress contrasts are neutralized (Ag0/St0), SVO interpretations of NVN jump up to 85%. When either the first or second noun is stressed, SVO interpretations drop from this 85% to well under 70%. Hence contrastive stress seems to increase the plausibility of an OVS reading. Stress serves two roles, then, on these items: to *suspend* a default structural assignment, and to *increase* marked interpretations.

On the other two word orders, Italians apparently have no default structural assignment. On NNV items, without morphological markings (and summing across animacy conditions), choice is close to 50% when there is no stress or when the first noun is stressed; the only configuration with a consistent reading is N*N*V, which is interpreted about 65% of the time as an SOV. On VNN items, again without morphological marking (and assuming across animacy conditions), choice hovers around 50% except for V*N*N, which is interpreted around 70% of the time as a VOS.

Another way of saying this is that Italians expect to hear default stress on NVN word order, and N*N*V for NNV and V*N*N for VNN. If these conditions are not met, so many interpretations are possible that word order alone is not a very useful cue. The only default interpretation of word order that Italians have available is SVO—and even here, Italians make less consistent use of word order than their American counterparts. Although these stress effects are not large (compared with the massive effects of agreement and animacy), they are

in the same direction reported for Italian by Bates et al. (1982). Hence they appear to be statistically reliable.

German Stress Effects

In German, the main effect of Stress, the interaction of Stress with Agreement, and the interaction of Stress with Agreement and Word Order all reached significance. In Figure 7 we see that Germans make as much use of stress as their Italian counterparts, but the pattern of use is rather different. First of all, the main effect of Stress reached significance in German but not in Italian. Choice of first noun averaged 65% with default stress, dropping to 60% on the average when either noun was stressed. Unlike the Italians, Germans have a default word order interpretation for all three order types: SVO, VSO and SOV. Stress serves to suspend or reduce this default structural assignment, across the board.

As can be seen in Figure 8, Stress had an impact in German under either of two conditions: Ag0 items, in which morphological cues are ambiguous (summed across animacy types), and Ag2 items, in which agreement and word order stand in direct competition. In Italian, agreement effects were so strong that there was essentially no competition when agreement and word order conflict. In German, the fact that
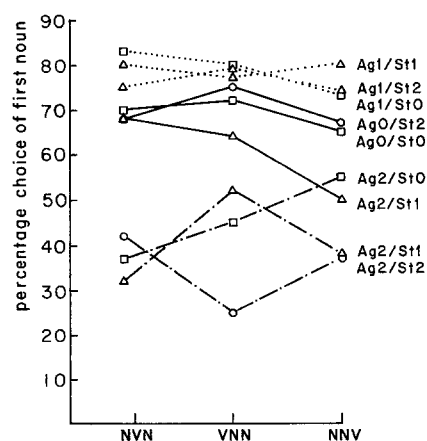

FIG. 8. German word order by stress by agreement.

agreement cues are weaker and that order cues are stronger creates a conflict in Ag2 items that is partially resolved by stress cues.

Examining the details of Figure 8, we can see that stress effects are negligible when order and agreement converge (Ag1). On morphologically ambiguous items, stress still has very little effect on NVN. On the other two orders, stress on the first noun reduces choice of that noun as subject— presumably because stress indicates new information, whereas subjects are more likely to encode given information. Finally, on the Ag2 items, stress again has a larger impact on the non-NVN word orders. On VNN, the most consistent response was given to VN*N* patterns, which were interpreted over 75% of the time as VO*S*. On NNV, stress on either noun reversed the default SOV interpretation in the direction of around 65% OSV.

We must be cautious about overinterpretation of these order and stress interactions—particularly for German, where the effects have not yet been replicated. Perhaps the best summary statement across both languages is that *stress plays a larger role in the interpretation of word order configurations in languages that permit variation in word order for pragmatic purposes.* Particularly in German, this involves a dual function of suspending or reducing default structures while increasing the probability of pragmatically marked variations. Where there is no default structure, as in two of the three Italian word orders, stress seems to indicate a distinction between new and given information.

DISCUSSION

The results of this study have consistently supported the predictions of the competition model. It appears to be the case that, for these data, cue applicability and reliability are the primary determinants of cue validity and cue strength.

English. The most valid cue to case role assignment in English is word order. With astonishing consistency, the actor in a transitive sentence is placed directly before the verb and the object follows the verb. No other cue in English can match this cue in terms of its availability and reliability. The results of this experiment for English indicate that native speakers of English make extensive use of this highly valid cue. Although agreement marking is available in English, its low reliability leads English speakers to pay little attention to it, as predicted.

Italian. The most valid cue to subject assignment in Italian is agreement marking on the verb, a fact that is reflected quite dramatically in the results. The fact that Italian, unlike English and German, is highly tolerant of subject omission means that often the only major cue for recovery of the identity of the subject is agreement marking on the verb. Although the cue of agreement marking is always available, it is often unreliable. It is particularly unreliable in transitive clauses with two full nouns. In such cases, Italians are forced to rely on animacy and certain constellations of word order and stress as cues to sentence interpretation. As noted, Italian also makes use of clitics as agreement markers. In these ways, Italian maintains the reliance on "local cues" found in Latin, although it has almost totally leveled the complex declensional system of its predecessor. As predicted in our analysis, both Italians and Germans made use of stress only in combination with specific word order patterns. In neither language was stress a major clue, but in both it was more important than in English.

German. The most valid cue to case role in German is case marking. Although this cue is high in occurrence, it is often ambiguous and hence unreliable. When case marking is ambiguous, Germans then have a variety of further cues to rely on. First, although there are a rather complex set of word order variations, it is more often the case that the first noun is the subject/actor. Agreement contrasts are also applicable, al-

though the German agreement system is less clear than its Italian equivalent. Hence, Germans may rely on animacy more than agreement, in contrast with their Italian counterparts. Like Italians, Germans have no single cue on which they can uniformly depend. The array of cues on which they apparently depend primarily involve "local" decisions, interpretations which will not be undone by new configurational information that comes in downstream.

On the use of English as a model of language in general. It is worth emphasizing how much these three, relatively closely related languages differed from one another in processing even these simple sentences. Of the three languages we studied here, only English relied heavily on word order as a near-categorical cue to sentence interpretation. This cue involved use of SV and VO patterns, leading to VOS interpretations of VNN and OSV interpretations of NNV. Germans, on the other hand, showed a less categorical tendency to select the first noun as the actor across all three sentence types. Italians, however, paid fairly little attention to word order per se. To the degree that they did pay attention to word order, it was in the context of certain canonical stress/order configurations.

When we looked at the use of agreement marking on the verb, the picture was exactly reversed. For Italians, agreement was the single most important cue in the study; for Germans it was of far less importance; and for Americans it was hardly important at all. Here, again, English provided us with a fairly poor guide to understanding the functioning of even closely related languages like German and Italian. For example, on the basis of the English data of both this study and that of Keeney and Wolfe (1972), one would hardly have expected that the most important single cue in Italian actor assignment would be verb agreement.

The use of animacy cues in the three languages points to the possibility that the English tendency to override lexical semantics during sentence processing may have little relevance to processing in even closely related languages. In this study, Germans showed the greatest reliance on animacy, followed by Italians, and then Americans. For all three languages, animacy played a role proportional to its cue validity. There was no tendency to bar this semantic cue from sentence processing. The fact that English speakers rely so little on this cue has been taken by some to indicate a strict separation between the syntactic parser and the semantic processor. However, the current data cast doubt on the universality of any such strict separation.

Finally, studies of English have told us very little about the role of stress in sentence interpretation. Studies of pronominal stress (e.g., Maratsos, 1973) have pointed to a "switch referent" role in the process of binding a pronoun to its referent in the previous clause. However, nothing in the English literature would lead us to expect stress to play a central role in the assignment of basic semantic–syntactic relations with simple sentences. The results from German and Italian suggest that word order rarely operates as an isolated cue; instead, listeners listen for certain order/stress configurations to indicate which of a variety of default or marked conditions hold. It is not at all obvious to us how parsing theories based on English could handle the pragmatic–syntactic interactions that characterize sentence processing in other languages.

On Language Typologies

We would like to conclude with certain speculations regarding the impact of sentence processing data on theories of language typology. Such theories are typically based on structural and distributional analyses and have not yet considered data on sentence processing. However, it may be the case that typological theory contains insights that should be incorporated into the competition model by way of constraints on interactions between cues.

Typologically, Italian is traditionally classified as an SVO word order language,

without case inflections. The results of the present study indicate that sentence processing in Italian more closely resembles the morphologically biased processing style of a case-inflected language like German— except that subject–verb agreement plays a deterministic role equivalent to the operation of case cues in German. In a sense, verb agreement marking is very much equivalent to case marking. In Bantu languages, for example, markings on the verb give identifying information about both the subject and the object which themselves are not marked for case. Of course, the difference between case marking and agreement marking is that the former is marked next to the item being categorized and the latter is not. It would be useful to investigate whether other morphological cues might play a similar "case-like" role in parsing. In Italian, a good candidate might be clitic object pronouns, which agree with the object in person and number (as in Sentences 2 and 5 earlier).

Indeed, natural languages may be less particular than linguists in deciding which cues should receive an "obligatory" or "deterministic" status, in what degree. In both Italian and German, animacy appears to be considerably more important than word order in determining sentence interpretation. We have not yet found evidence for any "universal" weighting of all grammatical morphology over open class lexical contrasts. It was the case in Italian that agreement outweighed animacy. In German, however, the opposite was true.

There remains one alternative typological interpretation of the results of this study which should be considered. This is the distinction between "local" and "topological" processing of grammatical cues. Examining data on the acquisition of grammatical marking in Turkish, Ammon and Slobin (1979) and Slobin (1982) suggest that children may be quicker to acquire grammatical cues that are marked directly on the stem than cues which are distributed across the entire clause. In the present study, both agreement and animacy are "local" cues,

in the sense that, by processing a single local package of sound, one can determine the role of each of the nouns (i.e., by markers directly on the noun, or by the semantic class of the noun itself). Of course, unlike case marking, agreement is coded not on the element being categorized, but on another element. Word order, like contrastive stress, is an inherently "topological" cue. That is, the decision to assign a given item to some underlying relational role is determined not by the identity of that item alone, but by its surface relationship with respect to its neighbors. Languages seem to divide themselves into those that favor local cues and those that favor topological cues. It may be the case that speakers of a language cannot commit processing resources in a way that allows them to search for grammatical cues on both levels simultaneously. If a language searches for grammatical cues locally, topological structure is then free to express meanings other than basic case relations. If a language searches for grammatical cues topologically, local features will not figure as prominently in grammatical processing, but may be available for use in entirely different ways. This distinction would provide us with a quite satisfactory and interesting account for the failure of English speakers to make any major use of lexical semantics in this experiment. Since animacy is a local cue and since English speakers focus on topological cues in sentence processing, they would not be disposed to attend to animacy cues. On the other hand, languages that make use of local cues such as case in German and agreement marking in Italian would be expected to also pay attention to locally marked cues such as lexical animacy.

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