

# Language contact and Spanish aspectual expression: a formal analysis\*

Andrew Koontz-Garboden  
Department of Linguistics  
Margaret Jacks Hall, Bldg. 460  
Stanford University  
Stanford, CA 94305-2150  
U.S.A.

telephone: +1 (1)650-723-1535

fax +1 (1)650-723-5666

[andrewkg@csli.stanford.edu](mailto:andrewkg@csli.stanford.edu)

<http://www-csli.stanford.edu/~andrewkg/>

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**Abstract**

This paper develops a generative analysis for a particular language contact phenomenon familiar in the variationist and language contact literature, namely indirect transfer (Klein, 1980; Mougeon and Beniak, 1991; Silva-Corvalán, 1994). This language contact effect, which is preferential rather than categorical, is difficult to deal with in traditional generative approaches, and has received no attention in this literature. My analysis focuses on Klein's (1980) study of synthetic/analytic verb forms used for the expression of progressive aspect in Spanish, where contact with English causes a skewing in the distribution of use of analytic forms in a bilingual variety compared to a similar monolingual variety. The analysis is carried out in a stochastic OT (Boersma and Hayes, 2001) framework, where I show that the indirect transfer effects observed by Klein can be captured by way of different ranking of a small set of OT constraints on a linear ranking scale. In addition to providing a model for the indirect transfer effects in Klein's study, my analysis also makes a typological prediction regarding morphosyntactic expression and Imperfective and Progressive verb forms: no language can have a synthetic Progressive and an analytic Imperfective. This prediction is supported by the absence of any such distribution in the surveys of Bybee et al. (1994) or Dahl (1985).

**Keywords:** Spanish, aspect, typology, syntactic variation, language contact, indirect transfer, Optimality Theory, Stochastic O.T.

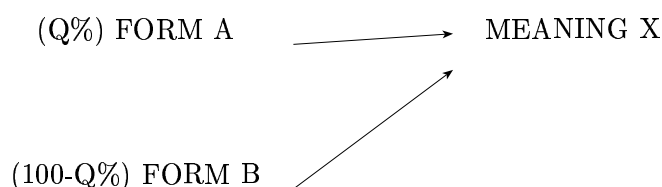
## 1 Introduction

Although much recent research has focused on developing formal approaches to phonological variation within contemporary generative theories of phonology (Anttila, 1997; Boersma and Hayes, 2001; Nagy and Reynolds, 1997) and to particular cases of phonological variation (Auger, 2001), much less attention has been paid to syntactic variation within modern generative theories, and even less to formal generative approaches to syntactic variation from language contact. One problem in language contact that has received no attention in any generative approach is the phenomenon known as *INDIRECT TRANSFER* (Silva-Corvalán, 1994:4), also known as *CONVERGENCE* (Klein, 1980; Klein-Andreu, 1985; Pousada and Poplack, 1982), *COVERT INTERFERENCE* (Mougeon and Beniak, 1991:chapter 9), and *COVERT INFLUENCE* (Romaine, 1995:177). This special type of contact-induced effect was defined by Silva-Corvalán (1994:4), as in (1).

- (1) *INDIRECT TRANSFER*  
The higher frequency of use of a form in language S, determined on the basis of a comparison with more conservative internal community norms, in contexts where a partially corresponding form in language F is used either categorically or preferentially. This constitutes an instance of *INDIRECT TRANSFER* from language F into language S.

The situation described in prose in (1) can perhaps be better understood by way of the illustrations in (2).

- (2) a. Form/meaning mapping in language ‘S’



- b. Form/meaning mapping in language ‘F’



Indirect transfer is said to have occurred under Silva-Corvalán’s definition, when speakers of ‘S’ who are also in contact with ‘F’ use form A more often than speakers of ‘S’ who are not in contact with F.

Although indirect transfer effects are somewhat understudied (Mougeon and Beniak 1991:159), several convincing cases have been documented, ranging from prepositional use in French in Canada (Mougeon and Beniak, 1991:chapter 9) to complementizer use in the Spanish of Los Angeles (Silva-Corvalán, 1994) to Klein's (1980) study of synthetic/analytic variation in the morphosyntactic expression of Spanish progressive aspect. Despite the attention the phenomenon has received in the sociolinguistic literature, however, it has received no attention from a generative perspective, perhaps because it is unclear how such effects should be captured in most generative approaches. Traditional generative grammars are computational systems that for a given structure determine only whether the structure in question is licensed by the grammar. Differences between linguistic systems can be thought of as differences in the structures licensed by the respective grammars. In the case of the monolingual variety of a language, and its contact counterpart, however, THERE IS NO DIFFERENCE IN THE STRUCTURES LICENSED BY THE RELEVANT GRAMMARS; it is a crucial property of indirect transfer that the effects give rise in the contact language to no utterance considered ungrammatical in the monolingual norm. The difference between the two systems can only be characterized at the level of PREFERENCES in usage of a particular structure. This idea is central to indirect transfer and was made explicit by Mougeon and Beniak (1991:178).

Covert interference [=indirect transfer—AKG] is a subtle effect of language contact that can only be isolated through quantitative investigation, since it does not entail any qualitative deviation from the conservative norm, only a statistical one ....

The traditional generative grammarian is then forced to say that the difference between 'S' and 'S-contact' is a performance effect. At the same time, however, those who study language contact view indirect transfer as an external cause whose effect is LANGUAGE CHANGE (Silva-Corvalán, 1994:chapter 5), and as having had an effect on something more akin to the traditional notion of competence, the object generative grammarians seek to understand.<sup>1</sup> Thus, the challenge for generative grammar with indirect transfer is that it is a phenomenon that causes change in a linguistic system, but at a level characterizable only in QUANTITATIVE rather than categorical terms. A satisfactory generative analysis needs to locate the source of variation in the monolingual, standard variety that makes indirect transfer possible, and show the results by formally characterizing the contact variety, and showing what gives rise to the quantitative differences in use of particular forms in the two mutually-comprehensible varieties.

This task has not been undertaken, either in the abstract or for any particular example of indirect transfer. This paper represents a first step in this direction

by unifying empirical results from language contact and variationist analyses with recent formal work in the generative tradition. I examine an empirical result in language contact discovered by way of variationist methodology: variation in the use of synthetic and analytic verbal morphosyntax in Spanish progressive aspect (Klein, 1980; Klein-Andreu, 1985). In the present study, I take Klein's empirical generalizations and analysis a few steps further, and fill a gap in the generative literature where no explanation of these facts exists. Since the phenomenon in question is representative of a more general language contact effect, the mechanisms of the formal analysis should be generalizable to other cases of this phenomenon. My analysis, then, suggests ways of dealing with similar language contact phenomena in terms of constraint reranking on a continuous scale in a stochastic optimality-theoretic grammatical framework (Boersma and Hayes, 2001).

I begin by discussing the facts under study, and Klein's generalizations. I then present a detailed formal analysis of Klein's facts and discuss the consequences of the account and conceivable alternatives. I follow this by suggesting directions for further research and some concluding remarks.

## 2 The morphosyntactic expression of progressive aspect in Spanish

### 2.1 The facts

Spanish grammarians have long recognized that Spanish has two verb forms that overlap in meaning, both being usable in progressive contexts (Comrie, 1976; Butt and Benjamin, 1994; Westfall, 1995). These forms are illustrated in (3), with a synthetic verb form (3a) and an analytic verb form (3b) used with an on-going interpretation.

- (3) a. Mira, sale            ahora el sol.  
      look comes-out now the sun  
      b. Mira, está saliendo    ahora el sol.  
      look, is coming-out now the sun  
      'Look, the sun is coming out now.'

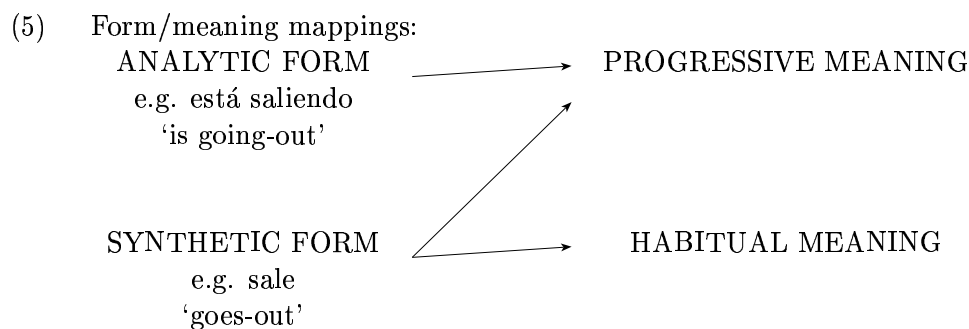
Westfall (1995:370) showed for the past tense on the basis of grammaticality judgments of sentences where an analytic and a synthetic form co-occurred in a progressive context, that 'The compatibility of [the analytic] and [the synthetic] indicates that duration of one is not less than the other. Semantically they are the same—open situations occurring at and around a [reference time] in the context.'<sup>2</sup> Comrie (1976:112) took a similar view and pointed out that analytic forms can '...always,

without excluding progressive meaning, be replaced by the non-Progressive [=synthetic] forms....' That the two forms have some sort of overlap in meaning seems to be uncontroversial for all researchers studying these facts.

Although both forms can be used with progressive aspect, the two forms overlap in their (truth-conditional) meaning only partially. The progressive interpretation tends to be the only interpretation available for the analytic form, but the synthetic form also has a habitual interpretation that tends to be the only way of expressing habitual meaning. The data in (4) show that while the synthetic form is normal in a habitual context, the analytic form is disfavored in such contexts.<sup>3</sup>

- (4) a. Como es joven, Miguel juega futbol los domingos.  
       as is young Miguel plays soccer the Sundays  
       b. ??Como es joven, Miguel está jugando futbol los domingos.  
       as is young Miguel is playing soccer the Sundays  
       'As he's young, Miguel plays futbol on Sundays.'

The relationship between the two forms, the synthetic and the analytic, and the two meanings, progressive and habitual, can be graphically represented, as in (5). This shows that there is a one-to-many mapping between form and meaning with the synthetic form. It can be used with both meanings, progressive and habitual. In contrast, the analytic form exhibits more of a one-to-one relationship between form and meaning, being usable only with progressive meaning.



## 2.2 Klein's (1980) results

Klein (1980:69-70) observed the state of affairs in (5) for Spanish and noticed at the same time that English has verbal expressions similar in form to their Spanish counterparts, but with significantly different form/meaning mappings.

- (6) a. Mary eats an apple every day.  
       b. ?Mary is eating an apple every day.<sup>4</sup>

- (7) a. Mary is eating an apple right now.  
b. \*Mary eats an apple right now.<sup>5</sup>

While (6) shows that the English synthetic form is favored in habitual contexts, (7) shows that in English the analytic form tends to be used in progressive contexts. Graphically, then, the relationship between form and meaning in English can be characterized as in (8), which shows that, in English, both the synthetic and the analytic forms have a one-to-one relationship between form and meaning. The synthetic form expresses habitual meaning, while the analytic form expresses progressive meaning.

- (8) English mappings between form and meaning
- |                 |   |                     |
|-----------------|---|---------------------|
| ANALYTIC FORM   | → | PROGRESSIVE MEANING |
| e.g., is eating |   |                     |
|                 |   |                     |
| SYNTHETIC FORM  | → | HABITUAL MEANING    |
| e.g., eats      |   |                     |

This subtle difference in the mappings between form and meaning for Spanish, in (5), and English, in (8), is due to the English and the Spanish synthetic forms being used for habitual meaning, while only the Spanish synthetic form is also used for progressive meaning. This led Klein to hypothesize that monolinguals and bilinguals might differ in the extent to which they used the Spanish synthetic and analytic forms for expression of progressive aspect in Spanish. Bilinguals, with access to both languages, might (subconsciously) minimize the differences between the two languages, yet use perfectly grammatical utterances. In short, Klein predicted *INDIRECT TRANSFER*.

To test this hypothesis, Klein collected data from groups of sociologically homogeneous monolingual and bilingual speakers. All the speakers were between 16-20 years old, and living in New York City at the time. In total, Klein interviewed 10 Spanish/English bilinguals, and 8 Spanish monolinguals from Puerto Rico, recording each two-part session. In the first part, Klein conversed freely with the participants, focusing the conversation on what she called ‘new developments,’ i.e., new developments in the speakers’ life, new construction at home, government programs, etc. Pilot work (reported in Klein 1980) showed that these topics elicited more utterances with progressive meaning, because they focused on ongoing issues. In the second part of the data collection, Klein showed each participant eight pictures of different activities in progress, and asked participants to describe what was happening.

Each occurrence of a synthetic or analytic form was placed into one of three categories according to the meaning of the utterance: (a) utterances expressing pro-

gressive meaning,<sup>6</sup> (b) utterances expressing habitual meaning, and (c) utterances where the intended meaning was not clear. The basic results are given in (9).

(9) % uses of synthetic versus analytic forms with progressive meaning (Klein 1980)

syntactic form	monolingual	bilingual
synthetic	26% (n=63)	6% (n=18)
analytic	74% (n=178)	94% (n=269)

$\chi^2 = 39.82, p < .001$

Monolinguals use the synthetic form for progressive meaning 26% of the time, while bilinguals use the synthetic form only 6% of the time. As the chi-square test shows, this result is statistically significant, going in the direction of Klein's hypothesis.<sup>7</sup>

In explaining these facts, Klein appeals to the notion of indirect transfer: bilinguals favor the analytic form more than the monolinguals, according to Klein, because their use of the analytic form aligns the Spanish system more closely with the English one, without affecting grammaticality from the perspective of the monolingual Spanish norms.

It is very important to highlight the fact that, as Klein argued, differences in frequency of use of the synthetic form between the two groups are due to SOCIAL FACTORS, i.e. to the fact that bilinguals are in contact with English, which gives them a bias towards the analytic form. The analytic form CAN be, and IS used by bilinguals without any change in the meaning or grammaticality of particular utterances. Klein's point, crucial here, is that the difference in frequency of use of the synthetic and analytic forms between the two groups is not due to differences in the meanings expressed by the two groups—they are expressing the same meanings, merely using different forms, both of which are licensed by all standard varieties of Spanish. This point of Klein's analysis is supported by at least two considerations: by the existence of stylistic differences in analytic versus synthetic use, and by her experimental design. The points are considered in turn.

### **2.2.1 Stylistic differences in synthetic/analytic use**

Klein's claim that the differences between the bilinguals and the monolinguals are due to social, rather than to linguistic factors, is supported not only by the social facts, but also by the existence of stylistic differences in synthetic/analytic use. Torres Cacoullós (2000:62ff.), for example, found on the basis of token counts in five corpora representing different styles of speech, that the analytic form (in all tenses regardless of auxiliary verb) is '...between three and five times more likely to appear in conversation than in formal texts.' Westfall (1995:384) claimed that there are significant differences in the use of synthetic and analytic forms for the expression of progressive aspect according to style, particularly in the backgrounding section

of narratives. Specifically, according to Westfall, it is more common to find the past tense synthetic form used with progressive aspect in the backgrounding section of a narrative in the written language, while in the spoken language, in this same section of the narrative, the analytic form is favored. Westfall (1995:384) gave the example in (10), with (10a) being found more commonly in the written language, and (10b) a form of the same narrative common in spoken varieties of the language.

- (10) a. El sol brillaba, los pájaros cantaban, caminábamos por el bosque...
- b. El sol estaba brillando, los pájaros estaban cantando, estábamos caminando por el bosque...  
'The sun was shining, the birds were singing, we were walking through the woods.'

It is a foundational principle of research in sociolinguistics that 'social and stylistic variation presuppose the option of saying "the same thing" in several different ways...' (Labov, 1972b:271). Stylistic variation entails that '...the variants are identical in referential or truth value [at least in some context—AKG], but opposed in their social and/or stylistic significance' (Labov, 1972b:271). The fact that stylistic variation exists in the domain of synthetic versus analytic use supports Klein's analysis that differences between the monolingual and bilingual groups are not due to significant differences in the meanings being expressed, since Spanish overall exhibits stylistic variation in this domain, and since stylistic variation presupposes different ways of saying 'the same thing.'

### **2.2.2 Klein's experimental design**

Klein's argument in favor of a social explanation is perhaps most strongly supported by her experimental design—she carried out the same sorts of experiments with both groups, focusing on the same topics of conversation in the free conversation section, and also using the same picture-based psycholinguistically-oriented experiment with all of the informants. So, meaning was held relatively constant for both monolinguals and bilinguals.

Given this consideration and those discussed above, the differences between the two groups in the frequencies of use of synthetic and analytic forms are unlikely to be due to differences in meaning. Rather, as Klein argues, the quantitative differences are due to social factors and to the fact that the synthetic form and the analytic form can both be used in Spanish for progressive aspect. So, increased use of the analytic form by bilinguals has no significant effect on the meaning of their progressive utterances, and no effect on the grammaticality of those utterances vis-à-vis standard Spanish.

Having now discussed in detail the results of Klein’s study, I turn to the formal analysis, and first motivate a particular representation of the content of the synthetic and the analytic forms, drawing in part on additional data collected by Klein (1980). I follow this with a stochastic OT analysis.

### 3 The content of the synthetic and analytic forms

As a preliminary to a formal analysis of Klein’s (1980) data, I first make explicit the content of the synthetic and the analytic forms.

For Westfall (1995:403, Table 7.5), the analytic form is overtly specified for attributes giving rise to progressivity, while the synthetic form is unspecified for these. So, the synthetic form is ‘vague’ rather than ‘ambiguous.’ Building on Glasbey’s (2001) LFG implementation of Smith (1991), I then represent the analytic and the synthetic forms as in (11).<sup>8</sup>

- (11) a. analytic  

$$\left[ \begin{array}{ll} \text{VIEWPNT} & \text{IMP} \\ \text{PROG} & + \\ \text{HAB} & - \end{array} \right]$$
 b. synthetic  

$$\left[ \begin{array}{ll} \text{VIEWPNT} & \text{IMP} \end{array} \right]$$

Such a representation is consistent with the truth-conditional equivalence discussed above, but also helps to explain subtle differences between the two forms. These differences consist of inferential differences and statistical differences in use.

#### 3.1 Possible inferences with the analytic form

Westfall (1995:chapter 7 and references there) reports that Spanish speakers exploit the full semantic specification of the analytic form vs. the semantic underspecification of the synthetic form in the past tense to make subtle pragmatic contrasts. According to her consultants, use of the analytic in e.g. (12) may indicate a ‘deeper’ sleep.

- (12) a. Juan dormía cuando llegué.  
 Juan sleeping when arrived-I  
 b. Juan estaba durmiendo cuando llegué.  
 Juan was sleeping when arrived-I  
 ‘Juan was sleeping when I arrived.’ (Westfall, 1995:363, (3-4))

For (13), Westfall (1995:383) reported that “...the change of state is felt by some native speakers to be more imminent with the progressive [=analytic] sentence.” Again, this emphasis could be attributed to pragmatic inference associated with the full specification of the analytic form versus the underspecification of the synthetic one.

- (13) a. Supe        que se moría.  
           found-out that self dying  
       b. Supe        que estaba muriéndose.  
           found-out that was    dying  
           ‘I found out that he was dying.’ (Westfall, 1995:382, (28-29))

Similar claims have been made of synthetic versus analytic uses with progressive aspect in the present (Torres Cacoullós 2000:184 and references there). These facts follow naturally from the vague analysis of the synthetic form proposed in (11). It is not so clear how one would deal with such facts under an ambiguous analysis, whereby there are two lexical entries for the synthetic form, one of which is identical in content to that for the analytic form.

### 3.2 Dialectal statistical differences in use

Further evidence in favor of the vagueness analysis in (11) comes from additional empirical generalizations. Klein (1980:77ff.) observed that use of the Spanish synthetic form could, in certain situations, lead to ambiguous utterances where it was not immediately apparent whether the speaker had intended the event in question to be encoded with progressive or habitual aspect. She conjectured that monolinguals, who use a good deal of the synthetic form in progressive contexts, would avoid the synthetic form when there was less contextual material available to disambiguate it; in such situations, Klein hypothesized, speakers should favor the analytic form since it is unambiguously progressive. To test her hypothesis, Klein divided all progressive utterances (in both the synthetic and the analytic forms) into two groups: those with good contextual support, and those with little contextual support.<sup>9</sup> Her results are given in (14).

- (14) a. Progressive utterances with less context (Klein 1980)
- | LESS CONTEXT | monolingual | bilingual   |
|--------------|-------------|-------------|
| synthetic    | 14% (n=24)  | 6% (n=13)   |
| analytic     | 86% (n=152) | 94% (n=221) |
- $\chi^2 = 7.99, p < .01$

b. Progressive utterances with more context

MORE CONTEXT	monolingual	bilingual
synthetic	60% (n=39)	9% (n=5)
analytic	40% (n=26)	91% (n=48)

$\chi^2 = 31.92, p < .001$

The data in (14a) show that in LESS CONTEXT environments, both monolinguals and bilinguals favor the analytic form, although there is still a significant number of LESS CONTEXT synthetic progressives for both monolinguals and bilinguals to be accounted for (14% and 6% respectively). In MORE CONTEXT environments, however, monolinguals and bilinguals diverge; while monolinguals slightly favor the synthetic form in MORE CONTEXT environments (with a large number of analytic instances to be accounted for), bilinguals still favor the analytic form in this environment. In fact, there is no significant difference for the bilinguals in synthetic versus analytic use along the MORE CONTEXT/LESS CONTEXT parameter (15b), but there is a significant difference for monolinguals (15a).

		monolingual	MORE CONTEXT	LESS CONTEXT
(15)	a.	synthetic	60% (n=39)	14% (n=24)
		analytic	40% (n=26)	86% (n=152)
$\chi^2 = 52.85, p < .001$				
		bilingual	MORE CONTEXT	LESS CONTEXT
	b.	synthetic	9.4% (n=5)	5.6% (n=13)
		analytic	91.6% (n=48)	94.4% (n=221)
$\chi^2 = 1.11, p < 1$				

In the monolingual data, then, Klein finds support for her hypothesis; she noted that use of the analytic form with less contextual support helps avoid indeterminacy in the speech signal, due to the full meaning specification of this form. Bilinguals, for independent social reasons (contact with English), tend to favor the analytic form even where the monolinguals use the synthetic form.

In summary, I have adopted a slightly modified version of Westfall's (1995) vague representation of the content of the synthetic and analytic forms, since it helps to capture (a) subtle pragmatic inferences possible with the analytic form, and (b) the tendency to use the analytic form in environments with less context to disambiguate the intended meaning of the synthetic form.

## 4 An OT analysis

Recent work on variation in OT (Anttila, 1997; Boersma and Hayes, 2001; Nagy and Reynolds, 1997) and morphosyntax in OT (Bresnan, 2001a; Kuhn, 2001; Sells, 1998) makes this framework a promising one for the development of an analysis of Klein's observations. In the remainder of the paper, I develop an optimality-theoretic analysis meant to capture the variable nature of Klein's generalizations, using typologically well-motivated constraints that can be applied to other languages, and that ultimately make predictions about possible and impossible types of languages with respect to the phenomena under consideration.

I proceed by giving a brief introduction to the theoretical framework. This is followed by discussion of the input contrasts under consideration and by the constraints needed to generate these contrasts and their morphosyntactic expression. I then turn to the contextually conditioned variation observed by Klein, following this by the actual stochastic OT implementation.

### 4.1 Theoretical assumptions

#### 4.1.1 OT-LFG

Lexical Functional Grammar (Bresnan, 1982, 2001b; Dalrymple, 2001; Falk, 2001) is a non-derivational, parallel correspondence theory of syntax which has been assumed in much work on OT syntax to date (Bresnan, 2000, 2001a; Choi, 1999; Kuhn, 2001; Lee, 2001; Sells, 2001a,b). A central feature of LFG (OT or non-OT) is the assumption of parallel structures linked together by correspondence functions. C-structure is the structural linguistic representation in the framework, often represented by way of a tree structure, and specified for any particular language by way of phrase-structure rules. F-structure contains the language independent grammatical content of an utterance. Additionally, following work by Kuhn (2001), I also assume that individual lexical items carry their own morphosyntactic information,  $\lambda$ -structure which is basically a mini f-structure for each lexical item. The  $\lambda$ -structure of each lexical item unifies with the  $\lambda$ -structure of other lexical items of an utterance to give rise to the global f-structure. Both f-structure and  $\lambda$ -structure are represented as attribute-value matrices. Figure 1 illustrates how f-structure, c-structure, and  $\lambda$ -structure fit together by way of correspondence relations in this theory.

INSERT FIGURE 1 ABOUT HERE

In OT-LFG output candidates are tuples of parallel structures: c-structure, f-structure, and  $\lambda$ -structure, as in Figure 1. Inputs are themselves fully specified f-structures, which the global f-structure of output candidates subsumes.<sup>10</sup> This

subsumption requirement entails that all output candidates share the same meaning (Kuhn, 2001:104ff.) with the input. Candidates that have an imperfect mapping between  $\lambda$ -structure and the global input-subsuming f-structure incur faithfulness violations. These are simply a failure of the candidate to faithfully express in  $\lambda$ -structure the information present in the global f-structure. MAX violations are instances where a particular f-structure attribute/value pair is not expressed in  $\lambda$ -structure. Figure 1 illustrates this state of affairs. Here, there is no  $\lambda$ -structure attribute/value pair expressing the PRED ‘PRO’ information present in the f-structure. DEP violations, which will play no role in the analysis below, are incurred by candidates having information in  $\lambda$ -structure that is not present in the global f-structure.

#### **4.1.2 Stochastic OT**

In order to capture the quantitative nature of the difference between the monolingual and bilingual varieties, I adopt stochastic OT (Boersma and Hayes, 2001), a variety of OT that has been applied to several cases of syntactic variation (Asudeh, 2001; Bresnan et al., 2001; Clark, 2002; Koontz-Garboden, 2002; Lee, 2002).<sup>11</sup> Stochastic OT differs from standard OT largely in two ways. First, in contrast to standard OT, constraint ranking in stochastic OT is along a continuous ranking scale, so that constraints can be closer to, or farther apart from one another, as illustrated in Figure 2. The second innovation is stochastic candidate evaluation, as illustrated in Figure 3. Under this assumption, at evaluation time, the position of each constraint is perturbed by a random variable so that the relative rankings of constraints can be disturbed, with the possible degree of disturbance following a normal distribution. The greater the overlap in the distributions of the constraints, the more likely it is that their relative rankings will be disturbed on a particular evaluation. It is changes in relative rankings on particular evaluations that can lead to variation in the output.

INSERT FIGURE 2,3 ABOUT HERE

Boersma and Hayes also adopt the gradual learning algorithm (GLA), an algorithm for the learning of stochastic OT grammars, which is implemented in the Praat (Boersma and Weenik, 2002) and OTSoft (Hayes et al., 2000) software packages. In what follows, stochastic OT and the GLA are used to model Klein’s results.

#### **4.2 The input and constraints on aspectual contrasts**

Bybee (1985); Dahl (1985), and Bybee et al. (1994) in particular have carried out large-scale crosslinguistic investigations of the aspectual categories under study, with results that aid the development of reasonable OT constraints. Their research sur-

veyed numerous languages to determine, among other things, (a) the extent to which languages have grammaticalized expressions of certain meanings, and (b) how these meanings are formally expressed.

To understand their results, I must first clarify some terminology. Up to now, I have maintained separate terms for the morphosyntactic shape of the forms under study (synthetic versus analytic) and their meanings (progressive versus habitual). In the typological literature, linguists name particular morphosyntactic expressions according to the type of meaning they express. I follow the tradition of distinguishing the names of forms from the names of aspectual meanings by use of a capital letter for the name of the form (see Comrie, 1976). Three forms, with names and definitions given in (16) bear on the development of the present constraint set.

- (16)
- a. PROGRESSIVE: the action takes place simultaneously with the moment of reference (Bybee et al., 1994:317).
  - b. HABITUAL: the situation is customary or usual, repeated on different occasions over a period of time (Bybee et al., 1994:317).
  - c. IMPERFECTIVE: a situation viewed as in progress at a particular reference point, either in the past or present, or one viewed as characteristic of a period of time that includes the reference time, that is a habitual situation (Bybee et al., 1994:125-126).

The Progressive and Habitual are somewhat similar in that both by definition have a one-to-one mapping of form and meaning, with the Progressive always giving rise to progressive meaning, and the Habitual to habitual meaning. This is clear in the explicit representation of the content of these forms.

- (17) The (language independent) content of Progressives and Habituals

- a. Content of Progressive

VIEWPNT	IMP
PROG	+
HAB	-

- b. Content of Habitual

VIEWPNT	IMP
PROG	-
HAB	+

Any output form labeled Progressive always has the content in (17a), while any output form labeled Habitual always has the content in (17b). The language independent contents in (17) are also possible inputs to an OT optimization: for progressive content as the meaning, the input contains the representation in (17a),

and for habitual content, the input contains the representation in (17b). A language using a Progressive to express progressive aspect gets a faithful mapping from an input (17a) to a (language particular) output form containing morpholexical features expressing the content in (17a). The input-output mapping for habitual content is parallel for a language with Habituals.

The Imperfective form is different in that imperfective meaning subsumes progressive and habitual meaning. So, an Imperfective form according to Bybee et al. (1994:125-126) is actually a form with a one-to-many mapping between form and meaning, and is either progressive or habitual in output meaning. This characterization of these forms is captured by the analysis of the Spanish synthetic form, itself an Imperfective,<sup>12</sup> with attributes of progressivity and habituality unspecified, so its representation is as in (18).

- (18) Content of Imperfective  
[VIEWPNT IMP]

The representation in (18) is crucially underspecified for the PROG and HAB attributes, so Imperfectives like the one in (18) can occur in contexts that are either progressive or habitual.

In contrast to the progressive content (17a) and the habitual content (17b), imperfective content (18) CANNOT be the input to an OT optimization given the assumption of full specification in the input. Imperfective forms are an OUTPUT phenomenon; there exists no input with a one-to-one faithful mapping between it and an Imperfective. In OT terms, use of an Imperfective form always entails violation of MAX, since an Imperfective is used to express either progressive or habitual content, but with a form that lacks full morpholexical specification for the content it is expressing.

#### **4.2.1 Aspectual contrasts and morphosyntactic form**

Typologists like Comrie (1976), Bybee (1985), Dahl (1985), and Bybee et al. (1994) have used the notions of Progressive, Habitual, and Imperfective to sift through scores of reference grammars to determine the extent to which particular languages encode these categories, and where they do, what the morphosyntax of the expressions for these categories looks like. Two results are important here. First, languages may or may not have grammaticalized verbal expressions for these aspectual categories. Some languages have them, and some simply don't, and there appears to be no implicational relationship with respect to the aspectual contrasts under study here. There exist languages with all possible combinations of the forms under discussion, as is shown in (19), for data from data Bybee et al. (1994:chapter 4) and

Dahl (1985).

	Categories overtly expressed	Language
(19)	Progressive, Imperfective, Habitual	Slave
	Progressive, Imperfective	Shuswap (also Spanish)
	Progressive, Habitual	Inuit
	Imperfective, Habitual	Georgian (Dahl, 1985:96,115)
	Imperfective	Modern Greek

Further, one cannot predict simply on the basis of knowing whether a language expresses a particular meaning how that meaning is morphosyntactically expressed; this is a matter of language specific morphosyntax. So, for example, Bybee et al. (1994:128-129) list languages with Progressives that are expressed via affixes (Slave), auxiliaries (Basque), tone changes (Krongo), etc. This suggests independent, interacting sets of constraints. One set generates aspectual contrasts to be formally encoded in the language in question, while the other set governs the morphosyntactic structure of the language, including how the aspectual contrasts are realized.

#### 4.2.2 Constraints to generate language particular aspectual contrasts

These generalizations about the morphosyntactic expression of aspectual content can be captured formally by introducing markedness and faithfulness constraints on aspectual contrasts.<sup>13</sup> The markedness constraints disfavor particular configurations of attribute/value pairs. This is implemented formally with local conjunction (Smolensky, 1995; Legendre et al., 1998) of particular attribute/value pair combinations. The local conjunctions in question disfavor the co-occurrence of the combinations of attribute/value pairs in the same output morpholexical structure ( $\lambda$ -structure). The proposed constraints are those in (20). These represent a formal way to disfavor Progressives and Habituals in the output.<sup>14</sup>

- (20) Markedness constraints
- a. \*PROG +/\*HAB -: \*PROG
  - b. \*PROG -/\*HAB +: \*HAB

Given that there are languages that formally express progressive and habitual content, there must be a constraint favoring the overt expression of these morpholexical features, since without such a constraint no languages would have Progressives or Habituals. The relevant constraint favoring the maintenance of these contrasts is a faithfulness constraint demanding the overt realization of f-structure information by way of morpholexical features (Kuhn, 2001:113).

- (21) Faithfulness constraint  
MAX- $\lambda$ : All attribute/value pairs in the input f-structure are morpholexically represented in the output.<sup>15</sup>

These three constraints with the stochastic OT architecture can derive languages with and without Habituals, Progressives, and Imperfectives and various combinations as in the types of languages observed by Bybee et al. (1994) and by Dahl (1985), illustrated in (19).

In languages like English with both and only a Progressive and a Habitual, the constraint ranking is straightforward. On the linear ranking scale assumed in stochastic OT the constraints are far enough away from one another to exhibit categorical behavior. The relative ranking in (22) gives this pattern. Faithfulness is ranked high, so that there is always a one-to-one mapping between input f-structure and morpholexical realization of that f-structure in the output.

- (22) English: Progressives and Habituals (no Imperfectives)  
MAX- $\lambda$   $\gg$  \*HAB, \*PROG

When a language has ONLY an Imperfective, as in Modern Greek according to Bybee et al. (1994), the ranking is as in (23). There, the markedness constraints on the continuous ranking scale are far enough above the faithfulness constraint that, with inputs having either progressive or habitual content, this content is never faithfully expressed by morpholexical features in the output. As a result, progressive content and habitual content are mapped to the Imperfective.

- (23) Modern Greek: Imperfectives (no Progressive and no Habitual)  
\*HAB, \*PROG  $\gg$  MAX- $\lambda$

Other language types are more complicated, and our assumption of the stochastic OT framework becomes critical. Recall the definition of an Imperfective in (16): An Imperfective is a form that can be used in contexts that are either progressive or habitual. In a language with both an Imperfective and either a Progressive or a Habitual, or both, there will be variation in the morphosyntactic form that progressive or habitual inputs take in the output, since Imperfectives by definition, are consistent with either progressive or habitual content, and since such languages map these inputs not only to Imperfectives, but to Progressives and/or Habituals. Spanish is just such a language, and is discussed in detail below.

### **4.3 The morphosyntactic form of aspectual realization**

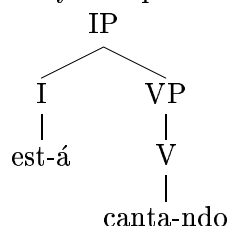
In order to determine how aspectual contrasts are realized in a particular language, the morphosyntactic behavior of that language must be well understood, with the

relevant constraints favoring particular types of realization identified, and their rankings understood. In the following sections, then, I discuss some particularly important morphosyntactic properties of Spanish and adopt OT analyses for them.

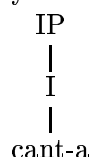
### 4.3.1 V-to-I movement

Spanish is widely recognized in the syntactic literature as having V-to-I movement, whereby inflected verbs appear in the head of IP, rather than in the head of VP (see Zagana (2002) for an overview). Under this analysis (regardless of whether it actually posits movement), the analytic form and the synthetic form can be configurationally represented as in (24).

- (24) a. Analytic expression



- b. Synthetic expression



Sells (2001b) gives a comprehensive OT-LFG analysis of V-to-I movement which I adopt here. Three of his constraints highlight configurational differences between the synthetic and analytic forms, and are therefore particularly relevant (Sells 2001b:109ff; see also Grimshaw (1997); Bresnan (2000)).

- (25) a. \*LEX-IN-I  
 Don't allow a lexical (i.e., non-auxiliary) V in the I functional head position
- b. OBHD(IP)  $\gg$  OBHD(VP)  
 A subhierarchy of markedness constraints, requiring each maximal projection to have an obligatory head; violated by a headless IP, etc.

The constraint in (25a), \*LEX-IN-I, or something like it has been posited by several researchers to deal with crosslinguistic differences in verb position (Sells, 2001b:109). This constraint is important for the analysis of verb position especially in English,

where lexical verbs appear in the head of a VP projection, but auxiliary verbs appear in the head of IP. It is also important in the present analysis, since it highlights a difference between the synthetic and analytic forms under discussion: while the analytic form satisfies \*LEX-IN-I by not having a lexical verb in the head of IP, the synthetic form violates this constraint, because it has a lexical verb in the head of IP.

The OBHD constraints in (25b) are Sells' way of getting the effects of V-to-I movement in a framework that assumes no movement. The hierarchy in (25b), with OBHD(IP) ranked above OBHD(VP) has the effect of favoring movement in cases where there is only one syntactic terminal to occupy a head position—it is more important that IP have a head than VP, and 'movement' is therefore favored unless some higher ranking constraint (e.g. \*LEX-IN-I) intervenes.

Whether the analytic or the synthetic form is optimal on a particular evaluation, Sells' work and work on Spanish syntax summarized by Zagona (2002), show that Spanish will require a ranking of the constraints in (25) as in (26).

- (26) Ranking for Spanish  
OB-HD(IP)  $\gg$  \*LEX-IN-I

The domination of \*LEX-IN-I by OB-HD(IP) forces the head of IP to be filled, giving the effect of V-to-I movement, which modern Spanish seems to show unambiguously for the constructions under consideration here.<sup>16</sup> The analytic form, with an auxiliary and non-lexical verb as part of the construction, has the auxiliary in the head of IP, and allows the lexical verb to appear outside the IP (here, the head of VP), this allows the construction to satisfy the \*LEX-IN-I constraint.

With these constraints alone, the synthetic form would never emerge as optimal; but further constraints favor it over the analytic form.<sup>17</sup>

### 4.3.2 Morphosyntactic economy

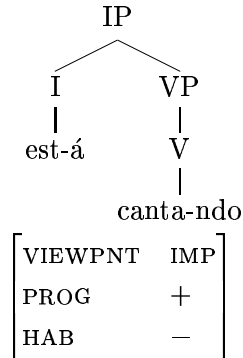
Klein's data show clearly that within a single variety of Spanish, synthetic and analytic forms compete as forms of expression of progressive aspect. Typological studies (Comrie, 1976; Bybee, 1985; Dahl, 1985; Bybee et al., 1994) have shown that crosslinguistically, aspect is expressed in diverse ways. These results collectively provide evidence that the Spanish analytic form (a Progressive) and synthetic form (an Imperfective) compete in expressing progressive aspect. These sources of data also suggest that morphology and syntax compete as formal modes of expression for this information. In light of this, I consider as part of the candidate set both morphological expression (i.e., a synthetic candidate) and syntactic expression (i.e., an analytic candidate) for each form under consideration here—Progressives, Habituals, and Imperfectives. The candidate set consists of a cross-product of form

and meaning. Since the only forms observed in Spanish are an analytic Progressive and a synthetic Imperfective, the remaining four candidates (a synthetic Progressive, an analytic Habitual, a synthetic Habitual, and an analytic Imperfective) are hypothetical. These types of analytic and synthetic forms DO show up in other languages, though (Bybee et al., 1994:chapter 5). For example, Nimboran has a synthetic Progressive, as in (27). The data in (28) illustrate a synthetic Habitual in Slave. Kanakuru, for its part has an analytic Imperfective, exemplified in (29), while Guaymí has an analytic Habitual, as in (30).

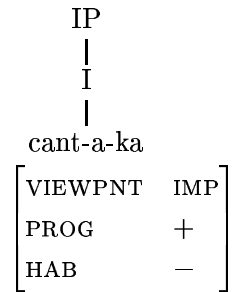
- (27) príp-tem-t-y  
 throw-PROG-PRES/IMP-I  
 ‘I am throwing (here)’ (Nimboran synthetic Progressive, Anceaux (1965:107))
- (28) nínayeh  
 ‘It arrives regularly’ (Slave synthetic Habitual, Rice (1989:671, (3)))
- (29) ji-no wupmai  
 IMP-I sell.it  
 ‘I used to sell/was selling it’ (Kanakuru analytic Imperfective (past tense), Newman (1970:4-31ff.))
- (30) Ni ngabere naen mro kwete  
 person Guaymí HAB banana eat-PRES PART  
 ‘The Guaymí people eat bananas.’ (It’s a characteristic of their culture)  
 (Guaymí analytic Habitual, Kopesec (1975:29))

The c-structures plus  $\lambda$ -structures in (31)-(36) make explicit my assumptions regarding the formal representations of the candidates competing with one another for the expression of progressive aspect in Spanish.

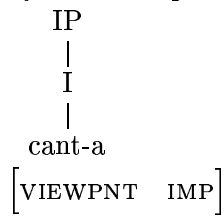
- (31) analytic Progressive (an actual Spanish output form)



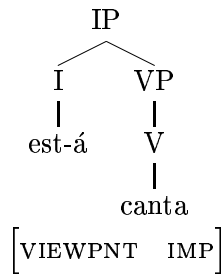
- (32) synthetic Progressive (cf. Nimboran, (27))



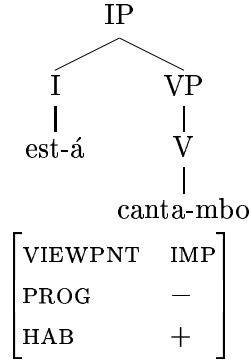
- (33) synthetic Imperfective (an actual Spanish output form)



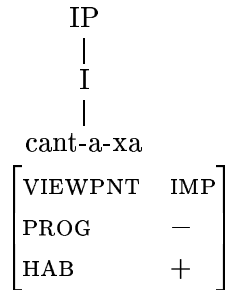
- (34) analytic Imperfective (cf. Kanakuru, (29))



(35) analytic Habitual (cf. Guaymí, (30))



(36) synthetic Habitual (cf. Slave, (28))



The forms in (31) and (33) require no further discussion; they are actual Spanish output forms and have been discussed at length above. The structure in (32) is one syntactic word composed of two affixes, one contributing VIEWPNT IMP information and the other the information that the structure has a progressive interpretation (PROG +, HAB -). This parallels the case of Nimboran in (27). The analytic Imperfective in (34) has two syntactic pre-terminals, and an affix carrying VIEWPNT IMP information, much as in Kanakuru, in (29). The structure in (35) is an analytic Imperfective similar to Guaymí, in (30). In (35) I assume the structure has two syntactic pre-terminals and an affix attached to each one, providing VIEWPNT IMP information and the information giving rise to the habitual reading (PROG -, HAB +). The final possibility is a synthetic Habitual in (36) similar to the Slave form in (28). The candidate in (36) has one affix providing VIEWPNT IMP information and another providing the information for habituality (PROG -, HAB +), as in Slave.

Since the structures in (31)-(36) are all possible expressions of aspectual content, any OT account must have a way of ruling them out and of explaining why Spanish has the forms it does, especially when given its particular aspectual contrasts and

the properties of its V-to-I clausal syntax.

To discriminate between the synthetic and analytic versions of the Progressive, Habitual, and Imperfective, I appeal to Sells (1997, 1998) constraints on morphosyntactic expression (his ‘economy constraints’) developed to deal precisely with synthetic/analytic competition. The two constraints proposed by Sells (1997:8-9;1998) are given in (37).

- (37) Constraints on morphosyntactic expression
- a. \*X<sup>0</sup>: Avoid syntactic pre-terminals.
  - b. \*AFFIX: Avoid Affix.

These two constraints formalize the direct competition between morphological structure and syntactic structure. The evaluation of the constraint in (37a), \*X<sup>0</sup>, is straightforward—it gives one mark for each node immediately dominating a syntactic pre-terminal. To take a concrete example, while the synthetic forms in (31)-(36) incur one violation of this constraint, the analytic forms in the candidate set incur two violations since they each have two nodes that immediately dominate a syntactic terminal.

The evaluation of (37b) is also straightforward under the original definition provided by Sells whereby \*AFFIX simply assigns one mark for each affix a candidate has. When this constraint is applied to the hypothetical structures in (38), they incur the same number of violations, since they have the same number of affixes.

- (38) a. stem-affix<sub>1</sub> stem-affix<sub>2</sub> stem-affix<sub>3</sub>  
b. stem-affix<sub>1</sub>-affix<sub>2</sub>-affix<sub>3</sub>

When the other economy constraint, \*X<sup>0</sup>, is taken into account, (38a) performs significantly worse than (38b), incurring three \*X<sup>0</sup> violations to the one violation of (38b). The candidate in (38a), then, is HARMONICALLY BOUND by (38b); (38a) will never surface as optimal. This seems like an undesirable outcome, and if one considers exactly what \*AFFIX is evaluating in comparison to the structures that \*X<sup>0</sup> evaluates, the source of the problem becomes clear: the locus of evaluation of \*X<sup>0</sup> is the clause. It favors clauses with fewer syntactic preterminals. The parallel locus of evaluation for \*AFFIX would be the syntactic word, with \*AFFIX favoring syntactic words with fewer affixes. The evaluation of \*AFFIX whereby (38a) and (38b) both incur three violations does not operate this way, particularly in (38a), where it simply determines the number of affixes in the entire candidate without regard to the number per word. What is needed rather than a global constraint that disfavors affixes regardless of the number of stems in the clause, is a more local constraint that disfavors stems with large numbers of affixes attached.<sup>18</sup>

I deal with this issue here by adopting the notion of a local conjunction power hierarchy (Smolensky, 1995; Legendre et al., 1998), whereby a constraint is recursively conjoined with itself within some local domain to give an implicational hierarchy of locally conjoined constraints. The constraint is Sells' \*AFFIX and the local domain is the syntactic word. When recursively locally conjoined, this results in the power hierarchy in (39a), abbreviated as in (39b).

- (39) Local conjunction power hierarchy with \*AFFIX
- a. ...>>\*AFFIX/\*AFFIX/\*AFFIX>>\*AFFIX/\*AFFIX>>\*AFFIX
  - b. Abbreviated as ...>>\*AFFIX<sup>3</sup>>>\*AFFIX<sup>2</sup>>>\*AFFIX<sup>1</sup>

This results in a hierarchy that disfavors increasing numbers of affixes attached to a single word. The overall effect is to disfavor agglutinative morphology. More locally, this interpretation of affixal economy has the desired effect of differentiating the candidates in (38a) and (38b). Now the two candidates no longer perform in the same way; while (38b) violates highly ranked \*AFFIX<sup>3</sup> because it has three affixes attached to a single stem, (38a) incurs three separate violations of \*AFFIX<sup>1</sup>, one violation for each single affix occurring in each of the three free-standing syntactic words.

#### 4.4 Capturing contextually conditioned variation

Both Klein (1980) and Westfall (1995) observed that use of the analytic form over the synthetic form is favored in contexts where indeterminacy could arise from use of the synthetic form. This pragmatic conditioning is somewhat reminiscent of discourse-pragmatic conditions encoded by constraints such as DROPTOPIC of Grimshaw and Samek-Lodovici (1998), which favors the use of null pronouns with a topic (when the discourse makes clear what the topic of conversation is) and the RECOVERABILITY constraint of Pesetsky (1998), which favors the pronunciation of a syntactic unit except when there is a 'sufficiently local antecedent' (Pesetsky, 1998:6). There may be several different ways of integrating this condition formally into the present analysis.<sup>19</sup> My proposal here is to assume the general discourse-pragmatic constraint in (40) disfavoring indeterminacy at a larger discourse level. This pragmatic constraint is then ranked with respect to the morphological and syntactic constraints.

- (40) \*INDETERMINACY: violated by a candidate that has more than one possible reading when there is not sufficient contextual support for the intended reading.

In the case under study, the effect of (40) is that the Imperfectives will receive a mark in the LESS CONTEXT environment, but will satisfy \*INDET in the MORE CON-

TEXT environment where there is sufficient contextual support for the intended reading.

#### 4.5 Spanish progressive aspect in stochastic OT

I now turn to an implementation of the specifics of the portion of grammar responsible (a) for the use of analytic Progressives and synthetic Imperfectives in Spanish, (b) the competition and variation between these two forms under different circumstances, and (c) the grammatical properties responsible for the differences in quantitative preferences for analytic Progressives and synthetic Imperfectives in Klein's bilingual and monolingual Spanish speakers.

Using the Praat software package (Boersma and Weenik, 2002), the candidate set in (31)-(36), and the constraints elaborated above, the Gradual Learning Algorithm was exposed to Klein's frequency distributions in (14), which take into account the effects of pragmatic conditioning, to learn two distinct grammars: a monolingual grammar and a bilingual grammar.<sup>20</sup> The monolingual grammar and the bilingual grammar are discussed in turn, along with the properties of each grammar that generate language internal variation, and the properties that distinguish the grammars from each other.

##### 4.5.1 The monolingual grammar

The grammar learned by the GLA upon exposure to the monolingual frequency distributions is given in (41). The ranking of the most important constraints concerning the generation of variation are depicted graphically with respect to one another in Figure 4.

(41) Constraint ranking values.

constraint	ranking value
*HAB	126.262
*AFFIX <sup>2</sup>	120.655
*INDET	111.068
*X <sup>0</sup>	108.276
MAX- $\lambda$	107.459
*LEX-IN-I	91.742
*PROG	66.279

INSERT FIGURE 4 ABOUT HERE

Given the ranking values in (41), the tableau in (42) shows the typical outcome of stochastic evaluation for a progressive input in the LESS CONTEXT environment

for monolingual speakers.

- (42) A progressive input in LESS CONTEXT environment with monolingual grammar.

	<i>*HAB</i>	<i>*AFFIX<sup>2</sup></i>	<i>*INDET</i>	<i>*X<sup>0</sup></i>	<i>MAX-λ</i>	<i>*LEX-IN-I</i>
PROG						
a.  analytic, PROG				**		
b. synthetic, PROG		*!		*		*
c. synthetic			*!	*	*	*
d. analytic			*!	**	*	

The synthetic Progressive, candidate b, is eliminated due to its non-conformity with the morphosyntactic principles of Spanish; it has too many affixes for the expression of the information under consideration. The Imperfectives, candidates c and d are eliminated on the typical evaluation by their violation of *\*INDET*; in LESS CONTEXT environments, an Imperfective use runs the risk of leading to indeterminacy in the discourse, due to lack of specification for attributes giving rise to a progressive reading. Candidate a emerges as optimal despite the fact that it incurs several violations of *\*X<sup>0</sup>*, the constraint disfavoring syntactic pre-terminals. Given stochastic candidate evaluation, this constraint does emerge as an important one on occasion—as is illustrated by Figure 4, the distributions of *\*INDET* and *\*X<sup>0</sup>* do overlap significantly, so there will be evaluations for which  $*X^0 \gg *INDET$ . On such evaluations it is more important to satisfy the economy constraint on syntactic pre-terminals than it is to satisfy *\*INDET*; candidate c, the synthetic Imperfective then emerges as optimal.

In the MORE CONTEXT environments, the constraint on discourse indeterminacy is no longer relevant—there is sufficient context to disambiguate uses of unspecified Imperfective forms. The canonical outcome is that the synthetic Imperfective is selected as optimal, because the syntactic economy constraint *\*X<sup>0</sup>* outranks the faithfulness constraint *MAX-λ*, a synthetic form uses fewer syntactic pre-terminals than an analytic one, and the synthetic Progressive uses more affixes than the language will tolerate for the expression of this information. This outcome is illustrated in (43).

- (43) A progressive input in MORE CONTEXT environment with monolingual grammar

		*HAB	*AFFIX <sup>2</sup>	*INDET	*X <sup>0</sup>	MAX-λ	*LEX-IN-I
	PROG						
a.	analytic, PROG				**!		
b.	synthetic, PROG		*!		*		*
c.	☞ synthetic				*	*	*
d.	analytic				**!	*	

Again, given the assumption of stochastic evaluation and the relative proximity of the ranking values of \*X<sup>0</sup> and MAX-λ observed in Figure 4, this will not be the only outcome of evaluation of a progressive input in a MORE CONTEXT environment. In fact, there are many evaluations for which MAX-λ ≫ \*X<sup>0</sup>; on these evaluations, the analytic Progressive emerges as optimal, since it then becomes more important to faithfully express morphosyntactically the input content than to satisfy the economy condition on the use of syntactic pre-terminals, \*X<sup>0</sup>.

Not all inputs are progressive; there are also habitual inputs. In Spanish, the high-ranking of \*HAB forces habitual inputs to be realized in the output by some kind of Imperfective. The tableau in (44) illustrates the effect of this constraint and its interaction with the constraint hierarchy in a LESS CONTEXT environment (the outcome is the same in a MORE CONTEXT environment).

- (44) A habitual input in LESS CONTEXT environment with monolingual grammar

		*HAB	*AFFIX <sup>2</sup>	*INDET	*X <sup>0</sup>	MAX-λ	*LEX-IN-I
	HAB						
a.	analytic, HAB	*!			**!		
b.	synthetic, HAB	*!	*		*		*
c.	☞ synthetic			*	*	*	*
d.	analytic			*	**!	*	

Given the high-ranking of \*HAB, habitual inputs are realized in the output by Imperfectives. The relative ranking of the syntactic economy constraint \*X<sup>0</sup> rules out the analytic Imperfective (candidate d), leaving the synthetic Imperfective (candidate c) as optimal. The fact that \*LEX-IN-I, which could otherwise favor the analytic Imperfective, is low-ranking, gives the result that the synthetic Imperfective will categorically surface as the optimal output, regardless of the relative rankings of \*X<sup>0</sup> and MAX-λ on any particular evaluation, since they both have violations of the latter, but the analytic Imperfective has more violations of the former.

As has become standard in stochastic OT analyses since Boersma and Hayes's (2001) work, after the learning of the constraint ranking by the GLA, the grammar (here the monolingual one) was subjected to repeated stochastic evaluation of the same types of inputs to determine the extent to which the frequency distributions generated by the GLA grammar match those of the actual data. The following tables give the results of this test.

(45) A progressive input in LESS CONTEXT environment (monolingual).

'Progressive' input	number of tokens	% generated	% observed
a. analytic, PROG	8,533	85%	86%
b. synthetic, PROG	0	0%	
c. synthetic	1,467	15%	14%
d. analytic	0	0%	

(46) A progressive input in MORE CONTEXT environment (monolingual).

'Progressive' input	number of tokens	% generated	% observed
a. analytic, PROG	3,911	39%	40%
b. synthetic, PROG	0	0%	
c. synthetic	6,089	61%	60%
d. analytic	0	0%	

(47) A habitual input in any environment (monolingual).

[HAB] input	number of tokens	percent
a. analytic, HAB	0	0%
b. synthetic, HAB	0	0%
c. synthetic	100,000	100%
d. analytic	0	0%

As the tables in (45)-(48) show, the output frequencies generated by the GLA-learned grammar match the frequency distributions actually observed by Klein (1980) quite closely. This need not be the case. There are input frequency distributions that, when fed to the GLA, cannot be reproduced. So, it is not the case that the GLA can learn any frequency distribution it is exposed to. The non-learnability of a particular frequency distribution is remarked on further in the discussion section below.

#### 4.5.2 Bilingual grammar

The GLA was also exposed to Klein's frequency data for bilinguals. One tweak to Klein's data in (14) was made for the bilingual grammar for the purposes of learning: since there is no statistically significant difference along the MORE CONTEXT/LESS CONTEXT parameter for bilinguals, the algorithm was exposed to

the same frequencies for both environments. Klein’s frequency distribution from the LESS CONTEXT environment was arbitrarily selected to represent both contexts for purposes of learning. The ranking values of the constraints learned by the GLA under this assumption are given in (48), with the relative ranking of the two most important constraints for the generation of language internal variation graphically depicted in Figure 5.

(48) Constraint ranking values (bilingual grammar)

constraint	ranking value
*HAB	124.726
*AFFIX <sup>2</sup>	118.604
MAX- $\lambda$	110.614
*X <sup>0</sup>	106.171
*LEX-IN-I	93.829
*INDET	83.125
*PROG	64.660

INSERT FIGURE 5 ABOUT HERE

The bilingual grammar is distinct from the monolingual one in two respects: (a) in the relative ranking of \*INDET with respect to other constraints, and (b) in the relative ranking of MAX- $\lambda$  and \*X<sup>0</sup>. These two differences seem to be due in part to somewhat separate generalizations. First, as is observed in Klein’s data in (14), while the monolinguals’ use of the synthetic and analytic forms is sensitive to the pragmatic indeterminacy condition (\*INDET), bilinguals’ use is not. This is reflected in the bilingual grammar in (48) by the fact that \*INDET has a ranking value below that of \*X<sup>0</sup>—pragmatic indeterminacy with respect to this portion of the grammar is no longer an issue in the grammar of the bilinguals. The bilingual grammar also differs from the monolingual one in having a significant increase in use of the analytic Progressive, argued by Klein to be an effect of contact with English. This increased use of the analytic Progressive by bilinguals holds for both environments, but is most dramatic in the LESS CONTEXT one, where monolinguals tend to favor the synthetic form and bilinguals the analytic. This increase is reflected in the bilingual grammar by the relative ranking of MAX- $\lambda$  above \*X<sup>0</sup>, with the effect of favoring forms with overt morphosyntactic realization of the input progressive specification. The morphological economy constraint, just as in the monolingual variety, dictates that this form be the analytic Progressive rather than the synthetic Progressive. Other than these two differences, the relative rankings of the remaining constraints in the two grammars are similar.

Given the ranking values in (48), consider the canonical outcome of evaluation of a progressive input for the bilingual grammar. Since context is not relevant, I give a tableau only for the LESS CONTEXT environment.

- (49) A progressive input in LESS CONTEXT environment with bilingual grammar

	<i>*HAB</i>	<i>*AFFIX<sup>2</sup></i>	<i>MAX-λ</i>	<i>*X<sup>0</sup></i>	<i>*LEX-IN-I</i>	<i>*INDET</i>
a. $\Rightarrow$ analytic, PROG				**		
b. synthetic, PROG		*!		*	*	
c. synthetic			*!	*	*	*
d. analytic			*!	**		*

On the most common constraint ranking, *MAX-λ* outranks *\*X<sup>0</sup>*, so the analytic Progressive, candidate a, emerges as optimal. As illustrated by Figure 5, however, *MAX-λ* and *\*X<sup>0</sup>* have distributions that overlap with one another, so there will be some evaluations for which the selection points of these two constraints are such that *\*X<sup>0</sup>*  $\gg$  *MAX-λ*. On these evaluations, phrase-structural economy is more important than overt morphosyntactic realization of the input progressive attributes, so the analytic Progressive (candidate a), with more syntactic pre-terminals than the synthetic forms, is eliminated in favor of the synthetic Imperfective (candidate c), with fewer pre-terminal nodes.

Given that *\*HAB* ranks highly in the bilingual grammar, the outcome for habitual inputs is the same as in the monolingual grammar—categorical synthetic Imperfective use. This outcome was illustrated for monolinguals in (44).

The bilingual grammar was also tested against the input frequencies. The results are given in (50). Since there was no significant difference between MORE and LESS CONTEXT environments, LESS CONTEXT was arbitrarily chosen as representative for the bilinguals.

- (50) Testing the grammar

a. A progressive input in LESS CONTEXT environment (bilingual)

[PROG] input	number of tokens	% generated	% observed
a. analytic, PROG	9,412	94%	94%
b. synthetic, PROG	0	0%	
c. synthetic	588	6%	6%
d. analytic	0	0%	

b. Habitual input in any environment (bilingual).

[HAB] input	number of tokens	percent
a. analytic, HAB	0	0%
b. synthetic, HAB	0	0%
c. synthetic	100,000	100%
d. analytic	0	0%

Again, as was the case with the learned monolingual grammar, the grammar learned by the GLA generates output frequencies close to those observed by Klein. As I already mentioned, it wouldn't necessarily need to be this way—there are frequency distributions that cannot be learned by the GLA.

## 5 Discussion and directions for further research

### 5.1 'Anti-Spanish'

The OT analysis developed here not only provides a model for the empirical generalizations observed by Klein, but also makes predictions about typologically possible languages. One prediction concerns the interaction of morphosyntax with Progressive and Imperfective forms.

The results of Dahl's (1985) and Bybee et al.'s (1994) typological surveys reveal considerable diversity in the formal modes of expression for Progressives and Imperfectives. Given the effort to obtain a typologically representative sample of languages, especially in Bybee et al.'s sample (see the discussion in Bybee et al. (1994:27ff.)), gaps in the typology should not be taken as accidental, especially when the same gap is not filled by additional studies (e.g. Dahl, 1985). Of particular interest here is a gap with respect to synthetic/analytic expression related to Progressives and Imperfectives. One finds systems like those in (51).

- (51) Analytic/synthetic expression and Progressive/Imperfective forms
- a. analytic Progressive, synthetic Imperfective (Spanish)
  - b. analytic Progressive, analytic Imperfective (Basque)
  - c. synthetic Progressive, synthetic Imperfective (Chacobo)

Another logically possible type of language is given in (52).

- (52) synthetic Progressive, analytic Imperfective (??)

Examination of the data tables in Dahl (1985) and Bybee et al. (1994) reveals no language in either sample resembling the logically possible language in (52); there is a gap in the typology.

The account I offered here is one of synthetic/analytic expression embedded in the context of V-to-I movement; it does not come close to accounting for all possible structural types of synthetic/analytic expression. Still, if my analysis can generate a language resembling (52) when it seems that such a language does not exist, this would suggest that the analysis is on the wrong track. The apparent non-existence of a language such as (52) represents one test of the present analysis.

Before determining whether such a language can be generated by the present analysis, it must first be determined what exactly such a language would look like. The language in (52) is actually the inverse of what one finds in Spanish, which has an analytic Progressive and a synthetic Imperfective. Because of this, (52) is referred to below as ‘anti-Spanish.’ Since anti-Spanish has the Spanish set of contrasts with the synthetic/analytic form reversed, it could conceivably have the same frequency distributions as Klein’s (1980) monolinguals, namely the distribution in (53).

(53) What would anti-Spanish look like?

a. Anti-Spanish with PROG input in LESS CONTEXT environment

PROG input	output frequency
a. analytic, PROG	0%
b. synthetic, PROG	86%
c. synthetic	0%
d. analytic	14%

b. Anti-Spanish with PROG input in MORE CONTEXT environment

PROG input	output frequency
a. analytic, PROG	0%
b. synthetic, PROG	40%
c. synthetic	0%
d. analytic	60%

c. Anti-Spanish with HAB input

[HAB] input	output frequency
a. analytic, HAB	0%
b. synthetic, HAB	0%
c. synthetic	0%
d. analytic	100%

The hypothetical frequency distributions for anti-Spanish in (53) were exposed to learning by the GLA to determine whether, given the present constraint set, such a grammar would be learnable. The GLA always learns SOME grammar; the question is whether its output frequencies match those of anti-Spanish. The grammar the GLA learned upon exposure to the anti-Spanish distribution in (53) is given in (54).

- (54) Constraint ranking values of grammar learned by GLA when exposed to anti-Spanish frequency distribution

constraint	ranking value
*HAB	111.065
*LEX-IN-I	100.322
*X <sup>0</sup>	99.678
*INDET	97.593
*PROG	94.849
MAX	96.119
*AFFIX <sup>2</sup>	-25,869.170

The ranking values in (54) by themselves are not very informative. The results of repeated stochastic candidate evaluation given in (55) are more informative.

- (55) Results of repeated stochastic candidate evaluation

- a. Output frequencies for PROG input in LESS CONTEXT environment with anti-Spanish primary linguistic data (PLD)

[PROG] input	number of tokens	% generated	PLD distribution
a. analytic, PROG	5,039	50%	0%
b. synthetic, PROG	3,461	35%	86.4%
c. synthetic	611	6%	0%
d. analytic	889	9%	13.6%

- b. Output frequencies for PROG input in LESS CONTEXT environment with anti-Spanish primary linguistic data (PLD)

[PROG] input	number of tokens	% generated	PLD distribution
a. analytic, PROG	2,268	23%	0%
b. synthetic, PROG	1,718	17%	40%
c. synthetic	2,589	26%	0%
d. analytic	3,425	34%	60%

- c. Output frequencies for HAB input with anti-Spanish primary linguistic data (PLD)

[HAB] input	number of tokens	% generated	PLD distribution
a. analytic, HAB	0	0%	0%
b. synthetic, HAB	0	0%	0%
c. synthetic	4149	41%	0%
d. analytic	5851	59%	100%

The output frequencies of the grammar in (54) for a progressive input in a LESS CONTEXT environment are given in (55a). It is immediately apparent upon comparison of (55a) with the frequency distributions fed to the GLA in (53) that the

output frequencies of the grammar differ markedly from the input frequencies. Anti-Spanish does not seem to be learnable by the GLA with the set of constraints posited above.

If anti-Spanish is unlearnable given my set of constraints, one wonders why this would be. What properties of these constraints produce this empirical result? Consider the tableau in (56), which gives the most common ranking of the constraints for the grammar in (54) learned by the GLA.

(56) PROG input in MORE CONTEXT environment.

	* <i>HAB</i>	* <i>LEX-IN-I</i>	* <i>X<sup>0</sup></i>	* <i>INDET</i>	* <i>PROG</i>	* <i>MAX</i>	* <i>AFFIX<sup>2</sup></i>
PROG							
a. analytic, PROG			**		*!		
b. synthetic, PROG		*!	*		*		*
c. synthetic		*!	*			*	
d.  analytic			**			*	

The problem with the anti-Spanish frequency distribution is made clearest by consideration of progressive inputs in the MORE CONTEXT environment, illustrated by the distribution in (55b) and by the tableau in (56). Here, the frequency distribution is supposed to be 40% synthetic Progressive and 60% analytic Imperfective. What happens instead is that the grammar generates outputs of several types. Output morphosyntactic form appears independent of output specification for attributes leading to progressivity. There are two crucial overlaps that are independent of one another. \**LEX-IN-I* has a distribution that overlaps with \**X<sup>0</sup>*; the relative ranking of these two constraints on any particular evaluation determines whether the output form will be synthetic or analytic. \**PROG* has a distribution that overlaps with \**MAX-λ*; the relative ranking of these two constraints on any particular evaluation determines whether the attributes leading to progressivity will be morphologically specified in the output, i.e. whether the output is a Progressive or an Imperfective. The fact that no other constraint (e.g. \**Affix<sup>2</sup>*) interacts with these two overlaps leads to the output frequencies in (55b).

One might still wonder what the logic is that leads to this ranking among the constraints. Anti-Spanish is a logically possible language where a large proportion of the expressions used in progressive contexts are synthetic Progressives (i.e. candidate b in the PROG tableaux), so \**AFFIX<sup>2</sup>* must have a low ranking value. \**LEX-IN-I* must also have a low ranking value in order for a synthetic Progressive to emerge as optimal, given the high-ranking of *OBHD(IP)*, which forces the head of IP to be filled. At the same time, anti-Spanish has an analytic Imperfective

form (i.e. candidate *d* in all tableaux above). Given that \*AFFIX<sup>2</sup> must have a low ranking value, the only constraint that favors the analytic Imperfective over the phrase-structurally more economical synthetic Imperfective is \*LEX-IN-I, so \*LEX-IN-I must have a ranking value above \*X<sup>0</sup>. But, \*LEX-IN-I must have a ranking value below \*X<sup>0</sup> for a synthetic Progressive to emerge (most of the time) as optimal in a progressive context. There is a ranking paradox, then, which shows why the anti-Spanish frequency distribution cannot be learned by the GLA with this set of constraints.

## 5.2 Variable rules

One of the primary motivations for the present study was to develop an explicit generative account of a particular case of indirect transfer. The OT framework, however, is not the only that might be considered for the development of a generative analysis of these facts. Another possibility within a transformational framework would be VARIABLE RULES (Labov, 1972a:chapter three and references).<sup>21</sup> Developing such an analysis would depend in part on finding a realistic transformation that could derive the synthetic from the analytic, or vice versa. As Fasold (1991) observes, this has been a problem in variable rule analyses of syntactic variation—often there appears to be no such transformation.

Assume, though, that a very reasonable transformation could be found that would relate the synthetic and analytic forms, what would the difference between a variable rule analysis and an OT analysis be? Paolillo (2000) has observed that variable rule analyses actually subsume OT analyses of variation as a special case. In light of this, one might consider an analysis incorporating variable rules as an alternative to the OT analysis proposed above. In light of the subsumption relationship between the two approaches highlighted by Paolillo, there is little question that one could develop a variable rule analysis that models the variation observed in the monolingual and bilingual varieties. What would be lost in going from an OT analysis to a variable rule analysis would not be coverage of the facts under study, but rather predictive power, at least absent further assumptions in the variable rule framework.

The stochastic OT analysis is itself embedded within a larger theory of constraint interaction and universal grammar. One of the leading methodological principles of work in OT is that constraints are not language-specific, but rather universal, forming the core of universal grammar.<sup>22</sup> So, when an analyst proposes a constraint in OT, s/he is making claims not only about one particular language, but about many languages. OT analyses of variation inherit this property; the same constraints responsible for a particular variable phenomenon are by hypothesis present in other grammatical systems. This property gives the analysis not only descriptive, but also

predictive power. It is precisely this property that led to the development of the anti-Spanish prediction above.

I am aware of nothing inherent about variable rules that would prevent the development of a similar type of theory. One place to look for similar types of predictive power would be in constraints on types of rule interaction with variable rules.<sup>23</sup> In practice, though, it seems that most work in the variable rule tradition has concentrated on the description of a particular case of variation (Guy, 1991), with much less work being carried out on typological questions regarding possible and impossible types of variation. I do not believe that such work is ipso facto incompatible with variable rule analyses. It would seem, though, that further development of the framework would be required for such work to be pursued. Work in OT has the goal of characterizing possible and impossible types of languages as one of its central goals. As a consequence, such questions perhaps occur more readily to analysts working on variation in this framework.

### **5.3 Outstanding issues**

#### **5.3.1 Indirect transfer in stochastic OT**

The general mechanisms invoked here to account for indirect transfer in the morphosyntactic expression of progressive aspect in Spanish should be extendible to other cases of indirect transfer. The only difference would be in the constraints responsible for the quantitative differences in the different varieties; these will depend on the phenomenon in question. The general mechanism, however, should be the same. For indirect transfer to take place, there must exist variation in the form of expression of some input in a monolingual variety. The bilingual variety of the same language has a preference for one of the forms that is quantitatively different from the monolingual variety. The differences between the two varieties is modeled in stochastic OT by way of different rankings of the same set of constraints on the continuous ranking scale.

What remains to be seen formally under this analysis are the mechanisms by which one language has an effect on another, leading to the indirect transfer effects. One prediction that might be made is that the constraint ranking of the bilingual variety represents at least a partial approximation toward the constraint ranking of the language that leads to the contact effects. This area is obviously in need of further research.

#### **5.3.2 Interpretational preferences**

Anttila and Fong (2000:305) raise the question of how an OT grammar can deal with preferences in interpretation.

Under the partially ordered OT model of Anttila and Fong (2000:306), interpretational preferences arise due to the number of possible rankings that give rise to a particular form/meaning pairing. A similar view could be taken here with stochastic OT: interpretational preferences could be derived from the likelihood of a given output corresponding to a particular semantic input in light of the language specific constraint rankings on the linear ranking scale. In the bilingual grammar the likelihood of a progressive input being mapped to a synthetic Imperfective is much less than it is in the monolingual grammar. We would therefore predict, under Anttila and Fong's assumptions, that bilinguals might have a stronger preference for a habitual reading with the synthetic Imperfective than monolinguals have.

Although systematic investigation of this matter is needed to determine whether this prediction is empirically correct, Klein's (1980:77) anecdotal comments are very suggestive:

A question I often asked was *¿Qué hacen esos chicos allá afuera?* This question was intended to refer to the other young people waiting outside in the hall, and so to be interpreted as 'What are those kids out there doing?' (or 'What are those kids doing out there?'). It was thus intended to refer to...the moment of speech itself—and it was so interpreted by Spanish monolinguals, although the question was phrased in the simple present [=synthetic Imperfective—AKG]. Spanish-English bilinguals, however, usually interpreted this question as referring to ...the general present, in accordance with English usage, and so as 'What do those kids out there do?'

Further quantitative study is needed to determine the extent of the effect suggested by Klein's comments, and how precisely this would fit into the quantitative model.

## 6 Conclusion

In conclusion, I began by observing that there exists a general phenomenon in the variationist and language contact literature known as INDIRECT TRANSFER which has until now received no attention in the generative tradition. I argued that this type of contact-induced language change is not easily characterized in standard generative approaches due in large part to the problem of accommodating syntactic variation in such frameworks. I then went on to examine in detail one of the paradigm cases of indirect transfer effects in the literature—synthetic/analytic competition in the expression of progressive aspect in Puerto Rican Spanish of New York City as studied by Klein (1980,1985). It was seen on the basis of Klein's study that

monolingual Spanish speakers and bilingual Spanish/English speakers differ in the extent to which they prefer synthetic or analytic constructions for the expression of progressivity, and that this difference in preferences was due to contact with English.

I then developed a formal analysis of these facts in which the differences between the two varieties of Spanish were captured by way of different rankings of a small set of constraints, most of which have already been independently proposed in the OT literature, along a linear ranking scale. Variation, then, was generated by assuming a normal probability distribution associated with each constraint, and stochastic candidate evaluation. In this model, the crucial difference between the two varieties arises from differences in the relative ranking of a syntactic economy constraint  $*X^0$  and a faithfulness constraint  $MAX-\lambda$ . While the monolinguals tend to favor syntactic economy, and therefore have a greater number of synthetic Imperfective outputs for progressive inputs (especially in MORE CONTEXT environments), the bilinguals tend to favor faithfulness to input specification under pressure from English, giving  $MAX-\lambda$  a ranking value higher than that of  $*X^0$ .

Subsequent to the formal analysis of Klein's data, I then showed that the account not only models the indirect transfer effects, but also makes a typological prediction regarding the co-occurrence of synthetic/analytic morphosyntax, and the inventory of aspectual contrasts: there can be no language with an analytic Imperfective and a synthetic Progressive. I suggested that the derivation of this prediction was a consequence of embedding the analysis of indirect transfer effects within a theory of universal grammar and argued that this differentiates the analysis from a possible analysis appealing to the notion of variable rules.

Finally, I highlighted several directions for further research. These included formal analysis of other cases of indirect transfer within the same type of framework (stochastic OT), and further research on interpretational preferences. Although much remains to be done on the general phenomenon and on this case in particular, in the end I hope to have provided a first stab at a formal analysis of one case of indirect transfer.

## Notes

<sup>1</sup>See Manning (2002:14) for references and discussion of the competence/performance distinction and syntactic variation.

<sup>2</sup>The two forms can differ pragmatically in particular contexts, as Westfall (1995) showed. This is discussed further below.

<sup>3</sup>In recent work, Torres Cacoullós (2000) has shown that this is changing, at least in the Spanish of the southwest United States, if not elsewhere.

<sup>4</sup>Smith (1997:51) notes that the English analytic form can occur in habitual contexts only with a somewhat stacked context.

<sup>5</sup>Such an utterance is acceptable only in certain marked registers of English e.g. sportscaster talk.

<sup>6</sup>Synthetic forms were only placed in this category by Klein as long as the verb in question could appear in the analytic form in English. In this way, then, Klein did not include in this category those progressive utterances in the synthetic form that could not possibly have appeared in the analytic form.

<sup>7</sup>See Koontz-Garboden (1999); Mrak (1998) and Pousada and Poplack (1982) for similar results.

<sup>8</sup>Glasbey (2001) doesn't discuss how she intends to deal with habituality in her formal representation. It is important here, though, that we have some sort of formal representation for it, so as to allow the synthetic form to occur in habitual contexts and to prevent the analytic form from appearing in such contexts. Further, it cannot be the case that PROG - represents habituality, since there are languages with structures that are both habitual and progressive (Comrie, 1976; Olsen, 1996). We add to Glasbey's system, then, an attribute HAB for habitual.

<sup>9</sup>Klein's criteria for the division between less and more context depend on the topics of conversation that promoted discussion. Those that promoted the greatest discussion were classified as providing more context, those that promoted less had less context (see Klein 1980:78).

<sup>10</sup>Note that when considering an entire utterance this is not the case, as e.g. subject/object selection is optimized (Aissen, 1999; Bresnan, 2000; Bresnan et al., 2001). For the attribute/value pairs under consideration here, however, everything is fully specified in the input.

<sup>11</sup>Although I use stochastic O.T., other types of probabilistic OT analyses are conceivable (Anttila, 1997; Nagy and Reynolds, 1997).

<sup>12</sup>See Bybee et al. (1994:126,141) for treatment of so-called Present tense forms as Imperfectives.

<sup>13</sup>See Fong (2002) for a conceptually similar approach to aspectual expression in Singaporean Colloquial English proposed independently of the present work.

<sup>14</sup>A third constraint is suggested by formalism: \*PROG +/\*HAB +: \*HABPROG. I assume that such a constraint is independently needed to deal with languages which do not allow progressive and habitual morphosyntax to co-occur in the output. I leave this issue aside to simplify the discussion.

<sup>15</sup> See Kuhn (2001:113) for details and for a more highly formalized definition.

<sup>16</sup>Evidence in favor of Spanish V-to-I movement comes from comparisons of question inversion and adverbial placement with English. See Zagona (2002) for an overview.

<sup>17</sup>In the discussion that follows, I consider only candidates satisfying OB-HD(IP), and therefore leave this constraint out of the tableaux.

<sup>18</sup>Such a constraint will be independently needed to rule out agglutinative morphology in languages that do not have it.

<sup>19</sup>This matter is in need of further exploration, but is a topic for a paper of its own, so in the interests of space, I don't go into it here. A possibility suggested to me by Hank Zeevat (p.c.) and Hans-Martin Gaertner (p.c.) is bidirectional optimization (e.g. Smolensky (1996); Blutner (2000)).

<sup>20</sup>The following settings were used in the implementation of the GLA.

- (i) a. Evaluation noise 2.
- b. Initial plasticity of 1.
- c. 4 plasticities with plasticity decrement of .1
- d. Algorithm exposed to 100,000 learning data per plasticity.
- e. Initial ranking of all constraints on the linear scale was assumed to be equal (100).

Evaluation noise refers to the degree of 'noise' in the model. The plasticity setting gives the algorithm assumptions regarding the rate of learning. The number of plasticities in the model is a specification of the number of stages the algorithm goes through in learning the grammar. The number of data per plasticity is the amount of data the algorithm is exposed to per stage. Finally, no assumptions were made

regarding the relative ranking of markedness and faithfulness in the initial state (Smolensky, 1996)—all constraints began with equal ranking.

<sup>21</sup>I refer here to the actual theoretical variable rule device, not to the Varbrul program, which is a useful tool for the analysis of linguistic variation independently of whether a variable rule type of analysis is assumed (Fasold 1991; John Rickford p.c.).

<sup>22</sup>Whether these constraints must be innate is an entirely different question. Universality does not entail innateness.

<sup>23</sup>This point was brought to my attention by Paul Kiparsky, and some phonological work in this direction has been carried out by Guy (1991).

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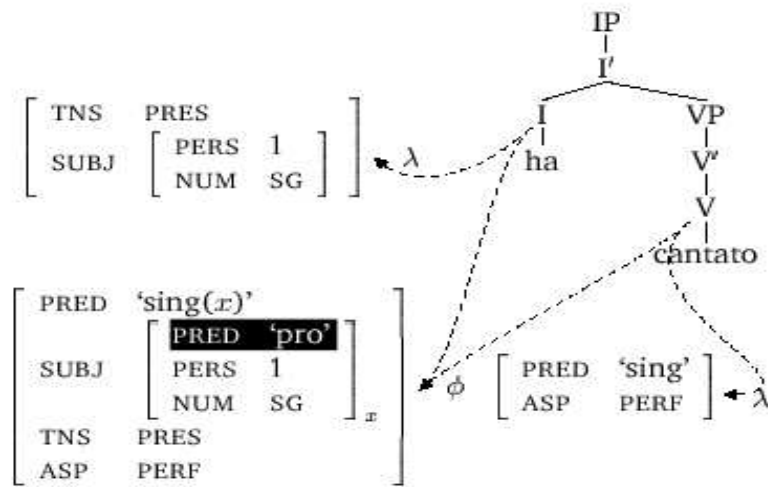


Figure 1: C-structure, f-structure, and  $\lambda$ -structure in OT-LFG (Kuhn 2001:112,4.78)

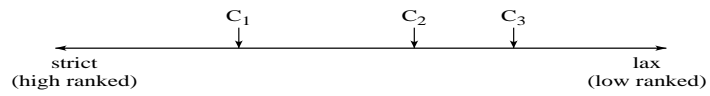


Figure 2: Continuous ranking scale

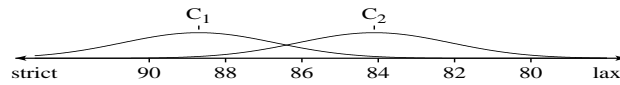


Figure 3: Relative constraint rankings vary

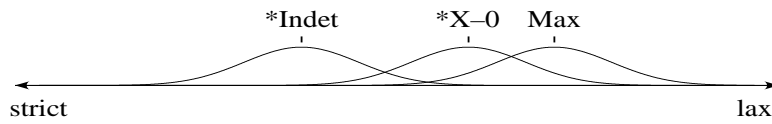


Figure 4: Graphical depiction of the relative ranking of \*INDET, \*X<sup>0</sup>, and MAX- $\lambda$  with respect to each other in monolingual grammar (not to scale).

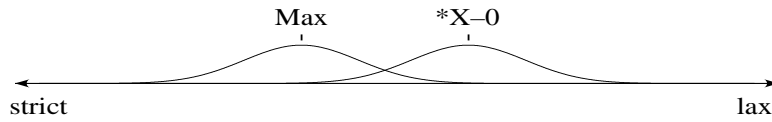


Figure 5: Graphical depiction of the relative ranking of MAX- $\lambda$  with respect to  $*X^0$  in bilingual grammar (not to scale).