To appear in P. Guijarro-Fuentes & M. Juan-Garau (eds.) *Acquisition of Romance languages: Old acquisition challenges and new explanations in generative perspective.* Berlin: De Gruyter Mouton.

Superset and subset grammars in second language acquisition: The role of sonority in the representation of /s/+consonant clusters

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Abstract

This paper explores the shapes of interlanguage grammars in the syllable structure domain from the perspective of the evidence available to learners indicating the well- or ill-formedness of /s/+consonant clusters in the language being learnt and how this interfaces with cross-linguistically motivated constraints on representation. The paper begins with the sonority profile of word-initial /s/+consonant clusters, and concludes that the constraints they respect mirror those that hold of coda+onset clusters, rather than branching onsets. This, in turn, is used to motivate different representations for each: /s/+consonant clusters are heterosyllabic, where /s/ is the coda of an empty-headed syllable, while obstruent-initial clusters form branching onsets. Drawing on data from several studies in the literature, the paper then turns to examine the acquisition of word-initial /s/+consonant clusters when the native language grammar is a subset of the second language as concerns cluster profile: East Asian and Ibero-Romance learners of Germanic. It is argued that cross-language differences in the developmental patterns observed – that is, whether or not they respect /s/+consonant cluster well-formedness on the sonority dimension – stem from the presence or absence of true branching onsets in the native language grammar, including the (un)suitability of redeploying this structure for /s/+consonant clusters, which is proposed to be linked to the relative stridency of /s/ in the native language. The paper then turns to examine the acquisition of /s/+consonant cluster ill-formedness when the first language grammar is a superset of the second language for word-initial cluster profile: English-speaking naïve learners of Brazilian Portuguese. It is experimentally shown that second language learners can use indirect positive evidence to learn that /s/+consonant clusters are ill-formed in the language being learnt: evidence from errors in the learner's first language made by native speakers of the learner's second language.

1. Introduction[*]

The acquisition of a second language can be aided or hindered by the first language grammar that is already in place. The kinds of evidence available to learners indicating the (un)suitability

[*] I would like to thank the audience at Romance Turn VI, where an earlier version of this paper was presented, for questions and comments. The written version has also benefitted from the comments of two anonymous reviewers and the editors, Pedro Guijarro Fuentes, and Maria Juan Garau. Thanks as well to Hye-Young Bang, Walcir Cardoso, Guilherme Garcia, Lauren Garfinkle, Natália Guzzo, Kris Onishi, and especially Misha Schwartz, who co-authored the study reported on in section 5. This work was supported by grants from the Social Sciences and Humanities Research Council of Canada and from the *Fonds de recherche du Québec – Société et culture*.

of the transferred grammar will depend on the particulars of the first and second language grammars and on the acquisition context. In this paper, I explore the shapes of interlanguage grammars from the perspective of the evidence available to learners and how this interfaces with cross-linguistically motivated constraints on representation. These issues are examined from a single empirical perspective: the acquisition of the well- or ill-formedness of /s/+consonant clusters.

I begin by examining patterns in the development of /s/+consonant clusters in language pairs where the first language is a subset of the second language on this dimension. That is, the first language is more restrictive: it is contained within the second language as concerns the grammar of left-edge clusters and, accordingly, positive evidence will be available indicating that such clusters are licit in the language being learnt. Drawing on data from several studies in the literature, it will be seen that the first language grammar to a large extent impacts the developmental patterns that learners display in their outputs. Specifically, learners of Germanic languages who are native speakers of Spanish follow a different path in development from those who are native speakers of East Asian languages (specifically, Mandarin, Cantonese, Japanese, and Korean). Surprisingly, native speakers of Brazilian Portuguese pattern more like the East Asian group, in spite of the genetic link that holds between Spanish and Portuguese. These cross-language differences will be proposed to stem from aspects of the native language grammar: the presence or absence of true branching onsets, including the (un)suitability of redeploying this structure for /s/+consonant clusters, which will be proposed to be linked to the relative stridency of /s/.

I then turn to examine patterns in the development of /s/+consonant clusters in a language pair where learners must determine that /s/+consonant clusters are illicit in the language being learnt, as the first language is a superset of the second language on this dimension. That is, the first language is more permissive: it contains the second language as far as the grammar of left-edge clusters is concerned. Drawing on experimental results from Schwartz and Goad (2015), where English-speaking naïve learners of Brazilian Portuguese are exposed to evidence indicating the ill-formedness of /s/+consonant clusters in this language, it will be suggested that, rather than resorting to some sort of negative evidence, in certain acquisition contexts, second language learners may be able to discover aspects of the second language grammar by relying on *indirect* positive evidence: evidence from errors in the learner's first language made by native speakers of the learner's second language.

An important theme that will reappear throughout the paper is the role that sonority plays in determining the well- or ill-formedness of different types of /s/+consonant clusters. This will be seen to impact the grammars that learners build when acquiring both superset Germanic and subset Ibero-Romance. As interlanguage grammars will be shown to respect the constraints that shape cluster well-formedness in end-state languages, it will be concluded that interlanguage grammars are possible grammars in the sense that they are constrained by Universal Grammar (contra Clahsen and Muysken 1986, 1989; Bley-Vroman 1990).

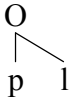
2. Word-initial clusters

I begin by examining the shapes of word-initial clusters across both cluster type and language. The discussion will focus on the two most common types of initial clusters, namely /s/-initial clusters (e.g., *spy, sly*) and obstruent-initial clusters (e.g., *ply, cry*), where obstruent henceforth refers to obstruents other than /s/. /s/-initial clusters defy many of the constraints that

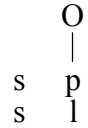
hold of obstruent-initial clusters; most notably, obstruent-initial clusters must rise in sonority in the vast majority of languages, while /s/-initial clusters may show a sonority plateau.[1] In non-linear approaches to syllable structure, this observation, among others, has been used to motivate different representations for these two types of clusters: obstruent-initial clusters form left-headed branching onsets (e.g., Kaye, Lowenstamm, and Vergnaud 1990), while /s/ is located outside of the onset constituent in /s/-initial clusters, as shown in (1).

(1) Preliminary representations:

a. Obstruent-initial clusters:



b. /s/-initial clusters (minimal representation):



(1b) is the minimal representation assumed by researchers who adopt an articulated view of the syllable. Probing this literature more extensively, /s/ has been analysed as extraprosodic (not linked to higher structure) (e.g., Steriade 1982), as organised directly by the syllable node (e.g., van der Hulst 1984) or prosodic word (e.g., Goldsmith 1990), or as the coda of an empty-headed syllable (e.g., Kaye 1992). The representation in (1b), which is contained in each of these proposals, is sufficient for the moment.

Sonority is the most commonly used criterion for determining cluster representation. Given that /s/-initial clusters can rise in sonority (e.g., *sly*), some researchers have analysed these particular /s/+consonant clusters as branching onsets, in contrast to those that show a sonority plateau (e.g., *spy*) (e.g., Hall 1992; Fikkert 1994). This view is challenged by the fact that, unlike branching onsets, the well-formedness of word-initial /s/+consonant decreases as the sonority of the consonant following /s/ increases (Goad 2011, 2012), as shown in Table 1.[2] Indeed, while obstruent+liquid is the optimal branching onset (Clements 1990), /s/+liquid is highly disfavoured.

Table 1. Sonority profile of word-initial /s/+consonant clusters across languages

	Spanish, Brazilian Portuguese	French, Picard	Greek, Romansch	Dutch, Italian	English, Russian
/s/+stop	*	✓	✓	✓	✓
/s/+nasal	*	*	✓	✓	✓
/s/+lateral	*	*	*	✓	✓
/s/+rhotic	*	*	*	*	✓

/s/+consonant cluster well-formedness instead parallels the phonotactic constraints that hold of word-internal coda+onset clusters. Specifically, when obstruents are permitted in coda, a flat sonority profile is preferred across the syllable boundary (e.g., [kt], [ks]); as the sonority profile steepens (e.g., [kn], [kl], [kr]), the cluster strives to be analysed as a branching onset. However, if

[1] I adopt the following sonority hierarchy:
obstruents (including /s/) < nasals < laterals < rhotics < vocoids.

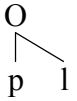
[2] Note that /s/+nasal clusters are only marginally well-formed in Greek. Information on Picard /s/+consonant clusters was provided by Julie Auger (p.c.).

a branching onset representation is never available for /s/+consonant clusters (Goad 2011), then rising sonority /s/-initial clusters will simply be ruled out, as we see progressively for Dutch (*[sr]), Greek (*[sr, sl]), and French (*[sr, sl, sn]), for example.

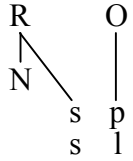
In view of these observations, I consider that the same representation holds for both flat and rising sonority /s/+consonant clusters, while other rising sonority clusters (i.e., obstruent+sonorant) form branching onsets, shown earlier in (1a) and repeated in (2a). In place of (1b), however, I adopt the position of Kaye (1992) that /s/ in initial /s/+consonant clusters is the coda (rhymal dependent) of an empty-headed syllable, as shown in (2b) (representation slightly simplified). This representation directly captures the phonotactic relations displayed in Table 1 (see Goad 2012). More concretely, I assume that the typology in Table 1 reflects a set of constraints, which are part of Universal Grammar, that govern coda+onset well-formedness of both word-initial and word-internal /s/+consonant clusters.

(2) Revised representations:

a. Obstruent+sonorant clusters:



b. /s/+consonant clusters:



The proposal that obstruent+sonorant and /s/+consonant clusters have different representations, along the lines of (2), is additionally supported by the observation that some languages contain word-initial clusters of one type but not the other; see Table 2.

Table 2. Typology of word-initial clusters

	Obstruent+sonorant clusters	/s/+consonant clusters
East Asian (Mandarin, Cantonese, Japanese, Korean)	*	*
Ibero-Romance (Spanish, Brazilian Portuguese)	✓	*
Acoma [Keresan], Blackfoot [Algonquian]	*	✓
Germanic (English, German, Swedish)	✓	✓

The goals of this paper are to explore the predictions of the different representations in (2) for second language acquisition, focusing principally on /s/+consonant clusters. We consider the challenges for learning both a superset language (East Asian and Ibero-Romance learners of Germanic) and a subset language (English learners of Brazilian Portuguese).

Table 2 shows that East Asian and Ibero-Romance are subsets of Germanic as far as /s/+consonant clusters are concerned. However, East Asian is additionally a subset of Germanic as far as obstruent+sonorant clusters are concerned. Given that obstruent+sonorant and /s/+consonant clusters have different representations, the presence or absence of obstruent+sonorant clusters should have no impact on the development of /s/+consonant. As we will see, this is not necessarily the case. /s/+consonant clusters take a surprising shape in the

acquisition of Germanic for learners coming from Ibero-Romance (notably Spanish) backgrounds, surprising from the perspective of the typology of options on the sonority dimension shown in Table 1. In view of this, we additionally strive to explain the shapes of interlanguage grammars, when these seemingly diverge from the expectations of Universal Grammar.

3. Predictions

We begin with the predictions for learners who are acquiring a superset grammar. In this type of acquisition context, positive evidence will be available: through detecting the presence of appropriate clusters in the ambient data, learners should conclude that a given structure is well formed in the language being learnt and acquisition should ultimately be successful. However, as we have seen, not all left edge clusters are of the same type. In view of the differing roles that sonority plays in determining the well-formedness of obstruent+sonorant versus /s/+consonant clusters and, consequently, the different representations that hold for each, specific predictions are in (3):

(3) Predictions for learning a superset grammar:

1. First language East Asian – Second language Germanic:
   Learners whose first language has no left-edge clusters should not use the same representation for obstruent+sonorant and /s/+consonant clusters in the second language (following from (2));

2. First language Ibero-Romance – Second language Germanic:
   Learners whose first language has obstruent+sonorant clusters only should not use this representation for /s/+consonant clusters in the second language (following from (2));

3. First language East Asian/Ibero-Romance – Second language Germanic:
   Learners whose first language lacks /s/+consonant clusters should acquire such clusters of shallower sonority profiles before those of steeper profiles (following from Table 1); at any given point in development, this should be reflected in fewer repairs applying to /s/+consonant clusters of shallower sonority profiles than to those of steeper profiles.

When learning a subset grammar, positive evidence is not always available or accessible, suggesting that learners must often rely on some sort of negative evidence to acquire the grammar. Given that second language learners have been shown to successfully learn syllable structure constraints in the absence of positive evidence (Trapman and Kager 2009), Schwartz and Goad (2015) propose that another sort of evidence may be available, in at least some acquisition contexts: indirect positive evidence.

Indirect positive evidence is evidence from errors in the learner's first language made by native speakers of the learner's second language. To illustrate, consider the following: A native speaker of English, who is in the process of acquiring Brazilian Portuguese, may hear a native speaker of Brazilian Portuguese, who is in the process of acquiring English, produce English words beginning with /s/+consonant with a prothetic vowel (*star* → *[i]star*). From this, the English speaker could conclude that the phonotactics of Brazilian Portuguese do not allow word-initial /s/+consonant clusters. Although the evidence that the English speaker used to arrive at

this conclusion was positive, it was indirect, because the evidence for the structure of one language was available through errors made in another language. Assuming that indirect positive evidence is practicable for learning a subset grammar, specific predictions are provided in (4):

(4) Predictions for learning a subset grammar:
First language English – Second language Brazilian Portuguese:

1. Learners exposed to the ill-formedness of /s/+consonant through indirect positive evidence will realise that /s/+consonant is ill-formed in the language being learnt;

2. Learners who recognise that /s/+consonant is ill-formed in the language being learnt will not overgeneralise this to obstruent+sonorant (following from (2));

3. Learners exposed only to the ill-formedness of /s/+stop through indirect positive evidence will conclude that /s/+sonorant is also ill-formed (following from Table 1).

We first consider, in section 4, the acquisition of superset grammars, using data drawn from the literature. We then turn, in section 5, to an experiment that was designed to examine the potential utility of indirect positive evidence for learning a subset grammar.

4. Learning a superset grammar

4.1. East Asian learners of Germanic

We begin with the results of four studies that systematically examine the acquisition of /s/+consonant and obstruent+sonorant clusters in English by native speakers of one or more of the following languages: Mandarin, Cantonese, Japanese, and Korean, all of which lack both cluster types (see Table 2).

Concerning the acquisition of /s/+consonant, Enochson's (2012) comparative study observed that sonority distance is negatively correlated with target-like production of such clusters in the English outputs of Mandarin, Cantonese, and Japanese speakers. Specifically, learners' performance was best on /s/+stop, followed by /s/+nasal, followed by /s/+lateral, followed by /s/+glide.[3] Enochson's findings for Japanese-speaking learners of English mirror the earlier results of Martz (2007) who found that accuracy on /s/+stop was higher than on /s/+nasal which, in turn, was higher than on /s/+lateral. And taken together, the results of Enochson and Martz mirror those of Kim (2000) and Kwon (2006) on Korean-speaking learners of English: Kim found that performance on /s/+stop was better than on both /s/+nasal and /s/+lateral, and Kwon found that performance on /s/+nasal was better than on /s/+lateral. The results of all four studies are consistent with Prediction 3 in (3), which states that learners whose native language lacks /s/+consonant clusters should acquire such clusters of shallower sonority profiles before those of steeper profiles, as per the typology in Table 1, which, at any given point in development, should

[3] We did not include glides in our earlier discussion of cluster type because, across languages, glides in consonant+glide+vowel strings can be syllabified in three different ways, only one of which bears on the constraints that hold of left-edge clusters: they can be located in the onset (either following coda /s/ or as part of a branching onset); they can be in the nucleus, forming a (light) diphthong with the following vowel; or they can be secondary articulations on a preceding onset consonant. Each of these representations respects different constraints.

be reflected in fewer repairs applying to /s/+consonant clusters of shallower sonority profiles than to those of steeper profiles.

Turning to Prediction 1 in (3), that learners whose first language has no left-edge clusters should not use the same representation for obstruent+sonorant and /s/+consonant clusters in the second language, Enochson (2012) reports that there was no correlation between sonority distance and target-like production of obstruent+sonorant clusters, in contrast to her findings for /s/+consonant: learners' performance was equally good on stop+glide, stop+liquid and fricative+liquid, in support of Prediction 1. Martz (2007), Kim (2000), and Kwon (2006) compare performance on analogous /s/+consonant and obstruent+sonorant clusters, that is, on clusters with the same sonority slope and voicing profile; specifically, /s/+lateral is compared with voiceless fricative+liquid in Martz, and with voiceless stop+liquid in Kim and Kwon. Martz finds better performance on obstruent+sonorant than on /sl/; Kwon finds better performance on /sl/ than on obstruent+sonorant (nears significance); and Kim finds better performance on /sl/ for less advanced speakers and on obstruent+sonorant for more advanced speakers. The results from all three studies are consistent with Prediction 1, which expects no correlation to be observed between learners' performance on /s/+consonant and obstruent+sonorant clusters, even when other factors (sonority slope, voicing) are controlled.[4]

In sum, the results from all four studies reviewed here are consistent with the particular role that sonority plays in determining the well-formedness of /s/+consonant clusters, in contrast to obstruent+sonorant clusters. We could conclude from this that interlanguage grammars are possible grammars, that is, grammars that are constrained by Universal Grammar. However, when we consider the results from studies that have examined the acquisition of /s/+consonant clusters by learners whose native language grammars contain obstruent+sonorant clusters, we arrive at a different conclusion: for the majority of learners, order of acquisition of /s/+consonant does not reflect the typology of options seen in Table 1. We examine these studies in the next section.

4.2. Ibero-Romance learners of Germanic

Table 3 summarises the results from several studies on the acquisition of Germanic languages by native speakers of Spanish and Brazilian Portuguese.[5] In the Spanish group of studies, performance on /s/+consonant clusters where the consonant is of higher sonority is better

[4] Further support for Prediction 1 in (3) comes from Detey and Nespoulous's (2008) study on Japanese-speaking learners of French. In a syllable counting task, participants treated /s/+consonant and obstruent+sonorant clusters differently: they displayed more epenthesis for /s/+consonant and earlier acquisition of obstruent+sonorant which, together, suggest different representations for these two cluster types.

[5] Results for German [ʃv], Swedish [sv], and English [sw] have been removed for several reasons. One, the status of glides in syllable structure is variable (see note 3). Two, both Spanish and Brazilian Portuguese have [sw] (where [w] is part of a light diphthong), in contrast to the other /s/+consonant clusters. Three, some learners may treat German and Swedish [v] as a low sonority fricative while others treat it as a high sonority glide, leading to results that are difficult to interpret.

than performance on such clusters when the consonant is of lower sonority.[6] This is inconsistent with Prediction 3 in (3), that learners whose first language lacks /s/+consonant clusters should acquire such clusters of shallower sonority profiles before those of steeper profiles. It appears, then, that these learners have misanalysed /s/+consonant clusters as branching onsets rather than as coda+onset clusters. This, in turn, is inconsistent with Prediction 2 in (3), that learners whose first language has obstruent+sonorant clusters should not use this representation for /s/+consonant clusters in the second language.

Table 3. Ibero-Romance learners of /s/+consonant clusters in Germanic.

First language	Second language	Performance	Study
Spanish	German	ʃl, ʃr, ʃn, ʃm > ʃp, ʃt	Tropf (1987)
	English	sl > sm, sn	Carlisle (1988)
	English	sl > st	Carlisle (1991)
	Swedish	sm, sn > sp, st, sk > sl (marginally significant)	Abrahamsson (1999)
	English	sm, sn > sp, st, sk	Escartín Ortiz (2005)
	English	sl > sn > st	Carlisle (2006)
	English	sl > sn > st	Carlisle and Cutillas Espinosa (2010)
	English	sm, sn, sl > sp, st, sk	Rauber (2006)
Brazilian Portuguese	English	sp, st, sk > sl	Major (1996)
	English	sp, st, sk > sm, sn, sl	Rebello and Baptista (2006)
	English	sm, sn, sl > sp, st, sk (not significant)	Rauber (2006)
	English	sl, sn > st	Cardoso and Liakin (2009)

In the Brazilian Portuguese group of studies, a mixed profile of behaviour is observed: in Major (1996) and Rebello and Baptista (2006), performance on /s/+consonant reflects what one would expect if learners have correctly identified these clusters as coda+onset, rather than as branching onsets. The results of Cardoso and Liakin (2009) follow the pattern observed for Spanish and the Rauber (2006) study trends in this direction as well. We strive to explain these cross-language and cross-study differences in the next section.

[6] Note that [sl] stands out in the Abrahamsson study in patterning with stops rather than with other sonorants. Abrahamsson suggests that this may be due to low number of tokens for [sl] in his study. An alternative is that this is due to the ambiguous articulatory properties of [l], which makes it both approximant-like and stop-like. Like oral approximants, air can flow freely out of the oral cavity, on one or both sides of the tongue, but because the tongue tip/blade also makes contact with the dento-alveolar region, the air is obstructed centrally in a similar manner to [t/d]. The ambiguous articulatory status of [l] may play a role in the results from Escartín Ortiz as well: after a vowel, [sl] patterns with /s/+stop but after a pause, it patterns with /s/+nasal.

4.3. In pursuit of an explanation

We first address why the Spanish speakers behave differently from the speakers of East Asian languages in their acquisition of Germanic /s/+consonant clusters. It appears that the East Asian speakers, whose performance mirrors cross-linguistic patterns on /s/+consonant cluster well-formedness (Table 1), start from scratch, whereas the Spanish speakers, whose performance on /s/+consonant mirrors the patterns expected for obstruent+sonorant (steeper sonority rises preferred for both cluster types), redeploy their branching onset representation for /s/+consonant. Although this would lead to the observed differences between these two populations of learners, there are two problems that must be addressed before this analysis can be accepted. One, we cannot explain the different patterns observed between Spanish and Brazilian Portuguese in Table 3, two closely related languages that both have obstruent+sonorant clusters. Two, we arrive at the conclusion that the interlanguage grammars built by Spanish-speaking learners are not constrained by Universal Grammar in that, for many of these learners, the only well-formed /s/+consonant clusters would be /s/+sonorant in shape.

In view of these problems, we consider an alternative explanation, one which stems from the phonetic properties and phonological behaviour of /s/ in dialects of Spanish and Brazilian Portuguese. In order to pursue this explanation, we must begin with some discussion of why it is /s/ (or some other type of sibilant) that displays unorthodox syllabification behaviour across languages.

Recent research has proposed that segments are ordered to maximise their perceptibility (e.g., Wright 2004). At the left edge of syllables and/or words, obstruents are optimally followed by sonorants, as their place and voicing are reliably identified only once they are released into the following segment. In light of this, the relatively free distribution of /s/ in relation to what follows may appear puzzling. However, strident fricatives, unlike other obstruents, have robust internal cues for place and manner, which ensures that they can be accurately identified, even in non-optimal contexts, as when followed by stops. Since phonological constraints require all languages that have /s/+consonant clusters to permit /s/+stop (section 2), it is essential that the sibilant that appears in such clusters meet a minimum threshold for stridency. (Note that stridency is a gradient phenomenon; see Brannen 2011.) In languages where /s/ does not meet this threshold, word-initial /s/+consonant clusters may be absent altogether (Spanish, Brazilian Portuguese) or the language may choose to substitute another sibilant in place of /s/ in such clusters (German, Acoma).

In order to achieve the characteristic stridency of /s/, a narrow constriction must be maintained at the constriction site (Shadle 1991). Apico-alveolar articulation is most conducive to realising strident anterior coronals; laminal tongue posture, as in the production of /θ/, involves greater constriction width than /s/, and is thus incompatible with the minimum threshold for stridency required. In the following lines, we examine coronal fricatives in German and Acoma from this perspective.

When compared to English /s/, German /s/ involves greater constriction width, which results in a lowered spectral mean (Fuchs and Toda 2010). Considered alongside Narayanan, Alwan, and Haker (1995), who report greater constriction width for English /θ/ than for English /s/, and Jongman, Wayland, and Wong (2000), who observe lower spectral means for English /θ/ than for /s/, Fuchs and Toda arrive at the conclusion that German /s/ is quite [θ]-like. A less strident /s/ is practicable in German because there is no contrast between /s/ and /θ/ in this language. There is, however, a consequence for the shape of /s/+consonant clusters: German selects /ʃ/ over /s/ in

such clusters, because /s/ is not strident enough, given the phonological requirement for /s/+stop to be well-formed in all languages with /s/+consonant (Goad 2012).

Turning to Acoma, Miller (1965) observes that /s/ in this language is dental and that /s/ is followed by a "theta offglide" (Miller 1965: 13). Both of these suggest that /s/ is non-strident in Acoma, akin to German /s/. As Acoma is a language where /s/+consonant clusters are confined to /s/+stop (like French; see Table 1), if /s/ were to surface as such in /s/+consonant clusters, its perceptibility would be compromised. /s/+consonant clusters are instead realised as posterior [s̺] or [ʃ] (contextually determined), similar to what is observed in German (Goad 2012).

With this background, we now turn to consider the phonetic and phonological behaviour of /s/ in dialects of Spanish and Portuguese. We will conclude that /s/ is non-strident in dialects of both languages, which will serve as a possible explanation for why /s/+consonant clusters have the profile of branching onsets in the interlanguage grammars of Ibero-Romance learners of Germanic languages.

In his comparison of Andalusian and Castilian Spanish, Romero (1995) experimentally confirms the observations of earlier researchers (e.g. Zamora Vicente 1967) that Andalusian and Castilian have different articulations for /s/. Castilian contrasts strident apico-alveolar /s/ and non-strident lamino-dental /θ/, whereas Andalusian has only one fricative in this region: laminal /s/ with a variable constriction location. Latin American dialects are like Andalusian in that they have similarly neutralised the contrast between /s/ and /θ/ (e.g., Lipski 1994). Romero experimentally demonstrates that the laminal tongue posture in Andalusian involves a reduction of gestural magnitude which, as discussed earlier, is inconsistent with the gestural requirements for stridency identified by Shadle (1991). In other words, Andalusian /s/ is low in stridency, and this likely holds for (some) Latin American dialects as well.

Turning to the phonological behaviour of /s/ in Andalusian versus Castilian, Romero proposes that gestural reduction of Andalusian /s/ was the triggering condition for lenition (/s/ → [h] or Ø). Lenition of coda /s/ is particularly widespread throughout the Spanish-speaking world: outside of Andalusia, it occurs in the Caribbean and in coastal regions of Latin America (e.g., Alcina Franch and Blecua 1975; Lipski 1994). While Romero (1995) roots lenition in the articulatory properties of /s/, from a perceptual perspective as well, the process was likely facilitated by the weak stridency of Andalusian /s/, in that the inception of this process would not be perceptually costly. Conversely, lenition that specifically targets /s/ would be surprising if /s/ were high in stridency, as the process would be easily detected by listeners. We can thus conclude that, at least for some dialects of Spanish, the stridency of /s/ and the presence/absence of lenition are likely linked.

Turning to Portuguese, a similar profile is found as concerns the phonetics of /s/. Conservative dialects, mostly in the north of Portugal, maintain two anterior sibilants, lamino-dental /s̪/ and apico-alveolar /s/ (Mateus and d'Andrade 2000). Most (southern) dialects have only one anterior fricative, which is described by Mateus and d'Andrade as dento-alveolar and by Emiliano (2009) as lamino-alveolar. As for Brazilian Portuguese, Mateus and d'Andrade state that Brazilian Portuguese converges with the southern dialects found in Portugal in this respect. Reference to dentality and laminality is consistent with a weakly strident /s/ in both of these dialects, as in Andalusian and possibly Latin American Spanish.

In some dialects of Brazilian Portuguese, lenition (particularly deletion) of /s/ also occurs (e.g., Guy 1981 on the dialect spoken in Rio de Janeiro; Hora, Pedrosa, and Cardoso 2010 on the dialect spoken in Paraíba) but it appears that it is not as widely attested (or at least as extensively

studied) as in Spanish; for instance, it is not mentioned at all in Mateus and d'Andrade's (2000) phonological grammar.

To summarise, phonetic and phonological evidence points toward non-strident /s/ in dialects of both Spanish and Brazilian Portuguese. With the information available, it is not possible to determine if /s/ is non-strident in the dialects of Spanish spoken by the learners in Table 3 as well as in the dialects of Brazilian Portuguese spoken by the learners in Cardoso and Liakin (2009)[7] and possibly Rauber (2006). However, if /s/ were non-strident in these dialects, then it would be non-strident in the (early) interlanguage grammars that these speakers build. /s/-initial clusters in these learners' Germanic outputs would then be akin to /f/- or /θ/-initial clusters in other languages. That is, they would be represented as branching onsets, using a structure already available from the native language grammar. Under this analysis, these interlanguage grammars are possible grammars, and the performance displayed by these speakers in their second language, where /s/+consonant clusters with a steeper sonority profile are preferred over those with a shallower profile, is as expected.

To conclude this section, we have argued that patterns in the acquisition of /s/+consonant clusters in English by learners whose first language has no left-edge clusters (East Asian) respect the phonotactic and representational differences observed for /s/+consonant versus obstruent+sonorant clusters. The interlanguage grammars built are thus constrained by Universal Grammar. Patterns in the acquisition of /s/+consonant clusters in Germanic by learners whose first language has left-edge obstruent+sonorant clusters (Ibero-Romance) do not necessarily respect the phonotactic and representational differences observed for /s/+consonant versus obstruent+sonorant. It was argued that this does not mean that these interlanguage grammars are not possible grammars. Instead, the source of parallels observed between /s/+consonant and obstruent+sonorant may lie in the low stridency of /s/ in the native language grammar: /s/+consonant clusters can therefore use the representation for branching onsets available from this grammar.

5. Learning a subset grammar

In the preceding section, we were concerned with language pairs where the first language is a subset of the second language for initial /s/+consonant clusters. In such situations, direct positive evidence – discovering that a structure is well-formed from exposure to the ambient input – is available for learners to determine that /s/+consonant clusters are licit in the language being learnt. In this section, we turn to the inverse situation, a language pair, English–Brazilian Portuguese, where the first language is a superset of the second language: as discussed above, Brazilian Portuguese lacks initial /s/+consonant clusters. In these types of learning situations, direct positive evidence is often not available, and even when it is, it may not be very accessible to learners (see Schwartz and Goad 2015).

Consider, for example, the potential utility of morphophonemic alternations. Although in Brazilian Portuguese there are alternations revealing that initial /s/+consonant is ill-formed (stems that begin with /s/+consonant undergo [i] epenthesis when they are not preceded by a vowel-final prefix (e.g., [ispɛra] 'hope.N, wait.N, wait.3SG' versus [pro-spɛrar] 'to flourish, be

[7] Walcir Cardoso has informed me that the Brazilian Portuguese speakers in the Cardoso and Liakin (2009) study were from Belém (Pará), a dialect where /s/ lenition (to [h] and Ø) occur, mostly in word-final position, although the process is stigmatised.

successful')), for learners to make use of this evidence, they must understand the morphological composition of words, which requires significant cross-form comparison. Alternatively, learners could rely on loanword adaptations (Trapman and Kager 2009) (e.g., English *stand* and *snob* are realised with initial [i] in Brazilian Portuguese (Cardoso and Liakin 2009)). However, if the learner of Brazilian Portuguese does not know the source language or the number of adaptations is too great to be able to recover the source word, this type of evidence will not be accessible. A similar argument can be made for learners relying on a comparison of cognates (e.g., Brazilian Portuguese *especial* corresponds to English *special*). They can be a useful source of positive evidence, but only if the learner's native language (or another language that s/he knows) is genetically related to the second language.[8]

Must we conclude from this that learners often have to rely on negative evidence when learning a subset grammar? Perhaps not. In some acquisition contexts, learners can use indirect positive evidence where, as exemplified in section 3, the evidence for the structure of the grammar of one language is accessible through errors made in another language (Schwartz and Goad 2015).

In the following section, I report on an experiment that was designed to test whether indirect positive evidence could be used by second language learners to inform them about aspects of the language they are acquiring.

5.1. Experiment

The experiment examined whether English speakers, who are naïve to the structure of Brazilian Portuguese, can acquire information about the phonotactics of Brazilian Portuguese after being exposed to indirect positive evidence in the form of Brazilian Portuguese-accented English.[9] Our focus was on clusters in word-initial position: (i) /s/+consonant clusters, which are ill-formed and repaired through [i] epenthesis in Brazilian Portuguese and in Brazilian Portuguese-accented English; and (ii) obstruent+sonorant clusters, which are well-formed in Brazilian Portuguese. The predictions that we tested were provided earlier in (4); they are repeated in (5) for convenience:

(5) Predictions for learning a subset grammar (repeated from (4)):
First language English – Second Language Brazilian Portuguese:

1. Learners exposed to the ill-formedness of /s/+consonant through indirect positive evidence will realise that /s/+consonant is ill-formed in the language being learnt;

2. Learners who recognise that /s/+consonant is ill-formed in the language being learnt will not overgeneralise this to obstruent+sonorant (following from (2));

3. Learners exposed only to the ill-formedness of /s/+stop through indirect positive evidence will conclude that /s/+sonorant is also ill-formed (following from Table 1).

[8] Thanks to Bernadette Plunkett for mentioning the potential benefit of cognates.
[9] The experiment reported on here appears in expanded form in Schwartz and Goad (2015).

5.1.1. Methodology

The participants were 32 native speakers of Canadian English (aged 19–33), with no higher than low-intermediate proficiency in another language. In addition, they had no knowledge of Portuguese or of Spanish, which has the same restrictions on /s/+consonant clusters (Table 1) and also repairs such clusters through epenthesis ([ɛ] instead of [i]).

Participants listened to one of two 7 minute dialogues between two native speakers of Brazilian Portuguese speaking Brazilian Portuguese-accented English; they were told that the native language of the speakers in the dialogue was Samoan to minimise the possibility that they would identify the native language as Portuguese (or Spanish). There were 48 tokens of /s/+consonant clusters, all of which appeared with prothetic [i]; place and manner of the consonant following /s/ were controlled. Each dialogue also contained 30 tokens of obstruent+sonorant clusters (including a range of place, manner and voicing values for the obstruent). Participants were assigned to one of two conditions. Those in the NoSonorant condition listened to a dialogue in which all /s/+consonant clusters were /s/+stop in shape (16 tokens each of /sp, st, sk/); those in the Sonorant condition listened to a thematically near-identical dialogue in which /s/+consonant clusters were both /s/+stop and /s/+sonorant in shape (8 tokens each of /sp, st, sk, sm, sn, sl/).

To test the predictions provided in (5), participants were orthographically-presented with 120 novel words that began with /s/+consonant (*n*=36), obstruent+sonorant (*n*=18) or singleton consonant (*n*=66). The /s/+consonant-initial words contained an equal number of stops and sonorants in second position, regardless of which dialogue participants were exposed to. Participants were asked to pronounce each word with the same accent as they had heard in the dialogue.

5.1.2. Results

Prediction 1 in (5) states that learners exposed to the ill-formedness of /s/+consonant through indirect positive evidence will realise that /s/+consonant is ill-formed in the language being learnt. To test this prediction, the data from the 32 participants were examined for whether or not they repaired /s/+consonant-initial words; see Figure 1.[10] (In all figures, the expected pattern is plotted in black; the unexpected pattern, in grey.)

Figure 1 shows that participants fell into three groups (determined by a binomial test). The behaviour of the 11 participants at the left end of the figure, henceforth the *learners*, was significantly higher than chance (ps ≤ 0.001); these individuals were able to use the indirect positive evidence available to determine that /s/+consonant clusters are ill-formed in the native language of the dialogue speakers. The behaviour of the 19 participants at the right end of the figure, henceforth the *non-learners*, was significantly lower than chance (ps ≤ 0.002); these individuals were not able to use the indirect positive evidence available and, instead, treated /s/+consonant clusters as well-formed in the dialogue speakers' native language. The

[10] All possible repairs to /s/+consonant clusters (i.e., prothesis [skesu] → [iskesu], anaptyxis [sikesu], deletion [sesu] or [kesu], and metathesis [seksu]) are collapsed together. The vast majority of participants used only prothesis (of all repairs employed, 95% involved prothesis). As performance decreases, however, the proportion of repairs of other types increases (see Schwartz and Goad 2015).

performance of the remaining two *chance* performers in the middle was neither significantly higher nor lower than chance.

We can conclude from Figure 1 that Prediction 1 is supported, but only for a subset of participants: the 11 learners.

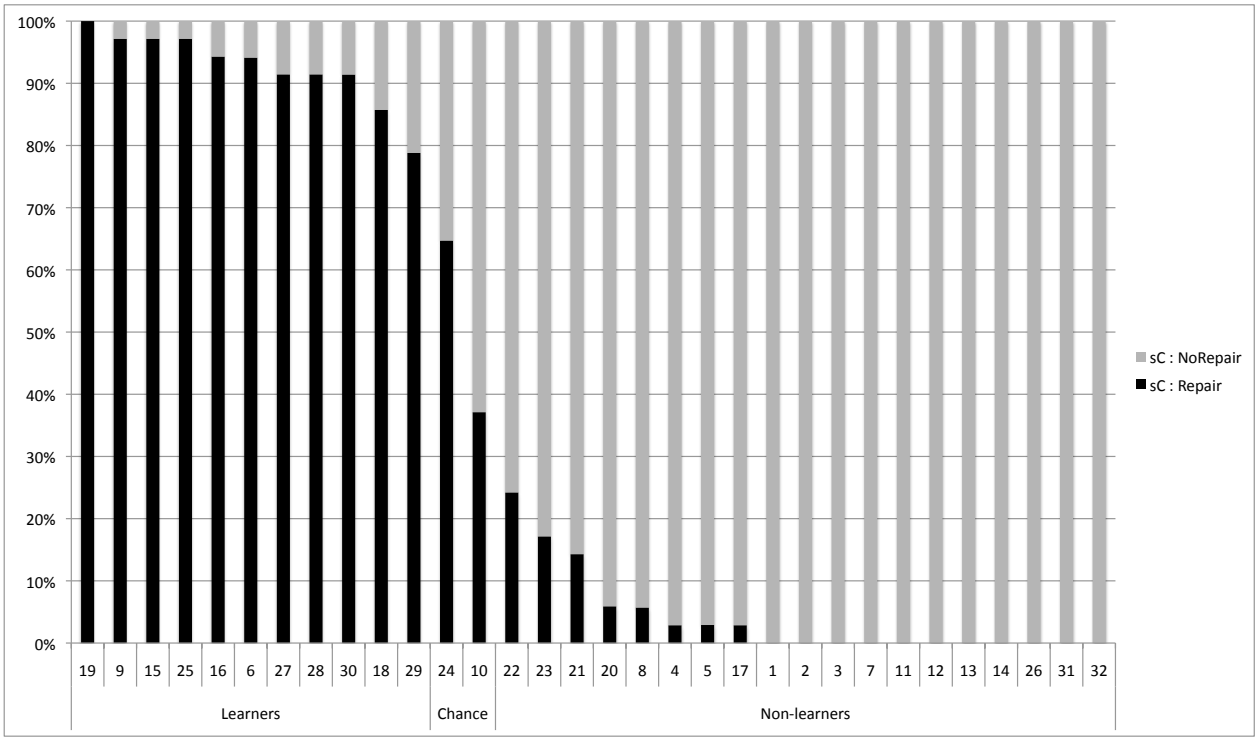


Figure 1. Responses to all /s/+consonant-initial words

Prediction 2 in (5) states that learners who recognise that /s/+consonant is ill-formed in the language being learnt will not overgeneralise this to obstruent+sonorant clusters. Figure 2 provides the results for obstruent+sonorant clusters for the 11 learners. As can be seen, Prediction 2 is strongly supported: obstruent+sonorant clusters were not repaired, as appropriate. This is not surprising: there is direct positive evidence in the data to which participants were exposed that obstruent+sonorant clusters are well-formed in the native language of the dialogue speakers.[11] Even if participants failed to notice this – on grounds that it may be more difficult to notice the presence of something expected (obstruent+sonorant as well-formed), from the perspective of the participants' native language grammar, than the presence of something unexpected (/s/+consonant as undergoing repair) – since different representations hold for these two types of clusters, any repair that participants apply to /s/+consonant should not be generalized to obstruent+sonorant.

[11] What is surprising is that some participants overgeneralized the repair to words beginning with singleton /s/, which are also well-formed in the dialogue speakers' grammar; see Schwartz and Goad (2015) for discussion.

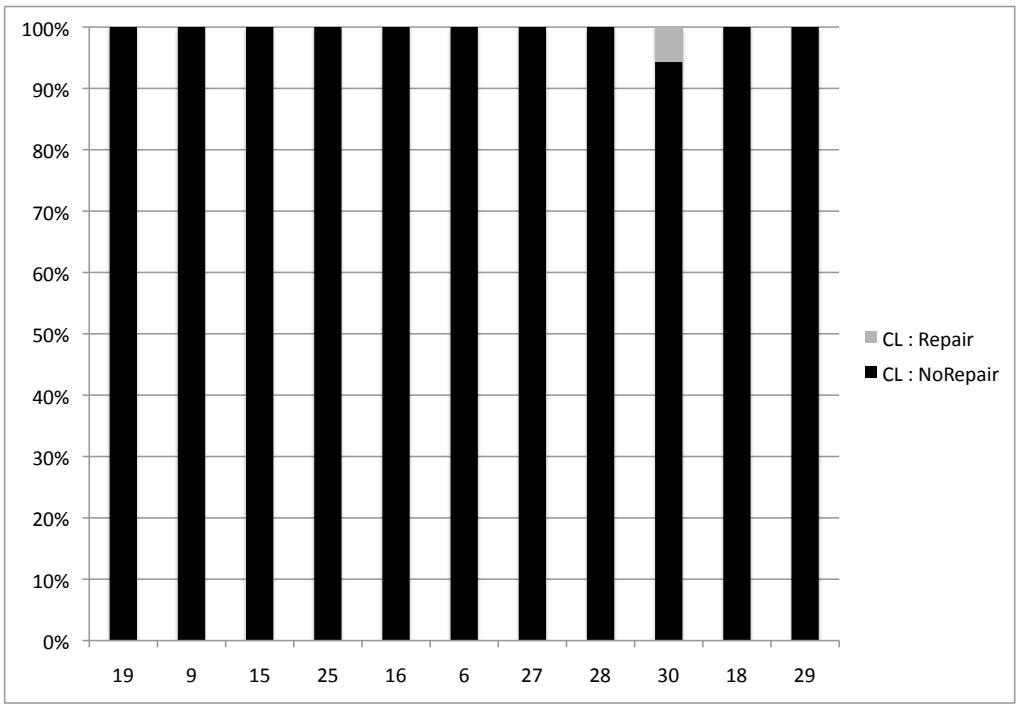


Figure 2. Responses of learners to obstruent+sonorant-initial words

We turn finally to Prediction 3 in (5), which states that learners exposed only to the ill-formedness of /s/+stop through indirect positive evidence will conclude that /s/+sonorant is also ill-formed. This prediction follows from the typological options displayed in Table 1 and, thus, if interlanguage grammars are constrained by Universal Grammar, we should find support for it.

To test this prediction, participants were randomly assigned to one of two conditions, as mentioned earlier (section 5.1.1). See (6):

(6) a. NoSonorant condition:
16 participants received evidence for the illicit status of initial /s/+consonant clusters only from /s/+stop: in the dialogue, all /s/+consonant-initial target words were of the shape /s/+stop and all were preceded by a prothetic [i];

b. Sonorant condition:
16 participants received evidence for the illicit status of /s/+consonant from both /s/+stop and /s/+sonorant: in the dialogue, /s/+consonant-initial target words were of the shape /s/+stop and /s/+sonorant and all were preceded by a prothetic [i].

Of the 11 learners in Figure 1, eight had been assigned to the critical NoSonorant condition. Figure 3 shows that all eight appropriately generalised the pattern they learnt regarding the ill-formedness of initial /s/+stop to /s/+sonorant, strongly supporting Prediction 3 in (5). A paired t-test for the learners confirms that their behaviour on these two types of clusters was not significantly different ($t = 1.8825$, $df = 7$, $p = 0.1018$).

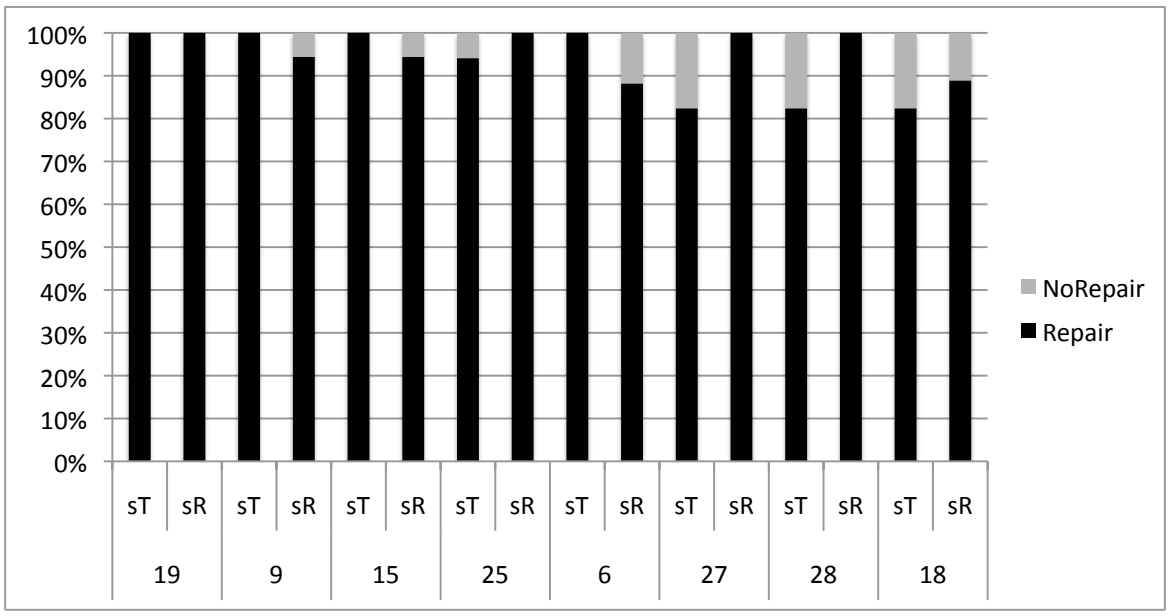


Figure 3. Responses of learners in NoSonorant condition
(sT = /s/+stop; sR = /s/+sonorant)

In sum, the results of this experiment have demonstrated that: (i) indirect positive evidence can be used to uncover the phonotactic constraints operative in a second language, and (ii) constraints on the well-formedness of different types of left-edge clusters drive the shapes of interlanguage grammars. As appropriate, the learners did not overgeneralise the repair pattern they had learnt for initial /s/+consonant to obstruent+sonorant clusters. They did, however, appropriately generalise the repair pattern to /s/+sonorant, when they had only been exposed to evidence that /s/+stop is ill-formed in the language being learnt.

6. Conclusion

This paper has examined: (i) acquisition of the well-formedness of /s/+consonant clusters in language pairs where the first language is a subset of the second language grammar: East Asian and Ibero-Romance learners of Germanic; and (ii) acquisition of the ill-formedness of /s/+consonant clusters in a language pair where the first language is a superset of the second language grammar: English-speaking learners of Brazilian Portuguese.

In case (i), learners differed in their treatment of /s/+consonant clusters: for some, relative difficulty reflected cross-linguistic patterns in cluster well-formedness on the sonority dimension, where accuracy on /s/+consonant clusters with a sonority plateau was better than on clusters with a sonority rise; for others, relative difficulty showed the inverse pattern: performance on clusters with a steep sonority profile was better than on clusters with a shallow or flat profile. This difference was argued to be due, in part, to the presence or absence of branching onsets in the native language grammar: East Asian learners of Germanic, who lack branching onsets in their native language, preferred /s/+consonant clusters with a shallower profile, while some Ibero-Romance learners, whose native language grammar contains branching onsets, preferred /s/+consonant clusters with a steeper profile. However, Ibero-Romance learners did not behave uniformly: Spanish learners preferred /s/+consonant clusters that mirrored

branching onsets, while Brazilian Portuguese learners were divided in whether they patterned with Spanish learners or with East Asian learners. This difference was proposed to be due to the relative stridency of /s/ in the native language grammar. In dialects of Spanish and Brazilian Portuguese with low stridency /s/, the branching onset representation could be redeployed for /s/+consonant in the second language, whereas in dialects with high stridency /s/, this representation would not be suitable.

To test the validity of this explanation for the differing performance of Ibero-Romance speakers, future research should compare, for example, the behaviour of speakers of Andalusian Spanish and speakers of (northern varieties of) Castilian Spanish. Andalusian speakers, who show lenition of /s/, should have weakly strident /s/ in their native and interlanguage grammars. They should redeploy the branching onset representation from their native language to use for /s/+consonant clusters in the interlanguage, and show better performance on /s/+consonant clusters with a steep sonority profile over those with a shallow profile. Castilian speakers, who do not show lenition of /s/, should have highly strident /s/ in their native and interlanguage grammars. They should not see their branching onset representation as suitable for /s/+consonant clusters in the second language and should instead acquire this structure from scratch, showing better performance on /s/+consonant clusters with a sonority plateau over those that rise in sonority.

Turning to case (ii), English-speaking naïve learners of Brazilian Portuguese, learners were faced with acquiring a subset grammar. In naturalistic situations like this, direct positive evidence may be lacking or inaccessible and we would thus expect the acquisition process to be protracted. However, it was shown that learners can use indirect positive evidence in an experimental setting to acquire a subset grammar: evidence from errors in the learner's first language made by native speakers of the learner's second language. The group of participants who were able to use the available indirect positive evidence – epenthesis errors in Brazilian Portuguese-accented English – appropriately did not overgeneralise the pattern of repair they had learnt for /s/+consonant clusters to obstruent+sonorant clusters. Further, when exposed only to epenthesis before /s/+stop, they correctly generalised the repair pattern to /s/+sonorant, indicating that they did not simply use analogy to perform the task.

Although the experiment demonstrated the potential efficacy of indirect positive evidence, a glance back at Figure 1 shows a striking pattern of results: those participants who successfully used the available indirect positive evidence showed near ceiling performance, while most of those who were unsuccessful showed near floor performance. Future research must strive to determine the factors that enable some participants to so easily identify errors in accented speech and recognise that these reflect some mismatch between these speakers' first language grammar and their second language, while others fail to make this connection. More generally, the potential benefits of indirect positive evidence in naturalistic learning remain to be explored, including comparisons of the developmental trajectories and time course of learners who do and do not have access to this type of evidence when learning a subset grammar.

The final conclusion to draw from the patterns of behaviour observed in the acquisition of both the well- and ill-formedness of /s/+consonant clusters is that they appear to reflect natural language grammars, supporting the position that interlanguage grammars are constrained by Universal Grammar.

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