Production and Comprehension in Context: the Case of Word Order Freezing

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Abstract

Freezing refers to a loss of word order freedom found across typologically very different languages. It occurs when argument identifying mechanisms such as agreement and case do not sufficiently distinguish verbal arguments. Word order can in such situations be said to be exceptionally used to unambiguously distinguish the arguments. In the optimality-theoretic literature it has been shown that a bidirectional grammar can elegantly capture this word order freezing.

Bidirectional optimality-theoretic grammar, however, does not typically deal well with ambiguity and optionality. This leads to problems in modeling word order, where these two types of variation do appear. In this paper, I will show that by adopting a notion of grammaticality in Optimality Theory we shall call *stratified strong bidirectionality* and by looking more seriously at the role of the context and argument markedness in comprehension, we can successfully model both word order freezing and word order freedom in bidirectional Optimality Theory.

1 Introduction

The effects of information structure (IS) on word order have been studied extensively for many languages and it is a truism to say that languages differ qualitatively and quantitatively in this respect. But despite such differences, there is an exception to IS-induced word order variation

that occurs across languages under very similar conditions known as *word order freezing*.[1] The classic example comes from Russian, a language otherwise very sensitive to IS in its word order (Jakobson, 1936):

(1) Mat' ljubit doč'.
mother.NOM/ACC loves daughter.NOM/ACC
Mother loves (her) daughter. (SVO)

Not: The daughter loves (her) mother. (OVS)

Although Russian readily allows OVS word order, the interpretation that would go with OVS is not available for (1). The lack of word order freedom in this example is observed in Russian with any two NP arguments that show syncretism of case. Another example comes from Japanese, a language that allows scrambling over subject (2a). Word order freezing in Japanese can be observed in double nominative constructions (2b), and with colloquial case drop (2c), which only allow SOV readings (Flack, 2007):

(2) a. Hanako-o Taroo-ga osore-ru.
Hanako.ACC Taroo.NOM fears
Taroo fears Hanako. (OSV)

b. Hanako-ga Taroo-ga kowa-i
Hanako.NOM Taroo.NOM is afraid of
Hanakoo is afraid of Taroo. (SOV)

Not: Taroo is afraid of Hanako. (OSV)

c. Hanako- Taroo- osore-ru
Hanako Taroo fears
Hanako fears Taroo. (SOV)

Not: Taroo fears Hanako. (OSV)

Similar to the Russian case, it seems that scrambling in Japanese is not allowed when we cannot assign grammatical function to a constituent on the basis of case.

In Germanic V2 languages like German, Swedish and Dutch, preposing of non-subjects may be restricted by freezing (Morimoto, ms; Vogel, 2004; Rahkonen, 2004). For instance,

[1]The term was supposedly coined by T. Mohanan in a talk delivered at the Stanford Syntax Workshop, 1992. For a list of languages for which freezing has observed, see Lee (2001a, and references therein) and the rest of the current paper.

in Dutch, agreement and/or case on pronouns may differentiate between subjects and objects. When certain IS requirements are met, Dutch will allow both the canonical, subject-initial (3a) and the topicalized, object initial (3b). However, the ambiguity that we would predict to exist in (3c), on the basis of the word order variation seen in (a) and (b), and the lack of distinguishing agreement, is in fact not observed.[2]

(3) a. De Rode Duivels verslaan Oranje.
the Red Devils.PL beat.PL Orange.SG
The Belgian national football team beat the Dutch national football team. (SVO)

b. De Rode Duivels verslaat Oranje.
the Red Devils.PL beats.SG Orange.SG
The Dutch team beat the Belgian team (OVS)

c. België verslaat Oranje.
Belgium.SG beats.SG Orange.SG
The Belgian team beat the Dutch team. (SVO)

Not: The Dutch team beat the Belgian team. (OVS)

Again we can observe that a structurally possible reading (OVS) does not emerge when there is no word order independent information (case, agreement) to distinguish the subject from the object. This lack of the additional reading – word order freezing – presents a challenge to any theory of word order in a free word order language. One needs to be able to model word order that is driven by by IS rather than by grammatical function, but at the same time this freedom has to be taken away when not obviously IS related, syntactic phenomena such as agreement and case are in a certain configuration.

Freezing has been dismissed as a 'processing effect' rather than a grammatical fact. The effect varies in strength and it is fairly easy to come up with contexts in which the effect disappears, for instance by using parallelism to trigger a non-canonical reading. This means amongst other things that trying to establish the existence of the effect simply by asking informants is not very reliable. Furthermore, the fact that word order freezing shows up cross-linguistically may also be taken as evidence that freezing is not strictly grammatical in nature (Flack, 2007,

[2]I am assuming a so called hat-pattern intonation, with a rise on the first NP, a high or a low flat, followed by a fall on the second NP. This intonation pattern is compatible with either word order. For the influence of another intonation pattern, see Section 3.

who discusses but does not hold this position). Although this position is far from unreasonable, there are aspects to freezing that are puzzling from a processing perspective, like the claim that for some languages the effect shows up as soon as there is no morphological disambiguating information – there might still be selection restrictions to disambiguate (Bloom, 1999; Flack, 2007). In Section 4, I will come back to this particular issue. On a more methodological note, the non-availability of a certain word order under certain conditions should be highly relevant if one wants to understand (information structure induced) word order variation. The fact that *context* can help overrule the freezing effect only supports this point.

A second way to accommodate word order freezing involves positing language particular solutions, for instance by claiming that freezing cases involve different constructions (Bloom, 1999, for Russian, and Tonoike, 1980 for Japanese). It is, however, not always clear what the difference in construction is apart from the fact that one construction freezes and the other does not. So, although for Japanese one might argue that double nominative sentences are structurally different from nominative-accusative sentences, it is hard to see how (3c) is different from (3a) or (3b) in a way that predicts the SVO-only reading. Perhaps more importantly, such a language particular approach means missing a cross-linguistic generalization and makes explaining any context effects hard.

Therefore, in this paper, I shall pursue a third line: The architecture of grammar is such that we can we expect word order freezing to exist. One might for instance posit general, grammar-wide, ambiguity avoidance principles, that kick in when a sentence shows ambiguous morphology (Kuno, 1980; and to some extent Flack, 2007; Zeevat, 2006). Freezing then occurs because the ambiguity avoiding mechanism only allows a canonical reading of an otherwise ambiguous sentence, as in (3c). In this paper, however, I will follow proposals by authors in Optimality Theory (Morimoto, ms; Kuhn, 2003; Vogel, 2004), and especially Lee (2001a, 2001b), that use a *bidirectional model* to account for freezing. In a bidirectional model abstract speaker and hearer perspectives are combined to model grammaticality. Ambiguity avoidance follows quite naturally from such a bidirectional model, without having to explicitly state it as a principle.

Bidirectional models of word order have recently been criticized for being too restrictive, because of their intolerance of any ambiguity and optionality. In this paper, I will show that using a well established extension to OT, that is, stratified ranking (Anttila, 1997), the bidirectional model can successfully explain freezing and capture ambiguity at the same time.

The rest of the paper is structured as follows: Section 2 briefly introduces OT and the bidirectional model of word order freezing. For reasons of space, I assume some basic familiarity with the OT framework.[3] In Section 3, the limits of the basic system are shown by looking at some problematic cases, which in Section 4 are tackled by extending the basic model. Section 5, finally, shows how the model can elegantly capture cross-linguistic differences in strength of the freezing effect.

2 An OT analysis of word order

In OT Syntax (Kuhn, 2003, for an introduction and formal treatment), a form – or rather a mapping from a meaning to a form – is grammatical exactly when it is the best option in a set of candidate realizations, where 'best' is defined with respect to a language particular grammar consisting of ranked constraints. One candidate is better than another if it satisfies the highest constraint that differentiates between the two candidates. This means that a form can, and often will, violate constraints of the grammar and still be grammatical.

Consider the interaction of two key constraints in the word order grammar for Hindi, as proposed by Lee (2001a):

(4) SUBJECT-LEFT: The subject aligns left in the clause.
TOPIC-LEFT: The topic aligns left in the clause.
TOPIC-LEFT $\gg$ SUBJECT-LEFT.

When one constituent realizes both topic and subject, these two constraints favour a subject initial sentence. However, in a situation where the topic is the object, the two constraints conflict. SUBJECT-LEFT prefers a subject initial construction, whereas TOPIC-LEFT prefers

[3]The main reference for OT is Prince and Smolensky (2004). See Kager (1999) for an introduction to and overview of OT in different areas of linguistics.

the object to be initial. This conflict is resolved by the constraint ranking. In Hindi, TOPIC-LEFT out-ranks SUBJECT-LEFT, which results in a language that shows IS driven word order variation. This is illustrated in the sentences in (5) (all data in this section taken from Lee, 2001b).

(5) a. Ilaa-ne yah k^{h}at lik^{h}aa.
Ila.ERG this.NOM letter.NOM wrote
Ila wrote this letter. (Ila topic)

b. Yah k^{h}at Ilaa-ne lik^{h}aa.
this.NOM letter.NOM Ila.ERG wrote
Ila wrote this letter. (letter topic)

OT competitions can be summarized in *tableaux*, which list the relevant candidates and their constraint violations. For (5b), the tableau is in (6). The input meaning is in the top-left and the candidate realizations are down the left hand side. A violation of a constraint is marked by a '*', a fatal violation by '!' and the optimal candidate by '☞'. For convenience, the tableaux contain the English glosses rather than the Hindi surface form.

(6)

write(Ila, this letter) ∧ topic(letter)	TOP-LEFT	SUB-LEFT
Ila.ERG this letter.NOM wrote	*!	
☞ this letter.NOM Ila.ERG wrote		*

This best-form-for-a-given-meaning approach can be referred to as *production optimality*. With the grammar in (4), production optimality gives us a very simple account of IS-driven word order variation. However, this production account does not predict freezing. For the input break(stone, cart) ∧ topic(cart) the account predicts an OSV realization. This is not correct. As can be seen in (7), the OVS interpretation of the production optimal string is lacking.

(7) T^{h}elaa patt^{h}ar todegaa
cart.NOM stone.NOM break.FUT
The cart will break the stone.

Not: The stone will break the cart.

To remedy this, one could fathom very specific constraints that target freezing cases, but such constraints would be hard to motivate independently. Rather, Lee argues that word order freezing is evidence that grammar is inherently *bidirectional*: that is, apart from the production perspective, we also need to take a *comprehension* perspective. There, we do not compare possible realizations for a given meaning, but possible interpretations of a given form. Note that production and comprehension are abstract labels and do not directly refer to actual speaker or hearer activity. The comprehension tableaux for (5a) and (7) are in (8) and (9), respectively:

(8)

this letter.NOM Ila.ERG wrote	TOP-LEFT	SUB-LEFT
write(Ila, this letter) ∧ topic(Ila)	*!	
☞ write(Ila, this letter) ∧ topic(letter)		*

(9)

cart.NOM stone.NOM break.FUT	TOP-LEFT	SUB-LEFT
☞ break(cart, stone) ∧ topic(cart)		
break(cart, stone) ∧ topic(stone)	*!	
break(stone, cart) ∧ topic(cart)		*!
break(stone, cart) ∧ topic(stone)	*!	*

The first constituent in (8) can be recognized as the object because of its case, and thus only the topic assignment varies between the candidates. In the optimal interpretation the topic is the object, satisfying TOPIC-LEFT. By contrast, the lack of differentiating case in (9) means that argument assignment can vary as well as topic assignment. As a result, the optimal interpretation is one where *both* the topic and the subject are leftmost, since this satisfies both TOPIC-LEFT and SUBJECT-LEFT. Consequently, the meaning that was the input for production optimization, is retrieved in (8) but not in (9). Comprehension optimality successfully separates the non-frozen from the frozen case.

Lee (2001b) – but also Morimoto (ms); Kuhn (2003); and Vogel (2004) – therefore propose to define grammaticality in terms of both production and comprehension optimality. Arguably the simplest combination of the two perspectives is *strong bidirectionality* (Blutner, 2000):

(10) a form-meaning pair is grammatical, iff

the form is production optimal for the meaning, and the meaning is comprehension optimal for the form.

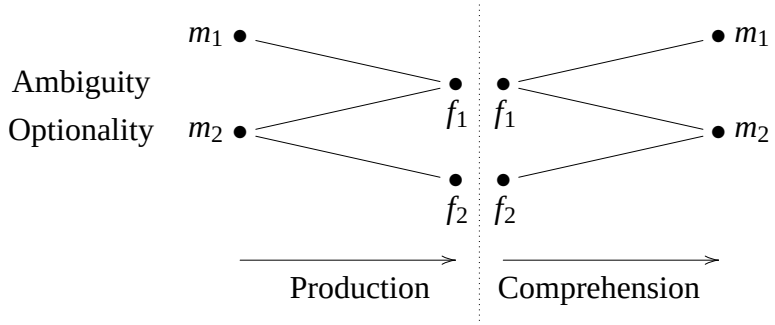
Other ways of combining production and comprehension will not be discussed in this paper (see Beaver & Lee, 2004, for an overview and Bouma, 2008, Sect. 5.6, for a discussion of word order freezing in other types of bidirectionality). There are a few things we can note about this definition of grammaticality. A language defined by a strong bidirectional grammar will always be a subset of a language defined just by production optimization, since it is the intersection of production optimization languages and comprehension optimization languages. The role that comprehension optimization plays in the definition can be characterized in several ways. Lee considers the added comprehension step as a way to formalize *recoverability* (citing a talk by Paul Smolensky in 1998). This means that freezing refers to the situation in which only subject-initial function assignments are recoverable. Comprehension optimization can also be viewed as an *ambiguity filter*, since it only allows one of potentially several production optimal form to be grammatical. In this way, we get ambiguity avoidance without having to state it as a separate principle

An unfortunate property of this simple, strong bidirectional setup, however, is its extreme restrictiveness. The possible word order ambiguity that we have seen is not the only ambiguity that is filtered out. Basically, strong bidirectional OT does not allow for any ambiguity. Furthermore, ambiguity's form counterpart, optionality, is also ruled out under a strong bidirectional setup. Recently, the bidirectional accounts of freezing have been criticized for these reasons (Zeevat, 2006; Flack, 2007). In what follows, I will address the issues raised in these papers, using techniques and constraints that are well established in the OT literature. The resulting system also allows us to give a finer characterization of what causes freezing.

3 Limits of the simple strong bidirectional model

Zeevat (2006) and Flack (2007) have independently criticized bidirectional accounts of word order freezing. Both give examples of ambiguity in the word order domain that are at odds with

Figure 1: Production (l) and comprehension (r) and their relation to ambiguity and optionality



a strong bidirectional model like the one just presented. Before I give the actual cases, let us briefly consider why strong bidirectionality does not allow ambiguity or optionality.

The relation between optimization direction on the one hand and ambiguity and optionality on the other has been extensively discussed in Asudeh (2001) and Beaver and Lee (2004). We speak of ambiguity when we have more meanings $m_1, m_2, \ldots$ mapped to one form f. Conversely, we speak of optionality when we have one meaning m that is mapped to more than one form $f_1, f_2, \ldots$. In Figure 1, ambiguity and optionality are drawn in both optimization directions. Form f_1 is ambiguous between meanings m_1 and m_2, and meaning m_2 can optionally be realized as f_1 or f_2.

In classic OT, optimization of an input generally yields exactly one output. So, the diverging lines ('$<$') in the figure are not normally obtained through classic optimization. In contrast, since there is nothing to prevent two inputs to be mapped to the same output, converging lines ('$>$') are easily obtained (a situation known as neutralization). Put together, this means that in production, ambiguity is easy but optionality is hard, and that in comprehension optionality is easy but ambiguity is hard. Since strong bidirectionality requires both comprehension and production optimality, ambiguity and optionality are both hard. In Figure 1, there is bidirectional optionality when we can travel from a meaning to itself, following paths that pass through different forms (from left to right: $m_2 \rightarrow f_1 \rightarrow m_2$ & $m_2 \rightarrow f_2 \rightarrow m_2$). Similarly, bidirectional ambiguity requires traveling from two meanings to themselves, through one form ($m_1 \rightarrow f_1 \rightarrow m_1$ & $m_2 \rightarrow f_1 \rightarrow m_2$). Note that both bidirectional ambiguity and bidirectional optionality at some point involve diverging paths '$<$'.

Let us turn to the counterexamples provided by Flack and Zeevat, that show that ambiguity and optionality are found in the domain of word order variation that we are trying to model.

(Japanese) Focus Scrambling A first example of ambiguity comes from Japanese, which, as mentioned in the introduction, shows freezing in double nominative constructions and when case is dropped in colloquial language. However, freezing only occurs with topic driven scrambling. Focus driven scrambling can always go through. As a result, the following sentence is ambiguous between SOV and OSV (Flack, 2007):

(11) TAROO-GA Hanako-ga kowa-i
Taroo.NOM Hanako.NOM is afraid of
TAROO is afraid of Hanako. (SOV, subject focus)

Or: Hanako is afraid of TAROO. (OSV, object focus)

This difference between topic and focus induced word order is also found in other languages. Lee notes similar effects with respect to the Korean suffix *-nun*, which may or may not be involved in freezing depending on whether it is interpreted as a topic or focus marker (2001b, Ch. 4). In Dutch, one finds that the frozen example (3c) is effectively 'thawed' when it is pronounced with a marked focus-background intonation, in which nuclear accent falls on the preverbal constituent. Like Japanese, Dutch will allow ambiguity when the initial constituent is focused.

Object Topicality Under the current proposal, topical objects are only recognized as such when they are in first position, as TOPIC-LEFT is the only constraint that influences topic assignment in comprehension. For Japanese, Flack assumes that topic scrambling is optional. Thus, a canonical sentence is, out of context, ambiguous between subject topicality and object topicality. This is illustrated in (12).

(12) Taroo-ga Hanako-o osore-ru
Taroo.NOM Hanako.ACC fears
Taroo fears Hanako. (SOV, subject topic)

Or: Taroo fears Hanako. (SOV, object topic)

The optionality of scrambling and the resulting IS ambiguity of canonical sentences are problematic for a strong bidirectional model. Zeevat (2006) further notes that the situation becomes worse in the context of freezing. After all, freezing refers to situations in which non-canonical word order is ruled out. This means that, in freezing cases, object-topics are never mapped to a form in the current model.[4]

(Germanic) Obligatory Wh-fronting Zeevat also raises the case of wh-fronting in languages like German and Dutch. Wh-constituents are obligatorily fronted, and in the resulting sentences, form does not always distinguish subject or object. Although word order in declarative sentences freezes in this situation, these questions are ambiguous. Take the following example from German:

(13) Welches Mädchen liebt Peter.
which.NOM/ACC girl loves Peter.
Which girl does Peter love? (OSV)

Or: Which girl loves Peter? (SOV)

Although the obligatory fronting of wh-constituents could be modeled by assuming a constraint WH-LEFT, this will not help much in comprehension; only SVO will be optimal. According to Zeevat, the ambiguity between SVO and OVS in (13) is exactly because there is no other option than to front the wh-constituent. This explanation is fundamentally unidirectional and relies on the concept of neutralization as explained in the introduction of this section.

We have seen three cases of ambiguity that are highly relevant to a model of word order variation capable of modelling freezing, in that they involve word order, argument assignment and IS. They are good examples of the wider point that a strong bidirectional model is problematic because it does not tolerate variation. However, modelling optionality and ambiguity has received significant attention in the literature on unidirectional OT and techniques exist that achieve variation which can be successfully employed in the bidirectional case. Furthermore, the bidirectional model as it is only considers morpho-syntactic information, that is, it does not

[4]This is a situation actually considered to be correct in Morimoto (ms).

really look at the role of the context or of any interpretation preferences. We will see that if we take these things into account, we can start to explain the counterexamples in a bidirectional model.

4 Modeling Ambiguity and Optionality

In classic OT, a language particular grammar is a full ranking of the available – supposedly universal – constraints. The language defined by such a grammar is then the set of all input-output pairs such that the output is the optimal candidate for the input under that ranking. Recall that for bidirectional OT, it is easier to talk about form-meaning pairs, because both are used as input and as output. Also, recall from the discussion of Figure 1 that the difficulty with ambiguity and optionality in a bidirectional setup lies in the '$<$'-part of the mapping: multiple outputs for one input.

There are two well-known approaches to achieving this one-to-many correspondence in the OT phonology and the OT syntax literature on variation: the Anttila model (Anttila, 1997) and Stochastic OT (Boersma & Hayes, 2001). Both approaches involve moving to a different, broader conception of what a language specific grammar is. In this paper, I will restrict myself to Anttila's method of achieving variation, but the results carry over to Stochastic OT.

For Anttila, a language particular grammar is not a full ranking, but rather a partial one. Anttila rankings are specified by placing constraints in strata: between strata, the order of the constraints is fixed, within strata, constraints are unordered. A language described by such a partial or stratified ranking is the union of the languages defined by every *full* ranking compatible with the partial ranking. Thus, the language described by partial ranking A $\gg$ {B, C} $\gg$ D, is the union of the languages defined by A $\gg$ B $\gg$ C $\gg$ D and A $\gg$ C $\gg$ B $\gg$ D. I will call the resulting notion of grammaticality *stratified strong bidirectionality*.

Although this move does not take us formally very far away from classic OT – we could see it as building on top of the classic conception of what a grammar and what a language is – there is one important difference between Anttila-style ranking and classic ranking. Consider the case in which constraints A and B conflict: A prefers one output, and B another. By ranking

the constraints, the conflict is resolved in favour of one of the constraints. Since constraints are always ranked in classic OT, conflicts are essentially invisible in a language. However, in Anttila-style ranking, these two constraints may be in the same stratum, like B and C in the abstract example above. When these two constraints conflict in that they each prefer a different structure, this is visible in the inventory of the language, since the language defined is the union of the language that results from giving B what it wants and the language that results from giving C what it wants. In short, a conflict between two constraints within one stratum will result in variation: one input is mapped to several outputs.

This means that we are now in a position to model optionality in production and ambiguity in comprehension directed optimization (see also Asudeh, 2001, who uses Stochastic OT). Putting this together with the fact that ambiguity in production, and optionality in comprehension was already available, we are in principle able to have production and comprehension in a bidirectional model. This approach has been suggested as future work in several places by Lee and is followed to some extent in unpublished work (Lee, ms). I will show below that with this approach, we can explain the counterexamples raised by Zeevat and Flack, using only constraints that have already been proposed for independent reasons in the literature. In the next section, I will also demonstrate how stratified strong bidirectional is able to deal with cross-linguistic differences in the freezing data.

It turns out that the cases that were raised by Zeevat and Flack are mainly problematic if we focus only on the production side of affairs: what can and can't one say, how is a certain meaning expressed, etcetera. This focus stems from the OT Syntax background, where optimization is production optimization. As soon as we start to take interpretation preferences more seriously, the problematic cases are not that problematic after all.

Wh-questions Obligatory wh-movement poses a problem for our theory of word order freezing, because in German and (especially) Dutch it can coincide with ambiguous morphology without triggering freezing. Since we claim that freezing is caused by very general properties of the grammar, this exception is surprising. However, the claim that all wh-questions that lack morphological clues as to what the subject is are simply ambiguous does not seem quite correct. Consider the following triple in Dutch, in which (b) is intended as the Dutch counterpart

of (13).

(14) a. Welk meisje zoent u?
which girl kisses you
Which girl is kissing you (SVO)

Preferred: Which girl are you kissing (OVS)

b. Welk meisje zoent Peter?
which girl kisses Peter
Which girl is kissing Peter (SVO)

Or: Which girl is Peter kissing (OVS)

c. Welk meisje zoent een jongen?
wich girl kisses a boy
Which girl is kissing a boy (SVO)

Not: Which girl is a boy kissing (OVS)

The (b) example is indeed fully ambiguous, but (a) and (c) are not, although all three sentences are equally ambiguous with respect to the morphology of their constituents. Example (c) does show word order freezing, and example (a), although it allows for both readings, is preferably interpreted as having the non-canonical word order OVS. Since the only difference lies in the type of the second NP – ranging from pronominal, through definite, to indefinite – the source of the difference in interpretation possibilities should be sought there. I would like to argue that the suitability of an NP-type as a subject influences interpretation and may thereby prevent freezing.

Backup for this claim comes for instance from work by Kaan (1997), who conducted reading time experiments of Dutch questions and declarative sentences. Kaan showed that there exists a preference for subject-initial interpretation in both declarative and interrogative clauses. Furthermore, she showed that a) this preference was stronger for declarative clauses than for interrogative clauses and b) for interrogative clauses the preference becomes weaker (or even non-existent) when the second NP is a definite or a pronominal NP. Furthermore, a corpus investigation in relation to the reading time experiments shows much the same results in terms of frequency. If we, following Kaan, treat wh-constituents as indefinite NPs, we can make the following generalizations: Subject-initial interpretations are preferred throughout (supporting

SUBJECT-LEFT as a constraint on all clause-types) and raising the definiteness-level of an NP – irrespective of its position – increases its fitness as a subject. This second generalization is captured by a family of constraints that has been proposed by Aissen (1999, and other places).

Aissen models the association of NP properties with grammatical functions with constraint hierarchies that can be derived from cross-linguistically observed tendencies. A hierarchy is a set of constraints whose ranking is universally fixed. Relevant here is the hierarchy stating that pronominal subjects are preferred over definite subjects, and definite subjects are preferred over indefinite subjects. In terms of constraints, this is expressed negatively using three constraints (where '*' is read as 'avoid'):

(15) *SUBJECT/INDEFINITE $\gg$ *SUBJECT/DEFINITE $\gg$ *SUBJECT/PRONOMINAL

Here, I shall concentrate on the effect of the highest constraint *SUBJECT/INDEFINITE. This constraint prefers a sentence of the form Wh-V-NP[+def] (14b, for instance) to be interpreted as OVS, since this avoids having an indefinite subject. SUBJECT-LEFT of course prefers the SVO interpretation. If we place these two conflicting constraints in the same stratum, ambiguity in comprehension results. A high ranking constraint on wh-fronting forces neutralization and thus ambiguity in production. Consequently, we have ambiguity in our bidirectional model, as shown in tableaux (16) and (17). The grammar fragment that we are interested in is WH-LEFT $\gg$ {SUBJECT-LEFT,*SUBJECT/INDEFINITE}. The two compatible full rankings are presented in turn. In each case, comprehension is in the top tableau, production in the bottom one. As before, the tableaux pertain to Dutch sentences, but the English glosses are shown as the surface form.

(16)

which girl kisses Peter		WH-LEFT	SUB-LEFT	*SUB/IND
☞	kiss(?girl, p)			*
	kiss(p, ?girl)		*!	

(17)

kiss(?girl, p)	WH-LEFT	SUB-LEFT	*SUB/IND
☞ which girl kisses Peter			*
Peter kisses which girl	*!	*	*

which girl kisses Peter	WH-LEFT	*SUB/IND	SUB-LEFT
kiss(?girl, p)		*!	
☞ kiss(p, ?girl)			*

kiss(p, ?girl)	WH-LEFT	*SUB/IND	SUB-LEFT
☞ which girl kisses Peter			*
Peter kisses which girl	*!		

Note that there is only one grammar, albeit a stratified one, used in both production and comprehension and that I assume that the full, spelled-out rankings have to be the same in both directions of optimization for a form-meaning pair to be bidirectionally optimal. Also note that constraints may have a different effect, or even have no effect, depending on whether one is free to vary form as in production or to vary meaning as in comprehension.

The constraints on definiteness ensure that when the second NP is definite, a wh-question is ambiguous between SVO and OVS provided there is no other information to decide between the two. However, when the second NP is indefinite, it is predicted that the the only interpretation is subject initial. The data in (14c) suggests this prediction is correct.

The overly-simple classification of NPs into definite and indefinite only scratches the surface of a whole sea of issues of specificity, referentiality and discourse givenness, which we will not address here. Similarly, treating wh-constituents as indefinites is cutting some corners. For instance, differences between bare wh-words (*who*) and complex wh-constituents (*which X*) in Dutch could be considered.

A consequence of adopting the constraints on subject definiteness is that we predict any Dutch sentence of the form NP[-def]-V-NP[+def] to be ambiguous between SVO and OVS. An example for which this is not correct is (18).

(18) Een jongen zoekt Piet.
a boy searches Piet
A boy is looking for Piet.

Incorrectly predicted, also: Piet is looking for a boy.

The OVS reading is considerably harder to get than with a wh-question. I would like to argue that this can ultimately be explained by appealing to production. For the OVS reading to be available, we need a comprehension reason as well as a production reason. We have a comprehension reason by means of the constraints on subject definiteness, but we also have to give a reason for why the direct object would be fronted in production. In the case of a wh-constituent, this is clear, because *all* wh-constituents have to be fronted. However, a fronted non-wh-constituent in Dutch typically is a contrastive or shift topic and although indefinites can be topics, this appears to a marked situation. Presented in isolation, then, a sentence like (18) is most easily interpreted as SVO, because it is harder to come up with a topic interpretation for the indefinite NP. In this case, the double motivation we need to derive variation in a bidirectional OT framework allows for an interesting type of explanation: we can explain an interpretation effect by appealing to (abstract) production.

Focus scrambling Focus driven scrambling in Japanese forms an exception to freezing, and similar facts are observed in for instance Dutch and Korean. Lee (2001b) proposes to analyze these cases by linking subjecthood to topicality. This can be done for instance by a constraint that requires the subject to be part of the information structural background of the sentence.

(19) BACKGROUND(SUBJECT) The subject is part of the background information of a sentence.

Constraints to this extent can be found in Lee (2001b, called SUBJECT=TOPIC), Beaver (2004, called ALIGN), and Zerbian (2007). A subject should serve as a fixed and given point in the information conveyed in the sentence and is therefore best part of the background information of the sentence, that is, the information that is completely and recently given, and not contrasted. One of the many places similar insights can be found is in Centering Theory (Grosz, Joshi, &

Weinstein, 1995), where there is a tight relation between subjects and continuing topics.

Since focused material does not belong to the background, any material that receives focus will be dispreferred as a subject on account of this constraint. Putting BACKGROUND(SUBJECT) into one stratum with SUBJECT-LEFT means that a Dutch sentence of the form NP–V–NP, with a focus-background intonation receives both SVO and OVS interpretations in comprehension. Focus fronting in production has to be taken care of by a further constraint.

Note that BACKGROUND(SUBJECT) will have an effect on the interpretation of wh-questions, too, and that this effect will partly overlap with the effect of the definiteness constraints. Whatever the information status of the wh-constituent is, it is safe to assume that it is not part of the background information, because as a whole, wh-constituents correspond to information that is asked for, not information that is provided. This means that, when the second NP in a wh-question is not focused, interpreting the question as OVS is also a way of satisfying BACKGROUND(SUBJECT). Investigating the extent and importance of this overlap remains future work.

Information Structural Ambiguity of Canonical Word Order Finally, there is the problem of canonical word order which can be used in different IS configurations, for instance when the object is topic. As with the analyses of ambiguous wh-questions and ambiguous focus-initial sentences, the crux lies in finding a way to recognize what is topic, that is, finding a word order independent information source, that will conflict with one of our existing constraints (in this case, TOPIC-LEFT) in comprehension. Notice that the optionality of fronting a topic in production is taken care of by having TOPIC-LEFT and SUBJECT-LEFT in one stratum (unlike Lee's original analysis for Hindi, which ranked TOPIC-LEFT over SUBJECT-LEFT).

The source of information we are after suggests itself when we reconsider the kind of linguistic evidence that we need to support the claim that canonical word order can be used for different IS configurations. This evidence consists in felicitously uttering a canonical sentence in a context that (strongly) sets up for a certain IS configuration. So, if we for instance can use a Japanese SOV sentence in a context that expects an object topic, we would have to say that Japanese SOV word order has an object topic interpretation.

However, rather than proving that Japanese canonical word order in some way *elicits* this

object topic interpretation, what this test shows is that canonical word order is not incompatible with such a context. In terms of constraints, we can say that the effect of the constraint TOPIC-LEFT, which links IS to word order, is moderated by a constraint that links IS to the context. Such a constraint has been proposed in Beaver (2004), again on the basis of Centering Theory. Ranking the constraint, called COHERE, at least as high as TOPIC-LEFT means that non-initial topics are recognized in the right context.

Interestingly, the bidirectional nature of the model makes sure that ranking COHERE over TOPIC-LEFT does not predict that every sentence always receives a discourse coherent interpretation. A sentence with a topicalized object in a subject topic context will not receive a subject topic meaning: in production this meaning would never have led to an object-topicalization. The bidirectional model captures the fact that canonical word orders are compatible with more contexts than non-canonical or marked word orders.

I have shown how stratified strong bidirectionality can be used to model a range of word order freezing facts, including previously problematic exceptions to word order freezing. Once we recognize the nature of the model, that all mappings between meaning and form that are not one-to-one need a double explanation – in production and in comprehension, plausible analyses for the problematic cases can be given using constraints available in the literature.

On a more general level, we can observe that different kinds of information guide interpretation of sentences in the model. It is when information is lacking, that options like word order variation are lost in order to be able to correctly assign grammatical function in interpretation. The fact that expressing IS with word order is sacrificed in favour of expressing grammatical function can be explained by the fact that, due to the type of meaning involved, information structure typically has sources like the context, that will not always help for grammatical function. There is no need, in the bidirectional model, to stipulate this asymmetry explicitly.

This does raise the question whether all sources of information will always be used in interpretation and whether all languages are alike in this respect. After all, OT has a strong typological flavour to it and positing two unrelated but conflicting constraints generally means making the prediction that there are at least two types of languages: one type in which the first

constraint is enforced, and one type in which the second is. In next section, we will see that there are examples in the literature that strongly suggest that languages differ in their sensitivity to freezing-preventing information. Just like classic OT, stratified strong bidirectional OT can capture these facts by appealing to constraint ranking.

5 Cross-linguistic Differences

We started the discussion of word order freezing by focusing on the lack of morphological indicators of which NP fulfills which grammatical function. In the analyses proposed for wh-questions and focus-scrambling in the previous section, we have already seen instances of non-morphological information (definiteness and information status) that can be used for grammatical function assignment in comprehension.

In her discussion of freezing in Hindi, Lee (2001b) explicitly excludes cases where there are strong non-syntactic factors that force an interpretation. So, whereas cases like (7) in Section 2 show freezing, the syntactically similar (20) does allow for an OSV reading:

(20) aam Raam k^{h}aayegaa.
mango.NOM Ram.NOM eat.FUT
Ram will eat the mango.

Obviously, if the verb is 'to eat' and the first NP refers to a type of food, and the second to a human being, an OSV interpretation should be preferred. The lack of case-marking and agreement cannot prevent this. Similar observations can be made for Dutch (21a, my judgement) and Swedish (21b, taken from Morimoto, ms, but see also Rahkonen, 2004), in which OSV is the only, or at least the preferred interpretation, despite the fact that with respect to morphology, freezing should be triggered.

(21) a. Het koekje eet Hans
the biscuit eats Hans
The biscuit is eating Hans. (SVO)

Preferred: Hans is eating the biscuit. (OVS)

b. Boken läser Anna
book.DEF reads Anna
Anna is reading the book. (OVS)

As before, there are strong semantic/pragmatic forces that prefer the non-canonical interpretation. Let us for the sake of argument assume that this is appropriately modeled by using a constraint that disprefers inanimate subjects (Aissen, 1999):

(22) *SUBJECT/INANIMATE: Avoid inanimate subjects.

There is much more to be said about selectional restrictions of verbs, but for now, note that ranking *SUBJECT/INANIMATE above SUBJECT-LEFT suffices to retrieve the object-initial interpretation in comprehension. This means that our bidirectional model can make the correct predictions for (21) and (22a,b).

Interestingly, quite the opposite claim is also found in the freezing literature: animacy information cannot prevent freezing. Russian (23a, from Bloom, 1999) and Japanese (23b, from Flack, 2007)[5] show freezing in spite of semantic/pragmatic factors.

(23) a. Jishin-ga Taroo-ga kowa-i.
earthquakes.NOM Taroo.NOM be afraid of.PRES
Earthquakes are afraid of Taroo. (SOV)

Not: Taroo is afraid of earthquakes. (OSV)

b. Koffe da'ot mat' pap'e
coffee.NOM/ACC gives mother.NOM/ACC father.DAT
Coffee gives mother to father. (SVDoIo)

Not: Mother gives coffee to father. (DoVSIo)

This cross-linguistic variation in the influence of animacy on grammatical function assignment in comprehension can be captured by the bidirectional model through constraint ranking. In languages like Swedish, Dutch and Hindi, where animacy may prevent freezing, *SUBJECT/INANIMATE is ranked above SUBJECT-LEFT. In languages like Japanese and Russian, *SUBJECT/INANIMATE is ranked below SUBJECT-LEFT.

[5]Similar data is found in Tonoike (1980) and Kuno (1980).

It is custom in the OT literature to investigate the factorial typology.[6] This investigation with respect to word order freezing, and the constraints used in this paper will have to wait until we have more extensive data and a more comprehensive constraint set.

6 Conclusion

Word order freezing is a relatively little investigated part of the larger area of interaction between information structure and syntax. From earlier proposals, we know that bidirectional OT is a good candidate to deal with word order freezing and its various exceptions. Recent arguments against a bidirectional explanation of freezing can be successfully addressed if we allow grammars to be partial rankings of constraints. The resulting stratified strong bidirectional OT is capable of handling all the examples of freezing and thawing that are discussed in this paper. In addition, a shift in focus from production oriented to both production and comprehension oriented preferences is needed to explain the data.

Bidirectional OT does not readily allow for ambiguity and optionality, because all of these cases need a double motivation – in production and in comprehension. However, this double requirement is also to our advantage, for instance in tempering the effects of a constraint like COHERE that might seem too strong at first sight. From the discussion throughout the paper, it should be clear that there are enough points for future theoretical and empirical, work.

I would like to end this paper with an observation about what drives freezing in stratified strong bidirectional OT. As mentioned, freezing has before been treated as resulting from an ambiguity avoiding strategy. However, given that language can be ambiguous in many ways and on many levels, and given that we have taken so much care to let our model predict ambiguity, I think there is a better way to explain what triggers freezing. In addition to the optimality requirement on a form of unidirectional OT Syntax, stratified strong bidirectional OT requires that the intended meaning is amongst one of the possible interpretations of a form. When this is not the case, the form-meaning pair is not grammatical. This can be considered a weakened version of recoverability. What drives freezing is not the avoidance of ambiguity, but rather

[6] With Anttila-style partial ranking, a better name might be over-factorial typology, as there are more than $n!$ grammars possible with n constraints.

the avoidance of the situation in which the intended interpretation does not show up at all: guaranteed miscomprehension.

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