Indirect Positive Evidence in the Acquisition of a Subset Grammar

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Indirect Positive Evidence in Acquisition

Abstract

This paper proposes that second language learners can use indirect positive evidence (IPE) to acquire a phonological grammar that is a subset of their L1 grammar. IPE is evidence from errors in the learner's L1 made by native speakers of the learner's L2. It has been assumed that subset grammars may be acquired using direct or indirect negative evidence or, in certain L1–L2 combinations, using positive evidence. The utility of IPE is tested by providing native speakers of English with indirect evidence of the phonotactic constraints holding of word-initial clusters in Brazilian Portuguese (BP), which are a subset of those in English. Participants were tested on the well-formedness of BP-like words and the results indicate that approximately one-third were able to use the IPE to make appropriate BP-like judgements. This suggests that IPE may be another source of evidence that learners can use to build a grammar that is a subset of their own L1 grammar.

1. Introduction

Research in generative grammar has traditionally assumed that only positive evidence, discovering that a structure is well formed from its presence in the ambient data, is available to first language learners (e.g., Pinker, 1984; Wexler & Culicover, 1980). More recent research has shown that, in addition to positive evidence (henceforth, direct positive evidence), negative evidence may play a role in the construction of a second language grammar. L2 acquisition has been at least moderately successful based on direct negative evidence, being explicitly told that a structure is illicit (e.g., White, 1991), as well as on indirect negative evidence, inferring that a structure is ill-formed through its absence from the ambient data (e.g., Trapman & Kager, 2009).

There is, however, another type of evidence that may be available to second language learners that has not been considered in previous literature: indirect positive evidence (IPE). IPE comes from errors that native speakers of the learner's second language make in the learner's native language. We provide an example from phonology, which is our focus in this paper. Consider a native speaker of English who is in the process of acquiring Brazilian Portuguese (BP). This individual may hear a native speaker of BP, who is in the process of acquiring English, produce English words that begin with an *s*+consonant (*s*C) cluster. If the English speaker hears the BP speaker epenthesize a vowel before the cluster, s/he may be able to conclude something about the grammar of BP, specifically, that the phonotactics of BP do not allow *s*C clusters in word-initial position. This type of evidence is indirect because the evidence for the structure of the grammar of one language is accessible through errors made in another language.[1]

This paper will investigate whether IPE is potentially efficacious for second language acquisition. To probe this question, we experimentally examine whether English speakers, who are naïve to the structure of BP, are sensitive to grammatical information about the phonotactics of the language after being exposed to IPE in the form of BP-accented English. We focus on word-initial clusters, in particular, on *s*C clusters. In contrast to other (obstruent + liquid) clusters, *s*C is illicit at the left edge of BP words. The main question to be examined is: can English speakers appropriately conclude, from exposure to BP-accented English, that *s*C is ill-formed in BP but that other left-edge clusters are well-formed in the language? To our knowledge, this is the first investigation into the potential utility of IPE in second language acquisition.

2. Evidence in acquisition

We begin by discussing the types of evidence considered to be available to language learners and the conditions under which they may be available. When learners are confronted with the task of

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[1] Randall (1987) uses the term indirect positive evidence in a different way: to refer to situations where direct positive evidence from some type of construction triggers the acquisition of a different, formally related, construction.

acquiring a language, they must construct a grammar that accounts for the evidence they have been exposed to (Archibald, 1998; Wexler & Manzini, 1987; White, 2003). In second language acquisition, this task can be aided or hindered by the L1 grammar that is already in place. Indeed, there is significant evidence that L2 learners begin constructing their L2 grammar using the transferred L1 grammar as a starting point (see, e.g., Broselow & Finer, 1991 on phonology; Schwartz & Sprouse, 1996 on syntax).

In the domain of phonotactics, a new learner may have successfully learned several words in the L2 (successful lexical acquisition) but still be pronouncing them according to the constraints of the L1 (incomplete grammatical acquisition). Consistent with the Full Transfer/Full Access model of L2 acquisition (Schwartz & Sprouse, 1996), which we assume, the learner's task is to modify the transferred phonotactic grammar to fit the new evidence, through accessing the appropriate grammatical mechanisms from Universal Grammar (UG) that interact with these phonotactic constraints.[2] However, the kinds of evidence available to learners indicating the (un)suitability of the transferred grammar will depend on the particulars of the L1 and L2 grammars and the acquisition context. In the following sections, we examine in more detail the types of evidence that learners may have access to.

2.1. Types of evidence available in learning subset and superset grammars

As mentioned above, previous research in generative approaches to language acquisition has identified three types of evidence potentially available to learners: direct positive, direct negative and indirect negative evidence. We discuss each in turn, focusing on left-edge clusters.

When considering a set of related constructions across grammars, it is often possible to organize them by relative complexity. Single consonants in word-initial position, for example, are grammatical in all languages, but only a subset of languages allow clusters. Languages also vary in the types of clusters they permit. Figure 1 illustrates this subset/superset relationship by comparing word-initial position in three languages: Mandarin, BP and English. Single consonants form the smallest subset, since all languages allow this level of complexity. This smallest subset represents the Mandarin grammar. Only BP and English allow obstruent+liquid (CL) clusters word-initially (where obstruent excludes *s*), and only English allows *s*C clusters.[3]

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[2] We remain agnostic as to the particular grammatical mechanisms that interact with phonotactic constraints to build a new grammar. The shift from one grammar to another can be formally expressed through the acquisition or suppression of rules (Chomsky & Halle, 1968; Stampe, 1969), through a change in parameter settings (Chomsky & Lasnik, 1993), or through constraints alone where grammatical changes are expressed via constraint reranking (Prince & Smolensky, 2004) or reweighting (Pater, 2009).

[3] As will be discussed in section 3, CL and *s*C clusters are standardly assumed to involve different structures. Because of this, there should be languages that permit *s*C clusters but forbid

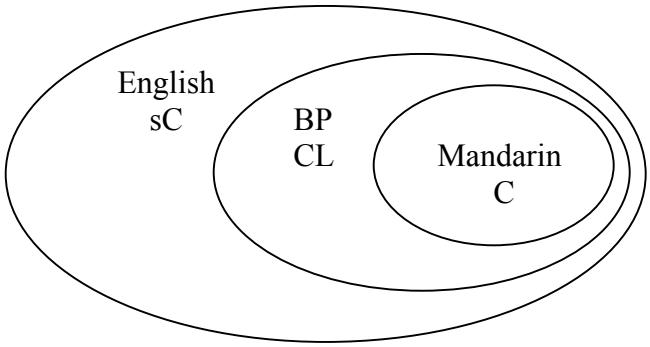

Figure 1. Subset/superset relationship for word-initial position in three languages.

2.1.1. Learning a superset grammar

Given the relationship in Figure 1, it should be easier for a learner to acquire the grammar of a language that is a superset of his or her L1. This is because direct positive evidence, any utterance or set of utterances demonstrating that some type of complexity is well formed, is always available. Thus, when a speaker of BP or Mandarin who is learning English as a second language hears words like *star* and *smell,* this constitutes direct positive evidence that English permits *s*C clusters word initially, a type of complexity permitted neither in BP nor in Mandarin.

In the phonological domain, however, one possible confounding factor is that clusters such as these may not intially be correctly perceived. Indeed, there is a growing body of literature which shows that when speakers are presented with strings containing what are phonotactically ill-formed clusters in their native language, they perceive an illusory vowel at the site where epenthesis would normally apply (see Dupoux, Parlato, Frota, Hirose & Peperkamp, 2011 on BP). Thus, although there may be positive evidence for initial *s*C clusters in the English input to which learners are exposed, input does not necessarily immediately lead to intake, so a change to the grammar may still take some time.

Learners may also potentially acquire a superset grammar using direct negative evidence, being explicitly told that an utterance is not well formed. For example, if the BP-speaking learner of English pronounced the word *star* as [istɑr] in a conversation with a native English speaker, the English speaker might inform him/her that the word is instead pronounced [stɑr].[4] Assuming

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CL. Acoma (New Mexico) is one such language (see Miller, 1965). Thus, an alternative to Figure 1 would be: [English CL [Acoma *s*C [Mandarin C]]].

[4] All forms are broadly transcribed throughout this paper and a combination of broad transcription and orthography is used when appropriate. Concerning the epenthetic vowel in BP

that the corrected form is appropriately perceived by the BP speaker, this direct negative evidence can then trigger a change in the grammar. However, this type of evidence is usually only available in classroom settings, since it is often seen as inappropriate to correct a new learner's speech in more naturalistic contexts (Lightbown & Spada, 2006).[5]

In sum, although perceptual limitations may persist for some time, when learning a superset grammar, the evidence available – direct positive evidence possibly coupled with direct negative evidence – should generally be more robust and more informative than when learning a subset grammar, which we turn to next.

2.1.2. Learning a subset grammar

When learning a subset grammar, direct positive evidence may be available in the form of morphophonemic alternations and, for some L1–L2 combinations, through loanword adaptation (see Trapman & Kager, 2009) or through a comparison of cognates. Concerning the ill-formedness of initial sC clusters, the English-speaking learner of BP may recognize that the likely source of BP *[i]stand* and *[i]snob* is English *stand* and *snob*, respectively (examples from Cardoso, 2008). Similarly, the learner may recognize that BP *[i]special* and *[i]stação* correspond to English *special* and *station*, respectively.[6] For L1–L2 pairs where evidence from loanword adaptation is not available or the two languages are not genetically-related, positive evidence showing that the L2 respects phonotactic constraints not observed in the L1 may only come in the

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in forms like [istɑr], it ranges from [i] to [ɪ] in quality (Barbosa & Albano, 2004), but we will continue to broadly transcribe it as [i].

[5] There could also be a more subtle indication of ill-formedness, such as a breakdown in communication when ungrammatical forms are used. Although this is a type of direct negative evidence, it is not necessarily reliable, because the breakdown in communication could easily be misinterpreted if the learner assumes that some other aspect of the utterance is ill-formed (see Archibald, 1998).

[6] Although we see the presence of cognates as being potentially helpful to learners of a subset grammar, an anonymous reviewer points out that this may not, in fact, be the case. If the English-speaking learner of BP hears the BP-speaking learner of English say [istɑr] for English *star*, he or she may conclude not that this reflects something about the grammar of Portuguese but, instead, that the source of the error lies elsewhere. That is, because the Portuguese cognate, *estrela*, is pronounced with an initial [i] in BP ([istréla]), the pronunciation [istɑr] for English *star* could reflect a miscoding error or lexical access problem. Although there is experimental evidence showing that word recognition in L2 benefits from cognate status (see, e.g., Midgley, Holcomb & Grainger, 2011), we are unaware of research that has examined the benefits or drawbacks of cognate status for the acquisition of syllable structure constraints. Further, as all of the stimuli we employ in our experiment are nonce words, we cannot examine this issue here.

form of alternations, contextually-determined changes in the shapes of morphemes (illustrated below). Unfortunately, however, alternations are not always available as a source of evidence. An English speaker learning Mandarin, for instance, would never have access to this sort of evidence: Mandarin does not permit clusters in surface forms (Duanmu, 2000) but, underlyingly, roots and bound morphemes do not exhibit more complexity than what is permitted in surface forms, eliminating the need for repair (see Yip, 1992).

Alternations are available for the English-speaking learner of BP. However, even when available, this sort of evidence requires a solid understanding of the structure of words which entails the segmentation of morphologically complex words into their constituent parts, the assignment of a unique underlying representation and interpretation to each morpheme, and the establishment of phonological rules (or other formal device) to govern the relation between morphologically-related forms. To carry out these steps successfully, extensive cross-form comparison is necessary.

To illustrate this, consider the BP examples in (1). The first form in each morphologically-related pair undergoes [i] epenthesis (1a), as the *s*C-initial root appears at the left edge of the word. The second form in each pair (1b) contains a prefix that surfaces as vowel-final, which enables [s] to be syllabified in the coda of the syllable containing the prefix. These data suggest that the roots begin with /sp/ and /sk/ respectively; the vowel appearing at the left edge of [isperár] and [iskawdár] is not present underlyingly but is, instead, epenthesized to enable the *s*C cluster to be syllabified in respect of the constraints of BP.

(1) a. [isperár] ‘to hope, wait’
[iskawdár] ‘to scald, burn’
b. [prosperár] ‘to flourish, be successful’
[reskawdár] ‘to overheat’

Although learners may have analyzed enough data to hypothesize that initial [i] in the forms in (1a) is epenthesized, this analysis cannot be confirmed until another has been considered and rejected, namely that [i] is present underlyingly as part of the root in forms like [isperár] and deleted in morphologically-complex forms like [prosperár], thus: /isperar/ → [isperár] and /pro-isperar/ → [prosperár]. This requires cross-form comparison of another type, namely comparing data like those in (1b) with surface forms like those in (2) where the root indisputably begins with /i/. The learner can conclude from these forms that vowels in hiatus are either tolerated (especially in careful speech) or repaired through diphthongization but, critically, not repaired through deletion and, thus, they can definitively reject the alternative analysis that the initial vowel in the forms in (1a) is underlying.

(2) [pro.ibír] ~ [projbír], *[probír] ‘to prohibit’
[re.iterár] ~ [rejterár], *[reterár] ‘to reiterate’

In sum, when learning a subset language, direct positive evidence may be available from loanword adaptation or cognates for particular L1–L2 combinations and it may be available from alternations for particular L2s. Although we speculate that data of the latter type is relatively common in the phonotactic domain, we have seen that it is likely to be difficult to interpret, especially for learners at early stages in acquisition.

In view of the fact that positive evidence is not always available or accessible when acquiring a subset grammar, learners may instead rely on indirect negative evidence to uncover the constraints of the language being learned. Indirect negative evidence is, in reality, a lack of evidence. If a learner never hears any evidence indicating that a particular structure occurs in the language being acquired, after a given amount of time and exposure to the new language, s/he may eventually conclude that the structure is ungrammatical. This may occur, for example, for *s*C-initial words in the case of English-speaking learners of Mandarin. However, even if some English speakers never reach this conclusion for Mandarin, they are not expected to make errors in production, precisely because no *s*C-initial words ever arise in Mandarin. These learners' lack of knowledge would thus go undetected, as the interlanguage grammar would be sufficient to produce Mandarin word onsets correctly. If, on the other hand, these same learners are required to judge Mandarin (pseudo)word well-formedness or to repair novel borrowings with initial *s*C in the source language, they should fail: they should incorrectly judge *s*C-initial words (which otherwise sound Mandarin-like) to be well-formed and they should fail to repair *s*C clusters in novel loanwords.

A study undertaken by Trapman & Kager (2009), however, has shown that the acquisition of a subset grammar using indirect negative evidence is possible, at least for some learners. Trapman & Kager experimentally probed Russian-speaking learners' knowledge of Dutch phonotactics, as Dutch onset clusters are a subset of those in Russian.[7] Their results revealed that learners judged ill-formed word-initial onsets in Dutch pseudowords correctly, but the behavior of the advanced participants was more Dutch-like than the beginners. This suggests that although the acquisition of a subset grammar using indirect negative evidence may be possible, it is likely to be protracted, as the point at which a learner can safely conclude that a given structure is ungrammatical depends on both time and frequency: the learner must have heard enough words spanning a range of syllable types in which an expected form could occur but does not, and enough time must have passed before the learner can safely conclude that a form will never occur and is therefore ill-formed (Saleemi, 1992).

In view of this, we conclude that indirect negative evidence is likely to be a less efficient source of information than other types of evidence available to L2 learners acquiring a subset grammar. However, in the absence of other types of evidence, namely direct positive evidence in the form of alternations, loanword adaptations and/or cognates, is there another way that learners could converge on the target grammar? In the next section, we answer this question in the affirmative. We propose that indirect positive evidence can be used in some L1–L2 settings and that this type of evidence may be available to learners at early stages of acquisition.

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[7] Mirjam Trapman informed us that the Russian participants in their study acquired Dutch through a combination of classroom-based instruction and immersion. There are no alternations in Dutch, which would reveal that illicit onset clusters are repaired.

2.2. Indirect positive evidence

As mentioned above, IPE is evidence from errors in the learner's L1 made by native speakers of the learner's L2. To illustrate this more concretely, we expand on the example provided earlier in the paper. A native speaker of English who is learning BP might engage in a conversation with a native speaker of BP who is learning English. If they conduct at least part of their conversation in English, and the BP speaker is not an advanced learner of English who has already acquired *s*C clusters in initial position, the native English speaker may notice that the BP speaker pronounces English words that begin with *s*C with an epenthetic [i] (e.g., [istɑr] for *star* and [islaj] for *sly*) which, as mentioned above, enables the *s*C cluster to be syllabified as a well-formed heterosyllabic cluster as per the grammar of BP ([is.tɑr], [is.laj]). Epenthesis is, in fact, the typical repair for *s*C clusters made by BP speakers when learning English (Cardoso, 2008). From productions like [istɑr] and [islaj], the native English speaker might correctly conclude that initial *s*C clusters are ill-formed in BP, which would account for the BP speaker's difficulty in pronouncing them in target-like fashion in English.

If IPE is indeed accessible to L2 learners, this type of evidence could provide a more direct path to learning a subset grammar than is available from indirect negative evidence or positive evidence from alternations.[8] This is because IPE takes advantage of the more complex superset grammar to immediately highlight the restrictions of the subset grammar. In addition, unlike alternations, IPE does not require any morphological knowledge of the target language and involves little or no cross-form comparison. Finally, we expect IPE to be accessible to speakers in natural contexts since speakers who are learning each other's native languages interact either for practice or convenience. Any code switching over the course of a conversation between two such speakers would provide an opportunity for whichever speaker is acquiring the subset grammar to be exposed to IPE.

3. Word-initial clusters in English and BP

In this paper, we experimentally probe the viability of IPE by examining how English speakers judge the acceptability of word-initial clusters of different profiles in BP, a language to which they have had no prior exposure. As evident from Figure 1 above, clusters in BP are a subset of those in English. This is shown more concretely in Table 1 where the profiles for each language are detailed (for BP, see Mateus & d'Andrade, 2000).

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[8] We leave aside loanword adaptation and cognates, given that they are only available in certain L1–L2 combinations.

		English	BP
CL	pl, bl	✔	✔
	pr, br	✔	✔
	tr, dr	✔	✔
	kl, gl	✔	✔
	kr, gr	✔	✔
	fl	✔	✔
	fr	✔	✔
	θr	✔	
*s*C	sp, st, sk	✔	
	sm, sn	✔	
	sl	✔	
	ʃr	✔	

Table 1. Word-initial clusters in English and BP.

Table 1 shows that both languages allow CL clusters of the shape stop+liquid and fricative+liquid. However, the two languages differ in the well-formedness of *s*C clusters: English permits *s*C word initially, where the second consonant can be a stop, nasal, lateral or rhotic (note that English [ʃr] is typically analyzed as derived from /sr/ (Clements & Keyser, 1983; Goldsmith, 1990)); in BP, by contrast, *s*C clusters in this position are altogether absent.

This cross-language difference is rooted in the observation that CL and *s*C clusters abide by different constraints which, in turn, suggests that they have different representations. CL clusters, by definition, rise in sonority and the two members of the cluster cannot share place (**tl, *dl*).[9] They are standardly assumed to form branching onsets, as shown in (3a). *s*C clusters, by contrast, do not respect either of these constraints. Although some languages, like English, permit *s*C clusters to rise in sonority, the optimal *s*C cluster, *s*+stop, has a sonority plateau and some languages allow *s*C clusters only of this shape, which we return to below. Considering place constraints, clusters such as *st, sn* and *sl* are well-formed in English and many other languages, even though they share place. Observations about sonority and place such as these suggest that *s*C clusters do not form branching onsets. Instead, *s* is outside the onset constituent that organizes the following consonant, as shown in (3b). Several alternatives for *s*C clusters have been proposed in the literature: *s* has been analyzed as an appendix or as extraprosodic (i.e., as not organized into syllable structure); as a segment that is linked directly to some higher prosodic constituent (usually the syllable node or prosodic word); or as the coda of a syllable with an

[9] Note that C*r* clusters never respect place identity constraints: thus, *tr, dr* are well-formed in languages with coronal *r*, like English and BP.

empty nuclear head (see Goad, 2011 for a review). All of these analyses minimally assume the representation in (3b). Exactly which analysis holds for us is of little consequence, as long as *s* is outside the onset constituent that contains the following consonant, as it is in (3b).

(3) a. CL cluster:

b. *s*C cluster:

As discussed in section 2.1.2, BP has many roots that underlyingly begin with *s*C clusters, but it does not allow such clusters to surface intact in word-initial position. Recall that in this position, the cluster is repaired through [i] epenthesis, a process seen in both native words (/sperar/ → [isperar] 'to hope, wait') and borrowings (English *stand* → BP *[i]stand*). These data show that the offending *s*C clusters are repaired via *prothesis:* the epenthetic vowel falls before the cluster. This is only possible in languages that permit coda *s*, like BP, as the *s*C cluster that results is syllabified as coda+onset, e.g. [is.pɛrar]. In languages without coda *s*, such as Japanese, a different pattern of repair is observed: *anaptyxis,* where the epenthetic vowel interrupts the cluster, e.g. [suki:] 'ski', [suma:to] 'smart'. There are languages that fall between these two extremes as well, as shown in Figure 2 (adapted from Fleischhacker, 2002).

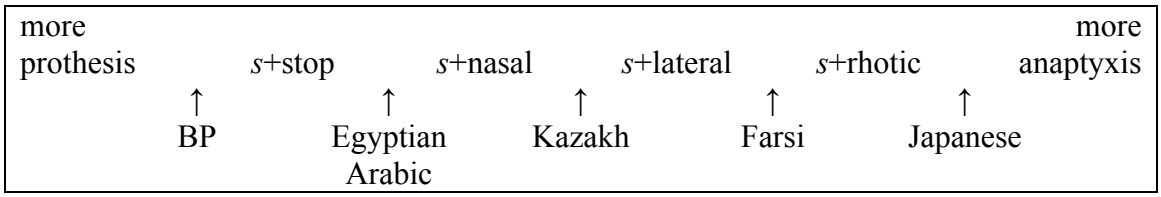

Figure 2. Prothesis and anaptyxis.

Figure 2 shows that more anaptyxis is observed when the *s*C cluster that would result from prothesis has an increasingly steeper rise in sonority, which is cross-linguistically marked for a coda+onset cluster. That is, a string like [əs.rV] is worse than [əs.lV] which is, in turn, worse than [əs.nV] (where [ə] represents an epenthetic vowel) (see Goad, 2011).

The role that sonority plays in determining where languages draw the line between prothesis or anaptyxis is mirrored in the patterns observed for word-initial *s*C clusters across languages: Table 2 shows that, as the consonant following *s* increases in sonority, the cluster worsens (adapted from Goad, 2012, to appear).

	BP	French	Romansch	Dutch	English
s+stop	*	✓	✓	✓	✓
s+nasal	*	*	✓	✓	✓
s+lateral	*	*	*	✓	✓
s+rhotic	*	*	*	*	✓

Table 2. Word-initial *s*C clusters across languages.

Among languages that permit word-initial *s*C clusters, no language forbids *s*+stop; French restricts *s*C to precisely this profile. Romansch is more permissive in additionally allowing *s*+nasal. Dutch is even more permissive in that *s*+lateral is well-formed. And English is the most permissive, assuming that [ʃr] in English is derived from /sr/, as mentioned above.

Clearly, the French, Romansch and Dutch patterns represent grammars that are intermediate in complexity between the least marked (most restrictive) BP and the most marked English. Assuming that the implicational hierarchy shown in Table 2 is formally expressed through a set of constraints or parameters available in UG, we would expect listeners who are exposed only to evidence that *s*+stop is ill-formed in a language like BP to appropriately conclude that *s*+sonorant is also ill-formed. This, as well as other predictions that stem directly from the typological options and representations outlined in this section, is addressed immediately below.

4. Predictions

We have proposed that IPE may be available to learners as one source of evidence when acquiring a language that is a subset of the native language grammar. In real-world language learning situations, direct positive evidence may also be available, in the form of morphophonemic alternations (and possibly loanword adaptations and/or cognates), or learners may additionally rely on indirect negative evidence to infer aspects of the grammar of the language being learned. As mentioned earlier, however, we hypothesize not only that IPE is a source of evidence that learners may tap into, but conjecture that it may be a particularly efficient way to discover the grammar of a second language, in comparison to the available alternatives.

The experiment undertaken in this paper explores whether learners could plausibly build an interlanguage grammar that is a subset of the grammar of their L1 using only IPE and with only minimal exposure to the second language. The particular question to be probed is: will English speakers make BP-like judgements on syllable structure well-formedness after being exposed to BP-accented English in a semi-naturalistic setting?

The predictions to be tested are as follows, each of which will be expanded on below:

(4) Predictions:
1: Participants will use IPE to determine that word-initial *s*C clusters are ill-formed in BP.
2: Participants will repair *s*C clusters in BP-like words using epenthesis, not deletion or metathesis; the epenthesis pattern will involve prothesis, not anaptyxis.
3: Participants who only receive evidence that *s*+stop clusters are ill-formed in BP will conclude that *s*+sonorant is ill-formed as well.

4: Participants will not overgeneralize the repair pattern they employ for word-initial *s*C clusters to CL clusters in this position.
5: Participants will not overgeneralize the repair pattern employed for word-initial *s*C clusters to words without clusters in this position.

Prediction 1, that participants can rely on IPE to infer that initial *s*C clusters are ill-formed in BP, is concerned with the acquisition of a *constraint* against clusters of this profile. We surmise that IPE is an efficient source of evidence in certain L1–L2 contexts, namely in superset/subset contexts where native speakers/learners of the two languages converse at least part of the time in the superset language. Because IPE takes advantage of the more complex superset grammar to directly draw attention to the restrictions of the subset grammar, we expect that in the mock-naturalistic setting of our experiment, participants will be able to make BP-like judgements after only a few minutes of hearing BP-accented English.

Prediction 2 concerns the *repair* used to satisfy the constraint against *s*C. Recall that BP repairs *s*C clusters through prothesis, so we predict that learners will do the same (e.g. [skesu] → [iskesu], one of the novel words used in our task). An alternative scenario, however, is that some learners recognize that word-initial *s*C is ill-formed, but fail to internalize the repair. There are three other ways that such learners could repair the illicit *s*C cluster: anaptyxis ([sikesu]), deletion ([kesu] or [sesu]) or metathesis ([seksu]). The latter patterns, if pervasive, would show only limited use of IPE by participants.[10]

Prediction 3 concerns *generalization* of the prothesis pattern beyond the data to which learners were exposed. We observed in section 3 that all languages with *s*+sonorant clusters additionally contain *s*+stop but that the inverse does not hold. The prediction is thus that speakers who are exposed to the ill-formedness of *s*+stop will additionally conclude that *s*+sonorant is ill-formed. This prediction goes beyond merely testing whether participants can use IPE; if supported, it would show that participants are forming appropriate generalizations about the patterns they have been exposed to, rather than making judgements through analogy.

Predictions 4 and 5 concern *overgeneralization*. Prediction 4 states that learners should not overgeneralize the repair they apply to initial *s*C clusters to CL clusters in the same position. Overgeneralization to CL should be ruled out on two grounds. First, the data to which learners are exposed reveal that CL clusters are well-formed in BP. However, it is conceivable that the lack of epenthesis for CL clusters may go undetected by participants, as constructions that are not

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[10] Predictions regarding the preferred pattern of repair for *s*C clusters cannot be made solely on markedness grounds. Although deletion is the most common repair in L1 acquisition (e.g., Fikkert, 1994), epenthesis is much more common in both L2 acquisition and loanword adaptation (Weinberger, 1994; Paradis & LaCharité, 1997). Concerning types of epenthesis, no preference for prothesis or anaptyxis can be established unless the sonority of the consonant following *s* is taken into consideration (see section 3).

repaired may not be noticed. If this were the case, we would still not expect overgeneralization to apply to CL on grounds that *s*C and CL clusters respect different constraints, motivating different representations for each, as was shown earlier in (3). In short, learners should not conclude that any behavior that holds for one type of left-edge cluster should hold for the other.

Finally, Prediction 5 states that learners should not overgeneralize the repair they apply to *s*C-initial words to words that begin with singleton consonants, including *s* (i.e., [skesu] → [iskesu] but [somi] → *[isomi]). Behavior of this type would indicate the use of IPE, but inappropriate extension of the pattern to yield a grammar that is not BP-like, which forbids only *s*C, to a grammar where singleton consonants are prohibited from appearing in initial position, even though they are licit in other positions in the word.

We turn now to provide details on how each of these predictions was tested.

5. Methodology

5.1. Languages

Brazilian Portuguese and English are the subset and superset languages examined in this study. This language pair was selected for two reasons. One, the number of Brazilian immigrants in Canada, where the study took place, is relatively small. Thus, a BP accent should not be immediately recognizable. Two, English has minimal pairs like [stejt] 'state' – [əstejt] 'estate' and [sli:p] 'sleep' – [əsli:p] 'asleep', where the initial vowel in the latter form in each pair may range in quality from [ə] to [ɨ] to [ɪ] (Ladefoged & Johnson, 2010), falling within or near the range described for prothetic vowels in BP, [ɪ] to [i] (Barbosa & Albano, 2004). Thus, English speakers should be sensitive to the presence or absence of the prothetic vowel in the BP data to which they are exposed, which ensures (to the extent possible) that, should participants not be able to use the available IPE, this is not due to the inability to perceive the vowel.

Prothesis is also used in Spanish, a language with the same constraints on onset types as BP, although the quality of the epenthetic vowel is different: in Spanish, it is [e] (e.g., Hualde, 2005). Spanish was not used as the subset language in this study, however, because Spanish-accented English would likely be recognized by many participants and because pre-*s*C epenthesis in Spanish is highly stereotyped in American media, which Canadians are commonly exposed to. We wanted to ensure that participants responded to the IPE, not to some preconceived notion of what Spanish 'should' sound like.

Although the selection of BP as the subset language largely avoids these problems, given the similarities between Latin American dialects of Spanish and BP, we must address the possibility that knowledge of Spanish could still influence participants' results. We strived to deal with this concern as follows. First, in addition to the different quality of the epenthetic vowel in the two languages, several other factors (e.g., vowel nasalization, lenition patterns for coda consonants) make BP-accented English sufficiently different from Spanish-accented English. Second, participants were told that the native language of the speakers in the dialogue (henceforth 'dialogue speakers') that they would be listening to was Samoan. This was done to minimize any potential bias if the participants identified the accent as Spanish. Third, selection of participants minimized exposure to Spanish, as will be addressed in section 5.2. Finally, after participants completed the study, they were asked what they thought the native language of the dialogue speakers was, given their accent (once they had been informed that the language was not

Samoan). These answers were compared with their performance on the experimental task, as will be discussed further in section 6.7.

5.2. Participants

Participants in the study were 32 native speakers of Canadian English, aged 19-33. According to self-report, participants had no knowledge of Portuguese, Spanish or any other language whose grammar makes similar repairs to word-initial clusters. Participants could not have lived in the United States for an extended period of time, due to the more common exposure to Spanish and Spanish-accented English in the US. Finally, participants had no higher than low intermediate proficiency in any other second or third language. Most had attained beginner or low intermediate proficiency in French (which does not make Portuguese-like repairs; see further note 16).

As there were two versions of the training component in the experiment, participants were divided into two learning conditions: 16 were assigned to the Sonorant condition and 16 to the NoSonorant condition (see section 5.4.1 for details). Males and females were equally divided between the two conditions. The average age for participants in the Sonorant condition was 24 and in the NoSonorant condition 26. Each condition contained 12 participants with some proficiency in French. The 11 participants who had some proficiency in a language other than French were split 6:5 between the two conditions (Sonorant:NoSonorant). The highest level of education completed or in progress for all but five participants was university. Of the remaining five, three had completed secondary school (two in the NoSonorant condition; one in the Sonorant condition) and two had completed college or professional training (one in each condition). See Appendix 1 for further details.

Participants were recruited through classified advertisement websites and personal contacts and were compensated for their time.

5.3. Procedure

The experiment proceeded as follows. After giving their informed consent, participants completed a background questionnaire, which elicited information about their exposure to other languages as well as demographic information.

The second step involved training. Participants listened (over headphones) to a seven minute dialogue between two native speakers of BP (one male, one female) speaking BP-accented English.[11] Immediately prior to hearing the dialogues, the participants were told that the native

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[11] A more naturalistic experience would have involved an exchange in English between one native BP speaker and one native English speaker. The number of tokens of [i] epenthesis would then be cut in half. We piloted a version of this experiment on six subjects but found that only

language of the two speakers was Samoan. All *s*C clusters in the dialogues appeared with prothetic [i]. Epenthesis was limited to this context. Both dialogue speakers were phonologists who were highly proficient in English. They were instructed not to produce any other BP-specific syllable structures (e.g., epenthesis after certain codas), to the extent possible. This was to ensure that the participants were only exposed to one type of syllable repair, given that our goal in this experiment was to test whether IPE is both accessible and interpretable given limited exposure to the language.

The third step involved testing. Participants performed a production task where they were shown a novel word (displayed orthographically on a computer screen), and were asked to produce it with the same accent they had heard in the dialogue. Recording was initiated by the participant and the response times were calculated for each word by taking the time from when the word was first displayed to when the participant began recording his or her response. Stimuli were presented orthographically rather than auditorily as the latter would have required that we present BP-accented *s*C-initial words without prothesis, which could have negatively impacted participants' understanding of the constraint and repair operating in the dialogue speakers' L1 grammar. Participants were cautioned that orthography was not always a reliable indication of pronunciation. This was intended to prompt them to focus on the pronunciations they remembered from the dialogue and to minimize any bias that orthography might present, particularly since the epenthetic vowel was not, of course, orthographically represented.

Finally, after telling the participants that the native language of the dialogue speakers was not actually Samoan, the experimenter asked the participants questions to probe their ideas on what the native language of the dialogue speakers could be, given the accent they had heard.

The experiment was designed in the Python programming language using the Pygame module (Pygame, 2009). Testing was carried out on a Macintosh iPad Air laptop in laboratory space at McGill University and the University of Toronto. Auditory stimuli were presented through a Logitech USB headset. Oral responses were recorded with the headset microphone and sampled at 44,100 Hz using Sound eXchange (SoX) software. Mouse click responses, oral responses and reaction times were all recorded by the testing program.

Preliminary analysis and coding were done automatically. Coding was refined and checked by the authors. Oral productions were phonetically transcribed and coded by trained linguists; all transcriptions and coding were verified by at least one other trained linguist.

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one was able to use the IPE to determine that *s*C-initial clusters are ill-formed in BP. A longer dialogue should resolve this problem, something we have planned for future work.

5.4. Stimuli
5.4.1. Dialogues

Two dialogues were created. Both have 24 *s*C-initial lexical types, all of which displayed epenthesis. Each lexical type was produced once by each dialogue speaker, for a total of 48 tokens; see Table 3. Dialogue 1 contains only *s*+stop clusters (48 tokens); Dialogue 2 contains *s*+stop and *s*+sonorant clusters (24 tokens each). The place and manner of articulation of the second member of the cluster was controlled so that there was an equal number of [sp, st, sk] tokens for Dialogue 1 and an equal number of [sp, st, sk, sm, sn, sl] tokens for Dialogue 2.[12] Half of the participants listened to Dialogue 1 and half to Dialogue 2, in order to address Prediction 3. Henceforth, these will be referred to as the NoSonorant and Sonorant conditions respectively.[13]

Dialogue 1 (NoSonorant condition)			Dialogue 2 (Sonorant condition)		
s+stop (48 tokens)			*s*+stop (24 tokens)		
s+labial	*s*+coronal	*s*+dorsal	*s*+labial	*s*+coronal	*s*+dorsal
spaghetti	stamps	scale	spaghetti	start	scarf/(ves)
spam	stand	scams	spare	stay	scary
spare	stay(ed)	scarf/(ves)	spark-plug	stop	scotch
spark-plug	start	scary	special	still	skills
speak(ing)	stick(s)	school	*s*+sonorant (24 tokens)		
special	still	scotch	*s*+labial nasal	*s*+coronal nasal	*s*+lateral
spiky	stop	skeptical	smell	snails	slam(med)
sports	stuff	skills	smooth	snap(ping)	sleeping
			smoked	snobby	slow(er)
			small	snow	slugs

Table 3. Lexical types for *s*C-initial stimuli.

[12] Due to an oversight, there was one extra instance of an [st] token and one fewer instance of an [sm] token in Dialogue 2. This did not appear to have any impact on the results.

[13] The design of the experiment was deliberately asymmetric, in respect of the typological options shown earlier in Table 2. If learners were only exposed to the ill-formedness of *s*+sonorant, they could generalize and conclude that *s*+stop is also ill-formed, or not. In either case, their behavior would be consistent with a well-formed grammar. In our experiment, failure to generalize would result in behavior that is inconsistent with a well-formed grammar: there are no languages where *s*+sonorant is well-formed to the exclusion of *s*+stop.

The length of the epenthetic vowel ranged from 45-55 ms for both speakers. This range was decided upon through examining naturalistic tokens produced by a female native speaker of BP who spoke English at an intermediate level of proficiency; she was naïve to the goals of the experiment and was not a linguist. Most of the dialogue speakers' epenthetic vowels fell within this same range of 45-55 ms; approximately five tokens per dialogue required shortening or lengthening. Manipulations were done by either removing or reduplicating a time slice of appropriate length at the mid point of the vowel, using Praat (Boersma & Weenink, 2013). This range is consistent with Rebollo et al. (2003) who observed that in experimentally-collected data on BP, the mean duration of unstressed [i] in pretonic position was 47 ms.

In both dialogues, all *s*C tokens occurred utterance-initially, at the beginning of an intonational phrase, or following a consonant-final word, all of which ensured that [s] could not be resyllabified in coda, which could have eliminated the need for epenthesis. To the extent possible, *s*C-initial targets occurred at approximately the same locations in both dialogues, including their first appearance.

To address Prediction 4, each dialogue had the same number of CL-initial words (30 each). As CL-initial words are well-formed in BP, they did not appear with epenthesis. A diverse range of CL clusters (for place, manner, voicing) was included; these factors were not perfectly controlled, nor was type/token ratio, as we did not expect either to have any effect on the results.

To address Prediction 5, each dialogue had approximately the same number of C-initial words of various profiles: *s*-initial tokens, other fricative-initial tokens, sonorant-initial tokens and stop-initial tokens. For the latter three profiles, a range of consonants (place, manner, voicing) was included, although these factors were not perfectly controlled, nor was type/token ratio as, again, we did not expect these to influence the results.

Finally, frequency of word types was not controlled. This was not possible in order to keep the dialogues as natural sounding as possible given other constraints discussed in this section (but see further section 7.2.2).

Complete dialogues are provided in Appendix 2.

5.4.2. Production task

The same words were produced by all participants, regardless of which dialogue they were exposed to in training. A total of 120 words were presented to participants, in pseudo-random order. Of these, 54 were critical words, which began with clusters, and 66 were fillers, which began with singleton consonants. Critical words were divided into two broad categories: there were 36 with an initial *s*C profile, divided equally into *s*+stop and *s*+sonorant, and 18 with an initial CL profile. Place and manner of articulation were controlled, as shown in Table 4. (As the place of articulation of *s*C-initial words and the segmental profile of CL clusters did not impact the results, they will not be discussed further.)

Category	Sub-category	Items and numbers	
*s*C	*s*+stop	[sp]	(6)
		[st]	(6)
		[sk]	(6)
	s+sonorant	[sm]	(6)
		[sn]	(6)
		[sl]	(6)
CL		[p/b]+[l/r]	(6)
		[t/d]+[r]	(6)
		[k/g]+[l/r]	(6)

Table 4. Initial profile of critical words.

The 66 fillers were of four types: 6 *s*-initial, 8 other fricative-initial, 14 sonorant-initial and 38 stop-initial.[14] See Appendix 3 for a complete list of stimuli.

6. Results

The data collected from the production task were first checked for reaction time. Answers with response times that were greater than 3 standard deviations from the mean were thrown out. Mean and standard deviation were calculated separately for each participant. No single participant had more than three answers that were removed in this way. Additional data were discarded as follows: (i) the responses for one [sp]-initial word failed to be recorded by the testing software, reducing the number of items of this shape to five for all participants; (ii) some responses had the beginning of the audio recording cut off, making the nature of the repair impossible to determine; and (iii) some responses were difficult to classify due to false starts, microphone interference, etc. For the reasons identified in (i) to (iii), 1.6% of total responses were discarded, with at most four responses (3.3%) being discarded for any individual participant; for *s*C-initial words, at most two responses (1.6%) were discarded for any individual. The remaining data were examined with a view to addressing the predictions in section 4.

[14] In view of many participants' treatment of *s*-initial words (see section 6.5), it would have been optimal to have included more stimuli of this shape to produce. In designing the experiment, we were reluctant to include more *s*-initial words, given the need to include many *s*+sonorant and *s*+stop words (i.e., the task already included 42 words that began with *s*, in singletons and clusters).

6.1. Prediction 1

Recall from section 4 that Prediction 1 states that participants will be able to use IPE to infer that word-initial *s*C clusters are ill-formed in BP. To test whether this prediction is supported, we examine participants' responses to all *s*C-initial words in the production task. Figure 3 plots the results (data from the NoSonorant and Sonorant conditions are collapsed here as they will be addressed separately in section 6.3). 'Repair' indicates that participants correctly judged *s*C-initial words to be ill-formed; that is, when presented with forms such as *skesu* and *smoti*, they fixed them to eliminate the cluster. In this figure, Repair collapses all possible solutions to the problem – prothesis, anaptyxis, deletion and metathesis – and thereby only reveals whether or not participants understand that there is a constraint against *s*C-initial words in BP.

A glance at Figure 3 suggests that participants fall into two groups. Those toward the left end of the figure robustly repaired *s*C clusters, while those toward the right end failed to do so. To determine if this was indeed the case and, if so, where the division lies between the two groups, we used a binomial test, which established whether the performance of each participant was significantly different from chance. As responses are of two types (Repair and NoRepair), the probability of repair for a single trial was considered to be 0.5. The binomial test revealed that the behavior of the 11 participants toward the left end of the figure (19-29), who repaired sC clusters 79%-100% of the time, is significantly higher than chance (cumulative probability ($x \leq$ number of successes): ps ≤ 0.001). We will henceforth refer to this group as the 'learners'. The behavior of the 19 participants toward the right end of the figure (22-32), who repaired sC clusters from 0%-24% of the time, is significantly lower than chance (cumulative probability ($x \geq$ number of successes): ps ≤ 0.002). These participants show little or no evidence of being able to use the IPE available (i.e., they accepted *s*C-initial words as well-formed in the dialogue speakers' L1 grammar) and we will thus refer to this group as the 'non-learners'. The behavior of the two remaining participants in the middle of the figure was either not significantly higher than chance (participant 24: $p = 0.061$), nor significantly lower than chance (participant 10: $p = 0.088$). We will henceforth refer to this group as 'chance responders'. In short, from the statistical analysis, we can conclude that Prediction 1 is supported, but only for a subset of participants, the 11 learners.

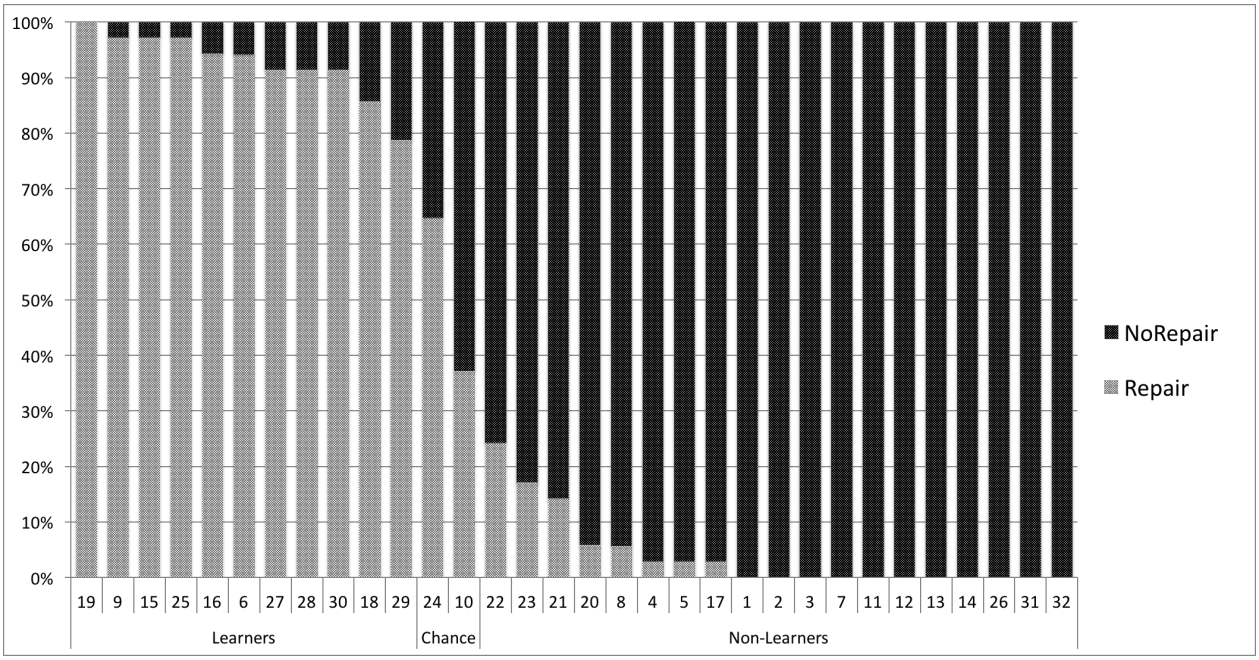

Figure 3. Responses to all *s*C-initial words.

From the demographic information that was collected, the difference in behavior between the learners and non-learners could not be definitively explained.[15] All of the 11 learners were university-educated, but most of the chance responders and non-learners (16 out of 21) were as well. The only other factor that stood out was gender. Of the 32 participants, 8 were male and 24 female. Only 1 of the 8 males was able to effectively use the IPE available, falling into the learner group, while 10 of the 24 females fell into this group. As this difference likely stems from the small number of male participants in the study, we will not discuss it further.

6.2. Prediction 2

Prediction 2 states that participants will repair *s*C clusters using epenthesis, not deletion or metathesis, and that the type of epenthesis will involve prothesis, not anaptyxis. Figure 4 shows that the learners overwhelmingly use prothesis, in support of Prediction 2.

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[15] As will be seen in section 6.7, it could also not be definitively explained by examining the relationship between the performance of individual participants and their views on what the native language of the dialogue speakers was.

In the vast majority of cases, the quality of the prothetic vowel in the learners' productions was [i] or [ɪ], consistent with the data to which participants were exposed in the dialogue speakers' productions. Ten of the 11 learners did, however, produce some instances of a more Spanish-like vowel: eight produced one instance of prothetic [e] or [ɛ], one produced two instances, and one produced three instances. This represents on average only 3.7% of the *s*C-initial forms that the learners repaired through prothesis; thus, although prothesis in Spanish is highly stereotyped in American media, this suggests that it had little effect on the behavior of the participants in our study.

Turning to the non-learners, although the rate of repair is low, there is more variation in the types of repairs they employ; however, once the number of repairs approaches 15-20% (participants 21, 23, 22), prothesis is preferred, consistent with Prediction 2. The surprisingly high proportion of repairs involving anaptyxis for participant 10 in the group of chance responders will be discussed in section 6.3.

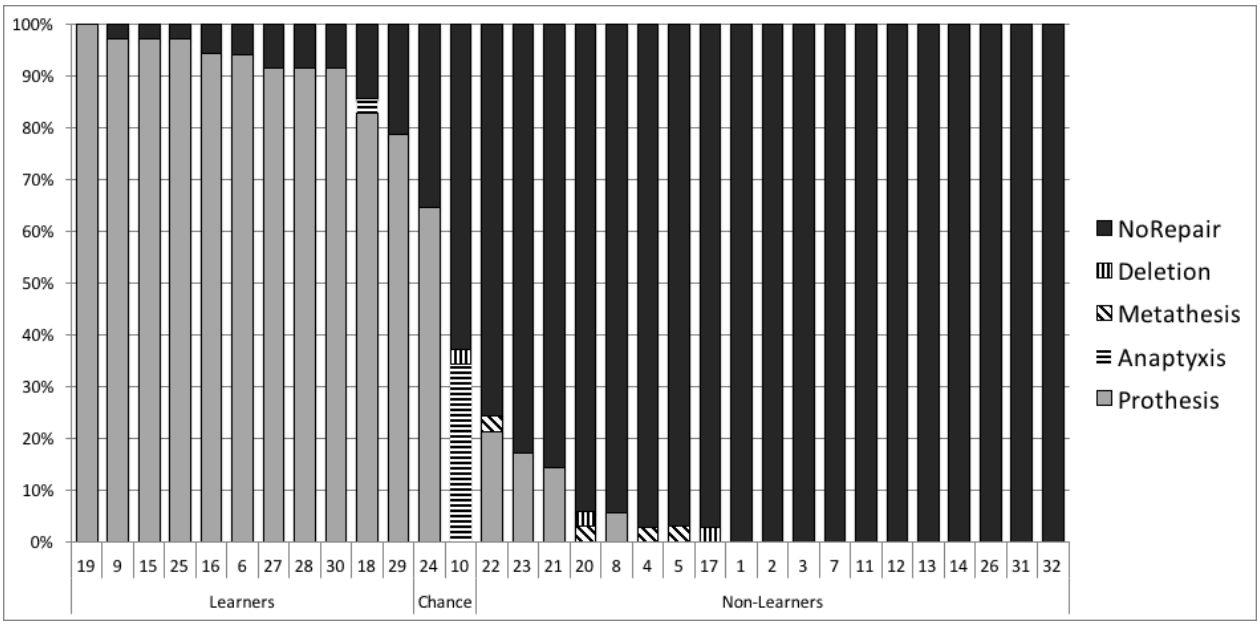

Figure 4. Repairs applied to *s*C-initial words.

6.3. Prediction 3

Prediction 3 concerns the well-formedness of sub-types of *s*C clusters. Recall from section 3 that all languages that permit *s*C contain *s*+stop and that when comparisons are made across languages, the well-formedness of the cluster gets worse as the sonority of C rises. Following from this, Prediction 3 states that participants who only receive evidence that *s*+stop clusters are ill-formed in BP will appropriately conclude that *s*+sonorant is ill-formed as well.

To test this prediction, participants were assigned to two conditions in the experiment. Half of them (participants 1, 2, 5, 7, 11, 12, 14, 16, 17, 20, 22, 24, 29, 30, 31, 32) were assigned to the Sonorant condition: they received evidence for the illicit status of *s*C from both *s*+stop and

s+sonorant. The other half (participants 3, 4, 6, 8, 9, 10, 13, 15, 18, 19, 21, 23, 25, 26, 27, 28) were assigned to the NoSonorant condition: they received evidence for the illicit status of initial *s*C clusters only from *s*+stop. The results of the latter group bear on Prediction 3.

Of the 16 participants in the NoSonorant condition, seven (3, 4, 8, 13, 21, 23, 26) were non-learners: they performed in an English-like manner, failing to repair *s*C clusters in initial position (see Figure 4). They also treated *s*+stop and *s*+sonorant in the same manner: they accepted *s*+stop as well-formed on average 91.9% of the time and *s*+sonorant, 97.2% of the time.

An additional participant (10), who was categorized as a chance responder in Figure 4, incorrectly accepted *s*+stop as well-formed at a high rate, 94.1% of the time, like the non-learners. However, she repaired *s*+sonorant 66.7% of the time, approaching the performance of the learners. Although a binomial test reveals that her behavior on *s*+sonorant is not significantly higher than chance ($p = 0.119$), her behavior on *s*+stop is significantly lower than chance ($p < 0.001$); the disparate treatment of the two types of *s*C clusters thus bears some resemblance to the grammar of French where, among *s*C clusters, only *s*+stop is permitted (see Table 2). Another unusual aspect of this participant's performance is the pattern of repair she employs for *s*+sonorant, anaptyxis (see Figure 4), which is not the repair that operates in BP. Anaptyxis is, though, selected by other languages, for example Japanese, as discussed in section 3.[16]

Most important for Prediction 3 are the results of the eight remaining participants in the NoSonorant condition, the learners (6, 9, 15, 18, 19, 25, 27, 28). Figure 5 shows that all eight correctly generalized the pattern they learned regarding the ill-formedness of initial *s*+stop (sT) to *s*+sonorant (sR). On average, they repaired *s*+sonorant through prothesis 95.0% of the time, similar to the amount of time they repaired *s*+stop, 92.7% of the time. A paired t-test for these 8 learners reveals that their treatment of the two types of clusters is not significantly different ($t = 1.8825$, $df = 7$, $p = 0.1018$). This supports Prediction 3, for the subset of participants who were able to use the IPE available.

[16] In French, there are no alternations indicating what type of repair would be chosen for *s*+sonorant words. There are, though, a number of *s*+sonorant words that have been borrowed from English, e.g. *snob*, *smoking*. These are not normally described as undergoing repair, although our informal observation of some speakers suggests that acoustic analysis may reveal an excrescent schwa between *s* and the following sonorant (i.e., anaptyxis).

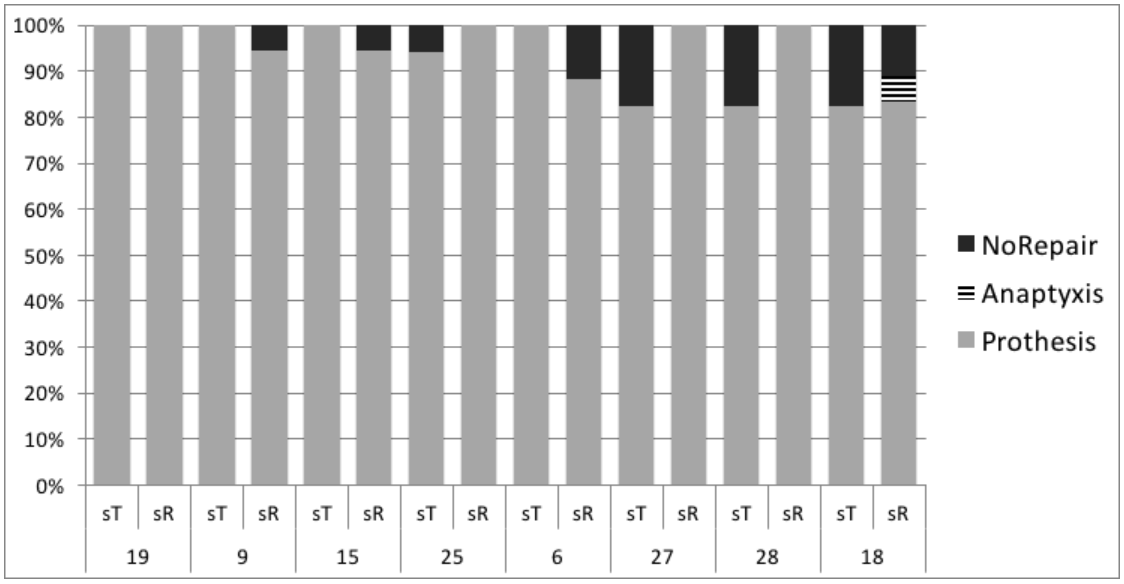

Figure 5. Responses for the learners: NoSonorant condition.

6.4. Prediction 4

Prediction 4 states that participants will not overgeneralize the repair pattern employed for word-initial *s*C clusters to CL clusters in this position. This prediction is based on two observations. One, as discussed in section 3, the constraints that hold of *s*C and CL clusters across languages are different, suggesting that they have different representations, as shown earlier in (3). Two, there is plenty of evidence in the dialogues that CL clusters are well-formed in BP-accented English and thus in BP.

The prediction that CL clusters will not be repaired is overwhelmingly supported, as shown in Figure 6. This is particularly important to show for the learners, given that they robustly epenthesize before *s*C clusters.[17]

[17] Participant 10, one of the chance responders, stands out in repairing CL clusters relatively frequently (27.8% of the time), through anaptyxis and metathesis, although we have no explanation as to why. Note that, unike her treatment of *s*C-initial words, her treatment of CL-initial words does not resemble the grammar of French.

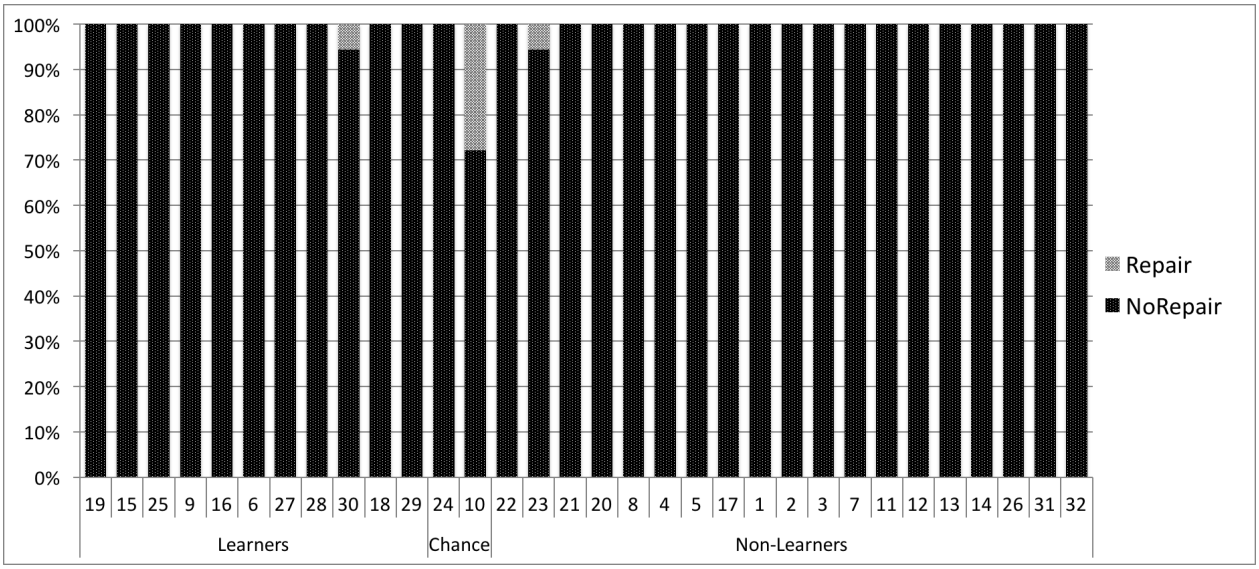

Figure 6. Responses to CL-initial words.

6.5. Prediction 5

Prediction 5 states that participants will not overgeneralize the repair pattern employed for word-initial *s*C clusters to words without clusters in this position. Recall from section 5.4.2 that 66 of the words that participants were asked to produce began with singletons of a variety of profiles. Of the 60 that began with stops, non-sibilant fricatives and sonorants, participants overwhelmingly produced these without repair; that is, they judged these words to be well-formed, as appropriate (99.9% of stop-initial, 100% of fricative-initial, 100% of sonorant-initial). From this perspective, then, Prediction 5 is supported. The landscape changes dramatically, however, when we consider *s*-initial words. The vast majority of participants who repaired *s*C-initial words overgeneralized the repair pattern(s) they employed to *s*-initial words, as shown in Figures 7 and 8.

We first address the behavior of the 19 participants (22 through 32) who, from Figure 3, showed little or no ability to use IPE (the non-learners). Figure 7 shows that, as these participants do not repair *s*C-initial words, not surprisingly, they also do not repair *s*-initial words. Participants 22, 23 and 21 show some evidence of moving toward the BP grammar: they repair on average 18.5% of *s*C-initial words and do not overgeneralize this pattern to *s*-initial words.

However, a binomial test reveals that repair to both types of words is significantly well below chance ($p \leq 0.002$).[18]

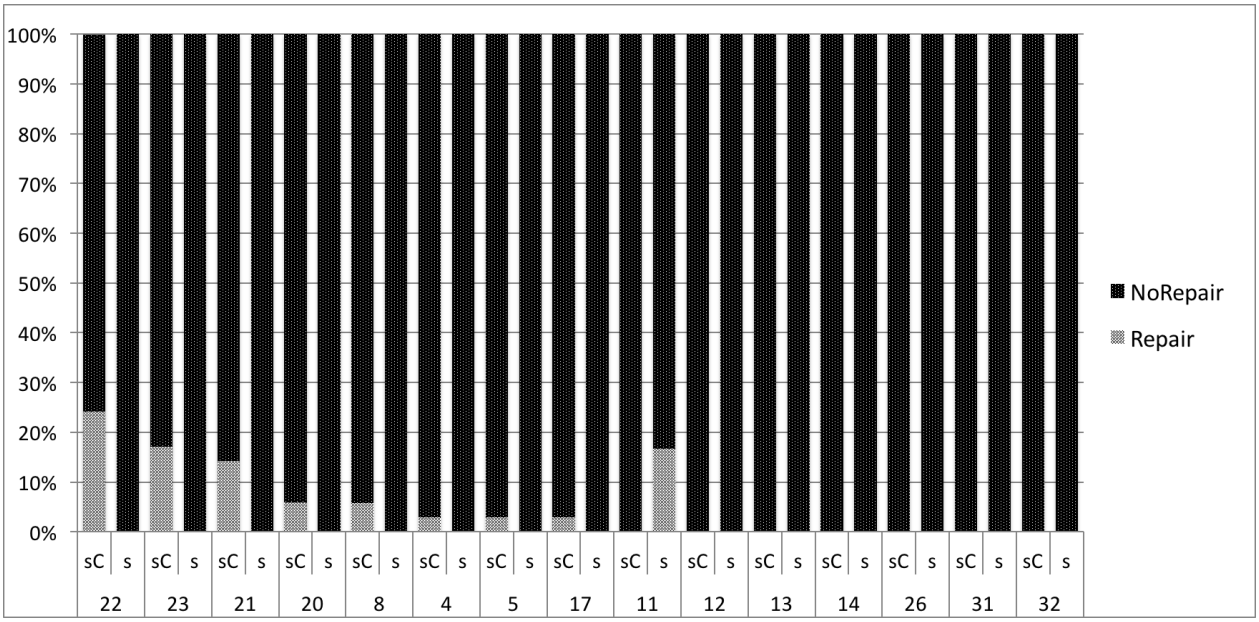

Figure 7. Responses to all *s*C-initial and *s*-initial words: non-learners.

We consider now the remaining 13 participants: the 11 learners who successfully use the IPE available and the two chance responders. The ten learners toward the left end of Figure 8 (19 through 18) incorrectly overgeneralize the repair they apply to *s*C-initial words to *s*-initial words as well, inconsistent with Prediction 5. Two of these participants (16, 30) do show less extensive overgeneralization than the others: they repair *s*C-initial words on average 92.9% of the time and fail to repair *s*-initial words 33.3% of the time. However, a binomial test reveals that these participants are no different from the other eight: all ten repair both *s*- and *s*C-initial words significantly more often than chance (ps < 0.001).

[18] Given the low number of *s*-initial words (n=6), all statistics for words of this shape were calculated on percentages. (All other statistics were calculated on raw numbers.)

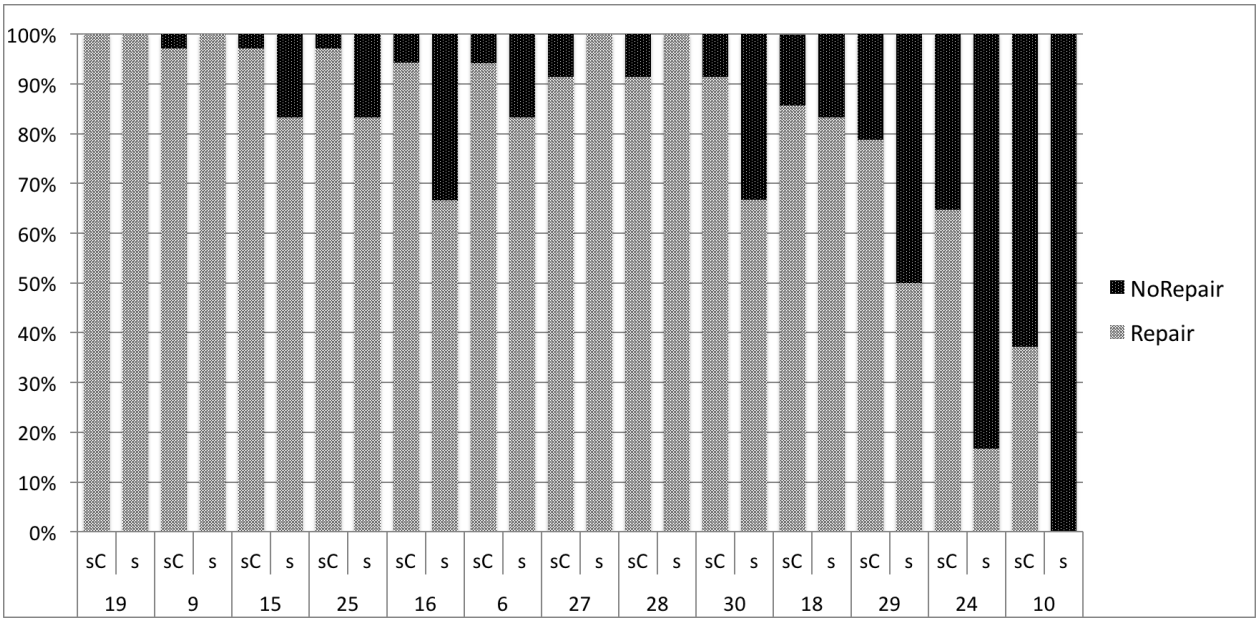

Figure 8. Responses to all *s*C-initial and *s*-initial words: learners and chance responders.

Surprisingly, only three participants, those toward the right end of Figure 8, show a significant asymmetry in their treatment of *s*C-initial words and *s*-initial words, suggesting closer approximation to the true BP grammar. Participant 29 repairs *s*C clusters more often than chance ($p = 0.001$), while *s*-initial words are repaired at chance ($p = 0.540$). Participant 24's performance on *s*C clusters is almost significantly higher than chance ($p = 0.061$), while repair of *s*-initial words is considerably lower ($p < 0.001$). Participant 10's repair of *s*C clusters only hovers around chance ($p = 0.088$), but she appropriately does not repair *s*-initial words at all ($p < 0.001$); recall, though, that this participant shows an asymmetry between *s*+stop and *s*+sonorant, more comparable to the grammar of French than to that of BP (section 6.3).

Figure 9 is a two-dimensional plot of the Repair results from Figures 7 and 8, and so is a better visual display of the behavior of each participant on *s*C- versus *s*-initial words. Participant 10 is split into two (10 sT and 10 sR), given her different treatment of *s*+stop and *s*+sonorant.

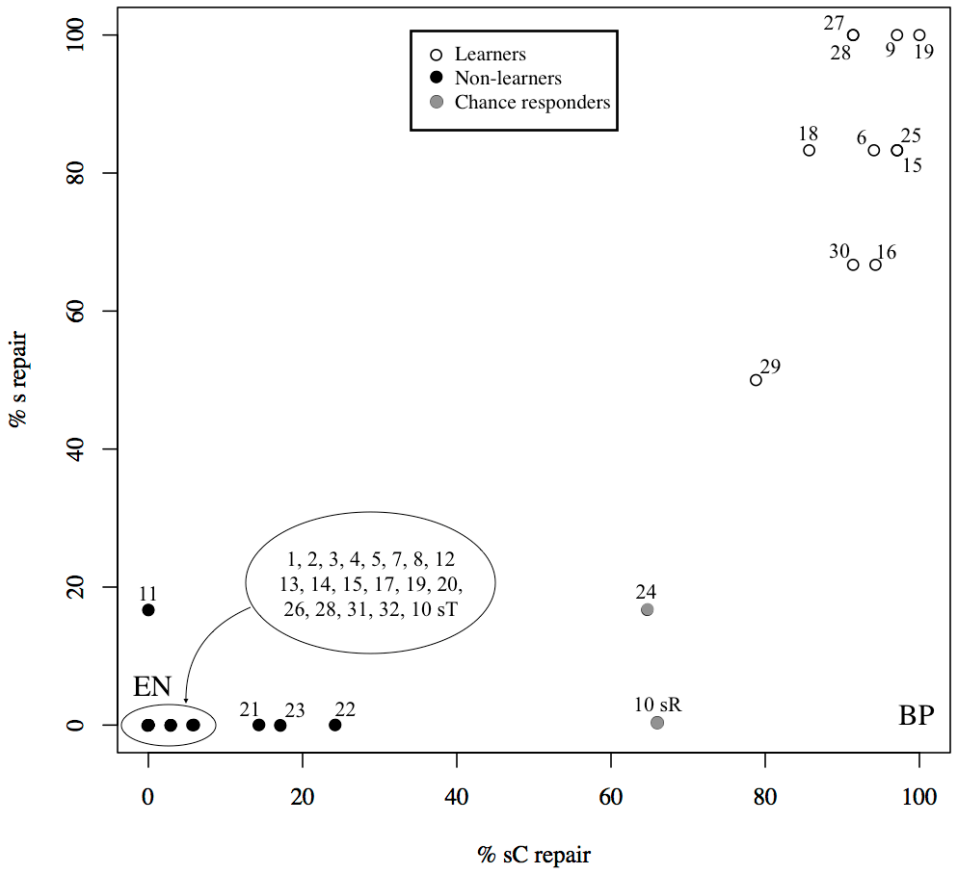

Figure 9. Rates of repair for *s*C- vs. *s*-initial words for each participant.

The figure shows that the participants who have an English-like profile follow this pattern robustly: they cluster quite tightly together in the bottom left corner labeled EN, revealing little or no understanding of the IPE available in BP-accented English. Participant 10 falls into the English-like group only as far as *s*+stop is concerned.

The participants who have overgeneralized the BP pattern to *s*-initial words similarly show this pattern quite strongly. They cluster together near the top right corner, indicating an ability to use the IPE available to repair *s*C-initial words, coupled with a solid trend toward overapplying the repair to *s*-initial words.

The three remaining participants (29, 24, 10 for *s*+sonorant) are in the middle, as their performance is more conservative. Importantly, though, participants 29 and 24 are trending toward the BP grammar in the bottom right corner in that they treat both types of *s*C-initial words differently from *s*-initial words, favoring repair of the former only.

6.6. A possible task effect?

Before turning to the discussion, we address two final aspects of our results. The first concerns a possible task effect emerging from the design of the production task. Recall that participants were asked to produce orthographically-presented stimuli in the same accent they had heard in the dialogues. We have suggested that the learners' insertion of a prothetic vowel before *s*C clusters reflects the ability to internalize the available IPE. One may question this interpretation on grounds that individuals vary in how well they are able to mimic a foreign accent. Perhaps, then, the performance of the learners reflects a more global facility with mimicking accents, rather than revealing some understanding of the well-formedness of initial *s*C clusters in BP. To dispel this concern, we draw attention to the fact that not all of the learners were skillful mimics and not all of the non-learners were unskilled in this respect: six of the participants (5, 11, 14, 25, 28, 32) produced the orthographically-presented stimuli with a BP-like accent but only two of these, 25 and 28, were learners. The other learners produced the stimuli with a Canadian accent, accompanied, of course, by the insertion of a prothetic vowel in the case of *s*C-initial words. This suggests that the methodology we have employed is indeed revealing of the ability to use IPE.

6.7. Checking for possible bias

The final aspect of our results to be discussed concerns the performance of individual participants in light of their views on what the native language of the dialogue speakers was. Recall that the participants were initially told that the language was Samoan. After they completed the production task, they were informed that this was not, in fact, the case and were asked to try to identify the language. Table 5 presents the participants' responses, divided into four categories: Spanish, Portuguese, Other (which included Austronesian, Germanic, Slavic and Indo-Aryan languages) and No Guess. As earlier, participants are divided into three groups: learners, chance responders and non-learners, based on their ability to use the IPE available for *s*C-initial words. An asterisk marks those participants who provided two responses that fell into two different categories.

	Learners	Chance responders	Non-learners
Spanish	9, 16, 19*, 25, 27, 28	24	1, 4, 13, 26*, 32
Portuguese	15		23, 26*
Other	18, 19*	10	2, 3, 7, 17, 20, 21, 22
No Guess	6, 29, 30		5, 8, 11, 12, 14, 31

Table 5. Participants' views on the native language of the dialogue speakers.

Recall that, in designing the study, we were concerned that participants who identified the native language of the dialogue speakers as Spanish might be influenced by exposure to Spanish-accented English in American media, where pre-*s*C epenthesis is highly stereotyped. Although one could make the argument that this helped the six learners who repaired *s*C clusters and identified the language as Spanish, there are an additional five non-learners who failed to repair *s*C clusters and yet arrived at the same conclusion. It thus cannot be presumed that previous exposure to high rates of epenthesis in Spanish-accented English is what led any of these

participants to identify the language as Spanish, in contrast to some other aspect(s) of BP-accented English that makes it sound similar to Spanish-accented English (e.g., prosody).

The same argument can be made for those participants who correctly identified the language as Portuguese. Previous exposure to Portuguese-accented English may have helped participant 15 but it did not serve to help participants 23 and 26. We thus do not know what the participants are attending to when they identify the language as Portuguese.

What may stand out from Table 5 is the high number of participants under Other and No Guess who failed to repair *s*C-initial clusters. At the same time, though, nearly half of those who did successfully repair these clusters also failed to identify the language or language family.

In conclusion, while we cannot rule out the possibility that previous exposure to Spanish- or Portuguese-accented English helped some participants, it is unlikely to have played a prominent role. If it did, not only would the results in Table 5 be surprising, so would the fact that most participants who showed an ability to use IPE overgeneralized the epenthesis pattern to *s*-initial words, which previous exposure to Spanish- or Portuguese-accented English would not predict.

7. Discussion

7.1. Predictions revisited

The data collected for this study reveal that most of the predictions outlined in section 4 are upheld, although not for all participants. The behavior of approximately one-third suggests that they were able to determine that *s*C-initial clusters are ill-formed in BP using IPE (Prediction 1). The learners repaired most of the *s*C-initial words, indicating that they were making a clear judgement on the ill-formedness of these words based on the available IPE. The non-learners repaired *s*C clusters very infrequently, likely indicating, for some, that they were uncertain of the illicit status of *s*C clusters or, for others, that they failed to internalize the IPE at all.

Of those who did repair the *s*C clusters, most used prothesis. We predicted that this would be the case (Prediction 2), since this was the repair that participants were exposed to in the training data. Interestingly, the learners exclusively used prothesis (except for a single instance of anaptyxis), whereas among the subset of non-learners who repaired *s*C occasionally, there was much more variation in the methods of repair they employed. This suggests that there is a correlation between a participant's ability to assess a form as illicit and to apply the appropriate repair.

Although both conditions had the same number of participants, nearly three-quarters of the learners were in the NoSonorant condition, where participants were only exposed to evidence for the illicit status of *s*C clusters from *s*+stop. This is surprising. Based on the speech perception literature, where highly variable input has been shown to provide a better platform for learning (e.g., Bradlow, Akahane-Yamada, Pisoni & Tohkura, 1999), we might have expected the participants in the Sonorant condition, who received more varied data, to be better at internalizing the evidence. We explain our findings as follows. Recall from Table 3 that the number of *s*C tokens and the type/token ratio was identical in both dialogues. This necessitated that the dialogue in the NoSonorant condition have a higher density for each cluster type: 8 tokens for each of /sp/, /st/, /sk/ versus 4 tokens for each of /sp/, /st/, /sk/, /sm/, /sn/, /sl/ in the Sonorant condition. It may be that, due to the limited exposure to BP, participants in the NoSonorant condition benefited from the higher density for each cluster type.

Nevertheless, the eight participants who regularly repaired *s*C and were only exposed to evidence from *s*+stop also appropriately judged *s*+sonorant clusters to be ill-formed (Prediction 3). The rate of repair for *s*+stop and *s*+sonorant clusters for each of these participants did not vary greatly, with a difference of 8% on average. Four participants even repaired more *s*+sonorant clusters than *s*+stop clusters. Given that this pattern of behavior differs both from the data to which participants were exposed in the training and from their native language, this may suggest that learners can tap into a set of constraints or parameters in UG that express the patterns of *s*C cluster well-formedness in Table 2, consistent with full access models of second language acquisition (e.g., Schwartz & Sprouse, 1996).

However, given that most participants who repaired *s*C clusters overgeneralized the repair to *s*-initial words at approximately the same rate, we cannot conclude with any certainty that this type of knowledge is available to L2 learners. Indeed, only two participants, 24 and 29, as well as participant 10, effectively differentiated between *s*C- and singleton *s*-initial words. Aside from these three participants, Prediction 5 is thus not well-supported. We surmise that exposure to a longer dialogue is needed for participants to retreat from the pattern of overgeneralization observed for singleton *s* which, if effective, would enable us to determine whether second language learners can truly tap into UG-based options and generalize only where appropriate.

We can probe this issue further by including a third condition in future work. Recall from section 5.4.1 that the design of our study was asymmetric: participants were either exposed to the ill-formedness of both *s*+stop and *s*+sonorant or to the ill-formedness of *s*+stop only. This was deliberate: if participants were exposed only to the ill-formedness of *s*+sonorant, they could generalize or fail to generalize the pattern of repair they employed to *s*+stop and the result would be consistent with a well-formed grammar (BP or French, respectively; see Table 2). However, in view of the robust pattern of overgeneralization observed with *s*-initial words in this experiment, it would be judicious to see if at least some participants exposed only to the ill-formedness of *s*+sonorant appropriately repair *s*+sonorant but fail to overgeneralize the repair to *s*+stop.

One final surprising pattern of behavior exhibited was that of participant 10 who only received evidence for the ill-formedness of *s*+stop and yet repaired *s*+sonorant clusters almost exclusively. Although participant 10's productions do approximate a well-formed grammar, French, which we return to below, her behavior raises questions as to *how* participants use the evidence to which they are exposed to make well-formedness judgements. Participant 10 is also the sole exception to Prediction 4: she is the only one who attempts to repair CL clusters (aside from participants 23 and 30, who repaired one CL cluster each). Otherwise, Prediction 4, which states that participants will not overgeneralize to CL clusters, holds.

7.2. Patterns of behavior

None of the participants behaved as completely BP-like which, in real world learning situations, would reflect the building of the target BP grammar. However, some were clearly more successful than others. Table 6 groups the participants into four categories. Each category shows distinct patterns of behavior according to their treatment of *s*+stop, *s*+sonorant, and singleton *s*-initial words.

	Repair	NoRepair	Pattern of Behavior	Participants
s+stop		✓	English-like	1, 2, 3, 4, 5, 7, 8, 11,
s+sonorant		✓		12, 13, 14, 17, 20, 21,
s		✓		22, 23, 26, 31, 32
s+stop	✓		Overgeneralize from BP	6, 9, 15, 16, 18, 19,
s+sonorant	✓			25, 27, 28, 30
s	✓			
s+stop	✓		BP-like	24, 29
s+sonorant	✓			
s		✓		
s+stop		✓	French-like	10
s+sonorant	✓			
s		✓		

Table 6. Four patterns of behavior.

7.2.1. English-like

Most participants (the non-learners) fell into the English-like category. The fact that a large number of participants responded minimally or not at all to the IPE is not entirely surprising. As the name suggests, IPE is not a direct type of evidence: some participants may not have received enough evidence to prompt them to depart from their English judgements. Others may have failed to establish the necessary link between production errors in a speaker's L2 and ungrammatical structures in that speaker's L1. It is unlikely that the problem reduces to a purely perceptual one: given the presence of minimal pairs like *state – estate* and *sleep – asleep* in English, participants should have no trouble perceiving the epenthetic vowel in the dialogue speakers' accent. Further study of learners in naturalistic settings is needed to determine the amount of IPE required to effect a change in the grammars of different types of learners.

If all participants in our study behaved as English-like, we might have concluded that IPE is not a useful type of evidence at all. However, the existence of the other patterns of behavior leads us to a different conclusion: that IPE is likely a valuable source of evidence that learners should be able to tap into in naturalistic settings.

7.2.2. Overgeneralization from BP

The majority of participants who used the available IPE followed the 'overgeneralize from BP' pattern of behavior. Participants in this group did not distinguish between *s*C- and singleton *s*-initial words: they understood from the dialogue that the words they heard in the production task beginning with *s*C were ill-formed, but they interpreted *s*-initial words of all types to be ungrammatical and thereby overgeneralized the pattern of repair. Presumably, the participants who fell into this category ignored evidence that singleton *s* is well-formed in initial position, as demonstrated by words in the dialogue such as *something*, *same* and *seriously*. It seems, then, that participants were much more sensitive to evidence from non-English-like forms in the novel accent, that is, to pronunciations they are not used to hearing. The fact that singleton *s* did not

require repair was not evident to these participants presumably because the singleton *s*-initial words in the dialogue were not pronounced in a non-English-like manner.

There are a number of factors that may have contributed to participants not detecting that *s*-initial words were treated differently from *s*C-initial words. One concerns the location of *s*-initial words in the dialogues. Unlike *s*C-initial words, which often appeared in prosodically prominent locations – at the beginning of an utterance or intonational phrase – *s*-initial words typically appeared in less salient medial position. Two, in contrast to the *s*C-initial words, which were all nouns, verbs and adjectives, that is, words that listeners must attend to in order to follow the dialogue, a number of *s*-initial words were intensifiers (*so*) which, although stressed, do not add to the propositional meaning of a sentence and quantifiers (*some*).

The third factor concerns frequency. As mentioned in section 5.4.1, frequency was not controlled in order to keep the dialogues as natural sounding as possible given other constraints. A post hoc analysis, however, reveals that on average the *s*-initial words employed in the dialogues were twice as frequent as the *s*C-initial words. The average frequencies, based on number of occurrences per million words, are 2729 for the *s*-initial words and 1378 for the *s*C-initial words (calculated on uninflected word types drawn from representative text corpora compiled in the CELEX corpus for English from Baayen, Piepenbrock & Gulikers, 1995). As less frequent words are more salient (Fowler, 1988), the presence of epenthesis on *s*C-initial words could have been more noticeable to listeners than the absence of epenthesis on *s*-initial words.

Given that many participants overgeneralized epenthesis to *s*-initial words, we must question why they did not similarly overgeneralize to CL-initial words. That is, there could have been participants who treated all left-edge clusters in similar fashion, in spite of the different representations that hold for *s*C and CL (see (3)).[19] Many of the same factors we raised as possible explanations for overgeneralization to *s*-initial words may explain the lack of overgeneralization to CL-initial words. First, unlike *s*-initial words, CL-initial words were all nouns, verbs and adjectives, that is, words that listeners must attend to in order to understand the dialogue. Second, the average frequency of CL-initial words in the dialogues was 441 instances per million words which makes them much less common than *s*-initial words, as well as than *s*C-initial words (see above). In short, participants may have been acutely aware that CL clusters were not repaired in the dialogues as their attention may have been drawn to these words because of their important role in comprehension and their higher salience due to their lower frequency.

Clearly, prosodic position, lexical category and word frequency are all factors that must be better controlled in future studies of this type. Concerning *s*-initial words, we speculate as well that, with exposure to a longer dialogue containing more instances of words of this shape,

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[19] Participant 10 comes close to this: she is the only participant who made repairs somewhat independent of cluster type. Recall that she repaired CL-initial words 27.8% of the time and *s*+sonorant words 66.7% of the time.

participants would start to recognize that *s*-initial words pattern with CL-initial words in not undergoing repair and not with *s*C-initial words.

7.2.3. BP-like

The productions of a small group of participants (24 and 29) reveal that they were able to make BP-like judgements, repairing a slight majority of *s*C clusters while leaving initial singleton *s* alone. Although these two participants were conservative (i.e., they did not repair all *s*C-initial words), they do show that it is possible to use IPE to make native-like judgements. The fact that the group is small could indicate that some learners are able to use some types of evidence more effectively than others and, thus, that the amount of exposure was too limited for most participants. We expect, though, that it might be these learners' conservatism that prevented them from overgeneralizing the repair to singleton *s*-initial words. Clearly, further study is required but the hope is that, with enough evidence, all learners would eventually make robust BP-like judgements, even if their trajectories look different: conservative learners may be slower to make fully target-like judgements for both *s*C and *s*, while non-conservative learners may hastily make target-like judgements for *s*C but then need to retreat from overgeneralization errors for *s*.

7.2.4. French-like

The productions of participant 10 indicate that she makes judgements that most closely resemble the grammar of French, repairing *s*+sonorant clusters almost exclusively and not repairing *s*+stop clusters. These judgements are not decisive since this participant only repairs *s*+sonorant clusters two-thirds of the time. On top of this, these clusters are repaired via anaptyxis, not prothesis. Participant 10 also repairs some CL clusters (which is not like the grammar of French). It appears that participant 10 has internalized enough of the IPE to understand that some repairs are required but not enough to be decisive as to what these repairs should be and which clusters they should apply to.

7.3. Using indirect positive evidence

Taken together, the results from our study indicate that a considerable number of participants display patterns of behavior suggesting that they are able to extract generalizations from the available IPE. However, in spite of the promise that IPE holds, this type of evidence did not lead most participants to make (near) categorical distinctions between well- and ill-formed words. That is, although the statistical analysis does reveal distinct patterns of behavior across groups of participants, there is gradience in the data. This, of course, is not unexpected: it is unrealistic to expect participants to make (near) deterministic judgements after exposure to 48 tokens of evidence. For some participants, though, the level of uncertainty exhibited likely indicates their reluctance to produce forms that stray from those that would be generated by their native English grammar, precisely because the words they were required to extract patterns from were produced in English. Being monolingual anglophones, the participants have had a lifetime of evidence indicating that *s*C clusters are well formed, competing with new evidence from another type of English that they are not. Even though the participants realized that they were judging a non-native English accent, their productions were still likely influenced, to varying degrees, by their

knowledge of the phonotactics of their L1, which are notoriously difficult to override (Moreton & Pater, 2012). Despite the level of uncertainty exhibited, the fact that the productions of several participants reveal that they made non-English-like judgements shows that IPE did influence their decision making and is thus likely to be a viable source of evidence for language learners in naturalistic settings.

8. Conclusion

This paper only hints at possible uses of IPE and it is clear that more research is required before we begin to understand its potential for second language acquisition. We have shown, though, that it is accessible as a source of evidence and we speculate that it may possibly be used as a shortcut to acquiring a subset grammar in naturalistic settings: learners exposed to IPE may arrive at a native-like grammar at an earlier point than those relying solely on other sources of evidence.

Although we have focused on phonology, the utility of IPE need not be restricted to this component of the grammar. In syntax, for example, IPE might help Japanese-speaking learners of English determine how binding works in English, which is a subset of their L1 grammar: Japanese permits both local and long distance binding of reflexive anaphors, while English permits local binding only. Hirakawa (1990) has shown that although Japanese-speaking learners of English show evidence of transferring their L1 grammar of reflexive binding into the L2, some learners also display some movement toward the English grammar. The question that arises is how, given the absence of direct positive evidence for this. One possibility is that IPE was available. To exemplify, consider a situation where native speakers of English and Japanese are learning each other's languages and converse at least part of the time in Japanese. If the English-speaking learner of Japanese interprets *Taro-wa Akira-ga zibun-o butta to itta* (Taro-TOP Akira-SUB self-DO hit COMP said 'Taro said that Akira hit self') to mean that Akira hit himself in a context where Taro is the one who hit himself, the learner's Japanese collocutor may correctly deduce that English only permits local binding of reflexives, information needed for the Japanese collocutor to correctly acquire the more restrictive English grammar.

From a more practical perspective, promoting the benefits of IPE may change educators' and learners' perceptions of the utility of non-native speech. Non-native speech is often stigmatized by both native and L2 speakers alike. Some learners are less willing to initiate a conversation in their L2 when they believe their abilities to be inadequate in some way (MacIntyre, Clément, Dörnyei & Noels, 1998). If non-native speech is presented to L2 learners as a useful learning tool for others, this may encourage them to feel less self conscious about conversing in their L2.

Further study is required to determine possible uses and limits of IPE as well as potential applications beyond phonology. However, this paper has shown that it may be a useful source of evidence for L2 learners, when confronted with the task of learning a subset grammar.

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Appendix 1: Demographic information.

The following table contains demographic information for the 32 participants. To ensure anonymity, those from small communities are identified by the nearest city (marked by *). Concerning proficiency in French and other languages: B = beginner, LI = lower intermediate.

Parti-cipant	Condi-tion	Age	Sex	Highest level of education completed or in progress	Place of longest residence	Proficiency in French	Other languages (proficiency)
1	Son	25	F	university	Toronto, ON	LI	Cantonese (B)
2	Son	19	F	university	Toronto, ON	–	–
3	NoSon	22	M	university	Toronto, ON	LI	–
4	NoSon	26	F	secondary school	Hamilton, ON	B	–
5	Son	22	F	university	Toronto, ON	–	–
6	NoSon	27	F	university	Kingston, ON	LI	German (B)
7	Son	23	M	university	Vancouver, BC	LI	–
8	NoSon	22	M	university	Vancouver, BC	–	German (B); Hebrew (B)
9	NoSon	22	F	university	Hamilton, ON*	B	Italian (B)
10	NoSon	21	F	secondary school	Montreal, QC	–	–
11	Son	32	F	university	Windsor, ON	B	–
12	Son	31	F	university	Peterborough, ON	LI	Russian (B)
13	NoSon	30	F	college or professional	Toronto, ON	B	–
14	Son	30	M	university	Oshawa, ON*	–	–
15	NoSon	27	F	university	Montreal, QC	B	–
16	Son	22	F	university	Vancouver, BC	B	Mandarin (B)
17	Son	28	M	secondary school	Halifax, NS*	LI	–
18	NoSon	33	F	university	Halifax, NS*	–	–
19	NoSon	22	F	university	Vancouver, BC	LI	–
20	Son	30	F	college or professional	Toronto, ON	LI	–
21	NoSon	25	F	university	Toronto, ON	B	Hebrew (LI)
22	Son	25	F	university	Thornhill, ON	–	–
23	NoSon	22	F	university	Toronto, ON	LI	Hebrew (LI)
24	Son	21	F	university	Toronto, ON	B	Hebrew (B)
25	NoSon	23	F	university	Halifax, NS	–	–
26	NoSon	23	M	university	Montreal, QC*	B	–
27	NoSon	24	M	university	London, ON	B	–
28	NoSon	21	F	university	Toronto, ON	B	–
29	Son	31	F	university	Montreal, QC	LI	–
30	Son	24	F	university	Winnipeg, MN	LI	Hebrew (LI)
31	Son	23	F	university	Regina, SK*	LI	–
32	Son	25	M	university	Edmonton, AB	LI	Italian (LI)

Appendix 2: Dialogues.
Dialogue 1 contains only *s*+stop clusters (for participants in the NoSonorant condition); Dialogue 2 contains both *s*+stop and *s*+sonorant clusters (for participants in the Sonorant condition). To facilitate the locating of words of different profiles, *s*C-initial targets are in bold and are preceded by an epenthetic [i]; word-initial CL clusters are underlined; and singleton *s*-initial words are in italics.

Dialogue 1: *s*+stop (NoSonorant condition)
1: Hey, I'm *sorry* for calling *so* early but can I borrow *some* tools?
2: What? What time is it?
1: It's five in the morning, I must have **[i]stayed** up all night. I'm *sorry*, did I wake you?
2: Of course you did, it's five in the morning? ! Why? !
1: I can't find my pliers. Do you have an extra you could **[i]spare** for a few hours?
2: What? Aren't you exhausted?
1: Yeah, I'll nap when I'm finished. I'm making a cricket habitat.
2: What? Why do you do these things?
1: Are you asking about **[i]staying** up or the cricket habitat?
2: The cricket habitat of course.
1: My nephew is really into insects and his birthday is today. I wanted to make his gift **[i]special**.
2: Don't you think that might be a little more **[i]special** than is really necessary?
1: What do you mean? I know for a fact that his mom got him a purple **[i]scarf** ... lame! At least now he'll get one good gift.
2: His parents will never **[i]speak** to you again. They're going to hate you, those bugs are loud and they're going to KEEP THEM AWAKE! ! ! **[i]scarves** at least are *silent*. You might as well get the kid a drum kit.
1: Don't flip out, I already *said* I'm *sorry*. You're **[i]scary** when you yell you know that?
2: You deserve it.
1: I *said* I was *sorry*.
2: You bring out my cranky and **[i]scary** *side*. You have the weirdest ideas for presents though, why not get him *something* more normal.
1: Like what? He hates **[i]sports**, I'm not going to get him *something* he hates.
2: I don't know, it doesn't have to do with **[i]sports**. What do kids like these days, does he collect things? Get him **[i]stamps** or *something*.
1: No one likes **[i]stamps**. He likes bugs ok, he has traps for them all over his yard.
2: Fine, whatever. Why not a quieter insect?
1: Well I was thinking of worms but I thought they'd be less interesting.
2: I can't **[i]stand** those I used to flick them off the porch and into the garden, they're basically legless *centipedes* you know. I can't **[i]stand** *centipedes* either actually.
1: I was thinking about a flying insect but they're too hard to keep contained, or crabs maybe.
2: Crustaceans aren't the *same* as insects you know. I always liked **[i]spiky** insects the best.
1: Like bees and wasps?
2: That's not the type of **[i]spiky** I mean. More like those beetles with the horns. Or, what are those one's that look like **[i]sticks** called?
1: **[i]Stick** insects?

2: Yeah those are cool. I'll just go make *some* coffee now that I'm up. You can come by to grab the tools if you want now.
1: I was actually hoping you could bring them over here. My car won't **[i]start**.
2: It won't **[i]start**? *Seriously*?
1: I'd really owe you. I'll buy you a bottle of that **[i]scotch** you like, the nice one we drank on new years.
2: **[i]Scotch**? Oh yeah that one, that was good.
1: Yeah.
2: You really need to take better care of your car. Didn't you have a flat just last week? And a busted **[i]spark**-plug the week before that?
1: A busted **[i]spark**-plug? No, it was the transmission.
2: Why don't you just take it in to a garage.
1: Garages are **[i]scams**. They always trick you into paying for things that don't need to be fixed. I can do it myself.
2: They're not **[i]scams**, and no you can't, you end up just breaking it more. Besides, you haven't even returned my hammer yet, or that **[i]scale** I lent you.
1: Fine, I'll give them both back, when you come over.
2: I didn't *say* I'd do it yet.
1: I have the hammer and **[i]scale** right here. Come on, you owe me.
2: I don't owe you anything ... Fine, what *size* do you need?
1: A large needle nose. Thank you *so* much.
2: Yeah yeah. I'll just get a bite to eat.
1: I'll feed you here. I have left over **[i]spaghetti** from last night, I can just heat it up.
2: No thanks, I'm not really feeling like **[i]spaghetti** for breakfast. Besides. I'd rather eat at home, I know about your **[i]skills** in the kitchen.
1: I have excellent cooking **[i]skills**.
2: Didn't you have to call 911 after the *sushi* incident last year?
1: Is there a reason why you're **[i]still** bringing that up? No one told me you can't barbecue *seaweed*!
2: **[i]Spare** me the excuses, you almost burned your house down. I can **[i]still** picture the *scene*. The flames were huge!
1: Fine, but don't let anyone tell you I don't make a mean **[i]spam** and eggs.
2: I can't believe you eat that **[i]stuff**, just thinking about it makes me cringe. I would not eat eggs and **[i]spam** if you paid me.
1: I know I know, you would not could not... you're missing out, it's good **[i]stuff**. You should really broaden your culinary horizons.
2: I'm just **[i]skeptical** of fake meat ok. Besides, last time you made it, it looked...
1: What? What was wrong with it.
2: It looked crunchy.
1: You're **[i]skeptical** of everything. Enough with the food, now I'm getting hungry. Can you come **[i]stop** by with the pliers now?
2: Give me an hour ok? But I need to get back in time to get Elli up for **[i]school**.
1: Of course, of course. I wouldn't imagine making Elli late for **[i]school**.
2: I know, she'd never forgive you.

1: Do you think she'd want a bug habitat too? I'm on a roll here and isn't her birthday coming up *soon*?
2: You bring crickets into my house and I'm never **[i]speaking** to you again. Besides, she doesn't like bugs. You can do *something* for me though.
1: What?
2: **[i]Stop** calling me *so* early in the morning!

Dialogue 2: *s*+stop and *s*+sonorant (Sonorant condition)
1: Hey, I'm *sorry* for calling *so* early but can I borrow *some* tools?
2: What? What time is it?
1: It's five in the morning, you weren't [**i]sleeping** were you?
2: Of course I was **[i]sleeping**! What tools do you need at five in the morning anyway?
1: I dropped my pliers on the floor and now I can't find them. I'm *so* close to finishing too.
2: Finishing what? You can't **[i]stay** up all night all the time, it's not good for you.
1: I'm making a cricket habitat, I decided I'll **[i]stay** up until I'm finished.
2: Why do you do these things?
1: Are you asking about why I'm up or the cricket habitat?
2: The cricket habitat of course.
1: My nephew is really into insects and his birthday is today. I wanted to make his gift **[i]special**.
2: Don't you think that might be a little more **[i]special** than is really necessary?
1: What do you mean? I know for a fact that his mom got him a purple **[i]scarf** ... lame! **[i]Scarves** do not make good presents. At least now he'll get one good gift.
2: His parents are going to hate you, those bugs are loud. You might as well get the kid a drum kit.
1: Calm down, quit **[i]snapping** at me. That's no way to talk to your friends.
2: I can **[i]snap** at you if I want! YOU WOKE ME UP!
1: Has anyone ever told you that you're terrifying when you yell? **[i]scary** in fact.
2: So they tell me. It's fine, really, I'm *sorry* if I was **[i]scary**. I'll just go make *some* coffee now that I'm up. I'll likely have to drink the whole pot. Why didn't you go with a quieter insect though or *something* **[i]slower** in case they get out.
1: Well I was thinking of **[i]slugs** but they're kind of gross in my opinion, and **[i]slow**. I thought they'd be less interesting.
2: I always hated **[i]slugs** I used to flick them off the porch into the garden, you know what they *say*, they're just **[i]snails** without a house.
1: You're hilarious. I was thinking about a flying insect but they're too hard to catch, or crabs maybe? Basically, they're **[i]snails** right?
2: Crustaceans aren't the *same* as insects you know.
1: They both have shells, what's the difference?
2: Never mind. I'm up, you can come by if you want now.
1: I was actually hoping you could bring them over here. My car won't **[i]start**.
2: Why do none of your things ever work? Your car won't **[i]start**? *Seriously*?
1: I'd really owe you. I'll buy you a bottle of that **[i]scotch** you like, the nice one we drank on new years, you remember?
2: That **[i]smooth** and delicious one? Yeah I remember, which in hindsight is kind of *surprising*. I really liked that **[i]scotch**. Do you remember what it was called?

1: No, I remember the label though. I don't know why people describe alcohol as **[i]smooth**, it all burns my throat. *So*, can you come by?
2: You really need to take better care of your car, you know. Didn't you have a flat just last week? And a busted **[i]spark**-plug the week before that or was it the transmission?
1: No, the transmission was last year, two weeks ago was the busted **[i]spark**-plug. Help me out, please!
2: Why should I lend you more tools, you haven't even returned my hammer yet.
1: You can have that one back. It **[i]slammed** my thumb just the other day. Man did that hurt.
2: I'll **[i]slam** your head with...
1: What?
2: Nothing. Besides, I didn't *say* I'd come yet.
1: Come on, his birthday is today. Please, you owe me.
2: I don't owe you, if anything you owe me ... Fine, what kind do you need?
1: One **[i]small** needle nose if you have it.
2: Yeah I have a whole range of *sizes*, **[i]small**, medium? you never can have too many is what I *say*.
1: Yeah, sure, I'll take whatever you can bring. Oh, thanks a lot by the way.
2: Yeah yeah. I'll just shovel all this **[i]snow** off the car first, then I'll be over.
1: Oh man I was watching it come down all night, I love watching it **[i]snow**.
2: Yea? I'd rather be in bed. I'll have to grab *something* to eat too.
1: I'll feed you here. I have left over **[i]spaghetti** from last night, I can just heat it up.
2: No thanks, I'm not really feeling like **[i]spaghetti** for breakfast. Besides. I'd rather eat at home, I've had way too much experience with your **[i]skills** in the kitchen.
1: I can't believe you'd *say* that, I am an excellent cook. My cooking **[i]skills** are impeccable, you're just being **[i]snobby**.
2: Just because I choose to only eat food that's actually edible doesn't mean I'm **[i]snobby**. If I remember correctly, didn't you have to call 911 after that disastrous **[i]smoked** *salmon* incident last year? And the pumpkin explosion the year before that?
1: Why do you bring that up **[i]still**? ! No one got hurt, well, not *seriously* hurt, no one told me you're *supposed* to *serve* **[i]smoked** *salmon* cold! And the pumpkin, I don't even know what happened there, just one of those mysteries.
2: **[i]Spare** me the excuses, you almost burned your house down, and the neighbor's. I can **[i]smell** the charred fish whenever I come over *sometimes*, even after all these months **[i]still**.
1: Did you just *say* '**[i]spare me**'? Who are you? my mother?
2: All I'm *saying* is the odor is **[i]still** there from over a year ago.
1: **[i]stop** it ok, when will you be here with the pliers?
2: Give me an hour ok?
1: Ok.
2: Oh and promise me one more thing.
1: What?
2: **[i]Stop** calling me *so* early in the morning!

Appendix 3: Production task.

The following list contains the words (in the orthographic transcription used) that participants were required to produce in the production task. Numbers in parentheses indicate order of presentation.

s+stop: stuta (3), spakego (4), skumit (11), spitu (14), stoda (25), spirona (26), skom (29), skol (30), stel (54), stimirak (57), skupegu (60), stulen (79), spegu (90), skesu (92), stom (96), spefu (109), spatu (119), skonat (120);

s+son: slos (7), sladu (8), snabe (21), smikesa (24), smehi (38), slere (44), slup (52), sluk (55), snahi (61), smoti (63), snep (72), slagiwi (73), snedek (75), smahi (87), smonu (94), snerula (98), snaya (106), smigo (107);

CL: trok (1), glita (5), glato (13), blawir (16), tral (20), draku (27), drulo (32), brila (35), plodi (43), prata (51), kluri (62), krefu (76), trevi (84), plutana (89), brenu (95), kredo (105), grom (111), drik (118);

stop: bempuru (2), pomeno (6), tudu (10), guti (12), doka (15), gogi (17), kibi (19), titur (22), gosa (23), tee (33), desha (34), puva (40), kobik (41), gowana (46), tulde (50), beko (53), tuk (56), bahon (58), bor (59), dorek (65), busel (66), bonito (69), piha (70), damu (71), kifas (77), kowana (81), baza (85), kinto (91), pahe (93), pina (99), dempani (100), tatuldu (103), gure (104), pilpi (108), datu (112), kunefo (113), don (115), kiloka (116);

fric: voyu (9), fot (37), vono (42), fol (47), fugi (48), vas (74), fonegli (80), faho (82);

s: somi (28), suk (39), sur (45), sok (64), seba (68), selane (83);

son: litek (18), ralini (31), lotushu (36), rakuna (49), linatu (67), luwa (78), ranis (86), riwi (88), litu (97), regoto (101), reshu (102), lene (110), loha (114), reshuzo (117).