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Constraints on constraints, or the limits of functional adaptation

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Abstract

The functional approach to typology often appeals to processing pressures in order to explain universals. This paper examines a case where the match between a processing asymmetry and a typological asymmetry is *not* one-to-one — a case where the functional approach appears to fail. For a particular typology of relative clauses, the psycholinguistic literature suggests two asymmetries: accessibility and parallel function. Only the former shows up as an implicational universal.

I argue that the innate language acquisition device imposes a constraint on the *adaptability* of language. This means that a language that had evolved through a process of linguistic selection to respond to parallel function could not in fact be acquired or represented. In this view all mismatches between processing and cross-linguistic asymmetries are the expected outcome of *meta*-constraints on cross-linguistic universals.

The functional approach to language typology (see, e.g. Croft 1990) often highlights the *fit* of universals to language processing.[1] My use of the term "fit" here is parallel to that in evolutionary biology, where a structure is fit if there it appears to be designed for some function (see Cziko 1995 for further discussion). In the functional-typological view, a cross-linguistic asymmetry is explained if a matching psycholinguistic asymmetry is found.[2]

This approach to explanation raises some interesting questions which this paper will explore:

- Exactly how does a feature of processing end up being expressed cross-linguistically?
- How complete are explanations that appeal to function?
- What are their limitations?
- How does function interact with innateness?

I will briefly present an answer to the first question above, which will allow us to meaningfully ask the following two, the answers to which will in turn have repercussions on the roles of both functional and formal approaches to explaining language universals.

The order of presentation will be: an examination of relative clauses from a typological and psycholinguistic perspective; a review of previous work on the link between processing and universals with respect to relative clauses highlighting a problematic mismatch between the two; a formal account of the relative clause constructions which explains this mismatch; and finally, discussion of two apparent counter-examples in Hopi and German.

1 Relative clauses

In the typological work of Keenan & Comrie (1977), relative clauses are categorised according to the grammatical function of the trace, or resumptive pronoun, within the subordinate clause. So, for example, the following sentences exemplify the first two positions on a hierarchy of relative clause types:

Subject: *The man who found me saw Ruth*

[1] Much of the material presented in this paper appears in an extended form in Kirby 1996b.

[2] I am particular interested here in functional explanations that relate to language processing. The general approach proposed will be equally applicable to other types of functional explanation, however.

Object: *The man who I found saw Ruth*

Any such categorisation is based on choices about what is relevant to typology, and what is not. It could be argued that a categorisation on the basis of the number of phonemes in the subordinate clause is equally valid, for example. It is unlikely that this would illuminate any particularly interesting cross-linguistic facts, however. In this section, the categorisation of relative clauses will be enriched by taking into account the grammatical function of the head noun in the matrix clause. This is also an available option and, as will be seen, it is commonly discussed in the psycholinguistic literature.

If our attention is restricted solely to the grammatical functions subject and object the following four categories of relative clause are distinguished:

Matrix subject, subject relative: *The man who found me saw Ruth*

Matrix subject, object relative: *The man who I found saw Ruth*

Matrix object, subject relative: *Ruth saw the man who found me*

Matrix object, object relative: *Ruth saw the man who I found*

A notation of the form XY will be used to signify a relative clause whose head noun has the function X in the matrix clause and whose trace, or resumptive pronoun, has the function Y in the subordinate clause. The four sentences above are examples of SS, SO, OS and OO respectively.

Given this taxonomy of relative clauses, are there any psycholinguistic differences between the various types? A study by Keenan & Hawkins (1987) looks at native English speakers' 'mastery' of relative clauses dependent on the function of the trace in the subordinate clause, using a repetition task. In their work Keenan and Hawkins make no mention of matrix function so we can characterise their results as follows on the assumption that their results should be generalisable to all relative clauses:

Accessibility $\{SS, OS\} > \{SO, OO\}$

The first experiments on the role of matrix function *and* subordinate function were carried out by Sheldon (1974). She used an enactment task with English-speaking children and showed that relative clauses were easier to process if the matrix function of the head matched the function of the trace in the subordinate clause. The results of this study, then, are:

Parallel function $\{SS, OO\} > \{OS, SO\}$

This result has proven hard to replicate (MacWhinney & Pleh 1988) and many studies have been carried out that give other rankings of structures in English. For example, DeVilliers *et al.* (1979) gives the results $\{SS, OS\} > OO > SO$ with a similar enactment task. Clancy *et al.* (1986:252) summarise the results of Sheldon (1974) and Tavakolian (1981) for their five-year-old subjects as giving evidence for $SS > OO > OS > SO$, which is in accord with their own study of Korean.

MacWhinney (1982); MacWhinney & Pleh (1988) review nine different enactment studies and note that "the results show remarkable consistency for the pattern $SS > \{OS, OO\} > SO$" (MacWhinney & Pleh 1988:117). They also cite studies of French and German (Kail 1975; Sheldon 1977; Grimm *et al.* 1975) that lend support to this ranking. Their own study of Hungarian also bolsters this ranking, at least for unmarked word orders.

Clearly, this is a controversial area, and many different factors have been proposed to account for the rankings. However, the results given above, although appearing to be in conflict, are not inconsistent with an interaction of both parallel function and accessibility. To see this, consider the two possible combinations of these factors. Either accessibility will be a more important factor than parallel function or vice versa:

Accessibility>Parallel function $SS > OS > OO > SO$

Parallel function>Accessibility $SS > OO > OS > SO$

All the rankings discussed so far are compatible with one of these possibilities (in other words, there are no predicted differences in any of the results that are not also predicted by one of the two rankings above). It is quite possible that *both* of these rankings are correct, and other factors relating to particular experimental materials such as the sentences under investigation mean that either accessibility or parallel function becomes the more important factor. If this is the case then over all possible relative clauses the ranking would be:

Accessibility=Parallel function $SS > \{OS, OO\} > SO$

This is the same as the ranking of MacWhinney & Pleh (1988), although they do not argue for a combined accessibility/parallel function account of their results.

Before continuing, it should be pointed out that there is a methodological difference here. Accessibility has been given support by Hawkins' independent complexity theory discussed

in Hawkins (1994), whereas parallel function (or any other possible determinant of processing difficulty) is not supported in this way. This might suggest that accessibility is after all the only factor influencing relative clause complexity. The problem with this is that it fails on its own to predict (although it is consistent with) the psycholinguistic results, particularly the result on which there is least disagreement: that SO relatives are harder to process than any others. It is not easy to work out what other universal principles are in operation, but clearly there is something more than accessibility at work. Let us assume for the moment that parallel function is a relevant factor as regards processing of relative clauses.

2 The selection model

As already noted, the functional approach to typology highlights the importance at looking at factors such as accessibility and parallel function above in examining language universals. In particular language is viewed as *adaptive* in the sense that it reflects functional/processing considerations in its structure. Kirby (1994, 1996a, 1996b) examines in detail the problem of exactly *how* a processing asymmetry might come to be reflected in the cross-linguistic distribution of language types — how functional adaptation might occur.

At the centre of the model is the suggestion that universals are emergent properties of a dynamic system. Just as Keller (1994) sees individual language changes as emergent properties of an "invisible hand" process, so too are language universals higher order emergent properties of a similar process. The local, individual actions of many speakers, hearers and acquirers across time and space conspire to produce non-local, universal patterns of variation. This view is in contrast to one in which language universals are pre-coded or hardwired in some sense. However, as we shall see later, this does not rule out the influence of a hardwired, or pre-coded influence on the process of emergence.

INSERT FIGURE 1 NEAR HERE

In this view, the influence of processing on language competence is a selective influence. Essentially, functional pressures affect the selection for production or acquisition of competing variant forms that exist in a particular speech community. In order to see how this selection works it is useful to think of the cycle of language acquisition and use as a sequence of transformations that map the competence of a speaker at time t_1 to the competence of a

speaker in the same speech community at some later time t_2. Functional selection influences this transformation in a probabilistic fashion.

Figure 1 shows the transformations involved that are proposed to be relevant by Kirby (1996a). (Interestingly, this map of transformations is almost identical to that discussed by Lewontin (1974, cited in Sober 1984) in relation to biological evolution.) The transformation from competence to competence involves objects in two different domains, commonly referred to as *I-language* and *E-language* in the generative literature. The former (Internalised language) consists of objects in individual speakers' brains and, along with the transformation **T4** (acquisition), are what Chomsky (1986) argues are the proper target of study for linguistics.

Functionalists tend to be more concerned with the objects that exist in the latter domain (Externalised language). This is the domain in which utterances — acoustic waveforms, gestural movements, etc. — exist. The transformation **T2** involves features of the world at particular points in time such as the level of noise, the arrangement of speakers and hearers and so on. Hurford (1990) has coined the phrase "Arena of Use" for this external domain and its transformations.

Of particular interest to us are the transformations **T1** and **T3** that map between *E* and *I*-domains; the former corresponds to production and the latter to parsing. Here, then, is the place where processing considerations can influence the dynamic system. Mirroring evolutionary biology this influence is viewed as selective. In other words, the psychological mechanisms that map between domains tend to filter-out forms. So, a particular speaker may have a number of different ways in which to produce a particular message. Similarly, an acquirer may only employ a subset of her total linguistic experience as trigger for acquisition.

This brief discussion can only give a flavour of the selection model. Kirby (1996b) demonstrates that a formal computational implementation of the model allows us to test exactly what universals will emerge given a particular set of processing pressures, and shows how the time-course of changes predicted mirrors the S-shape curves found by Kroch (1989) among others. Of relevance to this paper is a particular result relating to relative clauses, which is summarised below:

Given two relative clause types X and Y such that X is easier to parse than Y, then

a robust constraint on cross-linguistic variation will emerge such that $Y \rightarrow X$.[3]

We can now go and test this result against the two processing asymmetries reviewed in the previous section: accessibility and parallel function.

3 A failure of the functional approach

Given the theoretical conclusion above, we should find an implicational universal $(OO \vee SO) \rightarrow (SS \vee OS)$ corresponding to the psycholinguistic accessibility asymmetry $\{SS, OS\} > \{SO, OO\}$. In order to test any such predicted universal, we can re-write the implication as $(SS \vee OS)\&\neg(OO \vee SO)$. The language types that we expect to find if accessibility influences the selection of relative clauses are therefore:

1. $SS\&\neg OO$
2. $SS\&\neg SO$
3. $OS\&\neg OO$
4. $OS\&\neg SO$

As is well known, Keenan & Comrie's (1977) accessibility hierarchy explicitly states that all these language types exist:

> "For each position on the AH,
>
> [Subject>Direct Object>Indirect Object>Oblique>Genitive> ...]
>
> there are possible languages which can relativise that position with a primary strategy, but cannot relativise any lower positions with that strategy." (Comrie & Keenan 1979:653)

As pointed out above, in principle there is no reason why any other asymmetrical pressure on the processing of relative clauses should not also give rise to an implicational universal. The influence of parallel function $\{SS, OO\} > \{OS, SO\}$ should give rise to the universal

[3]Interestingly, Kirby (1996a) shows using simulations that this will only hold if there is a pressure on speakers to be concise, as well as a parsing pressure, and that these "competing motivations" are not fixed relative to one another.

$(OS \vee SO) \rightarrow (SS \vee OO)$. This can be re-written as a conjunction: $(SS \vee OO)\&\neg(OS \vee SO)$. Evidence for parallel function cross-linguistically should come as the following language types:

1. $SS\&\neg OS$
2. $SS\&\neg SO$
3. $OO\&\neg OS$
4. $OO\&\neg SO$

The second type corresponds to the second type giving evidence for accessibility and turns up as Iban, for example. The first, third and fourth types have not been found (although see the following section for apparent counter-evidence).

There is therefore no currently available evidence for parallel-function showing up cross-linguistically (although proving that some language type does *not* exist is impossible). Perhaps the problem is that the processing pressures are being considered in isolation, whereas we have argued that a combination of accessibility and parallel function is acting on the processing of relative clauses. The complexity hierarchy $SS > \{OS, OO\} > SO$ should give rise to the implicational universals:

$$SO \rightarrow (OS \vee OO)$$
$$SO \rightarrow SS$$
$$(OS \vee OO) \rightarrow SS$$

In turn these can be re-written as conjunctions:

$$(OS \vee OO)\&\neg SO$$
$$SS\&\neg SO$$
$$SS\&\neg(OS \vee OO)$$

The predicted types are therefore:

1. $OS\&\neg SO$
2. $OO\&\neg SO$
3. $SS\&\neg SO$

4. $SS\&\neg OS$

5. $SS\&\neg OO$

Once again, some of these types do occur (1, 3 and 5), but these are simply the ones that we have evidence for from the work on the accessibility hierarchy. The critical types regarding the added influence of parallel function are 2 and 4, and there is currently no evidence for the existence of these language types.

This poses serious problems for the functional approach. There is nothing in the theory that can explain why accessibility has cross-linguistic implications, but parallel function has not. It seems that the explanations put forward here suffer from being ad hoc, a common criticism of functional explanations (see, e.g. Lass 1980).

4 Innate constraints on adaptation

The failure of parallel function to show up cross-linguistically seems to be a fatal blow for functional explanations but this is because we have so far only been looking at one side of the coin as regards the adaptive nature of language. So far, we have only been concerned with the transformations **T1** and **T3** (production and parsing) in figure 1. In the simulation result reported in section 2, the relationship between trigger and competence (**T4**) was treated as a simple mapping. This is clearly a gross simplification of what is actually going on in acquisition, but it is justified inasmuch as we believe that the function mapping trigger onto competence does not affect the viability of variant forms over time. Furthermore, though less obviously, it also rests on an assumption that the medium of representation of competence does not also affect variant viability.

It is quite possible that something about the process of acquisition distorts the distribution of variants in more profound ways than assumed so far. This might be due to constraints imposed by the acquisition device, or it might be due to constraints imposed by the nature of competence itself. In other words, the structure of a grammatical meta-language may not in fact be able to accurately represent features of the trigger experience. If this were true then certain *constraints on adaptation* should be expected.

4.1 Constraints on adaptation in biology

Before going on to explore the implications of constraints imposed by acquisition or competence, it might be useful to look at a similar problem that crops up in another field of complex adaptive systems.

The adaptive nature of forms in the biological world has much in common with the adaptive nature of language. Both exhibit, to some extent, a striking 'fit' of form to function which inevitably leads us to look for an explanation of that form in terms of function. Although there are a number of crucial differences, the theory that links function and form in language proposed here has much in common with neo-Darwinian selection theory (see Nettle in this volume). Indeed, both areas have their generalised form in a theory of complex adaptive systems (Gell-Mann 1992; §2.2.3). It will be instructive, therefore, to look at a couple of cases of mismatches between form and function in biological evolution discussed by Gould (1983:147–165).

4.1.1 The non-occurrence of a form

Imagine you are an engineer attempting to design some mechanism for moving a machine efficiently over a flat surface. A good design would maximise the distance to work ratio of the machine. Given enough time it is likely that you would plump for a design that has been used by engineers time and time again to solve this very problem: the wheel.

Wheels are functional because they minimise friction when a body is moving over ground, and they stay with the body as it moves (unlike rollers). Although they are not as versatile as legs, for example, in terms of the terrain they can cross, the bicycle is a good example of the combination of the two that is amazingly effective at increasing the mobility and speed of a human being. Given that wheels are so functional — they are perfect examples of 'fit' between form and function — it is surprising that they are vanishingly rare in the biological world. Human beings are the only organisms with wheels, and even for us they are not part of our biological phenotype, but our "extended phenotype" in Dawkins's (1982) terms. In other words, we do not grow wheels, but have to fashion them from raw materials in our surroundings. Here then is an apparent failure of the theory of natural selection. The forms that occur across the biological kingdom do not live up to expectations; there is a mismatch between form and function.

The solution to this problem lies in the nature of wheels:

> "...a true wheel must spin freely without physical fusion to the solid object it drives. If wheel and object are physically linked, then the wheel cannot turn freely for very long and must rotate back, lest connecting elements be ruptured by the accumulated stress." (Gould 1983:160)

The problem for biological organisms is that the parts that make up the organism must be physically connected in order for nutrients to flow between them. As Gould points out, some of our bones are disconnected, but require a surrounding envelope of tissues preventing their free, or wheel-like, rotation.[4] It is impossible, then for biological wheels (as opposed to wheels made of non-living matter) to exist in the physical world due to a constraint on permissible forms.

> "Wheels work well, but animals are debarred from building them by structural constraints inherited as an evolutionary legacy. Adaptation does not follow the blueprints of a perfect engineer. It must work with parts available." (Gould 1983:164)

4.1.2 The occurrence of a non-functional form

As well as the possibility of an expected form not turning up in biology, Gould gives an example of an unexpected form that cannot be understood without looking at constraints on adaptation. The particular example may initially seem irrelevant to a paper on language universals, however as we shall see the similarities between this and the case of parallel function in relative clauses is striking.

The external genitalia of the female spotted hyena are remarkably similar to that of the male of species (so much so, that medieval bestiaries commonly assumed that the hyena was androgynous). This unusual similarity begs an explanation, although the selective advantage to the female of appearing to be male are rather hard to understand. One attempt at an explanation suggests that the female genitalia evolved for use in a meeting cer-

[4] It turns out that there is an exception to this rule. *Escherichia coli* has flagella that act like propellers. They are able to escape the constraint on physical connection only because of their small size. Nutrients and impulses are conveyed between the separate parts by diffusion.

emony, where typically more conspicuous structures would have an advantage in "getting the owner recognised". However, Gould points out:

> "Speculation about adaptive significance is a favourite ... ploy among evolutionary biologists. But the question 'What is it for?' often diverts attention from the more mundane but often more enlightening issue, 'How is it built?' " (Gould 1983:152)

Gould's argument runs that male and female hyena genitalia are similar because the embryological development of the structures follows the same course. In the genetically coded program for ontogenetic growth there is nothing that forces the female and male structures to differentiate.[5] The point is that we do not have to explain the existence of the occurrence of the female form — it is forced on the hyena by constraints on the pathways of embryological development.

4.2 Formal constraints on relative clauses

The examples from biology show that the adaptation of forms to fit some function can be limited by physical constraints on morphogenesis. This can mean that an expected form does not show up, and, more unexpectedly, that non-functional forms can exist. This means, as Gould argues forcefully, that it is not possible to simply equate function with form. Mismatches are the expected outcome of the system into which adaptive changes must be born.

For the hyena, the external sexual characteristics of the female are forced upon her by physical constraints on embryological development; they are a side-effect, if you like, of the existence of similar structures in the male of the species. Can a similar argument be used to explain why it is not possible to get a parallel function relative clause without also getting the non-parallel function equivalent? If so, the absence of the expected cross-linguistic asymmetry should not cause us to reject the functional approach.

There must be something about the transformation from trigger experience to competence (the transformation mediated by a Chomskyan Language Acquisition Device) that forces the language user to acquire OS relatives whenever SS relatives are acquired, and

[5] Of course, it is not impossible for other similar organisms to have this differentiation coded in the genome (such as other species of hyena), however this entails reducing levels of hormones in the female of the species. Gould suggests that the high levels of the hormones in the female spotted hyena are adaptive in some other way.

SO relatives whenever OO relatives are acquired. The tree in figure 2 is the familiar formal representation of a relative clause. Although the details of this representation may vary slightly from one syntactic theory to another, the important characteristics for this argument are uncontroversial.

INSERT FIGURE 2 NEAR HERE

Firstly, notice that the trace dominated by IP, the wh-element in [Spec,CP] and the nominal head in DP are all related in some way. The interpretation of a relative clause such as *the man who I found* requires this. The relative pronoun *who* is related to the trace position (as can be seen by the *who/whom* distinction in certain registers of English); this is indicated by co-indexation. Furthermore, the head of the relative clause, *the man*, must be interpreted as being the logical object of the subordinate construction. The operator *who* in the relative clause is a referential expression standing in for the head noun, and sharing its ϕ-features. So, in many languages the relative pronoun agrees in person, number and gender with the head. This relation is also shown by co-indexation; in Principles and Parameters theory, the relationship between the head noun and the relative pronoun is actually assumed to be between the head noun and the 'chain' of wh-element and trace. Hence, all three are co-indexed.

The formal mechanisms by which these elements are related might vary from theory to theory. A standard assumption is that the wh-element has moved from the position of the trace in the subordinate clause. The head DP is in a "predication relation" with the CP, which inherits the trace of the wh-element in [Spec,CP] by some kind of generalised Spec-head agreement. Whatever the theory, there are two distinct operations going on: one relating trace and relative pronoun, and the other relating the head noun with the subordinate clause. It is unlikely that these two operations, predication and wh-movement, could be subsumed under one mechanism in any grammatical formalism.

Now, in general, there may be constraints on the operation of mechanisms such as predication and wh-movement. These may be universal in nature or language-specific, forming part of the native speaker competence for the language. If parallel function were to be realised cross-linguistically the language types $OO\&\neg SO$ or $SS\&\neg OS$ should show up. If such a language were to exist, it would fall to language-specific constraints on the operation of predication and wh-movement to express the grammaticality of the parallel function rel-

atives and the ungrammaticality of the non-parallel function variants. However, in order to express exactly these grammaticality facts any constraint on predication would need to be dependent on information about wh-movement, or vice versa.

However, it is generally assumed that an operation like predication cannot be sensitive to the internal structure of the CP, and similarly wh-movement cannot be restricted on the basis of structure outside of the CP. These two operations in this structure are informationally encapsulated from one another. This means that, if these grammatical facts are mirrored in the LAD, the predicted language types are actually impossible to acquire or represent in the I-domain of figure 1. If a child acquires competence in response to a parallel function relative, then she cannot help but also acquire competence for the non-parallel equivalent. If the non-parallel function form is made ungrammatical, then the parallel function variant goes too.

The transformation **T3** will tend to filter out the forms that are more complex to process. So, the theory of linguistic selection predicts that the proportion of, say, SO variants relative to OO variants that form part of the trigger should be lower than the proportion in the language data. However, given this differential distribution, the LAD (transformation **T4**) can only do one of two things: both variants can be made ungrammatical, or both variants can be made grammatical (figure 3). Even if *no* SO variants made it into the trigger, they could still be acquired by the child. We might say that the SO form is a *latent variant* in that it can be retained from generation to generation in the I-domain conceivably without ever being expressed in the E-domain.

INSERT FIGURE 3 NEAR HERE

4.3 Some apparent counter-evidence

The argument put forward in the previous section seems to explain why the functional explanation for the accessibility hierarchy does not generalise to other processing asymmetries in relative clause constructions. The whole approach is put into jeopardy, however, if there are any counter-examples to the encapsulation of principles outlined above. This section introduces two cases where a language appears to have responded at least partially to pressures from parallel function.

4.3.1 Hopi relative clauses

Hale *et al.* (1977) note that "it would appear that Hopi exhibits a curious limitation on the accessibility of noun phrases to relativisation". In matrix subject position, only subject relatives are acceptable; SO relatives are ungrammatical (Hale *et al.* 1977:400–401)[6]:

(1) a. mí' tiyó'ya 'acáta-qa pákmīmīya
that boy lied-QA$_1$ cry
'The boy who lied is crying'

b. 'itána mí-t tiyó'ya-t nī'í' tīíwa:-qa-t hoóna
our-father that-OBL boy-OBL I saw-QA$_3$ sent home
'Our father sent home the boy whom I saw'

c. nī'í mí-t tiyó'ya-t 'acáta-qa-t hoóna
I that-OBL boy-OBL lied-QA$_3$ sent home
'I sent home the boy that lied'

These examples are cases of an SS relative (1a), an OO relative (1b) and an OS relative (1c) respectively. The "missing" relative clause type is shown below (Hale *et al.* 1977:402):

(2) * mí' tiyó'ya nī'í' tīíwa:-qa-t pay níma
that boy I saw-QA$_3$ already went home
'The boy whom I saw has gone home'

This is what would be expected if Hopi was responding to parallel function and accessibility. The complexity hierarchy that was argued for in section 3, $SS > \{OO, OS\} > SO$, should give rise to the universals $SO \rightarrow (OS\&OO)$, $SO \rightarrow SS$ and $(OO \vee OS) \rightarrow SS$, all of which are true for Hopi. Critically, the ungrammatical type appears to show that there is some mechanism whereby the position of the RC in the matrix can constrain the position that can be relativised. This is precisely what was claimed to be impossible in the previous section. It is important, therefore, that the properties of the Hopi relative clause are examined carefully.

The element *-qa* in the Hopi relative clauses seems to act as a relativisation marker that phonologically binds to the subordinate verb. In fact for other reasons Hale *et al.* (1977)

[6]The examples are taken directly from the cited source, except that the names of the suffixes on QA have been changed to numbers for clarity. The optional resumptive pronouns have also been omitted for clarity.

argue that this element is not simply a relativisation marker or complementiser, but acts as the head noun of the relative clause. The details of this argument are unimportant here, however. The crucial feature of the QA element is that it is assigned case in a rather peculiar way. In order to predict the morphological marking on the QA element, it is necessary to know whether the subject of the subordinate clause is coreferential with the subject of the main clause as well as the grammatical function of the trace in the relative clause. The three possibilities are (considering the singular only):

1. /*-qa*/: coreferential subjects and subject relativisation
2. /*-qa-y*/: coreferential subjects and non-subject relativisation
3. /*-qa-t*/: otherwise

Only the first and third markings are apparent in the examples so far. The second type is exemplified by the OO relative (Hale *et al.* 1977:400):

(3) n̄í' taávo-t n̄í' niína-qa-y sísk^{w}a
I rabbit-OBL I killed-QA$_2$ skinned
'I skinned the rabbit that I killed'

This system of marking, although unusual, does not seem to help us explain the ungrammaticality of (2). Although SS relatives are uniquely marked as *-qa*, there is nothing in the case marking system that reliably distinguishes the other three types.

Another feature of the morphological marking of the sentences above, is that all the non-subject noun phrases are marked with an oblique case ending /*-t*/. Another possible oblique case ending is /*-y*/, although this is not present in these examples. [7] The morphology of the second and third QA suffixes now looks very like /*-qa*/+OBL, the choice of the two OBL forms being dependent on whether subjects are coreferential or not. In sentence (2), the noun phrase in subject position thus appears to terminate with an oblique ending. However, this runs counter to the surface fact in Hopi that subjects are unmarked. The ungrammaticality of the SO relative is therefore due to the incompatibility of the morphological rules that mark QA as oblique in SO relatives and require subjects to be unmarked for case.

[7] This is a considerable simplification of what is going on with the oblique in Hopi, although it does account for the data given here. See Hale *et al.* 1977, 394–402 for a more detailed account of Hopi relatives, based on traditional transformational assumptions.

Further evidence for the "surfacy" nature of this constraint can be found by looking at the extraposed variant of (2) (Hale *et al.* 1977:402):

(4) mí' tiyó'ya pay níma, n̄í' t̄íwa:-qa-t
the boy already went home, I saw-QA_3
'The boy has gone home, whom I saw'

This variant on the *SO* relative is grammatical in Hopi because the surface subject does not terminate with an oblique ending.

4.3.2 German free relatives

The second apparent counter-example comes from a sub-type of German relative clause constructions. The constructions in question are free, or headless, relatives — relative clauses lacking a head noun (see, e.g. Groos & van Riemsdijk 1979). Given that these constructions are rather different from the standard headed, restrictive relatives that we have been considering so far, it is not at all clear that the psycholinguistic results about relative processing complexity should apply. However, if these constructions exhibit a grammaticality constraint that involves the interaction of matrix function and subordinate function, then the argument put forward in the previous section about an innate limitation on the format of constraints will be put in doubt.

In fact, German free-relatives (at least for some native speakers) do exhibit just this kind of grammaticality pattern (Cann & Tait 1990:25):

(5) a. Ich muss wen du mir empfiehlst nehmen
I must who(acc) you to me recommend take
'I must take who you recommend to me'

b. * Ich muss wer einen guten Eindruck macht nehmen
I must who(nom) a good impression makes take
'I must take whoever makes a good impression'

c. * Ich muss wem du vertraust nehmen
I must who(dat) you trust take
'I must take whoever you trust'

The first sentence (5a) is an example of an *OO* free relative, whereas (5b) is an example of

an *OS* relative, and is ungrammatical. There is not a simple constraint allowing *OO* and not *OS*, however, since (5c) is an *OO* relative, but is also ungrammatical.

The pattern of grammaticality is predicted by comparing the morphological case of the relative pronoun, and the case assigned by the matrix verb. In (5a), the accusative relative pronoun matches the accusative case assigned by *nehmen*, but in the other examples there is a 'clash' between the case assigned by the verb and the morphological case of the relative pronoun. This does not explain what is going on in German, however, because the equivalent headed relatives are all grammatical:

(6) a. Ich muss den Mann den du mir empfiehlst nehmen
I must the man who(acc) you to me recommend take
'I must take the man who you recommend to me'

b. Ich muss den Mann der einen guten Eindruck macht nehmen
I must the man who(nom) a good impression makes take
'I must take the man who makes a good impression'

c. Ich muss den Mann dem du vertraust nehmen
I must the man who(dat) you trust take
'I must take the man who you trust'

The sentences (5a-c), then, seem to allow some way for information about the grammatical function of the trace to interact with information about the grammatical function of the complex noun phrase. This will be a problem for the theory if these free relatives are assigned a structure similar to that in figure 2.

INSERT FIGURE 4 NEAR HERE

Cann & Tait's (1990) analysis of these constructions suggests that this is not the case. The tree in 4 has the subordinate clause generated internal to the NP, rather than adjoined to DP. In this structure, the DP dominating the relative pronoun *wen* has moved from within the IP to [Spec,CP] as normal. This forms a chain (DP_i, t_i) which is assigned accusative case by *empfiehlst*. A further movement of *wen* to the head of the maximal DP is forced in the theory proposed by Cann and Tait. This movement is required to satisfy a phonetic-form licensing principle that has the effect of restricting the occurrence of phonetically-null nodes that do not form a part of a chain headed by a licensed node; in this case, the head of [DP,CP], the

noun, and the head of the maximal DP.[8] Given this obligatory movement, the maximal DP inherits the case carried by its head *wen*. The category DP cannot be assigned contradictory feature values, so given that the two chains formed by the movement transmit the accusative case feature to the relative pronoun, the entire DP cannot be assigned anything other than accusative case by the matrix verb and yield a grammatical sentence.

For most speakers, the extraposed variants of (5) are grammatical (Cann & Tait 1990:25):

(7) a. Ich muss nehmen, wen du mir empfiehlst
I must take who(acc) you to me recommend
'I must take who you recommend to me'

b. Ich muss nehmen, wer einen guten Eindruck macht
I must take who(nom) a good impression makes
'I must take whoever makes a good impression'

c. Ich muss nehmen, wem du vertraust
I must take who(dat) you trust
'I must take whoever you trust'

Cann & Tait (1990) suggest that the structure of the relatives must be an adjunction structure $_{DP}[DP\ \ CP]$ (in other words, like the structure in figure 2). It cannot be the same structure as given for the free relatives in situ because moving the CP to the post-verbal position would leave the relative pronoun behind in the clause. Given the same structure as was put forward for non-free relatives, we expect the matching constraint to be impossible and hence the grammaticality of the sentences (7a-c).

The only question remaining is why Cann & Tait (1990) do not propose the adjunction structure for the non-extraposed free relatives (5), and instead opt for CP being generated internal to NP. The answer is rather technical, and only a flavour of it will be given here. Essentially, the phonetic form licensing principle requires that the empty DP_2 in the free relative construction $_{DP_1}[DP_2\ CP]$ be *governed* by the relative clause, CP. Because DP_2 is part of an adjunction structure, the other segment of this structure DP_1 must also be governed. This

[8]This is not the place to discuss the details of Cann and Tait's phonetic-form licensing principle (PFLP), suffice to say that it is motivated by the need to constrain the set of functional projections that the language acquirer has to postulate by requiring every syntactic projection to have some phonological representation. It is interesting to note that this principle is very similar to Hawkins's (1994) Axiom of MNCC Existence, which holds that every mother node must have a phonetically non-null constructor.

is not possible if the CP is dominated by DP_1 as it is here. However, if the CP is extraposed then it is available as a governor of both segments of the DP. This problem of government is, on the other hand, not an issue with the structure given in figure 4 because the DP is not empty, and is therefore already phonetically licensed.

In summary, the German free-relative data, and the Hopi data appear to contradict the explanation given as to why parallel function does not show up cross-linguistically. A closer examination of the syntactic explanations for these language-specific phenomena reveals that this is not the case. The particular idiosyncrasies of the language and/or structure in question may allow the parsing preference to be realised grammatically after all. The message should be that the architecture of grammar cannot be ignored in assessing the cross-linguistic effects of functional pressures.

5 Implications for linguistic theory

The discussion in this paper has highlighted the importance of examining both processing considerations and formal models of syntax in explaining the origin of language universals. Both the parser and the innate language acquisition device leave their mark on language, but it is only by taking into consideration both mechanisms that the role of each can be uncovered. The diagram in figure 5 shows the different possible classes of language. E is the set of logically possible languages; L is the class of learnable languages, its boundary set by the innate language acquisition device; and F is the class of languages predicted to occur given the basic functional selection model. Obviously, the languages we should actually expect are those in $F \cap L$. Some of the languages predicted by the application of parallel function to the selection model do not occur because they are in the set $F \cap \overline{L}$. Similarly there may be languages that do not occur but are perfectly learnable in the set $\overline{F} \cap L$. These are ruled out by considerations of processing. I would argue that many of the language types that are barred by the universals in the typological literature are in this set. So, for example, a language with oblique relatives but no direct object relatives is ruled out because of the interaction of different processing complexity hierarchies in the Arena of Use. However, there is nothing that should lead us to believe that such a language is actually unlearnable.

INSERT FIGURE 5 NEAR HERE

This diagram fails to capture some of the more subtle interactions discussed here, however. We have seen that languages *can* arise that respond to parallel function, albeit in unexpected ways. The acquisition device in a sense provides ad-hoc solutions to the problem of representing in I-language the pressure exerted by processing on E-language. What these 'solutions' will be is fairly predictable, although sometimes the outcome is unexpected. Hopi, because of the idiosyncrasies of its morphology (resulting in an interaction of the switch-reference behaviour of the relative pronoun and subject case marking) has a mechanism for coding a constraint on the matrix function of object relatives. Can we say that this is an adaptation to the pressure exerted by the parser against SO relatives? We cannot tell, although we might expect that there would be a pressure to change Hopi morphology if SS relatives were made impossible.

The processing mechanisms make selections among utterances, and those selections cannot inform the acquisition device except by filtering input from the trigger. The resulting changes in the grammar of the language may lead to the removal of the particular structures that cause problems for processing, but they may not. If we are to gain a deeper understanding of the origins of universals we need to look for all the processing pressures that might be involved *and* what role the effect of those pressures on the trigger might play in the process of acquisition. The advantage of this approach is that troublesome counter-examples from the functional perspective may be mitigated by looking into constraints imposed by the architecture of grammar; from another perspective the burden of explaining all constraints on distribution uncovered by typology can be lifted from a theory of the structure of an innate UG.

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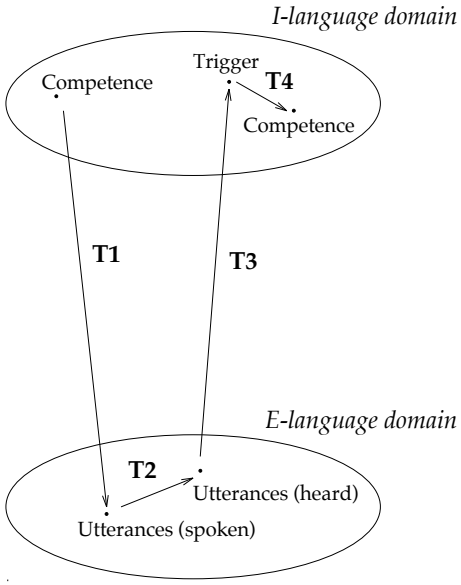

Figure 1: Transformations within and between *I*- and *E*-domains.

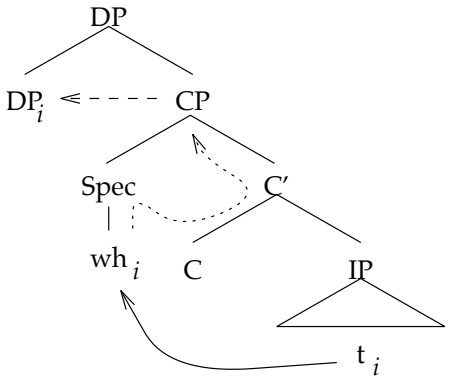

Figure 2: The structure of an abstract relative clause.

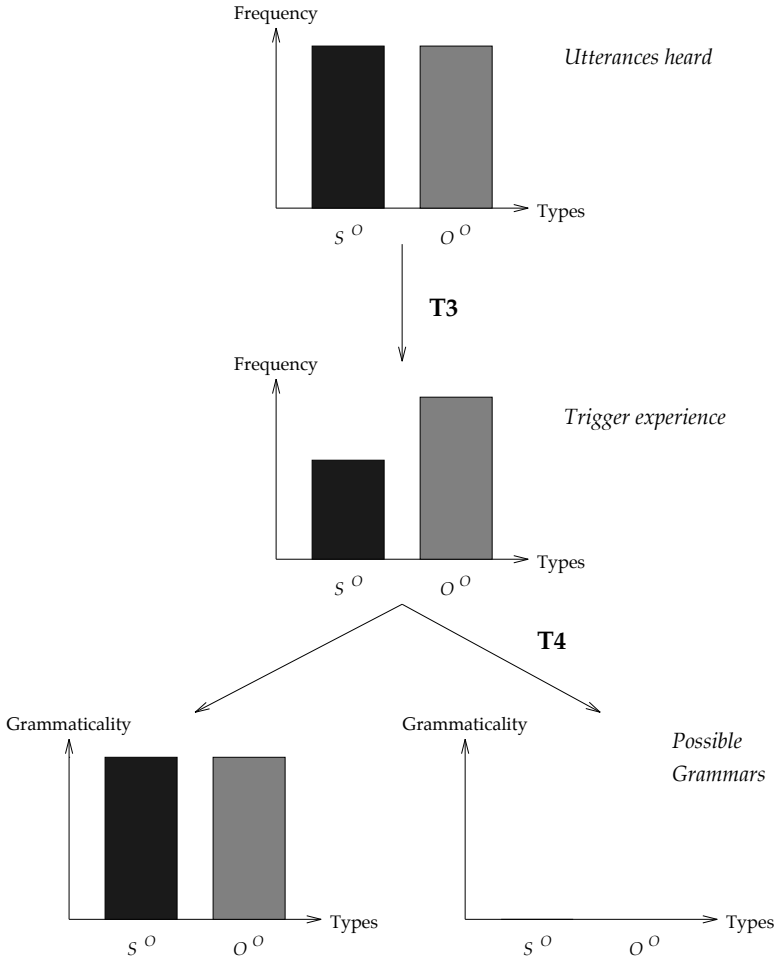

Figure 3: The possible pathways of SO and OO variants.

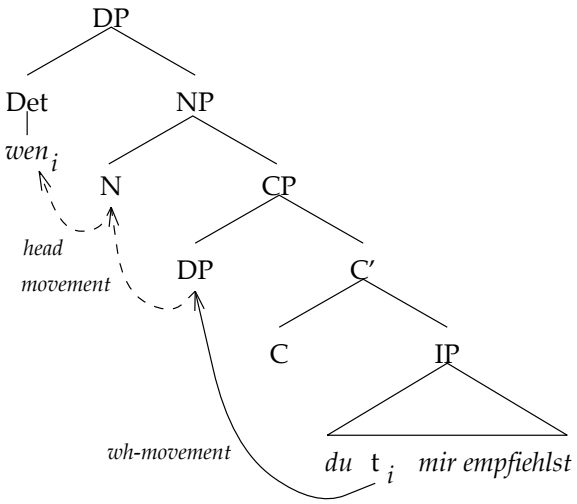

Figure 4: The structure of a German free relative.

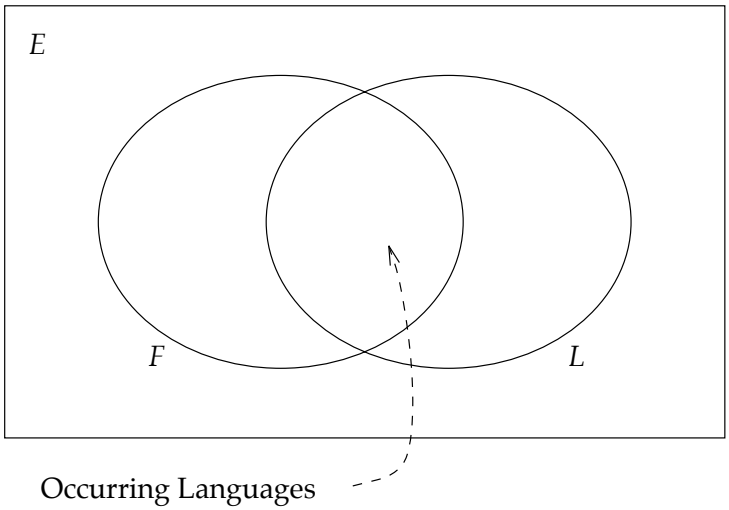

Figure 5: Interacting constraints on possible languages.