

Patterns of Relativization and Recent Formulations of Markedness

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1 Introduction

A subject-object asymmetry in humans' processing of relative clauses has been well documented (Gordon et al. 2001a). Gordon et al. (2001a) find, as others have, that object extraction is more taxing on language processing than subject extraction is. In the examples below, (1a) is an example of subject extraction, and (1b) is an example of object extraction.

- (1) a. The lawyer [that praised the doctor] climbed the mountain.
b. The lawyer [that the doctor praised] climbed the mountain.

In each sentence, the embedded relative clause is enclosed in square brackets. Relative clauses in English are adjoined to a preceding noun phrase (*the lawyer* in both examples above). In each relative clause, a grammatical element is missing from the embedded clause: note that *praised the doctor* in (1a) lacks a subject, and *the doctor praised* in (1b) lacks an object. This missing element is understood to be the same as the NP to which the relative clause is adjoined. Semantically, (1) can be interpreted as (2).

- (2) a. The lawyer [that {the lawyer} praised the doctor] climbed the mountain.
b. The lawyer [that the doctor praised {the lawyer}] climbed the mountain.

The sentences in (1) differ in that the gap in the embedded clause is in subject position for (1a) (hence “subject extraction” or a “subject relative”) and in object position for (1b) (“object extraction” or an “object relative”). Crucially, both sentences have exactly the same words. Only their orders and respective meanings differ.

Gordon et al. (2001a) report that in reading time experiments, subjects take longer to read object relatives than subject relatives¹. This is a processing phenomenon. The asymmetry is not a grammatical one, as both subject and object relative clauses are grammatically acceptable in English and appear in standard corpora of English usage. This paper examines linguistic explanations for the subject-object asymmetry. Three competing views on language

¹Gordon et al. (2001a) also report that the use of names and pronouns rather than full nouns such as *the lawyer* and *the doctor* influence reading times. Proposals that deal with this phenomenon will not be discussed here.

processing are considered, one dealing with linguistic markedness and the other two focusing on module interaction in language processing. I show that the subject-object asymmetry is a consequence of markedness features that can be modeled in an Optimality Theory (OT; Prince and Smolensky 1993) framework. The module interaction accounts do not cover the range of data concerning relative clauses as completely as an OT account does.

The paper is organized as follows. In Section 2, I review the existing proposals related to markedness and module interaction. In Sections 3 and 4, I discuss the viability of an OT account and the module interaction accounts respectively. I devote Sections 5 and 6 to discussions and conclusions, summarizing the effectiveness of the OT and module interaction accounts and identifying areas for future research.

2 Literature Review

2.1 Markedness

Keenan and Comrie (1977) survey the relativization strategies of a number of languages. They note that languages use two strategies for dealing with the syntactic position within the relative clause from which extraction has taken place. The first strategy is to leave a gap, as in English, and the second strategy is to fill the position with a resumptive pronoun that refers to the modified, or head, NP. To illustrate the resumptive pronoun strategy, consider Hebrew.

(3) From Borer 1984

- a. raʔiti ʔet ha-yeled she-ʔasher rina ʔohevet ʔoto
saw-I ACC the-boy that Rina loves him
I saw the boy that Rina loves.

These two strategies are not mutually exclusive; in fact, many languages use both strategies. In addition languages often restrict the grammatical positions involved in relativization.

To capture these restrictions, Keenan and Comrie develop the following NP Accessibility Hierarchy, where $x > y$ indicates that x is ranked higher than y .

- (4) Subject $>$ Direct Object $>$ Indirect Object $>$ Oblique $>$ Genitive $>$ Object of Comparison (OCOMP)

Keenan and Comrie maintain that any strategy used for relativization at a particular point on the hierarchy must be permitted at all points higher on the Accessibility Hierarchy. For example, if a language employs resumptive pronouns in oblique extraction, then it must allow resumptive pronouns in subject, direct object, and indirect object extraction. However, it does not necessarily have to permit resumptive pronouns in genitive or OCOMP extraction, as these positions are lower on the Hierarchy than oblique extraction. The use of a strategy at a particular point requires that this strategy be used at all points higher on the Hierarchy but not necessarily at lower points.

According to Keenan and Comrie, subject extraction, at the top of the NP Accessibility Hierarchy, is cross-linguistically the most common form of extraction, and extraction out of an object of comparison (see (5f)) is the least common. The kinds of extraction listed in the Hierarchy are illustrated in (5).

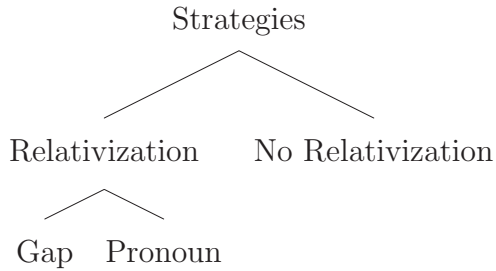
- (5) a. **Subject Extraction:** The lawyer that praised the doctor climbed the mountain.
b. **Direct Object Extraction:** The lawyer that the doctor praised climbed the mountain.
c. **Indirect Object Extraction:** The lawyer that the doctor glared at climbed the mountain.
d. **Oblique Extraction:** The police officer that the lawyer was questioned by climbed the mountain.
e. **Genitive Extraction:** The lawyer whose secretary attended the party climbed the mountain.

- f. **Object of Comparison Extraction:** The lawyer that the doctor is taller than climbed the mountain.

Keenan and Comrie claim that a language that allows extraction from a particular point on the Hierarchy must allow extraction from all positions higher on the Hierarchy. For example, any language that allows oblique extraction must also allow subject, direct object, and indirect object extraction.

Following Lehman (1986) and diverting from Keenan and Comrie, I reinterpret the NP Accessibility Hierarchy so strategies do not have to apply to a particular point and all points higher. Keenan and Comrie predict that any relativization strategy a language allows must apply to subject extraction in that language. This is because they claim any strategy that applies to a particular position on the NP Accessibility Hierarchy must apply to all positions higher on the NP Accessibility Hierarchy. Since subjects are the highest position on the Hierarchy, all strategies in a language must apply to subject extraction. Rather, based on Keenan and Comrie's own data (pp. 76-79), it is evident that a gapping strategy is used at the top of the Hierarchy and, at some point lower on the Hierarchy, resumptive pronouns "take over" for gaps. Finally, at another point lower on the Hierarchy, extraction is banned altogether. Thus one can construct an order of relativization as in (6) where the strategies are the terminal nodes of (6a), and the order of their implementations is noted in (6b). Hebrew, for example, contradicts Keenan and Comrie's interpretation of the NP Accessibility Hierarchy. Hebrew allows resumptive pronouns in all positions lower on the Hierarchy than subjects, but this strategy does not apply to subjects themselves. This should not be possible according to Keenan and Comrie's account presented here, but it is predicted by Lehman's reinterpretation of the mechanics of the NP Accessibility Hierarchy.

- (6) a. Relativization Strategies



b. Order of Implementation of Strategies

Gaps > Resumptive Pronouns > No Extraction

For any language each position on the NP Accessibility Hierarchy is located at one or more of the terminal nodes in (6a). That is, each grammatical position is relativized using gaps or resumptive pronouns, or it is not relativized at all in the language. Some languages also allow both gaps and resumptive pronouns for a particular grammatical position. The order of the NP Accessibility Hierarchy must be maintained, so each terminal node in (6a) applies to a continuous portion of the Hierarchy. In formal terms, for any two strategies α and β used in a language such that α outranks β (where “outranks” here means that α is implemented before β , or α is to the left of β in (6b)) and any positions on the NP Accessibility Hierarchy $\sigma_i, \sigma_{i+1}, \dots, \sigma_{i+n}$, such that σ_i is ranked immediately higher on the NP Accessibility Hierarchy than σ_{i+1} , β may not apply to σ_i unless α applies to a position σ_{i-x} , where x is any nonnegative integer. That is, in a language that uses both gaps and resumptive pronouns, gaps must be used higher on the NP Accessibility Hierarchy than resumptive pronouns, and all grammatical positions that allow either gaps or resumptive pronouns must outrank on the NP Accessibility Hierarchy any position from which extraction is not permitted. However, the range of positions covered by gaps may overlap with the range covered by resumptive pronouns. Hebrew, for example, allows gaps in subject and direct object extraction, and it allows resumptive pronouns in direct object extraction and all positions lower on the Accessibility Hierarchy (Keenan and Comrie 1977; Borer 1984). Both gaps and resumptive pronouns are allowed in direct object extraction. Note, however, that

the gapping and resumptive pronoun strategies still apply to continuous segments on the NP Accessibility Hierarchy.

(7) from Borer 1984

a. Subject Extraction:

- (i) ha-ʔarie she-/ʔasher taraf ʔet ha-yeled barax
the-lion that devoured ACC the-boy escaped
The lion that devoured the boy escaped.

b. Object Extraction:

- (i) raʔiti ʔet ha-yeled she-/ʔasher rina ʔohevet
saw-I ACC the-boy that Rina loves
I saw the boy that Rina loves.
- (ii) raʔiti ʔet ha-yeled she-/ʔasher rina ʔohevet ʔoto
saw-I ACC the-boy that Rina loves him
I saw the boy that Rina loves.

c. Indirect Object Extraction:

- (i) raʔiti ʔet ha-yeled she-/ʔasher rina xashva ʔalav
saw-I ACC the-boy that Rina thought about-him
I saw the boy that Rina thought about.

Moreover a language need not employ all three options in (6). English, for example, allows gaps in all grammatical positions. The other two options, resumptive pronouns and no relativization at all, are not used. On the other hand, Urhobo, a language spoken in Nigeria, does not allow gaps anywhere and uses resumptive pronouns at all positions on the NP Accessibility Hierarchy (Keenan and Comrie 1977). Urhobo still adheres to the requirements that all strategies in a language apply to a continuous segment of the NP Accessibility Hierarchy and that no strategy can apply to a position higher than the positions a higher-ranked strategy applies to. In Urhobo there are no gaps, so there is no higher-ranked strategy to dominate the resumptive pronoun strategy.

The NP Accessibility Hierarchy is a claim about linguistic markedness. Here, the term “markedness” refers to the idea that certain linguistic features or constructions are cross-

linguistically more common than other features or constructions, or they are preferable to other features. A marked feature is one that is less common or less preferable than another feature. Keenan and Comrie (1977) propose that extraction out of lower positions on the NP Accessibility Hierarchy is more marked than extraction out of higher positions. Subject extraction, therefore, is the least-marked kind of extraction, and extraction out of an object of comparison is the most marked. As a claim about markedness, this argument lends itself to an evaluation using OT, since OT is a theory that uses universal markedness observations in the modelling of a language’s grammar. For example, in phonology OT uses constraints such as NOCODA and ONSET, which ban syllable codas and mandate syllable onsets respectively, thus capturing the observation that codas are generally disfavored in languages while onsets are usually desired. Similarly OT can be used to model the observation that extraction out of an object of comparison is marked, while subject extraction is relatively less marked. I formulate such an account in Section 3. For the remainder of the paper, I combine indirect object extraction, oblique extraction, genitive extraction, and OCOMP extraction into a single “oblique” category, and I refer to direct object extraction as “object extraction.” As I focus on the subject-object asymmetry, it is not necessary to deal with each of the other kinds of extraction independently. Moreover most work on relative clauses has concentrated on subject and object extraction while ignoring other kinds of extraction, so little would be gained from keeping the oblique, genitive, and OCOMP categories distinct.

2.2 Module Interaction

While the NP Accessibility Hierarchy appeals to cross-linguistic patterns to explain language-specific relative clause-forming strategies, other explanations have been advanced that treat the subject-object asymmetry as an emergent property of how the language faculty interacts with other cognitive faculties². These accounts are referred to here as “module interaction”

²These interactions stress an important aspect of markedness, that is, why features are marked. It is possible that the markedness of certain kinds of extraction results from the fact that they cause difficulty in processing or burden some other cognitive function so that they are cognitively undesirable constructions. See Section 6 for further discussion.

accounts, as they involve the interaction of two cognitive modules. I will consider two kinds of module interaction explanations, language and processing interaction and language and memory interaction. These accounts differ from the markedness account in that they do not claim any grammatical preference for subject extraction over object extraction. Rather, the relative ease of processing in subject extraction is derived from discourse or cognitive elements that favor the syntactic organization of subject extraction. I present here chief proponents of each of these proposals.

2.2.1 Language and Processing

In the language and processing account, it is argued that maintaining grammatical points of view facilitates processing (MacWhinney and Pléh 1988). Here the language faculty interacts with the discourse frame that hearers construct and in which referents gain their discourse relevance. In their study of Hungarian relative clauses, MacWhinney and Pléh (1988) consider four kinds of relative clauses. The head NP may function either as a subject or an object of the matrix clause, and it is understood either as a subject or as an object of the embedded relative clause (i.e., subject or object extraction in a matrix subject or matrix object). There are four combinations of these possibilities: SS, SO, OO, and OS, where S = subject and O = object, and where the first letter in each pair is the matrix position of the head NP and the second letter is the head NP's role in the embedded clause. MacWhinney and Pléh report better performance for both reading time and comprehension in matched conditions (SS and OO) than in unmatched conditions (SO and OS). MacWhinney and Pléh explain this pattern of results by hypothesizing that switching grammatical points of view in a sentence impedes grammatical processing. Since Gordon et al. (2001a) conducted reading time experiments for only the SS and SO conditions, their studies indicate that subject extraction is easier to process than object extraction, because subject extraction occurs in a matched condition while object extraction occurs in an unmatched condition. MacWhinney and Pléh predict that reading time studies would show that object extraction is easier to

process if the conditions used were OO and OS. In fact MacWhinney and Pléh (1988) report that in Hungarian the OO condition is easier to process than the SS condition. According to the language and processing account, subject extraction is not easier to process than object extraction. Rather, the kind of extraction paired with the head noun's position in the matrix sentence determines the relative ease of processing.

This account differs from the Keenan and Comrie (1977) markedness account in the way it deals with the grammatical position from which extraction takes place. Keenan and Comrie claim that languages pay specific attention to grammatical position in determining what kinds of extraction it permits. The fact that extraction takes place out of a subject as opposed to a direct object, for example, is important. MacWhinney and Pléh claim instead that the specific identity of this grammatical position is not important. Rather, what matters is whether or not the position out of which extraction takes place is the same kind of position as the position of the head noun in the matrix clause. Oblique extraction is not less marked than subject extraction. In fact oblique extraction may theoretically be preferable to subject extraction if the oblique extraction occurs in a matched condition (such as OblObl [oblique-oblique]) while the subject extraction occurs in an unmatched condition (such as OS). The MacWhinney and Pléh (1988) theory is not an expansion of the Keenan and Comrie proposal to include a new dimension that is not modelled by Keenan and Comrie. It is a separate theory that abandons the NP Accessibility Hierarchy, relies on different mechanisms, and makes unique predictions.

2.2.2 Language and Memory

Under the language and memory account, object extraction places a heavier burden on memory than does subject extraction. I will consider two versions of this account, one by Pritchett (1992) and one by Gibson (1998). Pritchett argues that, across the grammar, nouns need semantic roles, and verbs and prepositions assign semantic roles. Intransitive verbs have one semantic role to assign, and transitive verbs have two roles to assign. Once

one encounters a noun, either in reading or in hearing, one searches for an empty semantic role to which this noun can be assigned. If no role is available, then the noun must be held in memory until a verb or a preposition appears, at which point the noun is assigned a semantic role. Nouns are assigned to the first semantic role that becomes available. We do not hold nouns in memory any longer than is necessary. Pritchett (1992) uses this system to explain the awkwardness of garden path sentences, but it can also be used to explain the subject-object asymmetry. In subject extraction the head noun must be held in memory until the verb is encountered. Once the verb appears, the noun may be assigned to the verb's subject role. This may involve holding the modified noun in memory while at most one word is read (depending on the presence or absence of a complementizer) before an empty semantic role is found (see (8)). In object extraction the modified noun must be held in memory while one hears or reads the complementizer (if any) and the subject of the embedded clause. Only after these several words are read or heard does one encounter the embedded verb. Clearly the modified noun is held in memory longer during object extraction than during subject extraction. Pritchett claims that this difference, illustrated in (8), causes the subject-object asymmetry.

(8) Subject Extraction:

The lawyer that praised the doctor



Object Extraction:

The lawyer that the doctor praised



In Gibson's version of the language and memory account, discourse referents specifically tax memory. If a noun must be held in memory while several discourse referents are encoun-

tered, then one’s memory will function relatively poorly. Note that in object extraction a discourse referent (*the doctor* in the examples above) falls between the head noun and the place in which the head noun is integrated into the relative clause. No such intervening referent is present in subject extraction. Therefore Gibson predicts object extraction should be more difficult to comprehend than subject extraction. Pronouns, such as first and second person pronouns, are salient to the discourse context and therefore do not tax memory the way full NPs do, according to Gibson. Pronouns count as “free” referents within the discourse in the sense that there is no memory penalty for using them. I return to this point in Section 4.

Pritchett and Gibson differ in two ways. First, Pritchett does not assign a special status to pronouns as Gibson does. According to Pritchett, all nouns impose an equal burden on memory. Second, Pritchett and Gibson use different notions of distance. In both cases object extraction is more taxing on memory than subject extraction because the head noun must be held in memory longer in object extraction before it can be integrated into the sentence. Pritchett measures distance by counting all words that fall between the head noun and the verb with which it is integrated. Gibson measures distance in terms of discourse referents. The head noun is farther from its grammatical position in object extraction than in subject extraction because more referents fall between the head noun and its grammatical position inside the relative clause. The two versions of the language and memory account make different predictions in certain constructions. For example, consider the two relative clauses *the lawyer that praised him* and *the lawyer that he praised*. The former is a subject extraction, and the latter is an object extraction. Pritchett predicts that the object extraction case should be more taxing than the subject extraction case because in the object extraction case an additional word—*he*—falls between the head noun and its grammatical position in the relative clause. Gibson, however, predicts that the two relative clauses should be equally taxing because in each case no discourse referents fall between the head noun and its grammatical position in the relative clause (recall that pronouns impose no burden on

memory in Gibson’s account).

The language and memory accounts differ from Keenan and Comrie in that certain grammatical positions, in a sense, simply “happen” to be more difficult to process than others in the language and memory accounts. While object extraction, for example, is more marked than subject extraction in the Keenan and Comrie theory, the language and memory account claims that there is nothing special about any grammatical position that makes it more or less taxing than another position except the distances it creates between nouns and the places in which they are interpreted. According to Pritchett and Gibson, the memory faculty is concerned with the distance between a noun and the position in which it is integrated into the clause, not whether the relative clause involves subject or object extraction. Object extraction is more burdensome than subject extraction in English because it creates a greater distance between the head noun and the position in which it is integrated into the relative clause than subject extraction does, not because it is more marked than subject extraction.

3 The Viability of a Markedness Account

In 3.1, I first present an OT account that employs the idea of constraint harmony (Lee 2001). Merging the dimensions of (1) subject extraction versus object extraction versus oblique extraction and (2) gaps versus resumptive pronouns in relative clauses, I develop an OT system that attempts to account for the patterning of these two dimensions simultaneously. This system, as I show in 3.2, is ultimately flawed because it cannot model the relative clause patterns of English, Urhobo, and similar languages. Possible improvements to the harmonic system are mentioned, and I also construct a simpler OT system that uses lambda operators and makes no claims about harmony between two dimensions.

3.1 A Harmonic System

Harmony is based on the idea that two interacting dimensions of a grammar can be collapsed into a single dimension. In this one dimension the two phenomena can be modelled simultaneously, and their interactions can be explained elegantly (Lee 2001). Such an approach is initially appealing for modelling cross-linguistic relative clause patterns because, as mentioned above, relativization can be thought of as operating along two dimensions: first, where extraction occurs (subject, object, or oblique) and second, whether gaps or resumptive pronouns are used.

As discussed above, the markedness view of the subject-object asymmetry claims the asymmetry arises from cross-linguistic patterns that adhere to some generalization about linguistic markedness. The various grammatical positions from which extraction may occur fall along the NP Accessibility Hierarchy in (4), reprinted here as (9) with the new “oblique” category covering all positions lower than subject and direct object on the Hierarchy.

(9) Subject > Object > Oblique

This hierarchy states that subject extraction is less marked than object extraction, which is less marked than oblique extraction. As is evident from Keenan and Comrie’s (1977) data, the hierarchy is universal. It can be translated into OT markedness constraints, as in (10).

(10) *Subject Extraction (*Subj): no extraction from a subject position
*Object Extraction (*Obj): no extraction from an object position
*Oblique Extraction (*Obl): no extraction from an oblique position

However, to build a harmonic system, binary hierarchies are required. I therefore propose two universal orderings, presented in (11). The first ranking states that subject extraction is less marked than all other (or non-subject) extractions. The second ranking breaks the non-subject extraction possibilities into two groups, object and oblique extractions, and states that object extraction is less marked oblique extraction. The order from (9) is preserved

in (11). The only difference is the rankings have been converted into the necessary binary forms.

- (11) Subject (Subj) > \sim Subject (\sim Subj)
Object (Obj) > Oblique (Obl)

(11) deals with one dimension of the harmonic system. The second dimension is concerned with the use of gaps versus resumptive pronouns in relative clauses. Since harmonic systems pair unmarked structures together and marked structures together, it is necessary to claim that gaps are less marked than pronouns. Gaps, if they occur anywhere, will occur with subject extraction (Keenan and Comrie 1977), and it has already been determined that subject extraction is the least marked form of extraction. Therefore, without regard for other ways of determining the relative markedness of gaps and resumptive pronouns, I am forced to assume the ranking in (12), where gaps are preferred over resumptive pronouns.

- (12) gaps (GAP) > pronouns (PRO)

Following Lee (2001), the hierarchies in (11) and (12) are collapsed. Least marked items are paired together and most marked items are paired together. These matched pairs in turn are posited as less marked than their mismatched (i.e. unmarked paired with marked) pairs. The ranking in (12) is combined with each ranking in (11), yielding four sets of binary hierarchies, presented in (13). The symbol \succ means “is preferred over.”

- (13) a. Subj > \sim Subj & GAP > PRO
Subj/GAP \succ Subj/PRO
 \sim Subj/PRO \succ \sim Subj/GAP
- b. Obj > Obl & GAP > PRO
Obj/GAP \succ Obj/PRO
Obl/PRO \succ Obl/GAP

According to the design of harmonic systems, only the four binary preferences derived in (13) are fixed. For example, (13) predicts subject extraction with a gap is universally preferred to (or is less marked than) subject extraction with a pronoun, but it makes no universal claim about relationships not explicitly stated. For example, the universal status of \sim Subj/PRO extractions with respect to Obj/GAP extractions cannot be determined.

These pairs must be converted into constraints for use in OT. This is done in (14). The preference statements have been converted to negative statements, and the universal rankings have been maintained. The constraints are defined in (15).

- (14) *Subj/PRO \gg *Subj/GAP
 \sim Subj/GAP \gg * \sim Subj/PRO
 Obj/PRO \gg *Obj/GAP
 Obl/GAP \gg *Obl/PRO

- (15) *SUBJ/PRO: no subject extraction with a resumptive pronoun
 *SUBJ/GAP: no subject extraction with a gap
 * \sim SUBJ/GAP: no extraction out of a non-subject position with a resumptive pronoun
 * \sim SUBJ/PRO: no extraction out of a non-subject position with a gap
 *OBJ/PRO: no object extraction with a resumptive pronoun
 *OBJ/GAP: no object extraction with a gap
 *OBL/GAP: no oblique extraction with a gap
 *OBL/PRO: no oblique extraction with a resumptive pronoun

At this point, the relativization pattern for Hebrew can be correctly modelled. Recall that Hebrew allows only gaps in subject extraction, only resumptive pronouns in oblique extraction, and both gaps and resumptive pronouns in object extraction. The ranking in (16) will produce this output.

- (16) *SUBJ/PRO, *~SUBJ/GAP, *OBJ/PRO \gg *SUBJ/GAP, *~SUBJ/PRO,
 *OBJ/GAP, *OBL/GAP \gg *OBL/PRO

In (16), all pairs of universal orderings are maintained. The Tableaux in (17)–(19) show how this ranking correctly predicts Hebrew relativization in all three types of extraction. As with standard OT Tableaux, the input is in the top left-hand box, and the output candidates appear below it. The constraints are placed along the top of the Tableau with the most highly ranked constraint at the left and the lowest-ranked constraint on the right. An asterisk in a box indicates that the candidate in that row violates the constraint in the intersecting column. An exclamation point indicates a violation that eliminates a candidate from consideration. Shading indicates that boxes are irrelevant to the particular Tableau because the candidate of that row either has already been eliminated or has won. The “winning” candidate is the one the system selects as the best output candidate based on the violations incurred by all of the candidates. It is marked with a finger pointing to it just to the left of the candidate number. A candidate is eliminated when it violates a constraint ranked higher than the highest-ranked constraint another remaining candidate violates.

(17) Hebrew Subject Extraction

	the lawyer that x praised the doctor	*SUBJ /PRO	*~SUBJ /GAP	*OBJ /PRO	*SUBJ /GAP	*~SUBJ /PRO	*OBJ /GAP	*OBL /GAP	*OBL /PRO
☞ 1.	the lawyer that {gap} praised the doctor				*				
2.	the lawyer that he praised the doctor	*!							

(17) shows that the universal ranking of *SUBJ/PRO over *SUBJ/GAP forces subject extraction to occur with a gap. The justifications for other rankings cannot be seen in this Tableau.

The Tableau in (18) shows how the *~SUBJ and *OBJ constraints work together to produce two optimal outputs.

(18) Hebrew Object Extraction

		*SUBJ /PRO	*~SUBJ /GAP	*OBJ /PRO	*SUBJ /GAP	*~SUBJ /PRO	*OBJ /GAP	*OBL /GAP	*OBL /PRO
	the lawyer that the doctor praised x								
☞ 1.	the lawyer that the doctor praised {gap}		*				*		
☞ 2.	the lawyer that the doctor praised him			*		*			

The *~SUBJ constraints prefer candidate 2 because it has a relative pronoun, and non-subject extraction with a relative pronoun is universally preferred over non-subject extraction with a gap (from (13) and (14)). The *OBJ constraints, however, prefer object extraction with a gap over object extraction with a pronoun (again from (13) and (14)), and thus they prefer candidate 1. However, with *~SUBJ/GAP co-ranked with *OBJ/PRO and *~SUBJ/PRO co-ranked with *OBJ/GAP, these preferences cancel each other out. Each candidate incurs two violations, but no violation is fatal because for each violation that one candidate incurs, there is another violation of a co-ranked constraint for the other candidate. The system cannot differentiate between the two candidates, so both are possible outputs.

The Tableau in (19) shows that the system correctly predicts the presence of resumptive pronouns in oblique extraction.

(19) Hebrew Oblique Extraction

		*SUBJ /PRO	*~SUBJ /GAP	*OBJ /PRO	*SUBJ /GAP	*~SUBJ /PRO	*OBJ /GAP	*OBL /GAP	*OBL /PRO
	the lawyer that the doctor glared at x								
1.	the lawyer that the doctor glared at {gap}		*!					*	
☞ 2.	the lawyer that the doctor glared at him					*			*

With *~Subj/GAP ranked above *~Subj/PRO, candidate 1 is eliminated. Note also that the ranking of *Obl/GAP above *Obl/PRO makes the correct prediction. The system would work equally well with *Obl/GAP ranked higher. Other co-rankings that have not been addressed directly here result from a lack of interaction between constraints, so their

rankings cannot be determined.

Welsh can be modelled in a similar way using the current system. Welsh permits extraction out of all positions. It allows only gaps in subject and object extraction, and only resumptive pronouns are permitted in oblique extraction. Welsh differs from Hebrew only in that it does not allow resumptive pronouns in object extraction. Therefore, in modelling Welsh, I will use the same constraint ranking that was used for Hebrew above, except that *Obj/PRO is now ranked above *~Subj/GAP, whereas the two constraints were co-ranked for Hebrew. The Welsh constraint ranking is shown in (20).

$$(20) \quad *SUBJ/PRO, *OBJ/PRO \gg * \sim SUBJ/GAP \gg *SUBJ/GAP, * \sim SUBJ/PRO, \\ *OBJ/GAP, *OBL/GAP \gg *OBL/PRO$$

The Tableaux for Welsh subject and oblique extraction work identically to those presented for Hebrew above, so I will not examine them here. Object extraction, on the other hand, does not work the same in these two languages, so it will be helpful to discuss the relevant Tableau, shown in (21). With the minimal change in the ranking (placing *OBJ/PRO above *~SUBJ/GAP), a single output is now selected. The absolute ranking of these two constraints eliminates the tie in the evaluation that gave Hebrew two optimal outputs.

(21) Welsh Object Extraction

		*SUBJ /PRO	*OBJ /PRO	*~SUBJ /GAP	*SUBJ /GAP	*~SUBJ /PRO	*OBJ /GAP	*OBL /GAP	*OBL /PRO
☞ 1.	the lawyer that the doctor praised x			*			*		
2.	the lawyer that the doctor praised {gap}		*!			*			
	the lawyer that the doctor praised him								

This section demonstrates how harmony can be used to model the relativization patterns in Hebrew and Welsh. The next subsection address problems that other languages present for the harmonic system.

3.2 Limitations of the Harmonic System

Once applied to languages that do not behave like Hebrew and Welsh, the harmonic system as it stands now breaks down. Two issues arise: first, it is impossible to force resumptive pronouns to occur in subject extraction, and, second, it is impossible to force gaps to occur in oblique extraction. I will elaborate on these problems and mention possible remedies for them, but I will not pursue the remedies in detail because they stray too far from the focus of this paper.

To illustrate the first problem, I turn to Urhobo. Urhobo allows relativization out of all positions, but only resumptive pronouns may be used. An example of Urhobo relativization is given in (22).

- (22) Object of Comparison Extraction in Urhobo (from Keenan and Comrie 1977)
- a. oshale na l- i Mary rho n- o
man the that Mary big than him
the man that Mary is bigger than

To model Urhobo, it is necessary to rank the constraints that ban gaps above the constraints that ban resumptive pronouns. This is simple enough for object and oblique extraction: as long as $*\sim\text{SUBJ}/\text{GAP}$ is ranked above $*\text{OBJ}/\text{PRO}$, only resumptive pronouns will appear in object and oblique extraction ($*\sim\text{SUBJ}/\text{GAP}$ is universally ranked above $*\sim\text{SUBJ}/\text{PRO}$, and $*\text{OBL}/\text{GAP}$ is universally ranked above $*\text{OBL}/\text{PRO}$). The Tableaux in (23) and (24) illustrate this, ignoring for the moment the $*\text{SUBJ}/\text{GAP}$ and $*\text{SUBJ}/\text{PRO}$ constraints.

(23) Urhobo Object Extraction

		*~SUBJ /GAP	*OBL /GAP	*~SUBJ /PRO	*OBJ /PRO	*OBJ /GAP	*OBL /PRO
the lawyer that the doctor praised x							
1. the lawyer that the doctor praised {gap}		*!				*	
☞ 2. the lawyer that the doctor praised him				*	*		

Here, the ranking discussed in the previous paragraph is used. Notice also that the universal rankings from (14) are maintained. The absolute rankings of co-ranked elements cannot be determined because any absolute ranking will produce the correct output. In object extraction, *~SUBJ/GAP does all the work, weeding out the candidate with the gap.

(24) Urhobo Oblique Extraction

		*~SUBJ /GAP	*OBL /GAP	*~SUBJ /PRO	*OBJ /PRO	*OBJ /GAP	*OBL /PRO
the lawyer that the doctor glared at x							
1. the lawyer that the doctor glared at {gap}		*!	*!				
☞ 2. the lawyer that the the doctor glared at him				*			*

Again, the absolute rankings of co-ranked constraints cannot be determined. It is unclear in oblique extraction whether *~SUBJ/GAP or *OBL/GAP is the driving force behind the selection of candidate 2, but with either constraint dominating the rest of the constraints, only resumptive pronouns will be allowed in oblique extraction.

While the harmonic system handles these cases well, it fails to allow the correct output with respect to subject extraction. The only constraints that pertain to subject extraction are *SUBJ/PRO and *SUBJ/GAP, and their fixed, universal ranking is *SUBJ/PRO \gg *SUBJ/GAP. The system necessarily predicts that subject extraction will always occur with gaps. This is illustrated in (25), where the symbol \otimes indicates the incorrect optimal output.

(25) Incorrect Prediction for Urhobo Subject Extraction

	*~SUBJ /GAP	*OBL /GAP	*~SUBJ /PRO	*OBJ /PRO	*OBJ /GAP	*OBL /PRO	*SUBJ /PRO	*SUBJ /GAP
the lawyer that x praised the doctor								
⊗ 1. the lawyer that {gap} praised the doctor								*
2. the lawyer that he praised the doctor							*!	

Using the constraint ranking developed for Urhobo object and oblique extraction, I have added the *SUBJ constraints at the bottom of the hierarchy to show that even when they are ranked as low as possible, the fixed ranking *SUBJ/PRO \gg *SUBJ/GAP will always select the wrong candidate. Moreover, since the candidates in (25) violate no other constraints, it is impossible to devise a ranking such that candidate 2 wins.

This problem constitutes an argument that the harmonic system has serious limits on its descriptive adequacy. The basis of harmony is that unmarked structures will tend to co-occur. Having found a counterexample to this generalization, one may be inclined to dismiss harmony as an adequate model for relative clause patterns. There is, however, a solution to this problem. The introduction of some constraint that bans empty items (in the pragmatic interest of being explicit) can force resumptive pronouns to occur. This constraint would be ranked lowly except when needed to ban gaps in subject extraction. However, I have no independent evidence for such a constraint, and its use predicts unattested grammars that, for example, use resumptive pronouns everywhere except in object extraction. As a result, I will not pursue this avenue further.

Turning to the second problem, that of gaps in oblique extraction, I will use English as the example language. English, or more precisely its standard dialect, allows only gaps in all relative clauses. Modelling subject and object extraction using the harmonic system developed here is relatively simple. The Urhobo discussion above demonstrated that subject extraction will always be predicted to occur with gaps. By ranking *OBJ/PRO over *~SUBJ/GAP,

object extraction can likewise be forced to occur only with gaps. The Tableaux in (26) and (27) illustrate this. The constraints $*\text{OBL}/\text{GAP}$ and $*\text{OBL}/\text{PRO}$ are omitted for now.

(26) English Subject Extraction

		$*\text{SUBJ}/\text{PRO}$	$*\text{OBJ}/\text{PRO}$	$*\sim\text{SUBJ}/\text{GAP}$	$*\sim\text{SUBJ}/\text{PRO}$	$*\text{OBJ}/\text{GAP}$	$*\text{SUBJ}/\text{GAP}$
	the lawyer that x praised the doctor						
☞ 1.	the lawyer that {gap} praised the doctor						*
2.	the lawyer that he praised the doctor	*!					

I have ranked $*\text{SUBJ}/\text{PRO}$ highly, alongside $*\text{OBJ}/\text{PRO}$, to reflect the fact that subject extraction always occurs with gaps, but, as was demonstrated above, the particular ranking of $*\text{SUBJ}/\text{PRO}$ and $*\text{SUBJ}/\text{GAP}$ with respect to the other constraints is inconsequential. The other co-rankings in (26) are also inconsequential. Beyond those discussed in the previous paragraph, particular (co-)rankings cannot be determined. Note once again that the universal rankings in (14) are maintained.

(27) English Object Extraction

		$*\text{SUBJ}/\text{PRO}$	$*\text{OBJ}/\text{PRO}$	$*\sim\text{SUBJ}/\text{GAP}$	$*\sim\text{SUBJ}/\text{PRO}$	$*\text{OBJ}/\text{GAP}$	$*\text{SUBJ}/\text{GAP}$
	the lawyer that the doctor praised x						
☞ 1.	the lawyer that the doctor praised {gap}			*		*	
2.	the lawyer that the doctor praised him		*!		*		

The ranking here is identical to that in (26). With $*\text{OBJ}/\text{PRO}$ outranking $*\text{OBJ}/\text{GAP}$, $*\sim\text{SUBJ}/\text{GAP}$, and $*\sim\text{SUBJ}/\text{PRO}$, object extraction will always occur with gaps.

Oblique extraction cannot be modelled so easily, however. There are four constraints that refer to oblique extraction: $*\sim\text{SUBJ}/\text{GAP}$, $*\sim\text{SUBJ}/\text{PRO}$, $*\text{OBL}/\text{GAP}$, and $*\text{OBL}/\text{PRO}$. Their universal rankings are presented again in (28), which is taken from (14).

- (28) $*\sim\text{SUBJ}/\text{GAP} \gg * \sim\text{SUBJ}/\text{PRO}$
 $*\text{OBL}/\text{GAP} \gg * \text{OBL}/\text{PRO}$

With these universal rankings, it is impossible to produce a system in which gaps are favored over resumptive pronouns in oblique position. In each pair in (28), the constraint banning gaps will always be ranked above the constraint banning resumptive pronouns. This is exactly the opposite of the constraints dealing with subjects. Recall from the Urhobo discussion above that with the fixed order $*\text{SUBJ}/\text{PRO} \gg * \text{SUBJ}/\text{GAP}$, subject extraction will always be predicted to occur with gaps. Likewise, since oblique extraction is at the marked end of the Keenan and Comrie NP Accessibility Hierarchy, the harmonic system predicts that it will always occur with resumptive pronouns, the marked element in the gap/resumptive pronoun distinction.

Solving this problem requires returning to the NP Accessibility Hierarchy, presented again here in (29).

- (29) Subject > Direct Object > Indirect Object > Oblique > Genitive > OCOMP

For the purposes of this paper, the lowest four items on the Hierarchy were collapsed into a single “Oblique” category. By expanding this category back into its original forms, one may apply the harmonic system to each of these positions separately. In the harmonic system presented here, the NP Accessibility Hierarchy was divided first into subjects versus non-subjects, and then the non-subjects were divided into objects and obliques. Another way of stating the second division is in terms of (direct) objects and items lower on the NP Accessibility Hierarchy than (direct) objects. This created a situation in which multiple pairs of constraints referred to direct objects. The $*\sim\text{SUBJ}$ constraints ($*\sim\text{SUBJ}/\text{GAP} \gg * \sim\text{SUBJ}/\text{PRO}$) favored resumptive pronouns in object extraction, while the $*\text{OBJ}$ constraints ($*\text{OBJ}/\text{PRO} \gg * \text{OBJ}/\text{GAP}$) favored gaps in object extraction. By ranking $*\sim\text{SUBJ}/\text{GAP}$ above $*\text{OBJ}/\text{PRO}$, one can create a grammar in which only resumptive pronouns are allowed in object extraction (see Urhobo). Reversing this ranking produces

a system like English, where only gaps are allowed in object extraction. Co-ranking these two pairs of constraints creates a language like Hebrew, where both gaps and resumptive pronouns are acceptable in object extraction. The NP Accessibility Hierarchy can be divided in similar ways for positions ranked lower than direct objects. For example, the next step would be to divide the Hierarchy into indirect objects and all positions lower, then obliques (in Keenan and Comrie’s terms) and all positions lower, and so on. The result will be multiple pairs of constraints for each position where at least one pair favors gaps and another pair favors resumptive pronouns. (30) shows several constraints that this exercise would yield.

- (30) *<DO/GAP: no extraction out of a position lower on the Hierarchy than Direct Object with a gap
 <DO/PRO: no extraction out of a position lower on the Hierarchy than Direct Object with a resumptive pronoun
 IO/GAP: no extraction out of an Indirect Object with a gap
 IO/PRO: no extraction out of an Indirect Object with a resumptive pronoun

The resulting system would give the grammar options in what it allows for each grammatical position in exactly the same way it allowed flexibility for direct objects, as discussed above. The exceptions to this are at each end of the NP Accessibility Hierarchy. As noted in the Urhobo discussion, harmony allows subjects to occur only with gaps. The elaboration proposed here does not solve this problem as no new constraints referring to subjects will be generated. Likewise, the lowest position in the Hierarchy (OCOMP for Keenan and Comrie, Obliques for the reduced ranking used here) will always be predicted to occur with only resumptive pronouns. This is because, in generating the harmonic system, the most marked items are paired with each other. In this case, resumptive pronouns are paired with OCOMP, using the detailed Hierarchy. Unless there exist items lower on the Hierarchy that allow a division into OCOMP and all positions lower, it is impossible to create a pair of constraints that favors gaps in OCOMP extraction. Similarly, another way to avoid the “subject ex-

traction with only gaps” problem is to posit an additional position on the Hierarchy above subjects. One candidate is topics, which, in English, can never occur with a gap (compare *Broccoli I like* with **{gap} I like*). It may be worthwhile to pursue these possibilities, but as the status of OCOMP extraction and these hypothetical additions to the Hierarchy are tangential to the subject of this paper, I will leave them unexamined here.

This subsection has demonstrated the drawbacks of using a harmonic system. The highest and lowest ends of the NP Accessibility Hierarchy present problems of inflexibility. I have discussed but not pursued possible ways to overcome these limitations. It should be clear that a harmonic system is promising but not perfect. I now turn to an OT system that does not use harmony to demonstrate that, should harmony prove inappropriate for relativization strategies, it is possible to model cross-linguistic patterns in a non-harmonic fashion.

3.3 Development of a Non-Harmonic Model

Rather than dealing with syntactic position (subject/object/oblique) as being governed by a distinct set of constraints that can operate independently of other hierarchies, I demote this hierarchy so that it is a subset of other hierarchies. In other words, the non-harmonic system decomposes other constraints into three instantiations, one for each syntactic position (subject, object, and oblique). Whereas relativization patterns were conceptualized in part A of this section as functions of the interactions of two dimensions that were collapsed into a single dimension, the system developed in this part approaches relativization as a function of a single dimension to begin with. No merging of hierarchies is needed.

I use as a starting point the hierarchy in (11), reprinted in condensed form below as (31). I have already presented independent evidence for this ranking, so there is no need to revisit this issue. The ranking in (32) may seem contradictory to my earlier assertion that gaps are less marked than resumptive pronouns, but I also mentioned in 3.2 above that pragmatic considerations may prefer explicit constructions over concise constructions. It is for this reason that I will use (32). It is not theoretically necessary to rank *GAP over *PRO, so

long as the constraint order is maintained for all languages.

(31) *OBL \gg *OBJ \gg *SUBJ

(32) *GAP \gg *PRO

It is useful to employ a more detailed analysis of the semantic representation of relative clauses. For simplicity I assume an analysis based on lambda operators (Chierchia and McConnell-Ginet 1990). With this analysis, gaps and resumptive pronouns are two syntactic realizations of a semantic parse that includes lambda operators and variables. Using lambda operators, (33) presents the possible syntactic realizations of the two kinds of relative clauses that correspond to a single semantic input.

(33) Semantic Form:

the reporter λx that the senator saw x

Realization with Gap:

the reporter that the senator saw {gap}

Realization with Resumptive Pronoun:

the reporter_{*i*} that the senator saw him_{*i*}

In order to distinguish these two possible outputs (more accurately, to distinguish gaps from resumptive pronouns), the grammar should be equipped with constraints that favor one form over the other. Having posited gaps as more marked than resumptive pronouns, the *GAP constraint in (32) will be decomposed so that it bans gaps in specific syntactic positions. In doing so the hierarchy in (31) is demoted so that it is a subset of the *GAP constraint, and the constraints in (34) are rendered. The decomposed *GAP constraints are explained in (34), and I maintain the universal ranking of these constraints as in (35).

(34) *GAP_{subj}: no gaps in subject position

GAP_{obj}: no gaps in object position

GAP_{obl} : no gaps in oblique position

$$(35) \quad *GAP_{obl} \gg *GAP_{obj} \gg *GAP_{subj}$$

Presumably this can also be done for the *PRO constraint. Such a step is not necessary for the development of a functional OT system, so I will omit it. In fact *PRO is no longer necessary at all, and I discard this constraint altogether to avoid cluttered Tableaux. This is not a significant loss since the new *GAP constraints still capture the idea that gaps are more marked than pronouns. Gaps have markedness constraints, but pronouns do not. By implication gaps are marked and pronouns are not.

At this point it is necessary to discuss the forms of input and output candidates. I assume that all input candidates are semantic analyses that contain variables where appropriate (marked by an “x”). Output candidates are syntactic trees that interpret lambda operators and variables as either gaps or coindexed items. Above, (33) illustrates possible input and output forms.

With these constraints alone, only resumptive pronouns will be allowed in relative clauses. I therefore posit a faithfulness constraint forcing output candidates to preserve any variables that appear in the input. This constraint is explained in (36).³

$$(36) \quad \text{IDENT-IO}_\lambda: \text{ variables in the input have corresponding gaps in the output, and gaps in the output have corresponding variables in the input}$$

IDENT-IO_λ requires that each input variable be paired with a gap in the output and that each gap in the output be paired with a variable in the input. When ranked above any of the markedness constraints in (34), this constraint forces gaps in extraction out of the relevant syntactic position.

The tools are now in place to deal with the languages already presented: English, Urhobo, Welsh, and Hebrew. Beginning with English, I create language-specific constraint rankings

³This constraint is perhaps theoretically more well formed if it is broken down into two constraints, a MAX-IO constraint and a DEP-IO constraint. The OT system developed here works equally well either way, but I use the IDENT-IO constraint for simplicity.

(maintaining the necessary universal ranking of course) and Tableaux for these key languages. The ranking for English is presented in (37).

$$(37) \quad \text{IDENT-IO}_\lambda \gg *GAP_{obl} \gg *GAP_{obj} \gg *GAP_{subj}$$

The Tableaux in (38) through (40) show how this ranking generates the correct outputs for English.

(38) English Subject Extraction

	the lawyer λx that x praised the doctor	IDENT-IO $_\lambda$	*GAP $_{obl}$	*GAP $_{obj}$	*GAP $_{subj}$
☞ 1.	the lawyer that {gap} praised the doctor				*
2.	the lawyer $_i$ that he $_i$ praised the doctor	*!			

(39) English Object Extraction

	the lawyer λx that the doctor praised x	IDENT-IO $_\lambda$	*GAP $_{obl}$	*GAP $_{obj}$	*GAP $_{subj}$
☞ 1.	the lawyer that the doctor praised {gap}			*	
2.	the lawyer $_i$ that the doctor praised him $_i$	*!			

(40) English Oblique Extraction

	the lawyer λx that the doctor glared at x	IDENT-IO $_\lambda$	*GAP $_{obl}$	*GAP $_{obj}$	*GAP $_{subj}$
☞ 1.	the lawyer λx that the doctor glared at {gap}		*		
2.	the lawyer λx that the doctor glared at him $_i$	*!			

In each Tableau, candidate 1, the candidate with a gap, wins. This is the correct outcome: English allows extraction from all positions and only gaps in relative clauses. In all cases the highly ranked faithfulness constraint forces gaps to occur.

Urhobo shows the opposite pattern. Here the low-ranked faithfulness constraint lets the markedness constraints dominate the process, and only candidates with resumptive pronouns win. The Tableaux in (41) through (43) illustrate this.

(41) Urhobo Subject Extraction

	the lawyer λx that x praised the doctor	*GAP _{obl}	*GAP _{obj}	*GAP _{subj}	IDENT-IO λ
1.	the lawyer that {gap} praised the doctor			*!	
☞ 2.	the lawyer _i that he _i praised the doctor				*

(42) Urhobo Object Extraction

	the lawyer λx that the doctor praised x	*GAP _{obl}	*GAP _{obj}	*GAP _{subj}	IDENT-IO λ
1.	the lawyer that the doctor praised {gap}		*!		
☞ 2.	the lawyer _i that the doctor praised him _i				*

(43) Urhobo Oblique Extraction

	the lawyer λx that the doctor glared at x	*GAP _{obl}	*GAP _{obj}	*GAP _{subj}	IDENT-IO λ
1.	the lawyer λx that the doctor glared at {gap}	*!			
☞ 2.	the lawyer λx that the doctor glared at him _i				*

Turning to Welsh, the system can handle a more complex pattern of relativization. Recall that Welsh allows only gaps in subject and object position and only resumptive pronouns in oblique position. By inserting the faithfulness constraint just below the markedness constraint referring to obliques, IDENT-IO λ can force gaps to occur in subject and object position, but the highly ranked oblique markedness constraint forces resumptive pronouns to occur in oblique extraction. The necessary ranking is presented in (44), and the Tableaux are presented in (45) through (47).

$$(44) \quad *GAP_{obl} \gg \text{IDENT-IO}_\lambda \gg *GAP_{obj} \gg *GAP_{subj}$$

(45) Welsh Subject Extraction

	the lawyer λx that x praised the doctor	*GAP _{obl}	IDENT-IO λ	*GAP _{obj}	*GAP _{subj}
☞ 1.	the lawyer that {gap} praised the doctor				*
2.	the lawyer _i that he _i praised the doctor		*!		

(46) Welsh Object Extraction

	the lawyer λx that the doctor praised x	*GAP _{obl}	IDENT-IO $_{\lambda}$	*GAP _{obj}	*GAP _{subj}
☞ 1.	the lawyer that the doctor praised {gap}			*	
2.	the lawyer _{<i>i</i>} that the doctor praised him _{<i>i</i>}		*!		

(47) Welsh Oblique Extraction

	the lawyer λx that the doctor glared at x	*GAP _{obl}	IDENT-IO $_{\lambda}$	*GAP _{obj}	*GAP _{subj}
1.	the lawyer λx that the doctor glared at {gap}	*!			
☞ 2.	the lawyer λx that the doctor glared at him _{<i>i</i>}		*		

To model Hebrew, one must only modify the Welsh system slightly. Hebrew allows gaps in subject and object extraction and resumptive pronouns in object and oblique extraction. By co-ranking the faithfulness constraint with the *GAP_{obj} constraint, this system can be produced. In object extraction neither candidate will be better than the other. The Tableaux in (48) through (50) illustrate this.

(48) Hebrew Subject Extraction

	the lawyer λx that x praised the doctor	*GAP _{obl}	IDENT-IO $_{\lambda}$	*GAP _{obj}	*GAP _{subj}
☞ 1.	the lawyer that {gap} praised the doctor				*
2.	the lawyer _{<i>i</i>} that he _{<i>i</i>} praised the doctor		*!		

(49) Hebrew Object Extraction

	the lawyer λx that the doctor praised x	*GAP _{obl}	IDENT-IO $_{\lambda}$	*GAP _{obj}	*GAP _{subj}
☞ 1.	the lawyer that the doctor praised {gap}			*	
☞ 2.	the lawyer _{<i>i</i>} that the doctor praised him _{<i>i</i>}		*		

(50) Hebrew Oblique Extraction

	the lawyer λx that the doctor glared at x	*GAP _{obl}	IDENT-IO $_{\lambda}$	*GAP _{obj}	*GAP _{subj}
1.	the lawyer λx that the doctor glared at {gap}	*!			
☞ 2.	the lawyer λx that the doctor glared at him _{<i>i</i>}		*		

With the faithfulness constraint ranked lower than $*\text{GAP}_{obl}$, resumptive pronouns are produced in oblique extraction. Ranked higher than $*\text{GAP}_{subj}$, IDENT-IO_λ forces gaps to occur in subject extraction. However, since IDENT-IO_λ and $*\text{GAP}_{obj}$ are given equal rankings, neither dominates the other, and neither gaps nor resumptive pronouns are banned in object extraction.

In its current state the system is not as powerful as it needs to be. It can control whether gaps or resumptive pronouns occur in a relative clause, but it cannot dictate whether or not extraction is even possible. For all syntactic positions a candidate containing a relative clause will be produced. Some languages, as noted in Section 2, do not allow extraction out of certain positions. To give the OT system the power to prevent a relative clause in certain positions, I posit the constraints in (51).

- (51) $*\text{EXTR}_{subj}$: no extraction out of a subject
 $*\text{EXTR}_{obj}$: no extraction out of an object
 $*\text{EXTR}_{obl}$: no extraction out of an oblique position

Each constraint prevents extraction from the relevant syntactic position. These constraints reflect pressure to avoid complexity. A sentence involving extraction is structurally more complex, and the constraints in (51) will prevent unnecessarily complex structures. They will prohibit extraction unless there is a compelling reason (i.e., a higher-ranked constraint) to use extraction. Recall that if extraction is banned in any position on the NP Accessibility Hierarchy, then it must be banned in a position lower on the NP Accessibility Hierarchy than the positions out of which extraction is permitted. The “no extraction allowed” option must occur lower on the NP Accessibility Hierarchy than both the gap and resumptive pronoun strategies. Therefore I propose the universal ranking in (52). This ranking captures the observation that oblique extraction is banned before object extraction and object extraction is banned before subject extraction. In other words, oblique extraction is

most marked, and subject extraction is least marked.

$$(52) \quad *EXTR_{obl} \gg *EXTR_{obj} \gg *EXTR_{subj}$$

Like the *GAP constraint, some *EXTR constraint has been decomposed into position-specific constituents. Effectively the *EXTR constraints function exactly as the *Subj, *Obj, and *Obl constraints did, banning extraction from a particular syntactic position. The difference between the two sets of constraints is that *Subj, *Obj, and *Obl operate conceptually independently, while the *EXTR constraints are bound to each other as constituents of a single *EXTR constraint. Using the *EXTR constraints maintains the demotion of the subject/object/oblique hierarchy from its place as an independent hierarchy to the status of a subhierarchy that exists within other hierarchies.

These constraints compete with a new constraint, IDENT-IO_{RC}, which is presented in (53). As long as IDENT-IO_{RC} outranks one of the constraints in (51), a candidate with a relative clause will be selected for the pertinent syntactic position because any candidate that does not contain a relative clause will violate IDENT-IO_{RC}. If one of the constraints in (51) outranks IDENT-IO_{RC}, then no extraction will be permitted from the relevant position.

$$(53) \quad \text{IDENT-IO}_{RC}: \text{ variables in the input have corresponding relative clauses in the output, and relative clauses in the output have corresponding variables in the input}$$

For all of the languages examined so far, IDENT-IO_{RC} is ranked above the *EXTR constraints, so all types of relative clauses can occur. To show that the new constraints do not interfere with the analysis of the languages presented above, Tableaux that incorporate the new constraints are presented in (54) through (56). The Tableau in (54) is a re-examination of English oblique extraction ((40) above) with the *EXTR constraints added to the bottom of the hierarchy just below IDENT-IO_{RC}. They must be ranked below IDENT-IO_{RC} because relative clauses are permitted in all positions, but their ranking with respect to the *GAP constraints cannot be determined for English. They are placed below the *GAP constraints

for simplicity. A new candidate, candidate 3, has been added. This candidate contains no relative clause, so it does not violate the relevant *EXTR constraint. But it does violate IDENT-IO_{RC} because it has no relative clause to correspond with the input variable. (It also violates IDENT-IO_λ because it does not have a gap.)

(54) English Oblique Extraction

	the lawyer λx that the doctor glared at x	IDENT -IO _λ	*GAP _{obl}	*GAP _{obj}	*GAP _{subj}	IDENT -IO _{RC}	*EXTR _{obl}	*EXTR _{obj}	*EXTR _{subj}
☞ 1.	the lawyer that the doctor glared at {gap}		*				*		
2.	the lawyer _i that the doctor glared at him _i	*!					*		
3.	the doctor glared at the lawyer	*!				*			

While (54) shows that the system can still generate relative clauses with gaps, the Tableau in (55), which reintroduces Urhobo subject extraction (from (41) above), demonstrates that production of relative clauses with resumptive pronouns is also still possible. This Tableau shows why IDENT-IO_{RC} is necessary. Without it candidate 3 would be the winning candidate because candidates 2 and 3 would have identical violations until the *EXTR_{obl} constraint is encountered, at which point candidate 2 would be eliminated. The two IDENT-IO constraints are co-ranked because their relative rankings cannot be determined. Once again the rankings of the *EXTR constraints with respect to the *GAP constraints cannot be determined, so they are arbitrarily placed at the bottom of the hierarchy. As long as the *GAP constraints outrank IDENT-IO_λ and IDENT-IO_{RC} outranks the *EXTR constraints, the system will generate the correct output. The remainder of the rankings are irrelevant.

(55) Urhobo Subject Extraction

	the lawyer λx that x praised the doctor	*GAP _{obl}	*GAP _{obj}	*GAP _{subj}	IDENT -IO _{λ}	IDENT -IO _{RC}	*EXTR _{obl}	*EXTR _{obj}	*EXTR _{subj}
1.	the lawyer that {gap} praised the doctor			*!					*
☞ 2.	the lawyer _{<i>i</i>} that he _{<i>i</i>} praised the doctor				*				*
3.	the lawyer praised the doctor				*	*!			

One final example to show that the new constraints do not cause problems for the languages already modelled is presented in (56). In this Tableau, Hebrew object extraction is shown (from (49) above). Candidate 3 must be eliminated, and candidates 1 and 2 must be equally acceptable since both gaps and resumptive pronouns are permitted here. The ranking from (49), in which IDENT-IO _{λ} was co-ranked with *GAP_{obj}, will be preserved. IDENT-IO_{RC} is moved to the top of the hierarchy, alongside *GAP_{obl}, so that candidate 3 violates a higher-ranked constraint than candidates 1 and 2. Once again candidates 1 and 2 have identical violations, so both are acceptable outputs.

(56) Hebrew Object Extraction

	the lawyer λx that the doctor praised x	*GAP _{obl}	IDENT -IO _{λ}	IDENT -IO _{RC}	*GAP _{obj}	*GAP _{subj}	*EXTR _{obl}	*EXTR _{obj}	*EXTR _{subj}
☞ 1.	the lawyer that the doctor praised {gap}				*			*	
☞ 2.	the lawyer _{<i>i</i>} that the doctor praised him _{<i>i</i>}			*				*	
3.	the doctor praised the lawyer		*!	*					

To show how the *EXTR constraints work, it is necessary to examine a language that has no extraction out of a particular syntactic position. The language Malagasy allows extraction only from subject position, and only gaps are allowed (Keenan and Comrie 1977). I propose the ranking in (57) for this language.

$$(57) \quad *EXTR_{obl} \gg *EXTR_{obj} \gg IDENT-IO_{RC}, IDENT-IO_{\lambda} \gg *EXTR_{subj} \gg *GAP_{obl} \gg *GAP_{obj} \gg *GAP_{subj}$$

Since the $*EXTR_{obl}$ and $*EXTR_{obj}$ constraints are ranked above $IDENT-IO_{RC}$, no oblique or subject relative clauses will be allowed. $*EXTR_{subj}$, however, is still ranked below $IDENT-IO_{RC}$, so subject extraction is still possible. $IDENT-IO_{\lambda}$ must be ranked above $*GAP_{subj}$ so that gaps are allowed in subject extraction. Otherwise its particular ranking cannot be determined. It is co-ranked with $IDENT-IO_{RC}$ for convenience. The Tableaux in (58) through (60) illustrate how the complete system permits extraction in subject position and bans extraction elsewhere.

(58) Malagasy Subject Extraction

	the lawyer λx that x praised the doctor	$*EXTR_{obl}$	$*EXTR_{obj}$	IDENT - IO_{RC}	IDENT - IO_{λ}	$*EXTR_{subj}$	$*GAP_{obl}$	$*GAP_{obj}$	$*GAP_{subj}$
☞ 1.	the lawyer that {gap} praised the doctor					*		*	
2.	the lawyer _i that he _i praised the doctor				*!	*			
3.	the lawyer praised the doctor			*!	*				

(59) Malagasy Object Extraction

	the lawyer λx that the doctor praised x	$*EXTR_{obl}$	$*EXTR_{obj}$	IDENT - IO_{RC}	IDENT - IO_{λ}	$*EXTR_{subj}$	$*GAP_{obl}$	$*GAP_{obj}$	$*GAP_{subj}$
1.	the lawyer that the doctor praised {gap}		*!					*	
2.	the lawyer _i that the doctor praised him _i		*!		*				
☞ 3.	the doctor praised the lawyer			*	*				

(60) Malagasy Oblique Extraction

	the lawyer λx that the doctor glared at x	*EXTR _{obl}	*EXTR _{obj}	IDENT -IO _{RC}	IDENT -IO _{λ}	*EXTR _{subj}	*GAP _{obl}	*GAP _{obj}	*GAP _{subj}
1.	the lawyer that the doctor glared at {gap}	*!					*		
2.	the lawyer _{<i>i</i>} that the doctor glared at him _{<i>i</i>}	*!			*				
☞ 3.	the doctor glared at the lawyer			*	*				

As the treatment of Malagasy shows, this system is capable of both modelling where gaps and resumptive pronouns appear and modelling languages that do not permit extraction out of certain positions.

Having accurately reproduced cross-linguistic relative clause patterns, I now return to English and the subject-object asymmetry. According to the OT model presented here, subject extraction is less marked than object extraction, yet both are grammatical in English. English therefore makes no grammatical distinction between subject and object extraction, but the relative markedness of these two constructions is manifested in reading time and corpus results. Following Bresnen and Aissen (2001), I propose that OT has explanatory power in the realm of performance in addition to grammaticality. The subject-object asymmetry is one example of markedness appearing not in grammar but in performance. Applying statistics to markedness so marked items are less statistically prevalent than unmarked items (as in stochastic OT), the OT system presented here predicts the corpus patterns reported by Gordon et al. (2001b). Namely subject extraction is more common than object extraction, and oblique extraction is the least common form of extraction.

4 The Viability of a Module Interaction Account

Each module interaction account presented in Section 2 has the potential to explain the subject-object asymmetry. In this section, I address each account's success in predicting the features of the asymmetry.

The language and processing account (MacWhinney and Pléh 1988) argues that the subject-object asymmetry arises from shifting points of view. In the studies by Gordon et al. (2001a), each experimental sentence involved a relative clause whose head noun was the subject of the matrix sentence. That is, only SS and SO relative clauses were studied. While MacWhinney and Pléh present data showing that OS constructions are also difficult to process in Hungarian, they do not show that this is true in English. This theory, contrary to the evidence in Gordon et al. (2001a), predicts that the types of NPs used in relative clauses should not have an effect on ease of comprehension. Gordon et al. demonstrate that, if the embedded NP is of a different type than the head NP (where "type" means pronoun, name, or full NP, such as *the lawyer*), then the subject-object asymmetry disappears. This should not be the case if point of view is the important factor. While the mechanics of the NP-type interactions are beyond the scope of this paper, this phenomenon is useful in analyzing the capabilities of the various theories addressed in this paper. Moreover Gordon et al. (2001a) studied cleft sentences. In these sentences, such as *It was the lawyer that praised the banker*, the head noun is in object position. MacWhinney and Pléh predict that the subject-extracted cleft sentences should be more difficult to process than the object-extracted cleft sentences because the head noun is in matrix object position in the clefts. In fact Gordon et al. report that the asymmetry is consistent: subject extraction is still easier than object extraction. Thus, based on a combination of factors, the language and processing account is a less than desirable model of the subject-object asymmetry and must be discarded.

The language and memory interaction account (Pritchett 1992; Gibson 1998) is also

falsified by the data. According to Pritchett’s theory, object extraction is more taxing on the memory because, compared to subject extraction, the modified NP must be held in memory longer before it can be integrated into the sentence structure. While this makes sense intuitively, the modified NP, when a matrix object, can be interpreted in the matrix sentence before it must be interpreted in the embedded clause. There is no reason to hold it in memory at all while the relative clause is being processed. As noted above, there are no data concerning reading times for relative clauses in matrix object position, so the viability of the language and memory account cannot be assessed in this respect. However, the cleft study mentioned above detracts from the hypothesis that object extraction is harder because of memory concerns. In cleft sentences the head noun is in matrix object position. Consequently it can be semantically integrated with the verb immediately because the verb is already present, yet the asymmetry is still observed. If memory is really a concern, then the asymmetry should not be observed in cleft sentences. Moreover note that in SOV languages, such as German, the same word order exists for both subject and object extraction (see (61)). The head NP must be held in memory equally long for both kinds of extraction. Pritchett therefore predicts that there should be no subject object asymmetry in languages such as German, but such an asymmetry has in fact been attested (Engelkamp and Zimmer 1983).

(61) SOV word order for relative clauses

Subject Extraction: NP₁ COMP {gap}_{subj} NP_{2, obj} V

Object Extraction: NP₁ COMP NP_{2, subj} {gap}_{obj} V

Gibson’s version of the language and memory account also encounters problems. As I discussed in Section 2, pronouns are “free” items in a discourse—they place no burden on the memory. Therefore relative clauses in which the embedded noun is a pronoun should show no subject-object asymmetry. This is true for relative clauses (Gordon et al. 2001a), but in cleft sentences, where both NPs can be pronouns, the asymmetry appears even though, according to Gibson, it should not: as long as the embedded NP is a pronoun, object extraction should

be no harder to process than subject extraction.

5 Discussion

Having examined three different accounts of the subject-object asymmetry, only the markedness account covers the full range of data. It makes the appropriate predictions with respect to reading time results as well as corpus statistics. The module interaction accounts, on the other hand, predict certain aspects of the asymmetry but not others.

Having used the NP-type effects reported by Gordon et al. (2001a) to disprove the module interaction accounts, it would be unfair to exempt the markedness account from scrutiny from this angle. The OT system developed in Section 3.3 does not explain the NP-type effects, but it is compatible with some other explanation (possibly rooted in language processing) of this phenomenon. While the module interaction accounts directly predict that NP type should not have an effect on the subject-object asymmetry, the OT system makes no such claim. In fact one can imagine a situation in which the markedness considerations discussed in Section 3 combine with whatever governs the NP-type effects to produce the asymmetry. Only when the conditions of (1) object extraction and (2) matched NP types are met does the asymmetry arise. While neither the module interaction accounts nor the OT account model the NP-type effects, the module interaction accounts suggest that the NP-type effects should not exist at all, and the OT account simply ignores the NP-type effects but leaves room for an expansion of the account to incorporate these effects.

6 Conclusion

I have shown that the subject-object asymmetry is an effect of cross-linguistic markedness that is best explained in a non-harmonic OT analysis. Several questions have yet to be answered though. The claim that the asymmetry is a result of markedness is circular. Something must be the cause of markedness. It is possible that processing concerns have

influenced Universal Grammar to favor subject extraction. If this is the case, then some factor other than the grammar-external factors discussed here must be involved, as I have already shown that two possibilities cannot be correct. On the other hand, it is not surprising that subject extraction is least marked because in other instances subjects receive special treatment (Givon 1984).

In order to more completely assess the properties of the asymmetry, studies should be conducted on relative clauses in which the head noun is a matrix nonsubject (object of a verb or preposition, for example). As some of the module interaction accounts discussed above make specific predictions based on the head noun's matrix position, it is important to examine processing phenomena in various grammatical environments to more wholly assess these theories' worth.

Further, certain varieties of English allow resumptive pronouns in extraction (Givon 1984). A useful test of the markedness account presented here is to examine its ability to describe the varieties of English that allow resumptive pronouns. The OT account predicts that resumptive pronouns should be allowed in oblique extraction if nowhere else, followed by object extraction and finally subject extraction. If this prediction corresponds with observations, then the markedness claims presented here are supported. The OT account also correctly predicts that subject extraction should occur more frequently in language use than object or oblique extraction (Gordon et al. 2001b).

An important issue that has not been discussed is that of the effects of NP type on relative clause processing. It is important that any theory dealing with the subject-object asymmetry be able to accommodate some explanation of the NP-type effects. Recall that the module interaction accounts failed to predict or allow for interactions of NP types. I leave it to others to address this issue and merely point readers to the discussion in Section 5 about the OT system's compatibility with NP-type factors.

By examining several competing views of relativization and language processing, it has been demonstrated that the subject-object asymmetry in English is a manifestation of cross-

linguistic markedness patterns. Even though English allows extraction from all grammatical positions, the universal markedness features can be seen in reading time and corpus studies. The subject-object asymmetry is best viewed as part of a universal grammatical phenomenon rather than as a demonstration of the mechanics of language processing.

References

- [1] Berman, R.A. (1978) *Modern Hebrew Structure*. Tel Aviv: University Publishing Projects.
- [2] Bresnen, J. and Aissen, J. (2001) Optimality and Functionality: Objections and Refutations. To appear in *Natural Language and Linguistic Theory*.
- [3] Borer, H. (1984) Restrictive relatives in Modern Hebrew. *Natural Language and Linguistic Theory* 2, 219–260.
- [4] Chierchia, G. and McConnell-Ginet, S. (1990) *Meaning and Grammar: An Introduction to Semantics*. Cambridge, Mass.: MIT Press.
- [5] Chung, S. (1978) *Case Marking & Grammatical Relations in Polynesian*. Austin and London: University of Texas Press.
- [6] Engelkamp, J., and Zimmer, H.D. (1983) The interaction of subjectivization and concept placement in the processing of cleft sentences. *Quarterly Journal of Experimental Psychology: Human Experimental Psychology*, 34A(4), 463–478.
- [7] Gibson, E. (1998) Linguistic Complexity: Locality of Syntactic Dependencies. *Cognition* 68, 1–76.
- [8] Givon, T. (1984) *Syntax: A Functional-Typological Introduction, Vol. 1 & 2*. Amsterdam and Philadelphia: Benjamins Publishing Co.
- [9] Glinert, L. (1989) *The Grammar of Modern Hebrew* Cambridge: Cambridge University Press.
- [10] Gordon, P.C., Hendrick, R., and Johnson, M. (2001a) Memory Interference During Language Processing. *Journal of Experimental Psychology: Learning, Memory, and Cognition* 27, 1411–1423.
- [11] Gordon, P.C., Hendrick, R., and Kaplan, A.F. (2001b, March) NP Types in Relative Clauses: Corpus Results and Reading-Time Measures. *CUNY Sentence Processing Conference*, Philadelphia, PA.
- [12] Keenan, E.L. and Comrie, B. (1977) Noun Phrase Accessibility and Universal Grammar. *Linguistic Inquiry* 8, 63–99.
- [13] Lee, H. (2001) *Optimization in Argument Expression and Interpretation: A Unified Approach*. Doctoral Dissertation, Stanford University.
- [14] Lehman, C. (1986) On the Typology of Relative Clauses. *Linguistics* 24, 663–680.
- [15] MacWhinney, B. and Plh, C. (1988) The Processing of Restrictive Relative Clauses in Hungarian. *Cognition* 29, 95–141.
- [16] Prince, A. and Smolensky, P. (1993) *Optimality Theory: Constraint Interaction in Generative Grammar*. Ms., Rutgers University, New Brunswick and University of Colorado Boulder.

- [17] Pritchett, B. (1992) *Grammatical Competence and Sentence Parsing Performance*. Chicago and London: University of Chicago Press.
- [18] Sadler, L. (1988) *Welsh Syntax: A Government-Binding Approach*. London, New York, and Sydney: Croom Helm.
- [19] Schacter P. and Otnes, F. (1972) *Tagalog Reference Grammar*. Berkeley, Los Angeles, and London: University of California Press.