
A Dynamic Model of the Evolution of Language

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A Dynamic Model of the Evolution of Language*

For use almost can change the form of nature.
Hamlet, III, iv

1. Introduction and Summary: The Three Linguistic Capacities

A person knows how to carry out three kinds of activities with his language: he can produce sentences, he can understand sentences, and he can make judgments about potential sentences. Recent linguistic investigations have concentrated on describing the facts brought out in speakers' predictions about sequence acceptability and structural relations within and among sentences. Such predictions have been assumed to reflect directly each speaker's knowledge of his language ("competence") while the capacities to speak and understand sentences have been viewed as revealing a person's linguistic knowledge only indirectly, due to the interposition of behavioral factors ("performance").

It clearly is the case that the activities of talking and listening can obscure much of a person's linguistic knowledge; but judgments about potential sentences are also behavioral manifestations of linguistic knowledge, and as such are not different in principle from the more direct uses of linguistic structure. Even though predictions about sentences may be the most direct evidence we have concerning linguistic structures, such judgments are not entirely free from behavioral effects. Thus, linguists and psychologists can utilize three kinds of manifest speech behaviors as data relevant to the study of linguistic knowledge: speech production, speech perception, and the prediction of new structures. In this paper, we shall discuss the evidence for the interaction of the systems of speech perception and sentence prediction in the history of the English language. We shall demonstrate that the history of a language, and therefore its synchronic state as well, are the products of a dynamic interaction between the rules required for the prediction of new sentences, and the behavioral mechanisms used to process actual sentences.

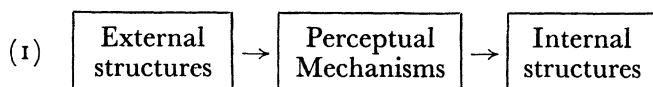
This demonstration implies that certain universal features of such grammars are due to laws governing their actual use by children and adults. This is distinct from the view that all of the universal properties are internal to the predictive grammatical

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mechanism (e.g. the principle that transformational rules are ordered). Since language learning includes the simultaneous acquisition of behavioral and predictive structures, the ultimate structure of the predictive system is partially a function of two kinds of simplicity: simplicity of the predictive mechanism itself, and simplicity of the processes of speech perception and production.

2. The Perception of Sentences by Adults and Children

Recent psychological studies have shown that the form in which sentences are understood corresponds closely to their internal grammatical structure (Miller 1962; Mehler 1963). Thus, any model for speech perception includes a mechanism which isolates the internal structure corresponding to each external form (1):



When transformational grammars were proposed, it was thought that the grammatical mechanisms were directly embedded within the operation of the perceptual mechanisms (Miller 1962). A preliminary series of studies appeared to support this view; they showed that certain sentences which involve more transformations in the *grammatical* description of the relation between their internal and external structures are relatively hard to understand. For example, passive sentences (2b) involve one more rule than corresponding active ones (2a), and are indeed harder to understand. This was shown in many different kinds of studies; for example, McMahon (1963) demonstrated that generically true actives (2a) are verified more quickly than generically true passives (2b):

- (2) a. Five precedes thirteen.
Thirteen follows five.
b. Thirteen is preceded by five.
Five is followed by thirteen.

The basic principle at issue in these studies was that every grammatically defined rule corresponds to a psychological operation, and that therefore sentences with more rules mapping the internal onto the external structure should be relatively more complex psychologically.

However, this simple view of the relation between formal grammar and perceptual processes is incorrect. There are many examples of sentences which have relatively more transformations in their derivation and which are clearly *less* complex psychologically. Thus, in ((3)–(5)), the grammatical derivation of the second sentence (b) is more complex than the first (a), but is clearly easier to understand:

- (3) a. Harry ate the baklava that was green.

- b. Harry ate the green baklava. (Relative Clause Reduction, Modifier Preposing)
- (4) a. That Harry liked the green baklava amazed Bill.
- b. It amazed Bill that Harry liked the green baklava. (Subject-clause Extraposition)
- (5) a. The boy the girl the man liked hit cried.
- b. The boy hit by the girl liked by the man cried. (Passive)

There are also various experimental demonstrations of an inverse relation between transformational and psychological complexity. Finally, recent reviews (Fodor and Garrett 1967; Bever 1970a) have argued that the previous evidence in support of the hypothesis that grammatical transformations are part of perceptual operations is inconclusive on methodological grounds. The conclusion from all these considerations is that the perceptual mechanism which carries out the mapping operation outlined in (1) is at least partially independent of the predictive grammatical rules that relate internal and external structures. It is not the case that the perceptual mechanism is a direct behavioral exploitation of grammatical rules.

This conclusion leaves open the question of what the nature of the perceptual mechanism really is. Current research has suggested that listeners make primary use of an ordered set of perceptual strategies which directly map external strings onto their internal structures. For example, a series of experiments has given initial support to the claim that a set of perceptual strategies isolates lexical strings corresponding directly to internal structure clauses early in the perceptual process (Fodor and Bever 1965; Garrett, Bever, and Fodor 1966; Bever, Fodor, and Garrett 1966; Bever, Kirk, and Lackner 1969). These investigations have studied the perception of nonspeech interruptions in sentences with two clauses. The basic finding is that subjects report the location of a single click in a sentence as having occurred towards the point between the underlying structure clauses from its objective location. Accordingly more clicks in sentence (6b) are mislocated immediately following the main verb than in (6a). This is in accord with arguments that "the troops" is a direct object of the verb "defy" while the entire complement sentence is the direct object of "desire" (Rosenbaum 1967):

- (6) a. The general defied the troops to fight.
- b. The general desired the troops to fight.

Bever et al. interpret the experimental result as a demonstration of the claim that listeners know that the sequence following a verb like *desire* can begin a new internal structure sentence (as indicated by the spacing in (6b)). In contrast to this, a verb like *defy* is known to permit only a direct object immediately following it (as indicated by the spacing in (6a)); accordingly, listeners have a greater immediate tendency to establish internal structure segmentation following verbs like *desire* than they do for verbs like *defy*.

It is clear that the application of such specific lexical knowledge in perceptual segmentation is not the application of a particular grammatical rule. Rather it is the knowledge of the possible derivations associated with each word that is reflected in the perceptual operation. Similar nongrammatical perceptual strategies are sensitive to the external patterning of major syntactic categories. In particular, there is the following perceptual strategy, which is independent of grammar: (a) that a string consisting of a nominal phrase is the beginning of an internal structure sequence (i.e. sentoid); (b) that the verb phrase (optionally including a nominal) is the end of such a sequence. This perceptual rule may be stated formally as in (7):

- (7) a. $X_1 \text{ Nominal } V_f X_2 \rightarrow X_1 [_s \text{Nominal } V_f X_2]$
 b. $X_1 [_s \text{Nominal } V_f (\text{Nominal}) X_2] \rightarrow X_1 [_s \text{Nominal } V_f (\text{Nominal})]_s X_2$

The application of strategy (7a) must precede that of (7b), in their application to certain verbs.¹ The reason is that people have no difficulty understanding sentences like (8). However, if the right bracket were assigned before or simultaneous with the left bracket, then the incorrect initial bracketing in (9) would result, and the sentence would be incomprehensible.

- (8) John believed Bill was a fool.
 (9) $[_s \text{John believed Bill}]_s$ was a fool.

Thus, strategy (7a) applies first to an entire string, and then strategy (7b) applies. After application of (7a), example (8) would be analyzed, as in (10):

- (10) $[_s \text{John believed } [_s \text{Bill was a fool}]]_s$

Strategy (7b) would then apply to produce (11):

- (11) $[_s \text{John believed}]_s [_s \text{Bill was a fool}]_s$

Notice that (7b) is prevented from assigning a right bracket after *Bill* in (11) because (11) does not meet the structural index of (7b).

The presence of the perceptual strategies in (7) is demonstrated by the existence of many sentences in English in which they produce temporarily misleading analyses, thereby making them hard to understand. In each of the examples ((12)–(14)) below, (a) is hard to understand relative to (b) because there is a nominal-verb sequence

¹ We should emphasize that such strategies as (7) are explicitly probabilistic, and should not be confused with syntactic rules. At the moment we are uncertain as to the most appropriate formalization of the perceptual rules, and our presentation of them should be taken only as suggestive. For example, the rules in (7) assume a prior assignment of major phrase boundaries, although the experimental literature is extremely unclear on the question of whether the complete surface phrase structure is assigned initially during perception. (Cf. Bever et al. 1969) If one were to formalize the prior assignment of *Nominal* (including complements) and *Verbal* phrases within the rules, then the constraints on ordering the assignment of sentence boundaries would differ, at least for the examples under consideration. It seems intuitively likely that (7a) and (7b) apply simultaneously, moving from left to right in a sequence. However, specific verbs (e.g. noun phrase complement verbs like ‘believe’) appear to suspend (7b) before the second application of (7a). Bever et al.’s (1969) results suggested that such specific knowledge is indeed utilized actively during perception.

present in its structure which does not, in fact, correspond to any internal structure cluster ((12), (14)), or which results in there being lexical material left over which cannot be assigned to such a cluster (13):

- (12) a. The umbrella the man sold despite *his wife is in the room*.
- b. The umbrella the man sold despite his relatives is in the room.
- (13) a. *The horse raced past the barn* fell.
- b. The horse that was raced past the barn fell.
- (14) a. The lecturer was believed by *John finished*.
- b. The lecturer was believed by John not finished.

While such examples demonstrate the activity of the rules in (7), there are also experimental studies which give further direct evidence for it.²

The presence of such perceptual strategies in young children cannot be taken for granted just because they appear in adult intuitions and behavior. The main result of our investigations into the ways in which young children acquire perceptual strategies (see Bever 1970a for a review) is that the child from age two to five years is heavily dependent on perceptual strategies in speech perception, even to the point of overgeneralizing them to sentences to which they should not be applied. For example, within a clause, children of four years tend *more* than younger children to take the first noun as the actor, even in passive (15b) or cleft (15c) sentences in which that strategy leads to misperception:

- (15) a. *The cow* kisses the horse.
- b. *The horse* is kissed by the cow.
- c. It's *the horse* that the cow kisses.

Thus, while the adult has intuitive control over the application of such perceptual strategies in most cases, the child is more often at their mercy. Some of our recent experiments have also explored the basic dependence in the child on a strategy like (7). For example, we have found that children at one age tend to recall (and act out with toys) the first "nominal-verb" string that they hear, even if it is in a dependent clause

² For example, Blumenthal (1968) examined the kinds of errors that subjects make when attempting to paraphrase center-embedded sentences like (i). He found that the largest class of errors is to take the three nouns as a compound subject, and the verbs as a compound predicate. For example, (i) would be paraphrased as though it were (ii):

- (i) The boy the men the girl liked hated laughed.
- (ii) The boy, the man, and the girl liked, hated, and laughed.

That is, a simple "Nominal-Verb" schema is imposed on what is actually a complex sentence. In a related experiment, Bever (1969) found that center-embedded sentences which have plausible, but misleading noun-verb sequences (iii) in them are relatively hard to paraphrase compared with sentences not having such sequences (iv):

- (iii) *The editor authors the newspaper* hired liked laughed.
- (iv) The editor the authors the newspaper hired liked laughed.

A striking aspect of these results is that sentences like (iii) were difficult even with repeated practice.

(e.g. *dog jumped* in (16a), *dog fell* in (16b)). Children at another age tend to recall the main clause “nominal . . . verb” and to drop the dependent clause (they recall the *dog fell* in (16a and b)).

- (16) a. The dog that jumped fell.
b. The dog fell that jumped.

That is, at one stage, children assign priority on the basis of superordinate structure, while at another age children take the first nominal-verb string that they encounter. Just as the adult perceptual strategies are in a system distinct from the rules of predictive grammar, their development is partially independent of grammatical acquisition. This ontogenetic independence of the perceptual and predictive systems implies that the perceptual system could itself influence the form of the predictive system as it is learned. In the remainder of this paper we explore an example of this in the history of English: the way in which the perceptual strategy in (7) has influenced the evolution of grammatical restrictions on the presence of the relative pronoun in relative clauses.

3. The Syntax of Relative Clauses in Contemporary English

The relative clause rules of English generate the various external forms exemplified in (17) from the same underlying structure:

- (17) a. Miss Hood met a ravenously hungry wolf.
b. Miss Hood met a wolf that was ravenously hungry.
c. Miss Hood met a wolf; he was ravenously hungry.

We assume, following Thompson (1971), that the underlying structure of (17a) is closest in appearance to the surface structure of (17c), and that the transformations in (18) are applicable in the order given:

- (18) a. *Relative Clause Formation*. Given a structure of the form:³

$[_S[_S X_1[_{Nom_i} X_2]_{Nom_i} X_3]_S; [_S X_4[_{Nom_i} X_5[_{Nom_i} X_6]_S]_S]_S$
convert it into the form:

$[_S X_1[_{Nom_i} X_2[_S X_4[_{Nom_i} X_5[_{Nom_i} X_6]_S]_{Nom_i} X_3]_S]_S$

That is, embed the second sentence as a constituent of the nominal in the first.

- b. *Relative Clause Reduction*. Delete certain combinations of *be* plus verbal auxiliary in a relative clause.⁴
c. *Relative Pronoun Formation*. Copy the nominal in the relative clause containing the shared nominal at the beginning of the relative clause, and

³ The subscript *i* indicates reference: accordingly, the formula requires that the two nominal expressions mentioned make the same reference. We call these the “shared nominals”. The symbols X_1 , X_2 , etc. are variables.

⁴ See Bach (1968) for discussion of limitations on what combinations of *be* plus auxiliary may be deleted in relative clauses. The full details have to our knowledge never been worked out.

replace the shared nominal in this copy by the appropriate relative pronoun.⁵

- d. *Shared Nominal Deletion*. Delete the original shared nominal in a relative clause.
- e. *Modifier Proposing*. Move any reduced relative clause consisting of an adjective phrase ending with its head adjective to a position preceding the noun it modifies.

One can easily verify that none of the transformations in (18) have applied in the derivation of (17c); that rules (18a, c, d) have applied in the derivation of (17b); and that (18a, b, d, e) have applied in the derivation of (17a).

The formulation of the rules of Relative Clause Reduction and Relative Pronoun Formation in (18) differs from standard transformational accounts (e.g. Smith 1964). In those accounts, Relative Pronoun Formation is obligatory, there being also a rule for deleting a relative pronoun under certain circumstances. Furthermore, the Pronoun Formation rule is standardly assumed to precede the Clause Reduction rule, so that the latter not only deletes auxiliary and *be*, but also the relative pronoun. Since there is no advantage in formulating the rules in this more cumbersome way either from a synchronic or diachronic perspective, we have chosen the form and order for these rules as given in (18).⁶ Rules (18a, b) are both optional. Rule (18c) is generally optional, but is obligatory in most contexts in which the shared noun is subject of the relative clause and the finite verb of the relative clause has not been deleted. Thus, for most speakers of English the sentences of (20) are not grammatically acceptable as counterparts of those of (19):

- (19) a. The man that wants to see the boss is waiting downstairs.
- b. The secretary discouraged the man that wanted to see the boss.
- c. There is a man that wants to see the boss downstairs.
- d. It was low wages and poor working conditions that caused the workers to strike.
- (20) a. *The man wants to see the boss is waiting downstairs.
- b. *The secretary discouraged the man wanted to see the boss.
- c. *There is a man wants to see the boss downstairs.
- d. *It was low wages and poor working conditions caused the workers to strike.

⁵ If the nominal containing the shared nominal is in fact just the shared nominal, then the relative pronoun is either the word *that*, or one of the interrogative pronouns *who*, *whom*, or *which* (the choice of the *who/whom* vs. *which* having to do with whether or not the shared nominal is assumed to designate a sentient being, and the choice of *who* vs. *whom* having to do with the syntactic functioning of the shared nominal in the relative clause).

If the shared nominal is wholly contained within a larger nominal expression, then the relative pronoun *whose* is chosen, and sentences like (i) are obtained.

(i) A man whose reputation I admire is looking for a job.

⁶ It has long been noted that under standard accounts, what is deleted by the Relative Clause Reduction rule is not a constituent. In our formulation, however, the deleted elements do form a constituent, which from a formal point of view is a decided advantage.

Rules (18d, e) are, on the other hand, obligatory. Rule (18d) in particular is obligatory, since sentences which retain shared nominals within relative clauses (21) are ungrammatical (the shared nominal in the relative clause is italicized):⁷

- (21) a. *Harry ate a baklava that *it* was slowly disintegrating.
 b. *The man that I saw *him* was wearing a polka-dot shirt.

4. The History of Relative Clause Formation and Reduction in English

It is convenient to distinguish six stages in the history of English relative clauses. Stage 1, Old English, dates from the time of the earliest manuscripts to about 1100 A.D.; Stage 2, Early Middle English, runs from 1100 to 1400; Stage 3, Late Middle English, from 1400 to about 1550; Stage 4, Early Modern English, from 1550 to 1700; Stage 5, Late Modern English, from 1700 to the beginning of this century; and Stage 6, Contemporary English.

A major general development during the first three stages was the loss of most nominal inflections by Stage 2 and verbal inflections by Stage 3. Simultaneously with these changes the structure of relative clauses was also evolving. In Stage 1 the element that could function as relative pronoun was the demonstrative *se* 'that', which was declinable, and which had a masculine, a feminine, and a neuter form. In Stage 2 the demonstrative as relative, (which now existed only in a single indeclinable form *þæt*, a continuation of the neuter form in Stage 1), was joined by various interrogative pronouns (the modern forms of which are *who*, *whom*, *which*, *whose*, etc.), a situation which has continued to the present day (the demonstrative is now, of course, spelled *that*). In addition, in Stage 1, a relative clause could be introduced simply by the indeclinable relative particle (n.b. *not* pronoun) *þe*, or by the demonstrative plus *þe*. The latter was also a possibility in Stage 2; but by Stage 3 the use of the relative particle had been discontinued.⁸

⁷ In case the shared nominal occurs in a relative or noun complement clause within the relative clause, the sentence is ungrammatical both if the shared nominal is deleted or if it is retained:

- (i) *The choir limped through the anthem (that) the organist couldn't make up his mind at what tempo *it* should be played.
 (ii) *The choir limped through the anthem (that) the organist couldn't make up his mind at what tempo should be played.

Omission of the shared nominal in sentences such as (ii) leads to an even greater degree of ungrammaticality than its retention (as in (i)). This is due to the operation of the "Complex Noun Phrase Constraint" discussed in Ross (1967), according to which a constituent cannot be deleted under identity within a clause wholly contained within a nominal expression if the identical element is outside that expression. If the shared nominal is retained, then the Complex Noun Phrase Constraint is not violated; rather the violation is that of the obligatory Shared Nominal Deletion transformation. Obviously, the retention of the shared nominal in sentences like (i) serves to remind the speaker and hearer of the grammatical source of the relative pronoun in a situation where the syntactic complexity is so great that it is easy to forget what that source is. Ross' Complex Noun Phrase Constraint and similar "derivational constraints" in grammar (Lakoff 1969) all seem to be reflections of perceptual strategies of one sort or another. To show this, however, would require extended discussion which would go far beyond the scope of this paper (but see also fn. 14, and Bever 1970a, b).

⁸ In Stages 2 and 3 there were also relative clauses introduced by a string consisting of an interrogative followed by the demonstrative (*which that*, etc.); quite possibly, this use of *that* in second position was a continuation of *þe* in second position.

- (23) a. Harry ate the baklava [_Sit was disintegrating]_S

Shared Nominal Deletion

- b. Harry ate the baklava [_Swas disintegrating]_S

From Stage 4 to Stage 5 it became obligatory to introduce a relative pronoun into clauses modifying an object noun. In Stage 5, the subject relative could only be omitted in existential sentences like (20c) and (24a), cleft sentences like (20d) and (24b), including question word interrogative cleft sentences, either direct, as in (24c) or indirect, as in (24d).¹²

- (24) a. There are lots of vulgar people live in Grosvenor Square. (J 145; Wilde)
 b. It was haste killed the yellow snake. (J 145; Kipling)
 c. Who is this opens the door? (P 1001; Thackeray)
 d. I wonder who it was defined man as a rational animal. (J 146; Wilde)

Finally, in Stage 6, it seems that subject relative omission has become archaic or ungrammatical in existential and cleft sentences of the type (24a, b), and for some people also in interrogative cleft sentences of the type (24c, d).

Omission of the object relative pronoun, which necessarily leaves a nominal or some constituent other than the finite verb as the first element of the relative clause, has always been possible in English, although instances are very rare in Stages 1–3 (examples being even less frequent than those of subject relative pronoun omission in Stages 1–2, although in Stage 2, the formula represented in *by the faith I have to you* is fairly often instantiated). But, by Stage 4, the phenomenon had become quite common (see figures cited in footnote 11), and it is, of course, firmly established in idiomatic English today.¹³

ratio is reversed in Caxton". He also cites figures from a dissertation by J. Steinki on the ratio of nonexpressed to expressed object relative pronouns in the works of various late Middle and early Modern English writers. The figures he gives are Pecock 1:950; Capgrave 53:1250; Cely Papers 4:172; Caxton 8:2800; Fortescue 1:245; Latimer 19:3100; Bacon 15:490; Sidney 331:2180. From these figures, we may conclude that both subject and object relative pronoun omission were quite rare for Chaucer, Caxton, and the other writers of the late ME period.

¹² Some examples which exhibit subject relative omission in relative clauses modifying direct objects can be found in the writings of certain nineteenth century novelists and poets such as Keats, Mrs. Browning, Thackeray, and Meredith, but these are deliberate archaisms. The construction has also been preserved dialectally, if we are to believe the testimony of Wright (1905, 280): "The relatives are, however, often omitted in the dialects, not only in the objective case in the literary language, but also in the nominative, as *I know a man will do for you.*"

¹³ According to Visser (1963, 538), in about 98% of the cases of object relative omission found in early Modern English texts, the relative clause begins with a pronoun, rather than with a full nominal expression. That is, sentences like (i) are about fifty times more common than sentences like (ii):

- (i) John saw the man she admires.
 (ii) John saw the man the woman admires.

Visser assumes this is so for metrical reasons; the omission of the object relative (*whom* or *that*) before a pronoun insures that two weakly stressed elements do not occur together. This explanation cannot be true, however, since

In brief, the historical developments in the structure of relative clause formation were the following:

- (25) a. relative pronoun not preceding the finite verb of the relative clause has always been omissible, whether the modified noun is initial within its own clause or not;
- b. relative pronoun preceding the finite verb of the relative clause has never been omissible when the clause modifies a noun that is initial within its own clause;
- c. relative pronoun preceding the finite verb of the relative clause is omissible through Stage 4 when the modified noun is not initial within its own clause;
- d. after Stage 4, relative pronoun preceding the finite verb of the relative clause is not omissible, except:
 - (i) through Stage 5, such relative pronoun is omissible if the modified noun is subject of existential or cleft sentence.
 - (ii) for some speakers in Stage 6, such relative pronoun is omissible in interrogative cleft sentences; for other speakers such relative pronoun is never omissible (see the discussion at the end of Section 5).

(Appendix 1 outlines a synopsis of the historical developments relating to the form of the relative pronoun, the retention of shared nominals in relative clauses, the omission of the relative pronoun, and the loss of noun and verb inflections in English. In Appendix 2, examples that illustrate these developments are given, and in Appendix 3 a formal account of the rules relating to relative clause formation and reduction are given for each stage.)

5. The Role of Perceptual Constraints in the Evolution of the Relative Clause Rules

Recent investigations of the history of linguistic structures have sought explanations within the formal rules themselves (Halle 1962; Kiparsky 1968; Traugott 1969). The goal of such investigations is to determine the way in which a linguistic change represents an “improved” grammar in formal terms. The primary attempts have been to argue that structural changes produce formally “simpler” grammars, or grammars with more general application of particular rules.

nominal expressions also generally begin with a weakly stressed element (*a* or *the*). The explanation probably has to do with a perceptual strategy which leads one to expect that when two independent nominal expressions of the same type (i.e. both full noun phrases or both pronouns) occur next to one another, they are part of a larger coordinate structure. The omission of an object relative before a full nominal expression modifying a full nominal expression leads to a violation of that strategy; e.g. when one hears

- (iii) John saw the man the woman —

one expects that it will be completed by another nominal, e.g. “and the child” rather than by a verb, e.g. “admires”.

However, there is no general trend towards formal rule simplification or elaboration to be found in the developments we have discussed. Examination of the formal rules alone leaves us without any understanding of the processes which might be involved. For example, the shift from Stage 5 to Stage 6 represents a generalization of the restriction on the absence of relative pronoun in relative clauses. This generalization is represented formally as a simplification of the rule which inserts relative pronouns (cf. Appendix 3, Rule c). However, the shift from Stage 4 to Stage 5 represents a reduction in the generality of the restrictions on relative pronoun insertion since the relative pronoun is still optional before a verb in the relative clause if the head noun is preceded by an expletive construction. This loss of generalization is represented formally as an addition to the rule which inserts relative pronouns. (We emphasize that the oscillation of the formal complexity underlying the description of the relative pronoun system in English is not a consequence of our decision to treat the presence of relative pronouns as due to the operation of a single rule of relative pronoun formation, as opposed to an early rule of formation and then optional deletion proposed in previous accounts (Smith 1964). If one adopted the previous solution, then one would find that the formal complexity of relative pronoun restrictions decreased from Stage 4 to Stage 5 but increased from Stage 5 to Stage 6.)

Of course, we do not want to exclude the possibility that some formal aspect of the rules might be found which represents a generally observed historical shift; nor can we claim that our formalization of the developments is not potentially subject to reformulation in the light of data that we have not considered. Such a reformulation might reveal a structural characteristic which would allow a satisfactory generalization about the historical developments. However, whatever formal account is found in terms of transformational rules, it will fail to represent that the two main historical changes (26a, b) we have discussed are related:

- (26) a. Disappearance of inflections, first in nouns then in verbs.
- b. Appearance of restrictions on the absence of relative clause markers in clauses modifying noninitial nouns.

Yet it is the presence of such a relation which can explain the historical changes in the relative clause rules. We shall assume for the moment that the loss of inflections occurred spontaneously (but see discussion below), and argue that this development was a precondition for the changes in relative clause formation; the loss of inflections created certain perceptually ambiguous constructions which were then ruled out of the language by the changes in relative clause formation.

Consider first the operation of strategy (7) in the history of English. In Old English the nominal inflections allowed relative freedom of word order, which would have reduced the usefulness of an order-bound strategy like (7). However, by Stage 2 word order had become constrained, justifying (7). The loss of inflections had strong effects on the marking of subordinate and superordinate clause relations in general and the

relation of a relative clause to its head noun in particular. First, it was apparently the case in Old English as well as in Modern English that the first "Nominal Verbal" sequence in a sentence was almost always part of the main clause unless specifically marked otherwise. Thus, if the first verb introduced a relative clause, there had to be some marker present in the surface structure.¹⁴ Such a constraint must exist if the perceptual principles in (7) are to be maintained. If there were no marker on a relative clause modifying an initial noun, then it would be confused with the main clause of the sentence, as in (20a).

Sentences in which the verb initial relative clause modified a nonsubject noun would have created little ambiguity in Stage 1, first because the reliance on strategy (7) was less justified than in later stages, and secondly because the noninitial nominals were marked by their case endings as nonsubject.¹⁵ However, as inflections dropped and ordering constraints and strategy (7) became more important, relative clause constructions with no subject pronoun modifying initial nouns became perceptually complex. For example, by Stage 2 a construction like (23a) would be treated by strategy (7) as though it were a construction like (8) and would be assigned the same perceptual bracketing as shown in (11). That is, in (23b) *the baklava was disintegrating* would be segmented together as the sentential object of *Harry ate*. Or, in example (3a), Appendix 2, Stage 2-3, *a cherl was in the town* would have been segmented together as the sentential object of *he sente after*. Such incorrect initial perceptual segmentations would make such constructions complex to understand. However, a certain amount of such perceptual complexity was tolerated, since as examples like (12)-(14) show, one cannot require of a language that it never generate a sentence which violates a perceptual generalization, only that the internal organization of actually uttered sentences be perceptually recoverable *in general*.¹⁶ The behavioral importance of the segmentation

¹⁴ This sort of restriction on the surface structure expression in internal relations could be interpreted, following Perlmutter (1968), Lakoff (1969), Ross (1967), and Langendoen (1970), as an example of an "output constraint" which restricts the kind of derivation which is possible from an internal relative clause to an external form. We see nothing wrong with such a formulation except that it merely restates the facts at issue. Our quest is to explain such features of sentences rather than enumerate them. For example, Bever (1970b) has suggested that it is characteristic of such "output constraints" that they reflect general perceptual processes which are true of the perception of stimuli other than language. The observation that an initial subordinate "nominal-verbal" is always marked as such by the end of the verb phrase was suggested to us by R. Kirk.

¹⁵ It has been claimed that order dependent sentence syntax can appear early in the language of all children, even those learning a highly inflected order free language (cf. Slobin 1970 for a review). Thus, a strategy like (7) may be used to some extent in all languages, even those where its use is limited by relative freedom of word order.

¹⁶ It is interesting to note that in all the cases of unmarked relative clauses in OE that we have found in the texts in which the object noun is object of a finite verb and confusable with a nominative, the relative clause verb is either a form of *be* or a modal. That is, the allowed ambiguity may have been restricted even further than we claim either by actual grammatical rule or simply by conventions of usage. This interpretation of the constraint would be further supported if it is true that sentences which began in initial nouns in the objective case could have a relative clause following with verb initial but without any relative clause marker, e.g. (i):

(i) Him likes me nobody likes.

Cases like this would not have run afoul of the segmentation strategies like those in (7) since the fact that the first noun is not in the nominative case marks that it cannot be subject of any following verb. So far we have not found any data that would decide this question.

ambiguity increased as the number of alternative ways of marking a relative clause diminished to the interrogative relative pronoun and the indeclinable demonstrative 'that' by the end of Stage 3. During Stages 2 and 3 the low frequency of subject pronoun omissions in actual usage implies that their perceptual complexity was only occasionally an issue for speakers. Consequently, these perceptually complex constructions died out gradually, rather than disappearing abruptly.

In sum, we interpret the appearance of an obligatory relative clause marker on non-initial nouns that are subject of the relative clause as a gradual response to the increase in perceptual ambiguity occasioned by the loss of declensions. In our view the two historical trends in (26a) and (26b) are directly related since the first is a sufficient motive for the second. As the number of false *NV* = *Subject Verb* segmentations determined by perceptual strategy (7) became too great the independent marking of the relative clause became obligatory. This development stands as an example of the effect of behavioral mechanisms on the formal rules, in which the rules changed so as to accommodate the perceptual strategies.

However, rule simplification is also a motivating force in linguistic change. For example, the restriction on the obligatory presence of the relative pronoun is becoming increasingly general, such that it includes cases where the perceptual mechanisms would not lead to semantically inappropriate segmentation. Consider the sentences in (27):

- (27) a. ?? $\left\{ \begin{array}{l} \text{It's} \\ \text{There's} \end{array} \right\}$ a boy wants to see you.
 b. ? Who is $\left\{ \begin{array}{l} \text{there} \\ \text{it} \end{array} \right\}$ wants to see me?

According to the data we have collected, sentences like (27a) are grammatically unacceptable for most speakers and sentences like (27b) are unacceptable for a subset of those speakers.¹⁷ Consider the operation of perceptual strategies (7) on the last part of a sentence like (27a):

- (28) There is [_S a boy wants to see you]_S

It is important to note that this segmentation is appropriate to the meaning of the

¹⁷ All of the intuitions in this section of our discussion are relatively evanescent. We suggest to the reader that he always compare each sentence in its versions with and without the relative clause marker in order to convince himself that our statements are correct, at least about the relative acceptability of the sentences. For example, in our dialects the difference in acceptability between (27a) and (a') is greater than the difference between (27b) and (b'). Indeed, while it is clear that (a') is more acceptable than (27a), it is not at all clear to us that (b') is more acceptable than (27b).

- (a') $\left\{ \begin{array}{l} \text{It's} \\ \text{There's} \end{array} \right\}$ a boy $\left\{ \begin{array}{l} \text{who} \\ \text{that} \end{array} \right\}$ wants to see you.
 (b') Who is $\left\{ \begin{array}{l} \text{it} \\ \text{there} \end{array} \right\}$ $\left\{ \begin{array}{l} \text{who} \\ \text{that} \end{array} \right\}$ wants to see me?

Note that the acceptability of (27a) is increased if *boy* is given contrastive stress.

sentence, unlike the inappropriate segmentations which the strategy would yield with cases like ((12)–(14)). (27a) is synonymous with (29):

(29) A boy wants to see you.

That is, in cases like this operation of strategy (7) interferes little with the recovery of the appropriate internal grammatical relations. What is lost by such a preliminary segmentation of (27a) is the information that the sentence is an existential statement about *a boy*. This information, however, is uniquely recoverable from the expletive use of the initial word *there*.¹⁸

Given that cases like (27a) and (27b) do not involve perceptual difficulty, we must ask why they appear to be in the course of becoming ungrammatical. We interpret this active development as due to the pressure for simplification of a rule of predictive grammar—that is, if both cases like (27a) and (27b) required a relative pronoun in all cases, then the relative pronoun formation rule (18c) would be as stated in Appendix 3 for Stage 6 but without any qualifications. Thus, this generalization can be taken as an instance in which the pressure to simplify the predictive rules is currently forcing a grammatical restructuring.

6. Summary and Conclusions

A. Summary

We have argued that the constraints which a child and adult have on the utilization of language in speech behavior limit the kind of sentences that are understood and therefore restrict the kind of grammatical structures which are learned. The historical relation between the loss of inflections and restrictions on relative clause formation exemplifies the historical competition between what makes a language easy to learn and what makes it easy to use. Between the 11th and 15th centuries the disappearance of most inflections simplified the learnability of the language by reducing the number of lexical classes and suffix systems. Similarly the universality of the absence of the shared nominal in relative clauses also made the predictive rules easier to master. However, both developments increased the perceptual complexity of individual sentences. First, inflectional systems and lexical class markers carry a great deal of information as to the internal relations in any given sentence. Second, the combined

¹⁸ If the locative use of *there* is intended then the absence of the relative marker involves a much less acceptable sequence, because the operation of strategy (7) on (i)

(i) (Over) there is the boy wants to see you.

leads to a nonsynonymous sentence (ii).

(ii) The boy wants to see you.

Notice that the cases with expletive *there* and *it* ought to have caused trouble in OE as well, since the initial noun is in the nominative case and therefore should have been segmented as the subject of the following verb. However, as we are arguing for modern English, this segmentation would not have involved a semantically inappropriate segmentation of the first clause.

loss of the oblique inflections on noninitial object nouns and the loss of all shared nominals created a perceptually confusing construction—a relative clause on a non-initial object noun. The possibility of such constructions had a gradual effect during Stages 2 and 3, when their actual frequency was low. Finally the perceptual difficulty was resolved in the 15th century by the restrictions on the presence of the relative pronoun in such constructions. This development constituted an increase in the grammatical complexity (and a decrease in the corresponding “syntactic regularity”). Finally, the modern generalization of the restrictions represent a grammatical re-simplification.

These developments in the past millennium are not susceptible to any generalization about the evolution of formal grammars as such. No tendency appears *always* to simplify rules or to maximize a formal property of the rules, such as the extent to which the output of one rule is part of the input to a subsequent rule (cf. Kiparsky 1968 for a discussion of this principle as a formalized motivating force underlying certain linguistic developments). Thus, while a plausible account can be found in the consideration of the interaction of the ease of learning and of understanding the language, the structure inherent to the formal account of what is learned and perceived does not itself reveal any plausible formal account of the historical changes.

B. The Mutational Basis of Linguistic Evolution and Linguistic Universals

Recent linguistic theorists have drawn a rigid distinction between linguistic structure (“competence”) and speech behavior (“performance”). The corresponding theories of linguistic evolution have concentrated on the changes that take place within linguistic structure. The main proposal has been that suggested by Halle (1962) that children *restructure* their predictive grammar to provide simpler accounts of the language they hear than in the grammar of their parents. This presupposes that new forms appear in languages spontaneously (at least from the standpoint of the predictive grammar) which then motivate a grammatical restructuring. This picture of linguistic change is outlined in (30):

(30)	<i>Stage</i>	<i>Sentence Types</i>	<i>Grammatical Structures</i>
	(a)	a z	A Z
	(b)	a z + \emptyset	A Z + \emptyset
	(c)	a z + \emptyset	A' Z'

On this view there is a period when adults may have one grammar (e.g. (30b)) while children in the same community have advanced to a restructured grammar (e.g. (30c)).

The application of this model to the facts we have discussed would be the following (in part). There was a period of time in which sentences like (24b, c, d) were all grammatical; i.e. the subject relative pronoun did not have to be expressed when the clause modified an object nominal or a nominal following *be* in an existential or

cleft sentence. Relative Pronoun Formation was therefore obligatory only under the conditions listed in (31):

- (31) Add the appropriate relative pronoun obligatorily to a relative clause which begins with the shared nominal and finite verb and which modifies a noun which precedes the verb in its own clause.

Somewhat later, however, sentences like (24b) became very infrequent (and presumably were viewed for a time as stylistic anachronisms). According to the theory of linguistic change we outlined above, there was a period when people learned the system described in (31) as children, but then added a rule to the end of their grammar, so that sentences like (24b) would be marked as ungrammatical. Such a rule is described in (32):

- (32) Add the appropriate relative pronoun obligatorily to a relative clause which begins with a finite verb and which modifies a noun which is an object of the verb in its own clause.

The complexity of a grammar which contains rule (18c) with the stipulation given in (31) and rule (32) is quite great, since rule (32) redoes obligatorily what rule (18c) does optionally. Thus, the children who heard adult speakers of the system described in ((31)–(32)) would restructure it to the simpler grammar containing the provision described in (33) as a condition under which rule (18c) is obligatory:

- (33) Add the appropriate relative pronoun obligatorily to a relative clause which begins with the shared nominal and a finite verb and which modifies a noun which either precedes the verb in its own clause or which is an object of the verb in its own clause.

This general model of linguistic evolution-by-simplification involves three claims:

- (34) a. children can replace learned grammatical structures while adults can only add rules to already learned structures;
 b. grammars learned by children are maximally simple representations of the linguistic forms the children experience;
 c. new linguistic forms appear spontaneously.

The first claim (34a) is related to the psychological hypothesis that there is a “critical period” for “creative” language learning which cuts off at about age 12. After that point new language learning is viewed as a relatively artificial process in which it is easier to learn new forms as a function of old structures rather than restructuring the already learned grammar *de novo*. This hypothesis has both clinical and anecdotal evidence in its favor (cf. Lenneberg 1968). However, it is a moot point whether or not children from two through twelve years of age are themselves willing to restructure their own grammars totally when presented with new linguistic forms. Recent investigations of the development of grammatical structure (at least as re-

vealed by speech production (cf. Brown 1965; Bellugi 1967; Bloom 1970) have demonstrated that the child's linguistic ability itself develops at each point by minimal changes in highly articulated grammatical rules. Thus, the fact that the adult appears not to be able to change his grammar in a major way may also be true of the child at every point in his language development: it may simply be the case that during the ten years that the child is acquiring language he has the ability to perform many more slight grammatical restructurings than an adult. That is, principle (35) governs the restructuring that a child will carry out at each point.

- (35) The child's grammar at one stage is a minimal change from the grammar at the preceding stage.

(35) raises an old theoretical problem: what constitutes a "minimal" change in grammatical structure? Detailed examination of the ontogenetic restructurings in the course of language acquisition may provide some empirical data which will clarify this theoretical question.

Proposal (34b), that children always learn the maximally "simple" grammar, would provide a natural basis for constraining the extent of restructuring that a child applies to his own grammar when he hears linguistic forms that are novel to him. The problem left open by (34b) is this: how does a child decide which of the sentences he hears are relevant data for a grammatical restructuring and which are not? Clearly if a child is presented with a foreign language at age four he does not learn it as a function of his already mastered linguistic structures: he recognizes intuitively that the difference between the foreign language and what he knows already is so great that it must be considered as entirely distinct (even if the same people in his environment speak both the first and second language). Presumably at each point in his speech development, there are certain possible additions to his first language that he will also be unable to learn as part of his language because their grammatical description represents too far a departure from the grammar he has already mastered. Thus, the possible novel forms that a child will try to take account of within his grammar are limited in part by the following sort of principle (36):

- (36) Neologisms that are recognized by children as motivating a restructuring, must (a) be comprehensible and (b) imply grammatical structures that are "close" to the already learned structure.

Of course, like (35) this leaves open the definition of structural "closeness".

The third proposal, (34c), that neologisms occur, is not intended as an explanation of their occurrence nor of their form. No doubt new forms may be introduced into a language by cross cultural contacts, as well as by creative individuals within the culture. Whatever the source of a particular neologism the problem remains to characterize the general constraints on what kind of neologisms are likely to occur. Part of the argument in the present paper is that nonstructural behavioral constraints modify linguistic evolution by their presence in the language learning child. An additional

way in which these behavioral systems influence language change is by limiting the neologisms that adult speakers themselves will produce and accept as "semisentences". Clearly semisentences (potential neologisms) which are incomprehensible or which violate some general behavioral laws will tend not to be uttered or picked up as part of a new argot (37):

- (37) Possible neologisms are limited by the systems of speech behavior ("performance").

The main burden of this paper has been to point out that language learning and linguistic evolution are not merely the learning and evolution of grammatical structure, but also of the perceptual and productive systems for speech behavior. The novel structures that the child recognizes as relevant motivation for restructuring his grammar must be sentences he can (at least partially) understand, desire to say, and learn from. Thus, we can see that there are at least two sorts of requirements that the child applies to a novel sentence before attempting to modify his grammar to predict it: (1) it must be comprehensible in some way; (2) its grammatical description must not be radically different from the grammar he has already mastered.

On this view linguistic evolution is interpreted as an interaction between systematically constrained neologisms and an ontogenetically shifting filter in the child: those neologisms that are appropriate to the particular stage in the child "survive"; they are picked up by the child and incorporated within the predictive grammar of his language. In this sense the effect of linguistic neologisms is analogous to the role of biological mutations in species evolution: their form is somewhat constrained by existing synchronic structures and if they create a structure which is too much at variance with existing structures they "die out" and do not become part of the structural evolution. In brief, the linguistic future is highly constrained by the structural and behavioral systems implicit in the linguistic present.¹⁹ One consequence of this

¹⁹ Such a view allows us to interpret the occurrence of particular developments in one language and their nonoccurrence in a closely related language. For example, German is highly inflected, such that singular nouns are uniquely marked as being in the objective case if they are not the internal structure subject of their verb. Yet relative pronouns may not be dropped in German sentences analogous to those in (24) above. This would seem to be at variance with our explanation of the deletability of relative pronouns in those positions in Old English as allowable because of the presence of noun inflections at the time. That is, while Old English had a rule for deletion of relative pronouns in certain positions German has no such rule. Thus to delete a relative pronoun in German even in positions which would not create perceptual confusions would be to change an exceptionless rule into a variable one. (Notice that the argument has the same form if one takes the view that relative pronouns are transformationally introduced in German since there is no rule that deletes them.) That is, if an adult or child makes a slip of the tongue in German and produces a relative clause without a relative pronoun it tends not to be picked up as a productive neologism since it is too much at variance with the existing linguistic structure. It would be tempting to argue for a principle like (a) as a specific subpart of (36), but the evidence is far too scanty to do any more than suggest it as a hypothesis for further investigation.

- (a) Changing an ungoverned (universal) rule into a governed rule (optional or restricted to certain environments), is not a minimal grammatical change.

Also, we have no explanation at present for why relative pronouns could be omitted in the older Germanic languages generally, e.g. Old High German, Old Saxon, etc., but not in modern German (cf. Williams 1970; Bever and Langendoen 1971 for further discussion).

is that certain universals of language which appear to be aspects of synchronic "linguistic structure" have sources in the ways in which language is learned and used. There is other evidence that this theoretical entailment of our empirical investigation of the history of English is correct (see Bever 1970a, 1970b; Bever and Langendoen, in preparation, for empirical investigations of the ways in which linguistic structures can be interpreted as linguistic reflections of cognitive structures).

C. Some Traditional Issues

Our investigations also bear on several issues which have been of traditional interest for all students of linguistic change: (1) the notion of "functional load" as an explanation for linguistic developments, (2) the claim that languages tend to change from dependence on inflections to express internal relations to dependence on superficial word order, and (3) the relative importance of factors external and internal to a culture in triggering linguistic change.

1. Various scholars have appealed to the notion of "functional load" as an explanation for the appearance of particular changes in the evolution of a language (cf. Martinet 1962). Basically, the proposals depend on a notion of optimum distribution of information-bearing features in a language: if a particular sound or distinctive feature becomes too important in distinguishing words or sentences, then the disproportion of the "functional load" on that sound or feature can be taken as "forcing" a restructuring of the language so that other units or sentences can take over some of the information load. The interest of such arguments depends entirely on the postulated nature of the manner in which functional load is optimally distributed. Clearly, maximum equality of distribution across sound types or syntactic constructions is not a linguistic optimum: many languages reveal large disproportions between the most and least frequent structures. Our arguments in this paper suggest that optimum frequency of a construction or informational load must be measured vis-à-vis the particular mechanisms for language perception and production. With this proviso, we agree with those who argue that the motivation for linguistic change can be found partially in the ways in which the structure of language is used. However, our position is that it would be circular to define language structure in terms of its function (cf. Martinet 1962) or function in terms of structure (cf. Kiparsky 1970). Rather, the two systems of linguistic organization must be defined and studied independently in order to understand how they interact within the speaking child and adult. Our advantage today over earlier scholars concerned with this interaction is that we have available independently motivated theories of linguistic structure and speech performance.

2. The more explicit and unique the markers of the internal relations are in the external sequence, the easier the sentence is to perceive. For example, a language in which the first noun is always the internal subject would be perceptually simple, as would a language in which the subject is invariably marked by one sort of case marking while the object is marked by another, regardless of their order. While there may be

no language which is entirely dependent on the use of case markings or entirely dependent on surface order, Old English was a relatively extreme case marking language with a variety of inflectional paradigms.

From the standpoint of language learning it is clear that a rich inflectional system is a mixed blessing. On the one hand, if the inflectional system is extremely general and without exception then the child need learn only one inflectional system for nouns and for verbs and then can apply it ubiquitously. However, it has been claimed (Jespersen 1940, 59) that even if inflections are small in number at one stage, they tend to multiply and become differentiated into many different systems of inflection which vary according to the syntactic, semantic, or phonological property of each lexical item. Once learned, such a varied inflectional system may increase the perceptual simplicity of the language as a whole, since the inflectional endings would then carry partial lexical class information. However, the learning problem itself is considerably complicated. Many authors have noted that even in an inflectionally simple language like modern English, children go through a period of great difficulty with exceptional forms for which they overgeneralize the inflectional regularities (e.g. they say "wented" instead of "went" or "childrens" instead of "children"). A language in which there is greater variety of inflectional classes than modern English must be more difficult to learn, at least in that respect.

Old and Early Middle English had a large variety of distinct paradigms of noun declension. Thus the child was faced with a formidable learning task. When the opportunity for some restructuring of his language arose it is not surprising that noun inflections were levelled. Of course, we have not explained what the basis of the opportunity to change the language was, only why it was utilized in this particular way.²⁰ Since many languages persist in maintaining complex irregular declension systems we cannot claim that the proliferation of declension systems was the sole cause of the loss of all inflections. One might be tempted to argue that the real "cause" of the loss of inflections was the Germanic tendency for word initial stress. This "caused" a reduction of stress on other syllables which "caused" the ultimate loss of phonetic differentiation of the inflectional endings which "caused" their ultimate deletion. Such an "explanation" would merely beg the question as to why the inflectional endings were dropped entirely: there are many examples of neutralized vowels which remain in English and have not dropped. Thus vowel reduction may be a prerequisite

²⁰ Subsidiary evidence for this interpretation of the loss of inflectional endings in English is found in the fact that noun inflections disappeared before verb inflections. Indeed, a system of verb inflection is residual in modern English. Our argument is that the basic pressure to change the noun system came from the fact that there were so many different paradigms. But the verb system was far more regular: there were two main classes, each with its own system of inflectional endings. Thus, the learning problem for the verb system was far less complex than for the noun systems, and the verb inflections dropped out of the language at a later time. The traditional analysis of the verbal inflections would appear to show that there were many different idiosyncratic kinds of verb inflections both among the strong and weak verbs. These complexities have been shown to be more apparent than real (Bever 1963).

for the loss of inflectional distinctions, but to take it as a direct cause would be as naive, as to take the complexity of the declension system as the single direct cause.

The evolutionary pattern of inflectional systems described by Jespersen may be interpreted as resulting from the conflict between the perceptual and predictive systems of language. We assume that there is a continual evolutionary pressure for a language to maximize the recoverability of deep structure relations in individual sentences. Thus, languages tend to develop both surface order constraints (using function words) *and* inflectional markings. Consider a (hypothetical) language in an initially stable state, having both inflections and ordering restrictions. If this language has one regular declension class, it is easy to learn—but the homogeneity of a single class inflectional system contributes information only about the logical relations within a sentence and this information is also generally recoverable (by hypothesis) from surface order (and special morphemes). However, the perceptual simplicity of each individual sentence would be increased if the inflectional endings contributed differential information about each phrase and attributive relations between words separated from each other (e.g. as between adjectives and their head nouns). (Note that this would be relatively difficult to attain through proliferation of ordering restrictions—there is an upper limit to the number of possible lexical-class orders within an average size clause, but there is no theoretical limit to the possible number of inflectional classes in the lexicon.) Accordingly, the second phase of the hypothetical language is one in which the ordering restrictions are somewhat tightened and there is a large number of inflectional classes. This in turn strains the learning process, which provides the conditions for leveling all the inflections.

This description of a pattern of linguistic evolution in terms of competition between language learning and perception leaves open too many questions to count as an explanation. Rather, its value lies in articulating the explanation of the evolution into specific questions concerning the interaction of the learning and perception of language—questions which may be answered through further research.

(3) The question as to what triggers any particular linguistic change seems to us to be wildly premature. It is clear that major effects often result from such obvious observable events as the incursion of a foreign vocabulary, or a shift in stress reducing the phonetic differences in inflectional endings. Usually the causes for such developments are attributed to extracultural factors such as being conquered by or conquering a group of speakers of a different language. However, our claim that linguistic evolution is in part a function of the balance between learnability and perceptibility raises the possibility that certain internal cultural developments can themselves motivate a linguistic shift, by changing what the language is used for. Suppose that there were a cultural change in the relative importance of the learnability of a language and its perceptibility. This would in itself place a new set of constraints on the evolution of the language since it would upset the previous balance in the culture between the language's learnability and perceptibility. For example, an increase in the relative

importance of "educated forms" of sentences (e.g. sentences with many embeddings) might place a greater relative emphasis on perceptibility constraints, and motivate those linguistic shifts which increase the perceptibility of individual sentences, even though such shifts would increase the complexity of the predictive grammar which must be learned.²¹

D. Conclusion

Such questions await further empirical and theoretical investigation. The focus of this paper is to emphasize that linguistic structure and evolution are a joint function of the various systems for the use of language. Attempts to explain language universals as a formal function of just one of these systems are doomed to incompleteness whether the system considered is that of speech perception, production, or the grammatical prediction of new sentences. We cannot explain a linguistic restructuring as a function only of an out-of-balance perceptual load, or of a learning difficulty, or of the formal complexity of the predictive grammar. All of the systems of speech behavior interact in the child and naturally constrain each other as the language evolves.

Appendix 1. Synopsis of Developments in Relative Clause Formation in the History of English, along with Some Other Developments.

<i>Phenomenon</i>	<i>Stage</i>					
	1 (OE) (to 1100)	2 (EME) (1100– 1400)	3 (LME) (1400– 1550)	4 (EMnE) (1550– 1700)	5 (MnE) (1700– 1900)	6 (CE) (1900–)
<i>Relative clause</i>						
<i>introduced by:</i>						
Particle <i>þe</i>	yes	no	no	no	no	no
Demons. pronoun + <i>þe</i> (<i>that</i> in 2)	yes	yes	no	no	no	no
Demons. pronoun (declinable)	yes	—	—	—	—	—
Demons. pronoun (indeclinable)	—	yes	yes	yes	yes	yes
Interrogative pronoun	no	coming	yes	yes	yes	yes
<i>Shared nominal</i>						
<i>retainable</i>						
Obligatorily if not subject & no rel.						
pronoun	yes	going	no	no	no	no
Next to rel. pron.	yes	yes	going	no	no	no
Elsewhere	yes	yes	yes	no	no	no

²¹ The reader may have noticed that we do not discuss the putative effects of the interaction of structure learning and perception with the system of speech production. This is not because we think that such effects do not exist, but because the system of speech production has been largely unstudied.

*Subject rel. pron.**form obligatory:*

On clause initial

preverbal nouns	yes	yes	yes	yes	yes	yes
On obj. nouns	no	no	no	coming	yes	yes
On subjects of existential & cleft sentences	no	no	no	no	coming	yes
In interr. cleft sentences	no	no	no	no	no	coming
Nom./Acc. distinction	yes	going	no	no	no	no
Verb inflection	yes	yes	going	residual	residual	residual

Appendix 2. Examples by Stages.*Stage 1*(1) *Relative clauses containing shared nominals*

- a. Nænig forþum wæs, þæt he æwiscmod eft siþade. (V 59)
'No one previously was there, that afterwards departed ashamed.'
- b. þonne fisc þe . . . mine geferen mid anum slege he mæg besencean. (V 59)
'than a fish that . . . can sink my companions with one blow'
- c. Se god . . . þe þis his beacen wæs. (V 58)
'the god whose beacon this was'
- d. We, þe us befæst is seo gyming Godes folces. (V 523)
'we to whom is entrusted the care of God's people'

(2) *Relative clauses introduced by se, þe and se þe*

- a. Geseoh þu, cyning, hwelc þeos lar sie, þe us nu bodad is. (Bede's Ecclesiastical History)
'Consider, king, what doctrine this is, which now is preached to us.'
- b. He þæt beacen geseah þæt him geiweð wearþ. (S 118)
'He saw the beacon that was shown to him.'
- c. Ond gif þu forþ his willan hearsom beon wilt, þone he purh me bodað ond læreþ, . . . (Bede's Ecclesiastical History)
'And if you henceforth are willing to be obedient to his desire, which he claims and teaches through me, . . .'
- d. Ure ieldran, þa þe þas stowa ær hioldan, hie lubodon wisdom. (Pastoral Care, Preface)
'Our forebears, who previously possessed these places, they loved wisdom.'

(3) *Relative clauses introduced by zero*

- a. Hwa is þæt þe slog? (C 16)
'Who is that [who] smote thee?'
- b. Sum welig man wæs hæfde sumne gerefan. (C 25)
'There was a rich man [that] had a steward.'
- c. Alle mæhtiga þæm gelefes. (C 180)
'All things are possible to him [who] believes.'

- d. Se fæder hire sealde ane þeowene Bala hatte. (J 133-4)
'Her father gave her a maid [who] was called Bala.'
- e. Her on þys geare gefor Ælfred wæs æt Baþum gerefa. (J 133)
'In this year died Alfred [who] was reeve at Bath.'¹
- f. se þæt wicg byrþ (V 537)
'He [whom] that steed bears'
- g. Wiste forworhte þam he ær wlite sealde (V 537)
'He knew to be guilty those [to whom] he previously had given beauty.'
- h. Bed him þet he scolde him giuen ealle þa minstre þa hæpen men hæfden ær tobroncon. (V 536)
'He asked him to give him entirely the monasteries [that] the pagans had earlier destroyed.'

Stages 2-3

(1) *Shared nominal immediately following relative pronoun*

- a. Ther no wight is *that he* no dooth, or sei that is amys (V 59; Chaucer, *Canterbury Tales*)
'There is no person who does not do or say what is wrong.'
- b. He knew sir Blamour de Ganys *that he* was a noble knyght. (V 59; Malory, *Morte d'Arthur*)
'He knew Sir Blamour de Ganys, who was a noble knight.'

(2) *Shared nominal separated from relative pronoun*

- a. Our Lord *that* jn hevene ne Erthe *he* hath non pere. (V 59; Merlin)
'Our Lord that has no equal in heaven and earth.'
- b. a jantyllwoman *that* semeth *she* hath grete nede of you. (V 59; Malory, *M. d'A.*)
'a gentlewoman who seems to have great need of you'
- c. It was þat ilk cok *þat* peter herd *him* crau. (V 59; Cursor Mundi)
'It was the same cock that Peter heard crow.'
- d. seynt lucie . . . , *þat* þe holy gost made *hire* so hevy þat sche myght not be draw . . . to þe bordelhous. (V 522; ab. 1400)
'Saint Lucia . . . whom the Holy Ghost made so heavy that she might not be drawn to the brothel.'
- e. And this man began to do tristely in the synagoge, *whom* whanne Priscilla and Aquila herden, they token *hym*. (V 522; Wyclif)
'And this man began to behave sadly in the synagogue, who when Priscilla and Aquila heard, they took.'

(3) *Subject relative pronoun omitted*

- a. He sente after a cherl was in the toun. (V 12; Chaucer, *C. T.*)
'He sent after a fellow [who] was in the town.'
- b. Ye ryde as coy and stille as dooth a mayde, Was newe spoused. (W 41; Chaucer *C.T.*)²
'You ride as coy and quiet as a maid does [who] was newly married.'
- c. Ther was noon auditour coude on him winne. (J 146; Chaucer, *C.T.*)
'There was no listener [who] could beat him.'

¹ Notice that in these examples, the relative clause without an introducer modifies a subject nominal that has been inverted with its verb.

² See fn. 1 above.

- d. This is the loue bes neuer gan. (C 184; Cotton MS)
'This is the love [that] never perishes.'
- e. Whar es now Dame Dido was qwene of Cartage? (R 109; Parlement of the Thre Ages)
'Where is now Dame Dido [who] was Queen of Carthage?'
- f. Where is the lady shold mete vs here? (J 147; Malory)
'Where is the lady [who] should meet us here?'
- g. Lete fetch the best hors maye be founde. (J 143; Malory)
'Go fetch the best horse [that] may be found.'
- h. With a knyght full sone she mette hyght Syr lucan de bottelere. (V 12; Malory)
'She soon met a knight [who] called himself Sir Lucan de Bottelere.'

(4) *Object relative pronoun omitted*

- a. Sir be pe feith I haue to yow . . . (V 538; Cursor Mundi)
'Sir, by the faith [that] I have to you . . .'
- b. The tresor they hadden, he it him reft. (V 538; Brunne Chronicle)
'The treasure [that] they had, he took it from them.'
- c. He had a sone men cald Ector. (V 538; Brunne Chronicle)
'He had a son [that] men called Ector.'

Stage 4

(1) *Subject relative pronoun omitted on object noun*

- a. My father had a daughter lov'd a man. (J 143; Shakespeare, *Two Gentlemen* ii, 4, 110).
- b. I see a man here needs not live by shifts. (J 143; Shakespeare, *Comedy of Errors* iii, 2, 186).
- c. I've done a deed will make my story quoted. (J 143; Otway)
- d. I bring him news will raise his drooping spirits. (J 143; Dryden)

(2) *Subject relative omitted on nouns introduced by expletive constructions*

- a. Some men there are loue not a gaping pigge. (J 134; Shakespeare, *Merchant of Venice* iv, 1, 47)
- b. There's one did laugh in's sleepe. (J 146; Shakespeare, *Macbeth* ii, 2, 24)
- c. 'Tis the God Hercules, whom Antony loued, Now leaves him. (J 145; Shakespeare, *Antony and Cleopatra* iv, 3, 16)

Stage 5

(1) *Same as Stage 4 (1), but alleged "archaisms" (J 144)*

- a. I had several men died in my ship. (J 147; Swift)
- b. I will advance a terrible right arm Shall scare that infant thunderer, rebel Jove.
(J 144; Keats)
- c. You beat that great Maryland man was twice your size. (P 1001; Thackeray)
- d. I knew an Irish lady was married at fourteen. (P 1002; Meredith)³

(2) *Same as Stage 4 (2)*

- d. 'Tis thy design brought all this ruin on us. (J 144; Dryden)
- e. See who it is lives in the most magnificent buildings. (J 145; Fielding)

³ This example is not to be interpreted as containing a complement, according to the secondary sources.

- f. 'Tis I have sent them. (J 145; Hardy)⁴
g. Grandpa, what is it makes your eyes so bright and blue like the sky? (V 13; G. Cannan (1913))

Appendix 3. Formal Account of Each Stage.¹

Stage 1

a. Relative Clause Formation:

$$\begin{array}{ccccccccccc} [s, [sX_1[Nom_i X_2, \phi],]_{Nom_i} X_3]_{S,}, [sX_4[Nom_i X_5]_{Nom_i} X_6]_{S,}]_S & & & & & & & & & & \\ 1 & 2 & 3 & 4 & 5 & 6 & 7 & & & & \\ \phi & 2 & (be) + 6 & 4 & \phi & \phi & \phi & & & & \Rightarrow \end{array}$$

b. Relative Clause Reduction:

$$\begin{array}{ccccccc} X_1[Nom_i X_2[s[Nom_i X_3]_{Nom_i}, Tense + be, X_4]_{S}]_{Nom_i} X_5 & & & & & & \\ 1 & 2 & 3 & & & & \\ 1 & \phi & 3 & & & & \Rightarrow \end{array}$$

c. Relative Pronoun Formation:

$$\begin{array}{ccccccc} X_1[Nom_i X_2[s, \phi, (be) X_3, [Nom_i X_4]_{Nom_i} X_5]_{S}]_{Nom_i} X_6 & & & & & & \\ 1 & 2 & 3 & 4 & & & \\ 1 & se_i & 3 & 4 & & & \Rightarrow \end{array}$$

Conditions: (i) Not applicable in case neither X_3 nor X_5 contains an unembedded instance of Tense.

(ii) Obligatory in case X_6 begins with a Verb and $3 = \phi$.

d. Shared Nominal Deletion:

$$\begin{array}{ccccccccccc} X_1[Nom_i X_2[s, (se_i), (be), X_3, [Nom_i X_4]_{Nom_i}, X_5]_{S}]_{Nom_i} X_6 & & & & & & & & & & \\ 1 & 2 & 3 & 4 & 5 & 6 & & & & & \\ 1 & 2 & 3 & 4 & \phi & 6 & & & & & \Rightarrow \end{array}$$

Conditions: (i) Not applicable in case $2 = \phi$; $3 \neq \phi$; $4 \neq \phi$.

(ii) Obligatory in case $2 = \phi$; $3 = \phi$.

Stage 2

- a. Same as Stage 1.
b. Same as Stage 1.
c. Add condition:

⁴ Jespersen (1927, 145) points out that a number of authors who use the accusative of the predicate nominal pronoun in simple sentences like:

- (i) 'Tis me.

use the nominative (as in (2f)) when the pronoun is followed by a relative clause with the subject relative pronoun omitted. This observation provides additional independent evidence for the interaction of strategy (22) on grammar.

¹ Note that nothing special about the history of the Relative Clause Reduction rule (18b) need be mentioned, given our decision to order that transformation before the rule of Relative Pronoun Formation (18c). The rule has remained optional in all environments throughout the entire history of English. If we were to remain with our earlier decision to have the rule follow Relative Pronoun Formation, we would find that the rule would have to be stated differently for each of the last two stages. We shall not discuss developments concerning the rule of Modifier Preposing.

(iii) Obligatory in case *pe* is present.

Change se_i to $\left\{ \begin{matrix} that_i \\ Interr_i \end{matrix} \right\}$

d. Omit Condition 1.

Change se_i to $\left\{ \begin{matrix} that_i \\ Interr_i \end{matrix} \right\}$

Stage 3

a. Omit (*pe*) from structure change.

b. Same as Stage 1.

c. Omit (*pe*) from structure index. Omit Condition (iii).

d. $X_1[Nom_i X_2[S, \left\{ \begin{matrix} that_i \\ Interr_i \end{matrix} \right\}, X_3, [Nom_i X_4], S_5]_{S, Nom_i X_6}$

I	2	4	5	6	\Rightarrow
I	2	4	ϕ	6	

Conditions: (i) Obligatory in case 4 = ϕ .

(ii) Obligatory in case 2 = ϕ .

Stage 4

a. Same as Stage 3.

b. Same as Stage 1.

c. Same as Stage 3.

d. Replace Conditions (i) and (ii) by:

(i) Obligatory

Stage 5

a. Same as Stage 3.

b. Same as Stage 1.

c. $X_1[Nom_i X_2[S, \phi, X_3[Nom_i X_4]_{Nom_i X_5}]_{S, Nom_i X_6}$

I	2	3	\Rightarrow
I	$\left\{ \begin{matrix} that_i \\ Interr_i \end{matrix} \right\}$	3	

Conditions: (i) Same as (i) in Stage 1.

(ii) Obligatory in case X_6 begins with a Verb and $X_3 = \phi$.

(iii) Obligatory in case $X_1 =$ Nominal Verb, but when Nominal is not an expletive such as *there* or *it*, and $X_3 = \phi$

d. Same as Stage 4.

Stage 6

a. Same as Stage 3.

b. Same as Stage 1.

c. $X_1[Nom_i X_2[S, \phi, X_3[Nom_i X_4]_{Nom_i X_5}]_{S, Nom_i X_6}$

I	2	3	\Rightarrow
I	$\left\{ \begin{matrix} that_i \\ Interr_i \end{matrix} \right\}$	3	

Conditions: (i) Same as (i) in Stage 1.

(ii) Obligatory when $X_3 = \phi$, except when $X_2 = \phi$ and $X_1 = \text{Interr it Tense} + be^2$

d. Same as Stage 4.

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² For those speakers of Contemporary English who, unlike us, find (24b, c) also ungrammatical, Condition (ii) lacks the *except*-clause.

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