The processing of restrictive relative clauses in Hungarian*

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Abstract

A rich variety of factors have been proposed as possible determinants of differences in the ease of processing of relative clauses. These determinants include the grammatical role of the head, the shape of surface order configurations, the occurrence of interruptions of the main clause, and the presence or absence of morphological cues. The strict SVO word order of English makes it so that subject-modifying relatives necessarily interrupt the main clause, thus confounding the effects of role and interruption determinants. Hungarian, with its variable word order, allows us to achieve a somewhat better understanding of the separate effects of roles, configurations, interruptions, and morphological cues. A study using 144 different restrictive relative clause patterns in Hungarian provided evidence for the importance of three determinants of relative clause processing. First, the importance of perspective maintenance was indicated by the fact that SS sentences were the easiest to process and that SO were the most difficult. Second, the extreme difficulty subjects had in processing NNV sentences with a relative clause modifying the second noun indicated the importance of limits on fragment construction of chunks in a bottom-up parsing process. The use of antecedent tagging to mark extraposed relatives in SOV languages with variable order such as Hungarian and Georgian also indicated the importance of limits on fragment construction. Third, the conflict between focusing in the relative clause and focusing in the main clause indicated the importance of focus maintenance. A variety of other proposed determinants were found to be of little importance in accounting for the processing of relative clauses in Hungarian.

Relative clauses present an interesting challenge to attempts to match linguistic descriptions to psycholinguistic data. Although many researchers have attempted to provide models of the processing of restrictive relative clauses, no single account appears to be able to account for all the observed phenomena. Hakuta (1981) and Clancy, Lee, and Zoh (1986) have suggested that a full account of the processing of restrictive relative clauses must look at the interaction of a variety of determinants. In this paper, we will review the status of work on this topic, examine the evidence in support of the various proposed determinants of relative clause processing, and present new data on the processing of restrictive relative clauses in Hungarian. Using both the new data and earlier data, we will find evidence for a multi-factor account of relative clause processing across language types.

The introduction to our study is composed of five sections. In the first section, we review the four relative clause constructions in English which have been the focus of nearly all psycholinguistic research on relative clauses. In the second section, we present the basic syntax of relative clauses in Hungarian. The third section looks at several possible determinants of the processing of relative clauses. The fourth section reviews experimental data on *relative clause* processing. The *fifth section examines some* genera/ ways in which language typology interacts with relative clause structure and processing.

Four relative clause patterns in English

Our attention will be focused on a small set of relative clause patterns. First, we will only look at restrictive relative clauses with definite NPs as heads. As Keenan and Comrie (1977) note, restrictive relative constructions can be given a syntax-free characterization in terms of their semantic structure. One can view the head of the relative clause as the "domain" of relativization which is then "restricted" or "identified" by the material in the relative clause. For example, in a relative clause such as "the girl that John likes," the domain is "girl" and the restricting sentence is "John likes." Thus the set of girls is being restricted to the one that John likes. Among the various types of restrictive relative clauses, we will only look at those that have as their head either the subject or the object of the main clause. Finally, we will only look at relative clauses where the noun that is "extracted" from the relative clause is either the subject or the object.

There are, of course, many other types of relative clauses (Quirk, Greenbaum, Leech, & Svartvik, 1985). There are non-restrictive relative clauses, such as "Bill Jones, who everyone knows as 'Bad Eye,' died last night at the

age of 73," where the additional information given by the relative clause is not essential for the identification of the head. There are a variety of non-finite clauses that are sometimes viewed as reduced relatives. These include sentences such as "The flowers sent to the performers had aphids." Some linguists view post-modifying prepositional phrases such as "on the team" in the sentence "Bill was the best player on the team" as elliptical relative clauses. There are extraposed relatives, such as "Bertram had a statue commissioned, which was to be poured with solid bronze." There are headless relatives, such as "What you don't know can't hurt you." Within each of these major construction types, a variety of particular patterns exist. First, the relative clause can modify virtually any type of nominal head. It can have a subject head as in "The girl he had just met gave the soldier a box of cigars," an indirect object head as in "Kim gave the soldier she had met a box of cigars," or a prepositional object head as in "Kim gave a box of cigars to the soldier who she had met." Relatives can even take adjectives or whole clauses as heads, as in "Lila painted the kitchen purple, which was a very lively color," or sentential relatives like "Things later improved, which surprised him." Within the relative clause, the head can also take on any role. It can be a subject as in "Kim gave the soldier who met her a box of cigars"; it can be a prepositional object, as in "Kim gave a box of cigars to the soldier to whom she had earlier given a peach"; or it can be an indirect object as in "Kim gave a box of cigars to the soldier she had given a peach."

Psycholinguistic researchers have ignored this fascinating diversity of relative clause types, choosing to focus attention on only four types of restrictive relative clause structures. These are the four types of full restrictive relative clauses which have either a subject or an object as head and which extract either a subject or an object. The four clause types are abbreviated as SS, SO, OO, and OS. The abbreviations use the letters "S" and "O" to tell us first the role of the head noun in the main clause and then the role of the head noun in the relative clause. Or, to put it another way, they tell us first the grammatical role of the noun that the relative clause is modifying and next the grammatical role that is being extracted from the relative clause. When the head is the subject in both clauses, we speak of an SS structure. When it is the subject in the main clause and the object in the relative clause, we have an SO structure. When the head is the object in the main clause and the object in the relative clause, we have an OO structure. When the head is the object in the main clause and the subject in the relative clause, we have an OS structure. Examples of these four sentence types in English are as follows:

(1)   The boy who sees the girl chases the policeman.   (SS)
(2)   The boy who the girl sees chases the policeman.   (SO)

(3)   The boy chases the girl who the policeman sees.   (OO)
(4)   The boy chases the girl who sees the policeman.   (OS)

We can refer to SS and OS types as "subject-extracting relatives" and OO and SO types as "object-extracting relatives." We can refer to SS and SO types as "subject-modifying relatives" and OO and OS as "object-modifying relatives."

   Given the diversity of relative clause types, why has the research literature focused on just these four patterns? In part, the reason is that these four types seem to provide a sampling of the three basic factors that appear to be most important in determining the difficulty of processing for relative clauses. They display variation in the role of the head in the main clause, the role of the head in the relative clause, and the positioning of the relative clause. It is also true that experiments investigating these four sentence patterns have found reliable differences between the four types. As so often happens in psychology, these findings have taken on a life of their own as facts to be explained.

   The problem is that a full and satisfying account of the processing of even this small subset of relative clauses has proven to be quite elusive. In attempting to account for the observed processing differences, researchers have proposed a wide variety of determinants of sentence processing. Each of these hypothesized determinants attempts to use relative clauses as a way of understanding basic strategies in sentence processing. For example, Yngve (1960) and Slobin (1973) attributed difficulties with SO relatives such as "The boy who the girl sees chases the policeman" to the interruption of the subject-verb unit of the main clause. Unfortunately, the actual number of data points to be predicted in English is simply too small to allow for a proper assessment of the many determinants of relative clause processing that have been discussed. With only four major sentence patterns, there are really only four data points to be predicted. A particularly dangerous confounding in English involves the role of the head in the main clause and the presence or absence of an interruption of the main clause by the relative clause. In English, subject-modifying relatives (SS and SO) usually come between the subject and the verb of the main clause, whereas object-modifying relatives (OS and OO) are usually placed after a complete and non-interrupted main clause. Thus, it is impossible to separate out the effects of sentential role from clausal discontinuity in English.

   In the current study we will look at the processing of relative clauses in Hungarian. Because it is a variable word order language, Hungarian permits the formation of at least 144 different relative clause structures, as compared to the 4 structures available in English. By analysing this much broader set of data points, we can perform a fuller evaluation of the relative importance

of the various determinants of the processing of relative clauses. We present this work as an example of the importance of conducting cross-linguistic tests of psycholinguistic hypotheses (MacWhinney & Bates, in press) and the dangers involved in relying exclusively on English data as a testing-ground for psycholinguistic theory.

Relative clauses in Hungarian

In order to understand the construction of the stimuli in this experiment and the results for the various sentence types, we will need to examine four aspects of Hungarian grammar: (1) the morphology of the cues marking grammatical roles, (2) the word order patterns in the main clause, (3) the word order patterns in the relative clause, and (4) the use of antecedent tags as cues to the identification of the head of the relative clause.

Morphological cues marking grammatical role

Hungarian provides full and unambiguous marking of the roles of all nouns in both the main clause and the relative clause. When a noun or pronoun is a subject, it appears in the nominative. Nominative case is indicated by the absence of any case marking on the noun. When a noun or pronoun is an object, it appears in the accusative case, which is marked by a final *t* with or without a linking vowel before it. Consider the following example:

(5)   A kutya kergeti a macskat.
       The dog(NOM) chase-3S-DEF the cat-ACC.
       "The dog chases the cat."

In this sentence "kutya" has no suffix and is therefore in the nominative. The noun "macska" adds a final *t* for the accusative and lengthens its final vowel yielding the form "macskat."

   This basic pattern of case marking also extends to the marking of elements in relative clauses. The role of the head in the relative clause is doubly marked. First, the role of the head within the relative clause is indicated by case marking on the relative pronoun. In (6) below, where the head is the subject within the relative, the relative pronoun takes the nominative "amely." In (7), where the head is the object within the relative clause, the pronoun takes the accusative "amely-et" form.

(6)   A kutya kergeti a macskat, amely nezi az egeret.
       The dog(NOM) chase-3S-DEF the cat-ACC, which(NOM) watch-3S-DEF the mouse-ACC.
       "The dog chases the cat that watches the mouse."

(7) A kutya kergeti a macskat, amelyet nez az eger.
     The dog(NOM) chase-3S-DEF the cat-ACC, which-ACC watch(3S-INDEF) the mouse(NOM).
     "The dog chases the cat whom watches the mouse."

The role of the head in the relative clause is also redundantly marked by inflectional markings on the verb. In these examples, the marking is given by the contrast between "nez" and "nezi." This contrast is based on the availability in Hungarian of two paradigms of verbal conjugation. In simple sentences, the definite conjugation ("nezi") is used when the object is definite and the indefinite ("nez") is used when the object is indefinite. In relative clauses, the contrast serves a different purpose. If the head noun plays the role of the object in the relative clause the verb is obligatory indefinite even though the head of a relative is usually thought of as semantically definite (Kuno, 1986) and this definiteness is even marked morphologically on the relative pronoun. If the head noun is the subject of the relative clause the conjugation varies according to the definiteness of the object in the relative clause. If the verb of the relative clause is intransitive, it will also appear in the indefinite. Thus the combination of the *t* accusative marker on the relative pronoun and the indefinite conjugation on the verb serves as a clear double marking of an object-extracting relative clause. Similarly, the combination of an unmarked nominative relative pronoun and the definite conjugation on the verb serves as a clear double marking of a subject-extracting relative clause.

Ordering in the main clause

In Hungarian, all six orders of subject, object, and verb (SOV, OSV, SVO, OVS, VSO, VOS) are grammatical. Although all six orders are possible and all occur fairly frequently, SOV order predominates when the object has no article and SVO predominates when the object has an article. This word order variability is interesting because it allows us to partially deconfound the effects of role determinants and configurational determinants. For example, one can have subject-modifying relatives which interrupt an otherwise intact S-V unit in both S-Rel-V-O and O-S-Rel-V sentences. Or one can have subject-modifying relatives with no interruption of the SV unit in O-V-S-Rel sentences. Because interruptions can appear at several places, we can evaluate whether processing is dependent upon the mere fact of interruption or whether there are critical units not to be interrupted, such as the SV unit or the VO unit.

However, this deconfounding is only partial. Like all other "free" word order languages with which we are acquainted, Hungarian favors some orders

over others. In Hungarian, the unmarked word orders are SVO and SOV. SVO order is the default when the object is modified by an article. SOV is the default when the object is indefinite and has no article. Because all free word order languages appear to show such markedness patterns, there may be no one language that provides a perfect deconfounding of configurational and role determinants. Nonetheless, we can still take advantage of this partial deconfounding in Hungarian to deepen our understanding of sentence processing.

The basic order of the Hungarian clause is defined not in terms of grammatical roles, but in terms of pragmatic roles. Hungarian is organized around the concept of topic, rather than the concept of subject (Li, 1976). The basic order is: topic + comment (Kiss, 1981). The unmarked topic is in the nominative case and corresponds roughly to the English subject. The association between topic and subject is not complete. It is perfectly possible to have Hungarian sentences with the object as the topic. However, such sentences are strongly marked pragmatically.

Order within the relative clause

Within the relative clause, both NV and VN orders are grammatical for both subject and object relatives. Which of these two orders is used depends on whether or not the noun in the relative clause is focused. Consider these two examples:

(8) A fiut csokolja a lany akit a kutya harapja meg.
     The   boy-ACC   kiss-3S-DEF   the   girl(NOM)   who-ACC   the
     dog(NOM)bite-3S-DEF COMPLET.
     "The girl who the dog bites kisses the boy."
     or "It's the boy who is being kissed by the girl that it's the dog who's
     biting."
(9) A fiut csokolja a lany akit megharapja a kutya.
     The boy-ACC kiss-3S-DEF the girl(NOM)who-ACC COMPLET-bite-
     3S-DEF the dog-NOM.
     "The girl who the dog bites kisses the boy."
     or "It's the boy who is being kissed by the girl the dog's biting."

In the first example sentence the word "kutya" comes before the verb and the verbal prefix "meg" follows the verb. In this structure, we say that "kutya" is focused. This is because the element immediately before the verb carries the main focus of the sentence (Kiss, 1981, 1983). If a relative clause has NV order this means that the noun comes before the verb and is focused. This use of NV order for focusing has somewhat the same effect as that

achieved in English by using cleft relative clauses such as "the cat that it was the rat who chased ate the cheese." However, in Hungarian, this contrastive focusing is more common and less marked.

The other major order pattern in the relative clause is VN order, as illustrated in example (9). In this order there is no major focus within the relative clause; instead the verb itself receives a certain weak focus. This focus on the verb can be clearly marked when the verb has a separable prefix. In that case, the order is RelPronoun - Prefix - Verb - NP and the prefix is in focus position. In RelPronoun - NP - Verb - Prefix orders the NP becomes contrastively focused in the relative clause and the separable prefix follows the verb.

Antecedent tags and extraposition

Earlier we noted that the interruption of the SVO unit can be avoided in Hungarian by use of orders such as S-V-O-Rel or O-V-S-Rel. Interruption can also be avoided through extraposition. Relative clauses can also be extraposed in English. However, the constraints on extraposition are much tighter in English than in Hungarian. In English, it is possible to extrapose subject-modifying relative clauses in simple intransitive sentences (Gueron, 1980; Quirk, Greenbaum, Leech, & Svartvik, 1985) when there are no nouns other than the subject, since the only competitor for the role of the head of the relative clause is the subject. When there are other competitors for the role of head, extraposition becomes more problematic. Consider the following examples:

(10) A man walked in, who was wearing a grey hat.
(11) The book was on fire, which was from Germany.
(12) A book was on the table, which was from Germany.
(13) The dog chased the cat that hit the elephant.

In (10) the only nominal in the main clause is "a man", so the relative clause must take "a man" as its head. In (11) there are two nouns, but semantic constraints mitigate against "fire" as the head of the relative clause. In (12) there is no such constraint against "table" as the head for the relative clause. If there is no comma or comma intonation to guide us, we would assume that "table" is the head of the relative. However, "book" could also be a head and the sentence could be understood as having an extraposed relative clause. Psycholinguistic studies of relative clauses have not looked at sentences like (10) to (12), focusing instead on sentences like (13). In (13), even with a comma or comma intonation, it is virtually impossible to get a reading in which "dog" is the head of an extraposed relative clause.

In Hungarian, on the other hand, all of the possible types of simple transitive sentences can undergo extraposition. Consider a few examples:

(14) Az a kutya kergeti a macskat, ami szereti a kislanyt.
      That(NOM) the dog(NOM) chase-3S-DEF the cat-ACC, which(NOM)
      like-3S-DEF the girl-ACC.
      "The dog that chases the cat likes the girl."
(15) A macskat, az a kutya kergeti, ami szereti a kislanyt.
      The cat-ACC that(NOM) the dog(NOM) chase-3S-DEF, which(NOM)
      likes the girl-ACC.
      "The dog that likes the girl chases the cat."
(16) Azt a kutyat kergeti a macska, ami szereti a kislanyt.
      That-ACC the dog-ACC chase-3S-DEF the cat(NOM), which(NOM)
      like-3S-DEF the girl-ACC.
      "The cat chases the dog which likes the girl."

In the sentences above, the forms *az a* and *azt a* are used to mark the head of the relative clause. They translate roughly as "this the," so that a phrase such as *az a lany* would be "that the girl." Downing (1978) refers to the nominal head of the relative clause as the "antecedent." When this antecedent is marked with some device such as a demonstrative pronoun or suffix that clearly indicates that it is the head of the relative clause, we can say that it is "tagged." We will refer to this *az a* marking as the "antecedent tag." The antecedent tag plays an important role in that it facilitates processing of extraposed relative clauses.

In terms of clarity of marking, one would expect the tag to facilitate understanding in sentences with a relative clause. However, the main function of the tag is not necessarily to facilitate processing of non-extraposed relative clauses, since these are already quite clearly marked in Hungarian. Rather tagging is important in that it permits identification of the head of an extraposed relative clause. One can then ask why clauses are extraposed in the first place. One possibility is that exposition marks the relative clause as somehow an afterthought.

Another possibility is that extraposition is particularly important in Hungarian NNV sentences when the relative modifies the preverbal focused noun. Of the various types of extraposed and non-extraposed relative clause patterns in the different word orders and different roles, only one type is ungrammatical. When the head of the relative is in preverbal focus position and when it is marked with an antecedent tag, the relative must be extraposed (Kiss, 1981).

(17) Janos azt a fiut mutatta be nekem, aki a sarokban iil.
    John(NOM) that-ACC the boy-ACC showed INN DAT-IS, who(NOM)
    the corner-INN sits.
    John that boy introduced to-me, who the corner-on sits.
    "John introduced to me the boy who is sitting on the corner."
(18) Janos azt a fiut, aki a sarokban iil, mutatta be nekem.
    John(NOM) that-ACC the boy-ACC, who(NOM) the corner-INN sits,
    showed INN DAT-IS.
    John that boy, who the corner-on sits, introduced to-me.
    "John introduced to me the boy who is sitting on the corner."

The two word orders in which this pattern arises most clearly are the OSV and SOV orders where the preverbal noun is always understood as focal. From a pragmatic point of view, tagging the head and placing it in focus position runs counter to modifying it immediately with a relative clause. The restriction can be understood in either pragmatic or processing terms. However, in either case, what is crucial is that Hungarian does not allow a relative clause to separate a preverbal tagged focal NP from the verb when there are two preverbal NPs.

Determinants of relative clause difficulty

The literature on the processing of relative clauses is large and complicated. From this complex literature, one can extract a variety of analyses regarding factors that are said to influence relative clause processing difficulty. One can differentiate four major types of hypothesized determinants of processing difficulty for relative clause structures: 1) those which focus on the grammatical roles played by the head of the relative clause, 2) those which focus on the use of word order configurations in surface structure, 3) those which focus on the interruption of processing units, and *4)* those which focus on the use of grammatical markers as cues to processing. For mnemonic purposes, we will call these "role determinants," "configuration determinants," "interruption determinants," and "cue determinants." In the next four subsections we will examine the predictions of ten different analyses. At the end of this section, these predictions are summarized.

Role determinants

We will examine five proposals that place emphasis on the processing of the role relations of the head noun. The first and most influential of these pro-

posals has been the determinant which Sheldon (1974) called "parallel function." According to parallel function, sentences in which the head of the relative clause plays the same role in both the main clause and the subordinate clause are easier to process than sentences in which the head plays different roles in the two clauses. Thus, SS (sentence 1) and OO (sentence 3) structures should be easier than SO (sentence 2) and OS (sentence 4) structures, or, put cryptically: {SS, OO} > {SO, OS}. Sheldon does not discuss any possible differences between parallel function for subject and for object, suggesting only that both types of parallelism should aid processing and memory.

Parallel function can be stated as a language-independent concept. It does not depend on the exact nature of the roles in the subordinate and matrix clauses - the unifying role in question could be "ergative" or "topic" and parallelism could still hold. However, in its formulation for English, parallel function is clearly designed to work on the roles of subject and object. When we extend parallel function to Hungarian, we immediately run into the fact that the correlation between subject and topic is weaker in Hungarian than in English. On the one hand, parallel function in Hungarian could track the subject role as it does in English. Alternatively or additionally, parallel function in Hungarian could be between the topic role in the relative clause and the topic role in the main clause. The head of a relative clause is always its topic and this means that parallelism in Hungarian would attain best when the head of the relative is also the topic of the main clause. This occurs when the head is in initial position in SVO, OSV, and SOV structures. In OVS and VOS structures, it occurs when the head is postposed. In VSO structures the exact preference for a topic head is unclear. There is no a priori way in Hungarian to distinguish between these two ways in which Parallel Function could operate. Either effect can be motivated theoretically. This is a case where we simply need to look at sentence processing data.

One obvious problem with Sheldon's parallel function is the fact that it appears to work much more strongly for the subject role than for the object role, as we will see later. If parallellism alone were at issue, this would not be the case. MacWhinney (1982) proposed a modification of parallel function which focused on the central nature of the subject role in English. MacWhinney (1977) reviewed a large number of psycholinguistic studies which indicated that both speakers and listeners prefer sentences in which the subject closely matches the unmarked human "perspective." Thus, we prefer sentences in which the subject is "above" to ones in which it is "below." We prefer to describe figures against grounds, rather than grounds as containing figures. We prefer to take the viewpoint of active agents, rather than passive recipients, etc. Together, these effects indicate that speakers and listeners prefer sentences in which the "starting point" matches the unmarked way in

which humans tend to see themselves as actors in the world. MacWhinney (1977) and Ertel (1977) further argued that this perspective is used as a basis for the active "construction" of the interpretation of the sentence. MacWhinney noted that perspective can therefore be viewed as the pragmatic counterpart to the formal category of subject. Where linguists use the concept of subject to explain grammatical phenomena, psycholinguists may find it more useful to use the concept of perspective to understand sentence processing effects.

When perspective is related to sentence processing, it becomes a still more dynamic concept. Moving through clauses, perspectives may either be maintained or shifted. MacWhinney (1977, 1982) hypothesized that structures that maintain the perspective or subject should be easier to process than those that shift it. Parallel function makes no predictions regarding effects of varying word orders on role parallelism, nor does it consider issues of role assignment during left to right parsing. Like the parallel function determinant, the perspective maintenance determinant predicts that SS relatives should be very easy, since they involve no shift in perspective. However, perspective maintenance predicts OO relatives to be worse than SS relatives because there is one shift of perspective in an OO relative like "The cat chased the dog the lion bit." In that sentence, perspective begins with "the cat" but then shifts to "the lion" right at the end. This shift is necessary to interpret the relative clause from the viewpoint of the lion as subject. Perspective maintenance also predicts a major difference between SO and OS structures. In OS structures only one shift of perspective is required. This shift occurs within the relative clause. The most difficult structures should be the SO structures since they require first a shift to the subject of the relative clause and then a shift back to the perspective of the head. Consider the sentence: "The dog the cat bit chased the monkey." The first perspective or subject is "the dog." Then perspective is shifted to "the cat" and finally back to "the dog" in order to process the rest of the clause. Thus, the perspective maintenance determinant predicts this order of difficulty for the four English patterns that have been so often studied: SS > {OO, OS} > SO.

When generalized to Hungarian, the perspective maintenance hypothesis makes predictions similar to those for English for orders in which the subject is initial. These are the canonical orders of SVO and SOV. When the object is initial, as it is in the non-canonical OSV and OVS orders, perspective maintenance holds that at least some perspective is invested in the object as a starting point. This should lead to a superiority of object-modifying relatives (OS, OO) over subject-modifying relatives for the non-canonical object-initial orders. For the two verb-initial orders, we would expect mixed results, since the subject is not in its canonical position, but the object is not fully topicalized either.

Another grammatical role determinant derives from the noun phrase accessibility hierarchy proposed by Keenan and Comrie (1977). On the basis of a survey of possible and impossible relative clauses in a wide variety of languages, Keenan and Comrie suggest a hierarchy that determines the way in which nominal arguments in the main clause vary in their accessibility to extraction or promotion. In this hierarchy, the subject is more accessible than the direct object which is more accessible than the indirect object which is more accessible than a prepositional NP which is more accessible than a possessive NP. This ordering can be abbreviated as S > DO > IO > PrepNP > Poss NP. Thus subject relatives should be easier to understand than object relatives. Keenan and Comrie claim that this Accessibility Hierarchy "reflects the psychological ease of comprehension" (p. 88) of the various resultant structures. They give two possible psychological reasons for the supposed advantage of subject relativizations over object relativizations. One focuses on the idea that there is a default processing strategy to take the head as the subject of the relative clause. The other is that subjects and heads share what they call the logical property of "independent reference." Whatever its psychological basis, the Accessibility Hierarchy clearly predicts this order of difficulty: {SS, OS} > {SO, OO} for the four structures that have been so often studied in English. This determinant should make similar predictions for Hungarian relative clauses, since it specifically focuses on the roles of subject and object, rather than topic and comment. Conceivably, the effect of this determitvatvt might be weaker it\ H.uv\g,ax\an, smce ttvs, subject. TO\e, \S not as prominent in Hungarian as it is in English.

A fourth possible role determinant that we will examine is one which has not been widely discussed in the literature. This determinant focuses on a possible superiority of object-modifying relatives over subject-modifying relatives. On pragmatic grounds, one might expect objects to be more appropriate heads than subjects, since the former are new and need to be further specified whereas the latter are old and need little further specification. A pragmatic determinant of this type could be particularly important in a language such as Hungarian that allows a dissociation between the pragmatic role of topic and the grammatical role of subject. We will call this determinant the "specification" determinant. This determinant would make object-modifying relatives easier than subject-modifying relatives, giving us: {OO, OS} > {SS, SO}.

Finally, we need to consider a role determinant suggested by an analysis of Hungarian grammar. This is the focus maintenance determinant. It operates somewhat differently from the perspective maintenance determinant in that it simply requires that focus conflicts in a complex sentence should lead to an increase in processing load. As we mentioned earlier, focus mainte-

nance requires that relative clauses modifying tagged preverbal focal elements be extraposed. If they were not extraposed, their presence after the head would directly conflict with its focality. A second type of focus conflict arises when the head of the relative clause is tagged and the noun of the relative clause is focused. This configuration is grammatically acceptable, but it forces the listener to split the assignment of focus between the main clause and the relative clause. In addition, this type of split focus interacts with perspective maintenance to increase processing load, as we will see later. It may be that there is a general psycholinguistic constraint against conflicts and splits in focus that operates across languages. However, the current determinant is being formulated solely on the basis of an analysis of Hungarian grammar. Its application to other languages is beyond the scope of the current article.

Local configuration determinants

The determinants we have discussed so far are all stated to operate upon a particular set of roles or role combinations. One can also imagine a set of determinants that operate upon particular linear surface structure configurations. Indeed, at least two such determinants have been discussed in the literature. One is Tavakolian's Conjoined Clause Analysis and the other is Sheldon's Adjacency Strategy. Unlike the role determinants that we have discussed so far, the local configuration determinants have been observed primarily as ad hoc processing strategies in children. There is very little evidence that these strategies have any major relevance to adult processing. Nonetheless, for the sake of completeness, we will include these strategies in our review of possible determinants of relative clause processing.

Tavakolian (1981) proposed a strategy according to which one "primitive" approach used by children in dealing with relative clauses is to treat them as conjoined clauses. According to this conjoined clause analysis, children first try to interpret the main clause and the relative clause as two conjoined clauses with a deleted subject in initial position in the relative clause. This analysis leads to systematically correct interpretations of SS structures. The child interprets the SS structure "the boy who sees the girl chases the policeman" as "the boy sees the girl and chases the policeman." This interpretation is basically correct. However, in OS and OO structures, the conjoined clause analysis leads uniformly to an incorrect parsing. The child would interpret both the OS structure "the boy chases the girl who sees the policeman" and the OO structure "the boy chases the girl who the policeman sees" as "the boy chases the girl and the boy sees the policeman." Thus, both OS and OO sentences are misunderstood. Tavakolian argues that, in SO sentences such

as "the boy who the girl sees chases the policeman," the child does not know which noun is the subject of the first clause when he begins to parse the relative clause. Since the child is forcetkto make a premature guess at the identity of the subject, sometimes he will guess correctly and sometimes incorrectly. Thus, using this strategy, he will always be correct for SS sentences, always wrong for OS and OO sentence's, and sometimes right and sometimes wrong for SO sentences. This determinant predicts an SS > SO > {OO, OS} order of difficulty.

Tavakolian used data from English-speaking children to argue for the conjoined clause determinant. If there were some universal early tendency to analyse relative clauses as conjoinings, what would we expect to find in a free word order language like Hungarian? First, it is clear that the conjoined clause analysis would work equally well with Hungarian SS sentences as with English SS sentences. Thus, (19) would be interpreted as (20).

(19) A fiu aki kergeti a lanyt latja a bohocot.
The boy(NOM) who(NOM) chase-3S-DEF the girl-ACC see-3S-DEF the clown-ACC.
"The boy who chases the girl sees the clown."

(20) A fiu kergeti a lanyt es latja a bohocot.
The boy(NOM) chase-3S-DEF the girl-ACC and see-3S-DEF the clown-ACC.
"The boy chases the girl and sees the clown."

This interpretation would be essentially correct. In this SS example, the word order is SVO in both the main and subordinate clauses. If the word order changes, this makes no difference in Hungarian, since the case marking remains available as a cue to case role assignment in each of the clauses. In SO sentences, the conjoined clause analysis would run into more difficulty. A sentence like (21) could be interpreted either as (22) or as (23), depending on which of the two nominative nouns the child decides to place into the accusative.

(21) A fiu akit kergeti a lany latja a bohocot.
The boy(NOM) who-ACC chase-3S-DEF the girl(NOM) see-3S-DEF the clown-ACC.
"The boy who the girl chases sees the clown."

(22) A fiii kergeti a lanyt es latja a bohocot.
The boy(NOM) chase-3C-DEF the girl-ACC and see-3S-DEF the clown-ACC.
"The boy chases the girl and sees the clown."

(23) A fiut kergeti a lany es latja a bohocot.
The boy-ACC chase-3S-DEF the girl(NOM) and see-3S-DEF the clown-**ACC.**
"The girl chases the boy and sees the clown."

Both interpretations would be incorrect. In (22), the error is that an SVO interpretation is being imposed on the first NVN unit. In (23), the error is that the subject of the first clause is used as the subject of the second clause. In OS and OO orders, the conjoined clause analysis also leads to errors. Thus, the application of the conjoined clauses strategy to Hungarian leads to essentially the same pattern of results we would find in English: SS is interpreted correctly and the other patterns are interpreted incorrectly. The only difference is that it is even less likely in Hungarian that SO sentences would be interpreted correctly than in English.

The second local configuration determinant that we will examine is the adjacency strategy of Sheldon *(1977a)*. Sheldon presented this strategy as an elaboration of some suggestions by Bever (1970) and an earlier proposal by Smith (1974). She formulated it in these terms:

> In parsing a noncompound sentence, starting from the left - group together as constituents of the same construction two adjacent NP's (i.e. not separated by other NP's) and an adjacent non-initial verb that has not already been assigned to a clause. Interpret the first NP as the subject of the verb and the second **NP** as the object of the verb. (p. 312)

Note that, according to Sheldon's definition, the NPs do not actually have to be adjacent. They can be separated by a verb or a relativizer, but not by another NP. When listeners use this strategy with compound sentences, they must treat the complex sentence as two simple sentences. In English, using this strategy leads to correct interpretations only for OS sentences. Sheldon (19775) reports that in both English and French there is a period during which processing of OS sentences improves, indicating that children may indeed be using this strategy during this period. Since the order of the noun and the verb in OS and OO sentences is variable in French, but not English, *the strategy might be of greater importance in French than English. The* order of difficulty predicted by this strategy for English is OS > {SS, SO, OO}.

Application of the adjacency strategy to Hungarian leads to rather different results, since the free word order of Hungarian radically changes the shapes of the local units of two NPs and a verb. Correct interpretations only arise when the first noun in the sentence is indeed the subject. Thus, in sentences with OVS, OSV, and VOS orders in the main clause, this strategy will always yield incorrect interpretations. With SVO or VSO in the main

clause, the results would be exactly as in English with only OS relatives being correctly interpreted. In SOV order even OS relatives will be interpreted incorrectly, since the initial S lies "stranded" outside of a local group of two nouns and a verb. Thus, the application of the adjacency strategy to Hungarian predicts some advantage for OS relatives, but only in two of the six possible main clause orders.

   Tavakolian, Sheldon, Bever, and Smith all recognize that the strategies they propose are probably not the only ones used by listeners. It could be the case that these configurational strategies are used along with many others in concert during sentence processing. Bever (1970) and Fodor, Bever, and Garrett (1974) explicitly propose that listeners have a variety of strategies that make use of different surface configurations to extract grammatical relations. Some strategies proposed by Bever were:

(1)   NVN sequences are parsed as canonical (Slobin and Bever, 1982) agent-action-object structures.
(2)   NNV structures are parsed as object-agent-action units.
(3)   Two verbs that occur in sequence are understood as representing the action of the embedded clause followed by the action of the main clause.

Unfortunately, these writers do not discuss any possible interactions between the various strategies that have been proposed. It is not clear whether all of them can be used together. If they are used together and two strategies conflict, it is not clear how the processor should decide which strategy to follow.

Interruption determinants

The other approaches which concentrate on the characteristics of the surface string basically all derive from an analysis originally proposed by Yngve (1960) for speech production. According to this analysis, difficulties arise when people (both adults and children) have to keep in mind too many grammatical commitments. In the more general form devised for the production model, this would mean that any interrupted structure would cause difficulties. Slobin (1973) phrased this as an "operating principle" that directs the learner to "avoid interruptions." Slobin viewed this determinant as an important factor in processing for both adults and children. With regard to relative clauses, this principle would suggest that embedded structures are difficult to understand independently of the role relations between the two clauses, i.e., in English all subject-modifying relatives (SS and SO) should be more difficult then object-modifying relatives (OS and OO). No differences are predicted between the two types of subject-modifying relatives or the two

such loads tend to bog down sentence processing, then Hungarian and English sentences with many unattached fragments should be difficult to process. Because of the emphasis it places on the construction of fragments in a bottom-up parser, we will refer to this second interruption factor as the fragment construction determinant.

Since English does not use NNV word order in the main clause, the full effects of the fragment construction determinant cannot be felt in this language. In Hungarian, on the other hand, variable word order produces a wide enough range of sentence patterns to partially deconfound these various determinants. The clearest cases in Hungarian are NNV sentences in which the relative clause modifies the second noun and in which the verb does not precede the noun in the relative clause. In such structures, three nouns follow in sequence before a verb is encountered. Such structures should be particularly difficult. In addition, NNV sentences in which the relative modifies the first noun should also be a bit more difficult than comparable NVN sentences.

Morphological cues as processing determinants

Yet another possible determinant of the relative ease of relative clause processing is the presence or absence of reliable morphological cues to role assignment. In English there are two major cues to relative clause processing. One cue is the relative pronoun "who/which" and the relativizer "that." The presence of the relativizer "that" after the noun is a highly "reliable" cue to the presence of a relative clause (MacWhinney, Bates, & Kliegl, 1984). However this cue is not always "available" since it can be deleted in object relatives. Moreover, in patterns such as "the man shouted to the girl that John left," the relativizer is ambiguous with the complementizer "that." This means that the relativizer is not entirely "reliable." The second cue in English is the word order cue. Within the relative clause, the order of elements is remarkably strict. If there is a noun preceding the verb of the relative clause, the relative clause is an object relative. If there is no noun preceding the verb of the relative clause, the relative clause is a subject relative. These cues to structure are completely reliable and are always there.

Thus, of the two major cues in English one is a morphological cue with low validity and the other is a word order cue with very high validity. Because the most valid cue in English is an order cue and not a morphological cue, there has been a certain emphasis in the relative clause literature on the importance of configurational patterns. In Hungarian, morphological marking of case role for the object works across all clause types uniformly. Thus, although the case marker may be a major determinant of sentence processing, its effects could only be easily studied by giving subjects sentences in which

the case marker had been removed. Since this leads either to ungrammatical sentences or, in one structure, to complicated ambiguous sentences, we will not perform this manipulation in the current experiment, leaving such a test to further work. However, evidence from MacWhinney, Pleh, and Bates (1985) indicates that case marking is the most important determinant of Hungarian sentence processing. In a sense, then, the current work can be viewed as an examination of the relative effects of the other determinants of relative *processing when the mast important determinant - the morphological* cue - is left constant.

There is another morphological cue that does not work in all relative clause structures. This is the presence of markers of the indefinite conjugation on the verb in object-extracting relatives. This cue should facilitate the processing of object-extracting relatives, leading to this order of difficulty: (SO, OO} > {SS, OS}.

A second way in which morphological markings can influence processing is through the matching of an extraposed clause to its head. The shape of the extraposed clause itself is governed by pragmatic factors. We have already noted that extraposition is obligatory for relative clauses modifying nouns in preverbal focus position. It is also true that extraposed relatives cannot have a marked VN word order, since this would imply that they expressed contrastive information. However, extraposing information treats it as non-focal or non-contrastive.

Determinants to be examined

Having completed our analysis of the various determinants of relative clause processing that have been discussed in the literature, we can summarize the analysis in terms of a series of determinants which will be tested in the current study. For Hungarian, if a given determinant were to operate by itself, the following orders of difficulty would be predicted:

(1) *Parallel function:* {SS, OO} > {SO, OS}.
(2) *Perspective maintenance:* SS > {OO, OS} > SO for subject-initial ca nonical orders. OO > OS > SS > SO for object-initial non-canonical orders.
(3) *Accessibility: {* SS, OS} > {OO, SO}.
(4) *Specification:* {OO, OS} > {SS, SO}.
(5) *Conjoined clause:* SS > SO > {OS, OO}.
(6) *Adjacency:* OS > {SS, OO, SO}.
(7) *Clausal unity:* Non-interrupted structures should be better than inter rupted structures. Extraposition should improve the processing of inter rupted structures.

(8) *Fragment construction:* NNV sentences in which the relative modifies the second noun should be quite difficult. NNV sentences in which the relative modifies the first noun should be easier, but not as good as comparable NVN sentences. These difficult structures should be easier when the relative clause is extraposed. Schematically: {NrelVN, NVNrel} > NrelNV > NNrelV.

(9) *Morphological marking:* {SO, OO} > {SS, OS}.

(10) *Focus maintenance:* Focusing in the relative should cause problems in structures with tagged antecedents, since focusing in the main clause is at variance with focusing another NP in the relative clause.

Studies of relative clause processing in various languages

Let us now turn our attention to a consideration of the current state of our knowledge regarding the various determinants of relative clause processing. By far the largest amount of work on relative clause processing has been conducted with English-speaking subjects. Work with adults has focused on an attempt to account for the extreme difficulty subjects have with multiple self-embeddings. Studies by Miller and Chomsky (1963), Miller and Isard (1964), and Yngve (1960) attributed the difficulty to a memory overload caused by the need to retain in memory the partial analyses of incompletely processed clauses. However, subsequent studies by Blumenthal (1966), Marks (1972), and Stolz (1967) indicated that, even when presented with full written versions of multiple self-embeddings and sufficient time to disentangle the relations, subjects still find them ungrammatical. On the other hand, multiple left- or right-embeddings do not cause the same kind of difficulty as multiple center-embeddings (Cook, 1975). Hakes, Evans, and Brannon (1976) and Holmes (1973) showed that, using reaction time measures, single center-embeddings (SS and SO) are either no more difficult or actually easier to process than right-embeddings (OO and OS). Baird and Koslick (1974) reported a similar result using sentence recall. This evidence has been used to call into question the application of the data on multiple self-embeddings to the processing of single self-embeddings. This is an important distinction. What is at issue is whether any real interruption of processing occurs in a single self-embedded sentence.

It is clear that multiple right- or left-embeddings are much better than multiple center-embeddings. However, the source of this asymmetry has still not been ascertained. There is a sense in which the processing of multiple right-embeddings ("The dog chased the cat that bit the rat that ate the cheese") must also place a load on the parser. If we are to replace "the cat"

with the full description "the cat that bit the ..." in a right-embedding we must wait until the end of the clause to do this, just as in a center-embedding. However, in a right-embedding we can create a series of self-contained fragments. We can imitate this structure with coordination as in "The dog chased the cat and the cat bit the rat and the rat ate the cheese." Such a form could serve as a temporary representation from which we can eventually derive the fully nested structure. This would be similar to the conjoined clause analysis noted by Tavakolian and Sheldon and even found in some adult processing of center-embeddings (Cook, 1975; Hakes, Evans, & Brannon, 1976). In experiments, extraction of the conjoined structure might be enough to pass as full comprehension. Thus, it is not clear that any multiply embedded structure really avoids the work that must eventually be done to create the full nested representation required by embeddings.

Studies of children's comprehension of relative clauses have nearly always used the enactment task in which the child is asked to act out the action described in the sentence. This work focuses on a comparison of the SS, SO, OO, and OS sentence types discussed above. In a review of this work, Mac-Whinney (1982) showed that these studies have supported five major conclusions:

(1)   55 *sentences are easier to enact than OS sentences*. This finding is re ported by H. Brown (1971), Ferreiro, Othenin-Girard, Chipman, and Sinclair (1976, p. 237), Fluck (1977, p. 62; 1978, p. 195), Lahey (1974, p. 665), Legum (1975), Sheldon (1974), and Tavakolian (1981).
(2)   55 *sentences are easier to enact than OO sentences*. This claim is sup ported by the results of Brown (1971), Ferreiro et al. (1976, p. 237), Legum (1975), and Tavakolian (1981).
(3)   55 *sentences are easier to enact than SO sentences*. This claim is supported by the results of Brown (1971), Cook (1975), de Villiers, Tager-Flus-berg, and Hakuta (1977), Ferreiro et al. (1976), Legum (1975), Sheldon (1974), and Tavakolian (1981).
(4)   *OS sentences are easier to enact than SO sentences*. This claim is sup ported by the results of Brown (1971), de Villiers et al. (1977), Ferreiro et al. (1976), Legum (1975), Sheldon (1974), and Tavakolian (1981).
(5)   *OO sentences are easier to enact than SO sentences*. This claim is sup ported by the results of Brown (1971), de Villiers et al. (1977), Ferreiro et al. (1976), Legum (1975), Sheldon (1974), and Tavakolian (1981).

The only exceptions to the five predictions noted above are failures to find significant differences noted in de Villiers et al. (1977). However, if we focus on significant differences, we can summarize the results of this work in the following order of ease of processing: SS > {OO, OS} > SO. Hakuta (1981)

and Bowerman (1979) argued that the findings of the studies of relative clause enactment in English were inconsistent. They reached this conclusion largely because they required that a significant difference found in one study should be found in all studies. However, what would constitute a real inconsistency would be to find a significant difference in one direction in one study and in another direction in another study. This does not happen. It is true that a consistent pattern of significant differences all of the same order of magnitude would be nice to obtain. But, given the vagaries of work with children and subtle differences between experimental techniques, we believe that the results show remarkable consistency for the pattern of SS > {OO, OS} > SO.

Hakuta (1981) reasoned that, by combining two configurational analyses one could generate this same SS > {OO, OS} > SO ordering. First, one could use Tavakolian's conjoined clause determinant to account for the superiority of SS. Then one could use the adjacency determinant to account for the absolute inferiority of SO. The other two orders are then left between these two extremes. However, it is not clear that these two strategies can be combined in this way, unless further assumptions are made. If adjacency works to create errors on SO, it should also create errors on OO. For neither SO nor OO does the conjoined clause analysis help to correct errors. So, the combination of the two strategies should lead to SS > OS > { OO, SO} rather than SS > {OO, OS} > SO. Nor is it really clear how to combine these two analyses. If the conjoined clause analysis is applied to OS and OO sentences, it leads to the wrong interpretation. Similarly, if the adjacency analysis is applied to SS and SO, it leads to the wrong interpretation. If the good parts of the two analyses could be combined and the bad parts excluded, we would have an efficient way of understanding relative clauses. However, there is no principled way to exclude either strategy from the cases where it fails. Thus, there is no clear way to achieve Hakuta's proposed combination of the two strategies.

Of the various determinants reviewed above, perspective is the one which most closely matches the SS > {OO, OS} > SO ordering actually found in the English data. In SS sentences, the same noun serves as the subject or perspective (MacWhinney, 1977,1982) of both clauses and there are no reversals in perspective during parsing. In the OO pattern, the object of the main clause is also the object of the relative clause. However, in order to interpret the relative clause, there must be a single shift of perspective to the subject of the relative clause. Similarly, in OS there is a single shift of perspective, this time to the noun that is also the object in the main clause. In both OS and OO orders, there is a single perspective shift. In the cases of SO sentences such as "the baby the rabbit scared hugged her mommy," there is a double

perspective shift. First perspective begins with "the baby." Then it shifts to "the rabbit" in order to interpret the relative clause. Then it must shift back to "the baby" in order to finish the interpretation of the main clause. As we noted above, these effects are independent of word order and are predicted to arise in both English and Hungarian.

So far, our analysis of the English data has focused on studies with school-aged children, mostly in the age range from 4 to 7. These studies have often used the enactment technique. A somewhat different picture emerges when enactment is not the dependent variable. Several studies of relative clause processing in adults have indicated that object-modifying relatives (OS and OO) are easier to process than subject-modifying relatives (SS and SO). The relevant studies are by Ford (1983), Holmes (1973), and Wanner and Maratsos (1978). Reaction time studies with children have also indicated that object-modifying relatives are processed more easily than subject-modifying relatives. Foss, Bias, and Starkey (1977) were able to show that eight-year-olds could process OO sentences faster and with fewer mistakes than SS sentences. This result replicates similar findings for adults by Hakes et al. (1976). Unfortunately, many of the studies cited failed to include the four relative clause types so commonly examined in the literature (SS, SO, OO, and OS), so that that relation of the preference for object-modifying relatives to the preference for subject relatives is not easily reconstructed. In any case, it is reasonable to expect differences between the enactment task and on-line processing. The enactment task focuses on the final integrated result of sentence processing, whereas the phoneme-monitoring task focuses on the nature of the processes occurring as that final integrated result is extracted. It is also likely that the role of determinants such as perspective maintenance is magnified in the enactment task, since it tends to induce subjects to actually take the point of view of the objects they are manipulating (Huttenlocher, Elsenberg, & Strauss, 1968). It makes sense that the on-line task should be more influenced by surface structure relations such as discontinuity or fragment construction and that the off-line task should reflect the stability of role relations such as parallel function or perspective maintenance.

The results from the studies of French (Kail, 1975; Sheldon, 1977a) and German (Grimm, Scholer, & Wintermantel, 1975) are remarkably similar to those from English, replicating the SS > {OO, OS} > SO ordering noted above. One difference that has been investigated in some detail is the use of case marking in the French relative pronoun. In French the relative pronoun is "qui" when the head plays the role of subject in the relative and "que" when it plays the role of object. In English, this corresponds to the difference between "who" and "whom" in formal written language. The studies by Shel-

don (1977a) and Kail (1975) both found that processing is easier for subject relatives. It is a fact of French grammar that relatives with "qui" (SS and OS) have only VO order in the relative clause whereas relatives with "que" (OO and SO) have both VS and SV orders possible in the relative. Thus the marking of "que" with SV is the clearest marking, since the configuration relative-N-V only occurs for object relatives, whereas the configuration relative-V-N occurs for both subject and object relatives. Thus, having SV order is a very reliable cue, but VO order is not a reliable cue. The studies by Kail and Sheldon both show that, for relatives with "que," the SV order is the easiest. Thus, there is a preference for sentences which are clearly marked. We also have data on relative clause processing for one language that is typologically quite different from English, French, and German. This language is Japanese. The two major studies here are by Harada, Uyeno, Hayashibe, and Yamada (1976) and Hakuta (1981). Harada et al. examined children between the ages of 3 and 10, and Hakuta examined children between the ages of 3 and 6. Both experiments used SOV and OSV word orders in the main clause and the four types of grammatical relations (SS, SO, OO, OS) for the relative clause. Although SOV word order is customary in Japanese, the OSV inversion is a frequent stylistic option. Because relative clauses precede the head in Japanese, the OSV order is particularly useful in converting center-embedding to left-embedding for object-modifying relatives. For subject-modifying relatives, on the other hand, it is the SOV main clause order that allows for left-embedding, since the subject is on the left in the SOV order. This property of Japanese is important because it allows us to separate the position of the embedding from the grammatical role structure of the head of the relative clause. Both studies showed that subject-modifying relatives were easiest in SOV order and that object-modifying relatives were easiest in OSV order. Hakuta went on to ask whether the difficulty with the singly center-embedded clauses in SOV and OSV orders was due to the "stacking of nouns" before the verb or to the placement of the relative between the head and its verb that constitutes center-embedding. To examine this, Hakuta compared center-embedded S(Rel)OV and O(Rel)SV sentences with center-embedded SV(Rel)O and OV(Rel)S sentences. In SVO order, object-modifying relative clauses appear between the verb and the object. In OVS order, subject-modifying relative clauses appear between the verb and the subject. Hakuta found it was not center-embedding that was causing problems, but rather the stacking of nouns before the main verb. These results clearly indicate an important role for the fragment construction determinant. When two nouns accumulate along with a relative clause and no verb has yet been encountered, a strain is placed on working memory. When the

relative and its head appear after the verb, no such strain is generated. However, we cannot tell from these results whether the difficulty is caused by having two nouns before the verb with a relative clause or by having the center-embedding precede the verb. Because Japanese has no relatives following the head, there are no center-embeddings with a single preverbal noun. However, Hungarian has NNV order with post(NOM)inal relatives, thus allowing us to investigate the consequences of these critical configurations.

Typological considerations in the study of relative clauses

Languages use rather different organizations to build relative clauses. The survey by Downing (1978) of relative clauses in over 50 languages indicates that some of the basic differences relate to the issue of whether relative clauses precede the head noun or follow it. In OV (object-verb) languages relative clauses usually precede their heads, whereas in VO (verb-object) languages the relative clause usually follows the head. Kuno (1974) has noted that this allows SOV languages to avoid center-embedding for subject-modifying relatives and that it allows VSO languages to avoid center-embedding for object-modifying relatives. However, when SOV languages have object-modifying relatives, it does not matter whether the relative clause precedes or follows its head, since the relative will be center-embedded in either case. Kuno notes that SOV languages such as Georgian and Persian that allow word order variation also allow for relative clause extraposition. This permits these languages to avoid center-embedding. Later we will see how this use of extraposition also applies to Hungarian which has many properties of SOV languages, although it also has properties typical of SVO languages, such as positioning of the relative clause after the head. Following Kuno's analysis, Antinucci, Duranti, and Gebert (1979) attempted to explain the preference for left or right branching as a means of avoiding self-embedding in languages with different word orders.

   These attempts to relate typological differences to putative sentence processing difficulties underscore the pressing need for cross-linguistic studies of sentence processing. In particular, the typologists seem to be assuming some version of the clausal unity determinant, although this determinant has not yet been tested cross-linguistically. In particular, what will happen in languages where there is a rich system of morphological marking which permits production of a wide variation of word orders? Downing notes that some languages, such as Navajo, permit the omission of the head noun from the main clause. However, this can only occur because of (1) the clear marking

of the relative clause in Navajo, (2) the rich marking for person and number of the subject on the verb in the main clause, and (3) the general use of subject ellipsis in the language. In other languages, such as Hungarian, we find constructions in which there is a tag marking the relativized status of the head in the main clause as well as a relative pronoun or other device marking the role of the head in the relative clause. Such structures are called "correlative." As we will explain below, markings of this type are required for reliable interpretation of extraposition in a variable word order language like Hungarian. In general, the relations between these morphological markings and the basic sentence orders are necessarily quite complex. This means that we will need to examine a variety of morphological/syntactic patterns before we can provide reliable psycholinguistic accounts for the observed typological patterns.

Method

Subjects: 20 undergraduate psychology students of Lorand Eotvos University participated in the experiment. All had previous experience of participating in psycholinguistic studies using video presentation of sentences, largely in the area of anaphoric processing. However, none had had experience with materials of the type used in this experiment.

Sentence material and design: Sentences were constructed by attaching a relative clause to a matrix clause. Both the relative and the matrix clause were simple transitive clauses with animate agent and animate object. The exact configurations of the stimuli were determined by systematic variation of five fully crossed factors. The factors were: (1) Main Clause Role (Subject, Object), (2) Repetition of Role in Relative (repeated, not repeated), (3) Word Order (SOV, SVO, OVS, OSV, VSO, VOS), (4) Extraposition (none, tagged, extraposed), and (5) Focusing (focused, not focused). Thus the design was a fully crossed 2 x 2 x 6 x 3 x 2 design. Let us look at each of the five factors in greater detail:

(1) *The role of the head in the main clause:* When the Role factor assumed the value of "S," the head of the relative clause was the subject of the main clause. These were the subject-modifying relatives. When Role was "O," the head of the relative clause was the object of the main clause. These were the object-modifying relatives.
(2) *Repetition of the role of the head:* When Repetition was "positive," the role of the head in the main clause was repeated in the relative clause.

This leads to SS and OO structures, depending on Role. When Repetition was "negative," the role of the head in the main clause was not repeated in the relative clause. This leads to SO and OS structures, depending on Role. English sentences corresponding to these four types were given as (1) to (4) above. In the Hungarian sentences, the identity of the object of both the verb of the subordinate clause and the verb of the main clause was always indicated by the presence of the accusative case suffix, as required by the grammar of the language.

(3) *Word order in the main clause:* There were six main clause word order configurations: SOV, SVO, OVS, OSV, VOS, and VSO.

(4) *Tagging and Extraposition:* The presence of tags and extraposition was varied on three levels. On level one, there was no tag and no extraposition. On level two, there was a tag on the antecedent but not extraposition. On level three, there was a tag and extraposition. No sentences had extraposition without a tag, since such sentences are not possible in Hungarian. To illustrate extraposition, consider these sentences:

- Az a fiii (akit a lany kergeti) az ujsagot olvassa.
  That the boy(NOM) who-ACC the girl(NOM) chase-3S-DEF the newspaper-ACC read-3S-DEF.
  That boy (whom the girl chases) the newspaper reads.
  "The boy the girl chases reads the newspaper."
- Az a fiu az ujsagot olvassa (akit a lany kergeti).
  That boy(NOM) the newspaper-ACC read-3S-DEF (who-ACC the girl(NOM) chase-3S-DEF).
  That boy the newspaper reads who the girl chases.
  "The boy the girl chases reads the newspaper."

The second sentence is formed by extraposing the relative clause in the first.

(5) *Focusing in the relative clause:* When Focusing was absent, the order in the relative clause was: RelPronoun - Prefix - Verb - Noun. When Focusing was present, the order was RelPronoun - Noun - Verb - Prefix. Placing the noun before the verb focuses it. The clarity of the marking of focusing was enhanced by the usage of verbal prefixes. In the matrix sentence none of the verbs used a separable verbal prefix, while in the relative clauses only verbs with a prefix were used. In a neutral clause, prefixes remain preverbal and carry the main stress of the sentence. If another NP is moved into immediately preverbal, i.e., focus position, the prefix has to be moved postverbally to give its place to the new focus (Kiss, 1981). Thus the usage of verbs with a prefix enhanced the identification of the focus in the relative clause even without the help of stress as a clue to focusing.

One token sentence was made up for each configuration using animal names like "elephant," "dog," and "cat" and verbs like "chases," "frightens," "catches," and "asks." The length of the sentences was controlled by using lexical entries of the same syllable length.

Procedure

The randomized list of sentences was supplemented by 28 filler sentences and 5 introductory sentences. The fillers were causal coordinate constructions of the type "John congratulated Ann because she won the contest." This list of sentences was divided into five parts, and the five parts were recorded separately as blocks in a special purpose microcomputer system which presents sentences on a TV screen.

Each experimental "unit" consisted of an experimental sentence followed by a question. Subjects had to read the sentence and understand it then push the SPACE button of the computer which triggered the question. They were allowed up to 10 seconds for reading of the sentence before the procedure timed out. After they pushed the button for the question, the question appeared at a delay of 30 msec. Similarly, subjects were^iven ur> to JO seconds to answer the question before the procedure timed out. After reading the question they had to provide the answer orally and at the same time push SPACE again. After this final press, there was a 3-second delay and then the next unit began. The order of the five units or blocks of sentences was varied across subjects. All subjects were given all 144 test sentences, along with the 28 filler sentences and the 5 introductory sentences.

Questions always required the subject to identify the head of the relative clause and the full NP of the relative clause always appeared in them. For the sentence "the bear that pushed the eagle chased the lion," the question was "who pushed the eagle?" For the sentence "the bear that the eagle pushed chased the lion," the question was "who did the eagle push?" The exact form of these questions was:

(24) Ki tolta meg a sasot?
      Who(NOM)push-3S-DEF up COMPLET the eagle-ACC?
(25) Kit tolta meg a sas?
      Who-ACC push-3-S-DEF COMPLET the eagle-NOM?

If the subject correctly remembers the nouns of the experimental sentence, the only way to give an incorrect answer is to select the wrong noun from the main clause. It would make no sense to give the full NP of the relative clause as the answer, since that noun was given in the question. If the sentence is

"the buffalo that chases the eagle kisses the turtle," the question could be "who chases the eagle?" and the error would be to choose the "turtle" as the one who did the kissing. Choosing the "eagle" as the one who did the kissing would indicate inattention to the form of the question.

Three dependent measures were obtained for each sentence: reading time, decision time, and the choice of one of the nouns as actor. If the subject did not read the sentence within 10 seconds, the program continued and registered no response. In these rare cases - about 1.5 on average in each subject - the missing data point was replaced by the cell means for this subject.

Results and discussion

We will discuss the results of this experiment in four separate sections. The first section will deal with those results that speak to the predictions of theories that focus on effects of role variations. The second section will examine the interaction between word order and role. This interaction is relevant to both the configuration and interruption determinants. The third section will examine the results of relating to the extraposition factor which bear specifically on the interruption determinants. The fourth section will analyse the effects of morphological markings on the processing of these sentences.

Roles of the head

The results that tell us the most about the role determinants are those relating to the two sentence role factors in the design. The first factor is Role which is the role of the head noun (S or O) in the matrix clause. The second factor is Repetition which is whether or not the role was repeated in the relative clause (SS vs SO and OO vs OS). Neither of the two role factors had a significant effect on either reading or decision times, as long as all the sentences were taken as a group. However, when the analysis was confined to just the sentences with no antecedent tags, reading times showed weakly significant results for Role, $F(1,119) = 6.52$, $p < .02$, and for Repetition, $F(1,19) = 4.95$, $p < .05$. Average reading times in seconds for the four configurations were the following: SS - 6.02, SO - 6.20, OO - 5.67, and OS - 5.96. Thus, the order of ease of reading is OO > OS > SS > SO.

The same pattern of results was also found for the errors in the choice of nouns as answers to the question given after the sentence. We will call these errors "decision errors." Subject-modifying relativizations proved to be more difficult in terms of number of decision errors produced, *F(1, 19) = 15.15, p*

< .001. There was a 20% error rate with subject-modifying relatives, whereas there was only a 12% error rate with object-modifying relatives. Role repetition also had a significant effect, $F(1,19) = 6.92$, $p < .02$. There was a 13% decision error rate when the noun phrase had the same role in both the relative clause and the main clause (SS and OO), whereas there was a 19% error rate when the role shifted (SO and OS). The pattern of errors for the four role configurations was the following: SS - 18, SO - 22, OO - 9, and OS - 15. Thus, the order of correct interpretation was OO > OS > SS > SO. The same order that was marginally significant for reading times was strongly significant for the decision error data. Given the very different nature of the three measures in this experiment, it is quite remarkable that exactly the same pattern of results holds across all three measures for the two Role factors.

The sentences most similar to English sentences were those with no antecedent tags. We performed three separate ANOVAs for each measure on this block of sentences and the picture was even clearer, with the same significant main effects: for Role, $F(1,19) = 14.72$, $p < .001$ and for Repetition, $F(1,19) = 7.08$, $p < .02$. The cell means for the decision errors were: SS - 15, SO - 24, OO - 8, and OS - 12. Here again the order of correct interpretation was OO > OS > SS > SO. The reading time data are clearly a more direct measure of sentence processing than the error data. However, it is interesting that both sets of data are in such close agreement.

We can summarize the results so far by saying that we found strong evidence for a superiority of object-modifying relatives over subject-modifying relatives - an effect that has never been reported for English. Of the various role and configuration determinants, only the specification determinant accounts for the superiority of object-modifying relatives over subject-modifying relatives. The conjoined clause determinant predicts a result exactly opposite to the one we found. The accessibility and adjacency determinants predict a greater ease of processing for OS patterns, but not OO patterns. Parallel function predicts the opposite effect. None of these determinants receive much support. The perspective determinant correctly predicts the superiority of the two object-modifying constructions (OS and OO) over the SO construction. However, the second prediction of the perspective maintenance determinant - that SS should be the easiest to access - was not supported.

In summary, the only determinant that accounts for all of the role data is the specification determinant. This determinant would lead us to understand the superiority of object-modifying relatives in Hungarian in terms of the relatively weaker role of the "subject" in Hungarian and the relatively greater importance of the object of the verb as the "new" item that needs to be specified by the relative clause. However, we cannot really interpret this

main effect by itself, given that the critical interactions with word order which we will now examine will force a major reinterpretation of the results for roles.

Word Order and Role

The second major manipulation in the experiment was the use of the full set of six possible word orders. In order to evaluate the effects of configurational and interruption factors, we must look at the interaction between Word Order and Role. The reason we are interested in this interaction, and not some main effect, is that the locus of the interruption depends on which noun is the head in which order. For example, if there is an SVO sentence, a subject-modifying relative interrupts the main clause but an object-modifying relative does not. Since we are examining six word order variations, there are many possible points of interruption.

There was a significant main effect of Word Order in the main clause both for reading times, F(5,95) = 12.08, p < .00001 and for decision times, F(5,95) = 3.45, *p* < .01. There was no main effect of Word Order for decision errors. As the upper line in Table 1 shows, the effect on reading times was mainly due to two factors. The first three word order configurations (SOV, SVO, and VSO), where the subject precedes the object in the matrix sentence, were read faster than the sentences where the object precedes the subject (OSV, OVS, and VOS). The subject-first sentences took 5.98 s vs. 6.21 s for the object-first sentences. Within each subtype the sentences with the verb in the middle (SVO and OVS) were processed faster. The same pattern held for decision times. Following subject-first sentences, subjects took 2.11 s to answer, while following object-first sentences they took 2.30 s. For both groups of sentences, decisions were fastest when the verb was in the middle.

There was a significant Word order by Role interaction for all three dependent measures. The effect found in decision errors, *F(5,95) = 8.94, p < .00001* was easily interpretable. As Figure 1 shows, both subject-modifying

Table 1.   *Means for the 6 different matrix word orders in the two time measures*

	Measures					
	SOV	SVO	VSO	OSV	OVS	VOS
Reading (s)	6.03	5.74	6.17	6.38	5.94	6.32
Decision (s)	2.14	2.02	2.17	2.32	2.26	2.32

Figure 1.   *Percent decision errors across word orders and relative clause types for all sentences.*
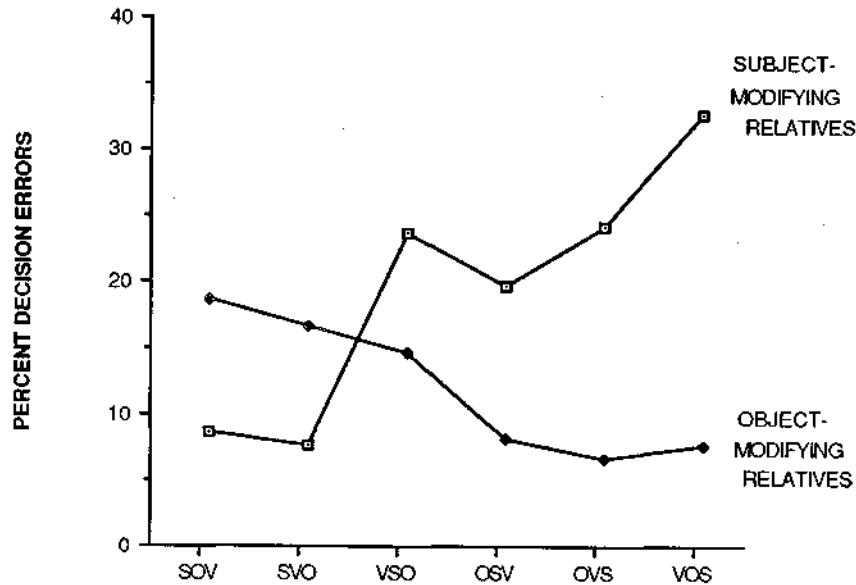
and object-modifying relatives produced the least errors when the head was sentence initial. This effect was particularly strong when the subject was initial, as it is in SVO and SOV order - the two unmarked orders of the language. When the subject was not initial, the error rate climbed steeply. When the object was not initial, the error rate increased some, but not nearly as much as when the subject was not initial.

The same preference for a relative attached to an initial noun appears when we look at just those sentences in which there is no antecedent tag. As we mentioned above, there was a strong main effect of Roles with a 20% decision error rate for subject-modifying relatives and a 10% error rate for object-modifying relatives. The interaction between Order and Role was very significant, $F(5,95) = 11.69$, $p < .00001$. Figure 2 shows the pattern of this interaction. Both types of relatives were most accurately recalled if the head noun was the first noun in the sentence. If the head noun followed the verb, there was a slight increase in errors. Notice that, in the SVO pattern where the sentences have the same order as in English, there are less errors for the subject-modifying relatives. A similar pattern is present for the SOV sen-

tences. For these two orders, then, we see a replication of the results of the many studies that have been conducted with English and French stimuli. As we noted earlier, these two orders - SVO and SOV - are the basic, un-marked, word orders of Hungarian. For all of the marked word orders of Hungarian (VSO, OSV, OVS, and VOS), we find a superiority of object-modifying relatives over subject-modifying relatives. In general, if a relative clause modifies the subject, then the listener seems to expect the subject to occur initially.

Now let us look at the interactions for the reading time measure. In the block with no antecedent tags, the interaction between Order and Roles was strongly significant, $F(5,95) = 3.54, p < .01$. Figure 3 displays this interaction. There was a slow-down in reading times for subject-modifying relatives in the OSV sentences and for object-modifying relatives in SOV sentences. This latter effect is especially remarkable because it overrides the main effect mentioned above, i.e., that object-modifying relatives were usually faster than subject-modifying relatives.

In decision times there was also a significant interaction between Word Order and Roles, $F(5,95) = 5.33$, $p < .0002$. The basic meaning of this interaction was the following. After subject-first matrix sentences (SOV,

Figure 2.   *Percent decision errors across word orders and relative clause types in sentences with no antecedent tags.*
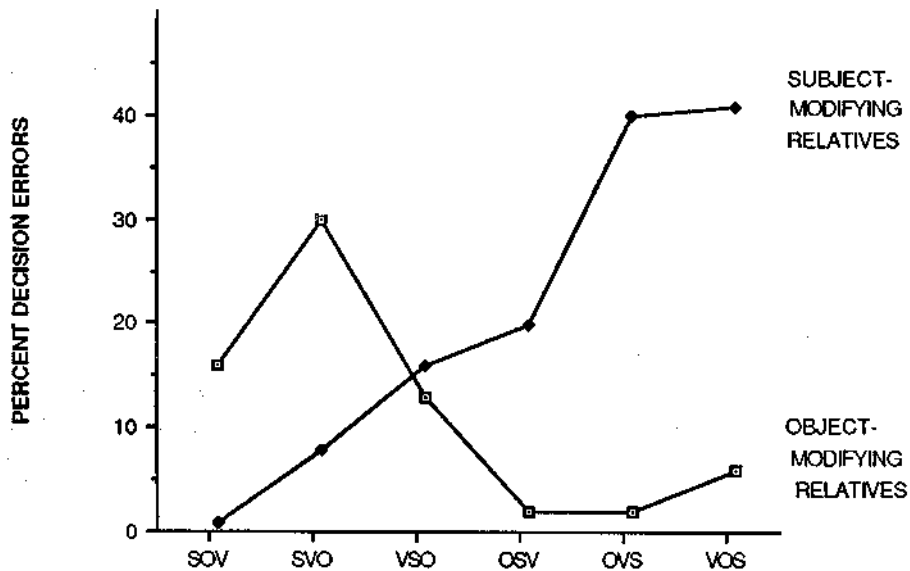
SVO, and VSO), decisions were faster in the case of object-modifying relatives (1.97 s) as compared to subject-modifying relatives (2.25 s), while if the object was first in the matrix sentence (OSV, OVS, VOS) no such difference was observed.

Summarizing the most important results across the three measures, we find five major word order effects:

Figure 3.   *Reading times in sentences with no antecedent tags.*
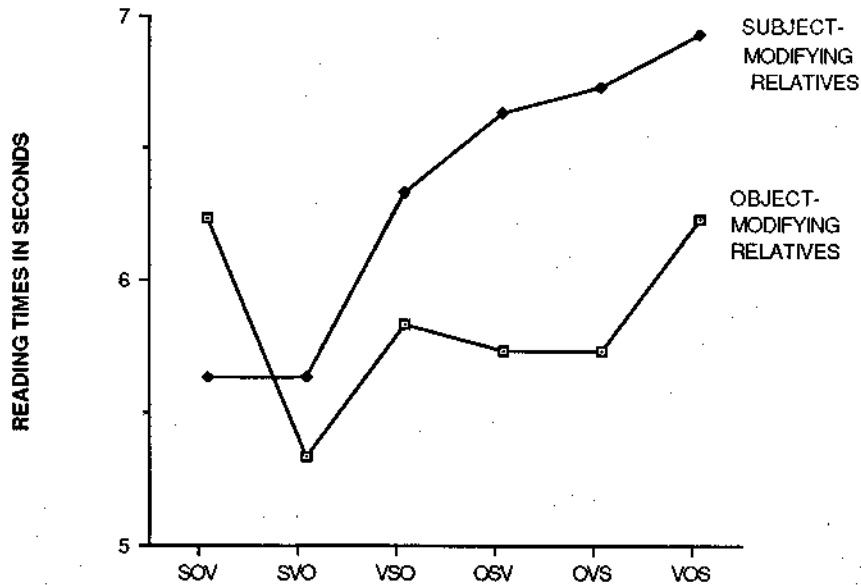
(1)   There is a preference for orders in which the subject precedes the object.
(2)   NVN order is preferred to NNV and VNN orders.
(3)   There is a preference toward attaching relative clauses to initial nouns, particularly when they are subjects.
(4)   NNV orders in which a relative clause is attached to the second noun are more difficult.
(5)   The preference for object-modifying relatives is confined to the non-ca nonical word orders in which the subject is not initial.

The first three of these results are not too surprising. They simply indicate that frequent and canonical patterns are easier than rarer, non-canonical patterns. The fourth result is exactly what is predicted by the fragment construction determinant.

The fifth result allows us to clarify a number of issues raised in the previous section. We now see that, in the unmarked SVO and SOV word orders, there is no superiority of object-modifying relatives over subject-modifying relatives. Moreover, there are very few errors in subject-modifying relatives when the head is sentence initial. The overall superiority of object-modifying relatives which had appeared so important in the last section is now seen to be confined to the various non-canonical word orders of Hungarian. What is unique in two canonical word orders is that the subject occurs first and serves clearly as the perspective (MacWhinney, 1977) and topic. The four marked word orders all serve to "demote" the subject from its central role as topic and to promote the object to this role. In a sense, these orders function much like the passive construction in English by making the logical object the topic. The fact that object-modifying relatives are better than subject-modifying relatives in the four non-canonical orders can be explained by viewing the object in these constructions as inheriting the subject property of topicality. In English, a sentence such as "the boy who liked the girl was hit by the bike" has the SS construction and is subject-modifying. In Hungarian, the corresponding sentence has the OS construction and the relative is object-modifying.

The perspective account of MacWhinney (1977, 1982) can be used to understand these results. In those word orders which preserve the association between subject and topic, Hungarian shows the same SS > {OS, OO} > SO ordering that we find in English. However, when the object takes over the role of topic, it also appears to take over the role of perspective. In three of the four non-canonical orders the object precedes the subject. In such sentences, the head is not yet firmly in an object role vis-a-vis the main clause and there is no need to switch perspective during the processing of the relative. In OO constructions in these non-canonical orders, the head is topical enough to serve as the head of a relative clause. At the same time, it already has the object role which it retains throughout. In OS constructions, the head begins as object and then undergoes a shift to the subject role. However, this is not a strong shift, since it already has the subject property of topicality in the main clause. In SS constructions in the non-canonical orders, the listener must first shift perspective from the main clause object to the head of the relative. This is a fairly strange shift, since there is nothing in the main clause to motivate the head as topic. Rather, it assumes the roles of topic and perspective because of its role in the relative clause. In SO constructions, processing is just as difficult as in English, since the perspective must first shift onto the head of the relative and then the role of that head must be shifted in the relative.

The word order results also allow us to evaluate the role of the clausal

unity determinant. This determinant predicts that subject relatives should be the easiest to process in VOS and OVS orders and that object-modifying relatives would be easiest to process in SVO and VSO orders. This prediction is based on the fact that only in these structures is processing of the main clause completed before the beginning of the relative clause. The clausal unity determinant makes no predictions regarding the placement of the relative clause in SOV and OSV orders. Figures 1 and 2 show that the clausal unity determinant does not correctly predict the error rate data. In the case of subject-modifying relatives, it was the two orders that should have been the easiest - OVS and VOS - which were in fact the worst. In the case of object-modifying relatives, the two orders that should have been the easiest were SVO and VSO. Again, the two orders that should have been the easiest were among the worst three. The Clausal Unity determinant also fails to predict the data for extraposition. Rather than decreasing the error rate, extraposition increased the error rate.

However, the clausal unity determinant is chiefly concerned not with predicting error rates, but with predicting processing times. As Figure 3 shows, there was no evidence for either OVS or VOS subject-modifying relatives being easier to read than any of the other orders. For object-modifying relatives the two fastest orders should have been SVO and VSO. The VSO order was among the three slowest orders. On the other hand, SVO was in fact the fastest order for object-modifying relatives. Thus, out of the four predictions made by the clausal unity determinant, only one appears to be supported. However, we should be careful in interpreting this one successful prediction as support for the clausal unity determinant, since SVO word order was also the fastest order for subject-modifying relatives where there is an interruption of the main clause. Presumably, the superiority of SVO is due to the fact that it is one of the two unmarked word orders of the language.

Extraposition

The third major manipulation in the experiment was the contrast between extraposed and non-extraposed relative clauses. The comparison of extraposed and non-extraposed relatives across the six word order types helps us to further evaluate the interruption determinants. When the tag is present, the relative clause can either follow directly after the tag or be extraposed to the right so that it appears at the end of the sentence. In the analysis of variance, we treat Extraposition as a separate factor. However, the reader must bear in mind that, for some word order/role combinations, there is no difference between the extraposed and non-extraposed sentences with antecedent tags. This "confounding" is an unavoidable consequence of the grammar

of Hungarian. The confounding occurs for subject-modifying relatives in VOS and OVS orders and for object-modifying relatives in SVO and VSO orders. When the head occurs in last position in the sentence, there is no difference between an extraposed relative clause and a normal relative clause. This is simply a fact about what constitutes extraposition. However, in order to balance the design of the ANOVA, it was important to allow for extraposition in all word orders. When analysing the effects of extraposition, we will find some effects due simply to this feature of the design. In discussing this we will distinguish between the factor of "Extraposition" in capital letters (what we had to do to get a fully crossed ANOVA) and "extraposition" in lowercase letters (the syntactic construction which allows Hungarian relative clauses to come at the end of the sentence).

The presence of the antecedent tag had a considerable effect both on correct choice, $F(2,38) = 6.87$, $p < .005$, and on reading times, $F(2,38) = 8.24$, $p < .001$. As Table 2 shows, both in errors and in reading time the effect was due mainly to Extraposition. In the ANOVA performed in the two blocks with antecedent tags the main effect of Extraposition was significant both for errors, $F(1,19) = 13.26$, $p < .002$, and for reading, $F(1,19) = 5.82$, $p < .05$. Thus Extraposition slows down processing by 0.2 s. However, we will need to look at the interactions of Extraposition with Word Order to understand the true effect of "extraposition."

Let us now look at the interaction of Extraposition with Word Order in order to reveal the real effects of extraposition. The Role by Order by Extraposition interaction for error rates was highly significant, $F(5,95) = 2.66$, $p < .05$. This interaction is due to the simple fact that extraposition led to an increased error rate.

Although extraposition had a detrimental effect on error rates, it had a beneficial effect on reading times for which there was a significant Role by Word Order by Extraposition interaction, $F(5,95) = 3.85$, $p < .005$. Extraposition speeded up reading if the antecedent tag appeared on an initial noun in verb-medial constructions. Thus in SVO subject-modifying relatives the reading time was 5.66 s if the relative clause was extraposed compared

Table 2.   *Reading times and errors in function of the antecedent tags*

	Patterns		
	No antecedent	Antecedent	Antecedent/extraposition
Reading (s)	5.96	6.08	6.25
Errors	15	11	23

to 6.17 if there was a tag without extraposition, and in OVS object-modifying relatives the comparable means were 6.00 with extraposition and 6.27 s without it.

The Clausal Unity determinant predicts that extraposition should facilitate reading times. We did indeed find this facilitation, but only for SVO and OVS sentences. Moreover, this facilitation of initial processing is bought at the price of a 30% increase in errors for SVO and a 12% increase in errors for OVS. These results are most easily viewed as reflecting a speech-accuracy trade-off induced by the fact that SVO and OVS sentences with extraposition allow the subject to use standard strategies for canonical SVO sentences, even if the facile application of these strategies can lead to an increase in errors. In the case of extraposed sentences, the reader can put off the task of replacing the head noun with the complex concept until he finishes with the task of processing the main clause. Then he must process the extraposed clause as a conjoined clause. He can then link the relative pronoun of the extraposed clause to the antecedent tag in the main clause and replace the tag with the full clause during the process of sentence interpretation.

The Fragment Construction determinant predicts that any structure where two nouns are piled up before the relative clause with no verb to attach them to should be harder to process. In the case of subject-modifying relatives, this predicts specific difficulties with OSV, and in the case of object relatives, the difficulty should be with SOV structures. For the crucial reading time measure, the predictions of the fragment construction determinant were supported (Figure 3). It was also clear that leaving one single noun unbound before the beginning of the relative clause did not cause difficulties. This occurs in SOV and SVO order with subject-modifying relatives and OSV and OVS with object-modifying relatives. The decision time data did not illustrate this same pattern of results. However, the fragment construction determinant is an on-line processing determinant whose effects should be felt primarily on reading times and not decision times.

In general, these data support the basic predictions of the fragment construction determinant. They also support a weak version of the clausal unity determinant which allows that absence of interruption will facilitate initial processing. However, this initial facilitation leads to incomplete construction of the final representation of the sentence.

The fact that SVO sentences were the fastest in both subject-modifying relatives and object-modifying relatives must be understood in terms of the fact that, for the relative clause constructions, SVO is the basic and unmarked word order of Hungarian. What is interesting here is that the same results we found for simple sentences (MacWhinney, Pleh, & Bates, 1985) are pervasive enough to influence the processing of complex sentences where the

SVO unit is broken up in various ways. In this sense, we see evidence for a certain continuity between the strategies used in the processing of simple sentences and those used in the processing of complex sentences.

Focusing

The fourth major manipulation in this experiment was the focusing manipulation. In sentences with focused relatives, the noun of the relative clause was placed before the verb. This serves to make it pragmatically contrastive. Our earlier examples of this contrast are repeated below:

(26) A fiut csokolja a lany akit a kutya harapja meg.
       The   boy-ACC   kiss-3S-DEF   the   girl(NOM)who-ACC   the
       dog(NOM)bite-3S-DEF COMPLET.
       "The girl who the dog bites kisses the boy."
       or "It's the boy who is being kissed by the girl that it's the dog who's biting."
(27) A fiut csokolja a lany akit megharapja a kutya.
       The boy-ACC kiss-3S-DEF the girl(NOM)who-ACC COMPLET-bite-3S-DEF the dog-NOM.
       "The girl who the dog bites kisses the boy."
       or "It's the boy who is being kissed by the girl the dog's biting."

In the first sentence, focus in the relative clause is on "kutya." In the second it is on the verb.

There were no significant main effects of Focusing for either errors or reading time. However, focusing in the relative clause significantly increased decision times from 2.16 s to 2.25 s, $F(1,19) = 7.00$, $p < .02$. For decision times, there was a significant interaction of Focusing with Role, $F(1,19) = 14.10$, $p < .001$. Focusing did not change decision times following object-modifying relatives. But, following subject-modifying relatives, decisions with focusing slowed down from 2.14 to 2.36 s. This effect was especially clear when antecedent tags were present. In the block with no antecedent tags, no significant interaction between Focusing and Role was found, while in the two blocks with antecedent tags, the same interaction was even stronger than in the overall model $F(1,19) = 9.90$, $p < .005$.

The meaning of the decision time interactions can be summarized in the following way: Since the subjects always had to answer with the head noun, highlighting it with the antecedent tag increased further its role as perspective. When the other participant is then focused in the relative clause, it competes with the head for perspective. This competition creates an interference which does not arise in sentences without focusing in the relative clause.

There was also a barely significant interaction between the Role factor and the Focusing factor for reading times, $F(1,19) = 5.83$, $p < .05$. In subject-modifying relatives, focusing in the relative clause speeded up total reading times from 6.22 s to 6.09 s. This has to be interpreted in the light of the triple interaction between Role, Repetition and Focusing. Facilitation was particularly strong for subject-modifying relatives in which the head was the object of the relative clause (SO structures). For these sentences, decisions were speeded up from 6.44 s to 5.99 s. These are the sentences which produced the highest error rate, as we noted above. In a separate ANOVA for sentences with no antecedent tag the speed-up produced by focusing in SO sentences was from 6.44 to 6.00, and this was responsible for a triple interaction between Role, Repetition, and Focusing, $F(1,19) = 6.47$, $p < 0.02$.

Here, again, we see a trade-off between a speed-up in reading times and a slow-down in decision times. The crucial sentences are the subject-modifying relative sentences in which the head plays the role of object in the relative clause (SO) and in which the subject of the relative clause is focused. Consider these examples:

(28) A kutya amelyet a PAPA kerget el szereti a macskat.
     The dog which+ACC the FATHER chases away loves the cat+ACC.
(29) A kutya amelyet elkerget a papa szereti a macskat.
     The dog which+ACC away+chases the father loves the cat+ACC.

In both construction types, perspective begins with the head, shifts to the subject of the relative clause, and then shifts back to the head as the subject of the main clause. The difference is that in the focused structure the first shift is so strong that it is relatively more difficult to make the second shift back to the head as perspective. This shift must be done in "overtime" after the sentence is completed, thereby leading to a slow-down in decision times for these focused structures.

Conclusions

The richness of Hungarian syntax has provided us with a complex array of relative clause structures. We have used this rich array of constructions to test the ways in which a variety of proposed determinants contribute to sentence processing. No single determinant can account for all of the findings. However, we can look at those combinations of determinants which, together, provide the fullest account of the results. The combination which provides the fullest account is based on the perspective maintenance determinant, the fragment construction determinant, and the focusing maintenance determinant.

The perspective maintenance determinant accounts for the main effects for Role and Repetition, when these are interpreted in the light of the interactions with Word Order. Although object-modifying relatives were faster than subject-modifying relatives, this was only true for marked, non-canonical word orders where the object takes on certain properties of the subject. In the unmarked SVO and SOV word orders, the subject is clearly established as the perspective. For these orders, the pattern of results is the same as that found in English, French, and German. This SS > {OS, OO} > SO pattern is the one predicted by the perspective maintenance determinant.

In non-canonical orders, when the subject is postposed, its status as a perspective is much less established and there is a competition between the preposed object and the postposed subject for perspective which then leads to conflicts in relative clause processing and errors in decisions. When we look at the overall pattern of results, it becomes clear that perspective is an important controller of processing even in a topic-oriented language like Hungarian. MacWhinney (1977) reviews the psycholinguistic literature pointing to a role for perspective in language processing, attempting to relate perspective maintenance to the underlying sensorimotor proces by which a deep interpretation is extracted from linguistic form. However, the data that Mac-Whinney examined were derived largely from speakers of English and German. It could be that perspective is a category used only by speakers of subject-prominent languages like English and German. In topic-prominent languages such as Hungarian, perspective might serve no major function. On the other hand, if perspective were a pervasive language-general cognitive category, we would expect it to play a role in both types of languages. The fact that the perspective determinant works so well for our current Hungarian data can be taken as preliminary evidence that perspective maintenance is based on general cognitive principles and not just language-specific strategies.

A particularly clear case of the importance of perspective is provided by the difficulty subjects have with SO sentences. These sentences force the same double reversal of perspective as SO sentences in English. Although they are read fairly quickly, they lead to high error rates, indicating that some reorganization of the conceptual structure of these sentences may occur after reading is completed. Sentences with SO relatives were also the locus of the three-way interaction between Role, Repetition, and Focusing. Focusing of the subject of the relative clause in these SO sentences further dramatizes the shifts of perspective required to understand these constructions. Focusing of the noun in the relative can also conflict with focusing in the main clause induced by the presence of an antecedent tag. In both cases, focusing involves a departure from the pragmatically unmarked situation. In the unmarked and easiest case, the subject of the main clause remains the subject, topic, and

perspective throughout. In the unmarked case weak focus is assigned to the element preceding the verb in the main clause. Departures from this canonical and unmarked distribution of focus, topic, and perspective all lead to increases in processing difficulty. An increase in difficulty can arise when the subject of the main clause is not the subject of the relative clause. An increase in difficulty can also arise when the focus of the main clause is not the focus of the relative clause. Thus, both perspective and focus place the least burden on processing when they are maintained.

In addition to perspective maintenance and focus maintenance, a complete account of the results must make use of the fragment construction determinant. We need this determinant to account for the difficulties subjects had in processing NNV sentences where the relative clause modified the second noun. As Hakuta (1981) suggested, such structures lead to a "stacking up" of unattached fragments that pose a load on sentence memory. Because Japanese places the relative clause before the head, Hakuta could not study the processing of NVN sentences with relative clauses after the first noun in order to determine whether the problem was one of noun stacking or placement of a relative clause on the noun before the verb. In Hungarian, we see that SVO and OVS sentences with a relative clause on the first noun are quite easy. Thus, it appears that the problem with NNV sentences is indeed one of noun stacking or fragment construction.

The predictions based on the various other determinants that have been discussed in the literature turned out to be much less accurate. Parallel function predicted a superiority of SS and OO over OS and SO. This pattern is close to that predicted by perspective maintenance. However, perspective maintenance predicted the order for canonical sentences exactly and could be extended in a meaningful way to account for the relative order of ease of processing in non-canonical sentences as well. In order to extend parallel function in a similar way, it would be necessary to restate parallel function in the functionalist terms of the perspective hypothesis. A similar problem confronts the accessibility determinant. Like the parallel function determinant, the accessibility determinant was only partially supported for canonical main clause orders. There is also no obvious way in which to make two sets of predictions from the accessibility determinant for canonical and non-canonical orders.

The local processing determinants - conjoined clause and adjacency - received virtually no support at all in these data. This is perhaps not too surprising given that these determinants were formulated on the basis of enactment data from English-speaking children. It would be quite remarkable to see such age- and task-specific strategies extending to another task, another age group, and another language. For somewhat different reasons it is also not

too surprising to find that the morphological marking determinant had no major effect on the data. As we noted earlier, the role of the head in the relative is marked both on the relative pronoun and by the conjugation of the verb in object relatives. The previous marking is much simpler, more uniform, and corresponds to the way in which roles are marked in main clauses. Given this, it can be expected that subjects would make little use of the secondary cue. However, a real test of the importance of this cue would require testing subjects with ungrammatical sentences in which the major cue had been removed. Until such a test is conducted, we cannot fully assess the role of the secondary marking cue.

Perhaps the biggest surprise in this study was the failure to find any support for the clausal unity determinant. It is likely that the picture of the importance of clausal unity suggested by the English data is slanted by the confounding of role structures and clausal interruption found in English relative clause constructions. However, viewed in another light, the fragment construction determinant can be seen as a rephrasing of the clausal unity hypothesis. In this more limited shape, we find that the typologists' emphasis on word order as an attempt to avoid interruption during processing makes good sense. In these terms, we can think of the importance of extraposition in Hungarian as evidence of the ways in which cues are formed in response to particular processing problems. As Kuno (1974) noted, languages with SOV order that allow word order variation are likely to also permit extraposition of relative clauses. In a sense this is done in response to the fragment construction problem in NNV sentences. By providing morphological marking of the moved relative, Hungarian and other languages like it preserve clausal unity and cut down on the stacking up of fragments. However, as we have seen, this gain in immediate processing is purchased at the price of an increase in error rates, indicating that such extraposed sentences must still be integrated after initial processing is completed.

In summary, the results of this study point to the importance of perspective maintenance, focus maintenance, and fragment construction as determinants of the processing of restrictive relative clauses in Hungarian. These three determinants can interact smoothly during processing, since each addresses a different aspect of processing. Perspective and focus maintenance are over-all guides to the processing of two different aspects of functional structure. Fragment construction, on the other hand, relates to the bottom-up construction of the pieces from which the overall interpretation must be derived. Given an initial perspective, it is still necessary to continue to construct the predicate on the basis of individual noun phrases, relative clauses, and verbs.

Data from English indicated the possible importance of perspective maintenance, but not of the other two determinants. It was the specific struc-

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Resume

Un grand ensemble de facteurs ont ete avances comme pouvant expliquer des differences dans le traitement des phrases relatives. Parmi ces facteurs, on trouve: le role grammatical de la tete de la phrase relative, l'ordre de surface des constituants, l'existence d'interruptions de la phrase principale, et l'existence ou non d'indications morphologiques. Comme l'anglais possede un ordre strictement SVO, les relatives qui modifient le sujet dc la principale interrompent necessaircment celle-ci, et par consequent il est impossible de separer les effets dus au role grammatical et aux interruptions. Le hongrois, dont l'ordre des mots est variable, permet de mieux distinguer l'effet du role grammatical, des configurations, des interruptions et des indications morphologiques. Unc etude basee sur 144 types de relatives en hongrois suggere quc trois facteurs jouent un role important dans le traitement dcs relatives. Premierement, l'importance de la conservation dc la perspective est demontree par le fait que les phrases SS sont les plus faciles a trailer, et les phrases SO les plus difficiles. Deuxiemement, la grande difficulte de traitement des phrases NNV, ou la relative modifie le second substantif, demontre les limitations importantes du processus de construction de fragments par unc analyse syntaxique "bottom-up". L'existence d'un marquage dc l'antecedent pour les relatives cxtraposees dans le cas de langucs SOV avec ordre des mots variable comme le hongrois et le georgien, est une autre indication dcs limitations importantes que conanait la construction de fragments. Troisiemement, le conflit qui apparait entre une phrase relative focalisee et une phrase principale focalisec montre que la conservation du focus joue un role important. Un ensemble d'autres facteurs auxquels on attribue souvent un role dans le traitement des relatives ne semblent pas avoir d'influence sur le traitement des relatives en hongrois.