Indirect Positive Evidence in the Acquisition of a Subset Grammar in Phonology

Misha Schwartz and Heather Goad

1. Introduction

There is significant evidence that learners begin constructing a second language (L2) grammar using their first language (L1) grammar as a point of reference (Broselow & Finer, 1991; Schwartz & Sprouse, 1996; White, 2003). The L1 grammar can either help or hinder the acquisition process as learners strive to adapt this grammar to account for the evidence present in the L2 data. This paper examines L1/L2 interaction in the acquisition of word-initial /s/+consonant (sC) cluster well-formedness and how different types of evidence can or cannot be used to acquire a target-like grammar in this domain. In the particular case to be examined, L1 English and L2 Brazilian Portuguese (BP), the L1 is a superset of the L2, and this therefore represents a situation where direct positive evidence is not always available or accessible to learners. In view of this, we propose that learners may have access to a previously unexamined type of evidence, Indirect Positive Evidence, when other types of evidence fall short. We experimentally demonstrate the potential utility of IPE for the L2 acquisition of a target-like subset grammar.[1]

As mentioned, well formed word initial clusters in BP are a subset of those found in English. Both languages permit obstruent initial clusters but only English permits sC clusters in this position (Mateus & d'Andrade, 2000). In BP, sC-initial words are repaired through prothesis (*sC...* → *isC...*). For BP speakers learning English, direct positive evidence – indication that a structure is well formed from its presence in the ambient data (Pinker, 1984) – is amply available to show that sC is well formed. Thus, assuming that BP speakers can correctly perceive sC-initial words in English (e.g., that they can perceive the difference between *steam* and *esteem*), they can use this evidence to shape their developing L2 grammar. Learning based on direct positive evidence is typical when progressing from a subset grammar to a superset grammar.

English speaking learners of BP cluster well-formedness must instead retreat from a superset to a subset grammar. This is usually more difficult because learners must recognize that a form that they expect to occur (since it is grammatical in their L1) does not occur in the target L2 grammar. Recognizing the non-existence of a form is much less obvious than recognizing its existence. In fact, direct positive evidence is often not available in such situations.[2]

It would appear, then, that learners must rely on negative evidence, either direct (being explicitly told that a structure is ill-formed) or indirect (inferring that a structure is ill-formed through its absence from the ambient data). Direct negative evidence is often only available in formal learning settings, such as classrooms. In other, more naturalistic contexts it is considered inappropriate to directly correct

* Department of Linguistics, McGill University; authors can be contacted at: misha.schwartz@gmail.com and heather.goad@mcgill.ca. We would like to thank the GALANA audience for questions and comments. Thanks as well to Hye-Young Bang, Walcir Cardoso, Guilherme Garcia, Lauren Garfinkle, Natália Guzzo, Alexei Kochetov and Kris Onishi. This work was supported by grants from SSHRC and FRQSC.

[1] The experiment reported on here appears in expanded form in Schwartz & Goad (2015).

[2] Some languages provide direct positive evidence for the acquisition of subset syllable structure constraints from alternations: contextually-determined changes in the shapes of morphemes. However, alternations are not always available and often require a relatively high level of proficiency to interpret. Other direct positive evidence may include loanword adaptation (Trapman & Kager, 2009) or comparison of cognates (Bernadette Plunkett, p.c.). See Schwartz & Goad (2015) for discussion of the challenges that each of these types of evidence presents.

 Proceedings of the 6th Conference on Generative Approaches to Language Acquisition North America (GALANA 2015), ed. Laurel Perkins et al., 102-109. Somerville, MA: Cascadilla Proceedings Project.

new learners' errors (Lightbown & Spada, 2006). Indirect negative evidence requires learners to encounter enough utterances in which a given form could but does not occur in order for them to deduce that such a form is ungrammatical in the target L2. Before learners can make the appropriate judgement, the number of utterances they must be exposed to is high, which limits the use of indirect negative evidence to learners who are at relatively advanced stages of learning (Saleemi, 1992). Some conservative learners may never make judgements based on this sort of evidence.

The lack of reliable or accessible evidence presumably makes the acquisition of a subset grammar a challenging and protracted task for L2 learners. However, we propose that the process can be facilitated in certain L1/L2 contexts, using evidence from errors in the learner's L1 made by native speakers of the learner's L2. This type of evidence, which we call indirect positive evidence (IPE), draws on the learner's knowledge of his/her own L1 in order to highlight aspects of the target L2 grammar that are different. An example would be a speaker of English learning BP who has yet to realize that word initial sC is ungrammatical in BP. The English speaker may encounter a native BP speaker who epenthesizes a vowel before sC clusters when speaking English. If the English speaker recognizes this as an unnecessary repair in English, s/he may be able to deduce from this that the BP speaker is repairing the cluster because this conforms to the phonotactic constraints of BP. IPE is considered to be indirect because information about the grammar of one language is accessed through errors made in a different language.

2. Word initial clusters

The fact that there are languages like BP that permit obstruent initial clusters yet lack sC clusters suggests that these two cluster types respect different constraints. This is indeed the case. Across languages, obstruent initial clusters typically must rise in sonority. Steep rises are preferred over shallow rises, which in turn are preferred over sonority plateaus (e.g., Clements, 1990). Languages that allow sC clusters, on the other hand, show the opposite profile. sC clusters with a steep sonority slope are only permitted if clusters with a shallower profile are attested as well (Goad, 2011, 2012). This is shown in Figure 1 below.[3]

Figure 1. sC cluster profile across languages.

	BP	French	Greek	Dutch	English
s+stop	*	✓	✓	✓	✓
s+nasal	*	*	(✓)	✓	✓
s+lateral	*	*	*	✓	✓
s+rhotic	*	*	*	*	✓

This difference in sonority, among other things, has been used to motivate different prosodic representations for these two types of clusters. Obstruent initial clusters form left-headed branching onsets, as shown in (1a) (e.g., Kaye, Lowenstamm & Vergnaud, 1990). In sC clusters, /s/ is outside the onset constituent to which the following consonant is linked; see (1b). There are various proposals for exactly how /s/ is prosodified in the literature: for some researchers, it is extraprosodic (e.g., Steriade, 1982); for others, it is organized directly by higher structure, typically the syllable or prosodic word (e.g., van der Hulst, 1984; Goldsmith, 1990); and for others, it forms the coda of an empty-headed

[3] The parentheses for Greek indicate that s+nasal is only marginally well-formed in this language. s+rhotic is realized as [ʃr] in English.

syllable (e.g., Kaye, 1992). The representation in (1b) is contained within each of these proposals and suffices for our purposes.

(1) a. Obstruent initial clusters:

b. sC clusters:

As discussed above, both English and BP allow obstruent initial clusters and thus the representation in (1a). Obstruent initial clusters in both languages are of the shape obstruent+liquid and so are hereafter abbreviated as CL. English additionally permits sC clusters and so a representation along the lines of (1b) is well-formed in this language as well. In BP, however, words cannot begin with sC: native sC-initial roots that surface without prefixation and loanwords from English-type languages are repaired through [i] epenthesis (Mateus & d'Andrade, 2000; Cardoso, 2008). BP is therefore a subset of English as far as left-edge clusters are concerned.

3. Experiment

This paper experimentally examines whether second language learners can make use of IPE in order to acquire a subset grammar. The specific focus is on whether (near) monolingual speakers of English are able to use IPE in the form of BP-accented English, which includes [i] epenthesis before sC clusters, to determine that word initial sC is ungrammatical in BP. We hypothesize that, after being exposed to the IPE, English speakers will behave in ways which demonstrate that they are beginning to build an interlanguage grammar that (i) reflects the different status of (1b) in BP as compared to their native grammar and (ii) reflects cross-linguistic constraints on the well-formedness of sC clusters (as per Figure 1).

3.1. Predictions

We predict the following:

1. Participants will use IPE to conclude that BP does not permit word initial sC clusters;
2. When asked to repair sC initial words in BP, participants will do so using prothesis and not some other type of repair (i.e., anaptyxis, deletion or metathesis);
3. Participants who are only exposed to IPE demonstrating that s+stop is ill-formed in BP will generalize beyond the data to which they are exposed and reach the conclusion that s+sonorant must be ill-formed as well;
4. Participants will only repair word initial sC clusters and not overgeneralize the repair to CL clusters in this same position.

Prediction 1 is concerned with the ability of learners to develop a (potentially rudimentary) grammar that differs from their L1 based only on exposure to IPE. In other words, not only should learners detect the presence of epenthetic [i], but they should be able to determine the condition under which it applies, before initial sC clusters.

Prediction 2 focuses not only on learners' ability to determine which forms are ungrammatical in BP but, more specifically, on the process that is used to repair them. sC clusters can be repaired in several ways (i.e., prothesis: *skuta* → [iskuta], anaptyxis: [sikuta], deletion: [suta] or [kuta], metathesis: [sukta]), but it is prothesis that is observed in the IPE and so this should be the repair of choice.

Prediction 3 tests whether learners are able to generalize beyond the IPE they have been exposed to and build a grammar that reflects cross-linguistic constraints on the well-formedness of types of sC clusters. Specifically, if the data only evidences the ill-formedness of s+stop (for learners assigned to the NoSonorant condition), learners should conclude that s+sonorant is also ill-formed, given the typological options shown in Figure 1.

Prediction 4 is concerned with overgeneralization. It predicts that any repair that learners determine is necessary for word-initial sC clusters should not be incorrectly applied to other types of word-initial clusters, namely CL clusters. This prediction follows from two observations: (i) CL clusters are well-formed (not repaired) in the data to which learners are exposed; (ii) if (i) goes undetected by learners (on grounds that constructions that are not repaired may not be noticed), CL and sC clusters have different representations (see (1)), which suggests that evidence for the ill-formedness of one should not be generalized to the other.

4. Methodology

4.1. Participants

In order to examine the predictions in section 3.1, we tested 32 native speakers of Canadian English between the ages of 19-33. All participants were either monolingual or had no more than low-intermediate proficiency in another language (according to self report). Any participant who had studied Portuguese or any other language with the same constraint against sC and similar repair of such clusters (notably Spanish) was excluded. Finally, participants could not have spent an extended period of time in the United States, due to the more common exposure to Spanish in the US.

4.2. Procedure

The experiment proceeded in three steps. First, participants were exposed to IPE in the form of a dialogue spoken between two native speakers of BP speaking BP-accented English. Participants then performed a judgement task, which tapped their ability to use the available IPE. Finally, they were asked to attempt to identify the native language of the speakers in the dialogue.

In order to avoid any biases due to previous exposure to Portuguese or Spanish, or to Portuguese- or Spanish-accented English, the participants were told that the L1 of the speakers in the dialogue was Samoan, not BP. Samoan was chosen because we assumed that the likelihood that participants had been previously exposed to Samoan or had any preconceived ideas about what Samoan or Samoan-accented English should sound like would be low.

4.3. Dialogues

There were two different dialogues (see below). Each dialogue was seven minutes long and contained 48 tokens of words with initial sC (two tokens each of 24 lexical types). Place and manner of articulation of the second consonant in these clusters was controlled in order to have an even distribution of each type of sC cluster employed (8 each of /sp, st, sk, sm, sn, sl/ in one dialogue; 16 each of /sp, st, sk/ in the other). All sC clusters were pronounced with a prothetic [i]. The length of this vowel was controlled to be between 45 and 55 ms in length. This range was chosen to correspond to the length of the prothetic vowels used in the naturalistic speech produced by a female intermediate speaker of English whose L1 is BP. She was unaware of the nature of the study at the time and she is not a linguist.

The dialogue was recorded by two other native speakers of BP. These individuals were advanced speakers of English and both were linguists. They no longer regularly repaired sC clusters in English but were able to convincingly produce prothesis and minimize syllable structure repairs of other types (i.e., to codas).

In addition to the 48 tokens of word initial sC clusters, each dialogue contained 30 tokens of CL clusters in this position. These displayed the full range of values for voicing, place and manner of articulation but were not perfectly controlled. No prothesis nor any other sort of repair ever applied to these clusters, given their well-formed status in BP.

As alluded to above, the two dialogues differed in that one contained evidence for the illicit status of sC clusters from both s+stop and s+sonorant; the other contained evidence from s+stop only (i.e., the dialogue contained no s+sonorant initial words at all). The two dialogues differed in this manner in

order to test prediction 3. Half of the participants listened to the first dialogue; we refer to this as the Sonorant condition. Half listened to the second dialogue; we refer to this as the NoSonorant condition.

4.4. Judgement task

After participants listened to one of the dialogues, they performed a judgement task in which BP-like novel words were displayed orthographically on a computer screen. Participants were asked to pronounce the words on screen in the "Samoan" accent they had heard in the dialogue. There were 120 words in total: 36 sC-initial words, 18 CL-initial words and 66 fillers, all of which began with a single consonant.

4.5. Identifying the native language

As a final check to ensure that there was no language bias (i.e., that the results from the judgement task truly reflected participants' ability to use the IPE present in the dialogue), we revealed that the L1 of the speakers was not Samoan and asked participants to guess its identity. Our concern was that, if participants guessed that the language was Portuguese, Spanish, or some other language that treats sC clusters similarly, their answers may have been influenced by prior knowledge of the phonotactics of that language.

4.6. Testing

Testing was carried out in laboratory space at McGill University and the University of Toronto. The experiment was designed in the Python programming language using the Pygame module (Pygame, 2009) and was carried out on a Macbook Air laptop. Auditory stimuli were presented through a logitech USB headset. Oral responses during the judgement task were recorded using the headset microphone and sampled at 44100 Hz using Sound eXchange (SoX) software. Transcription and analysis of the participants' responses was done by linguists specifically trained for this task.

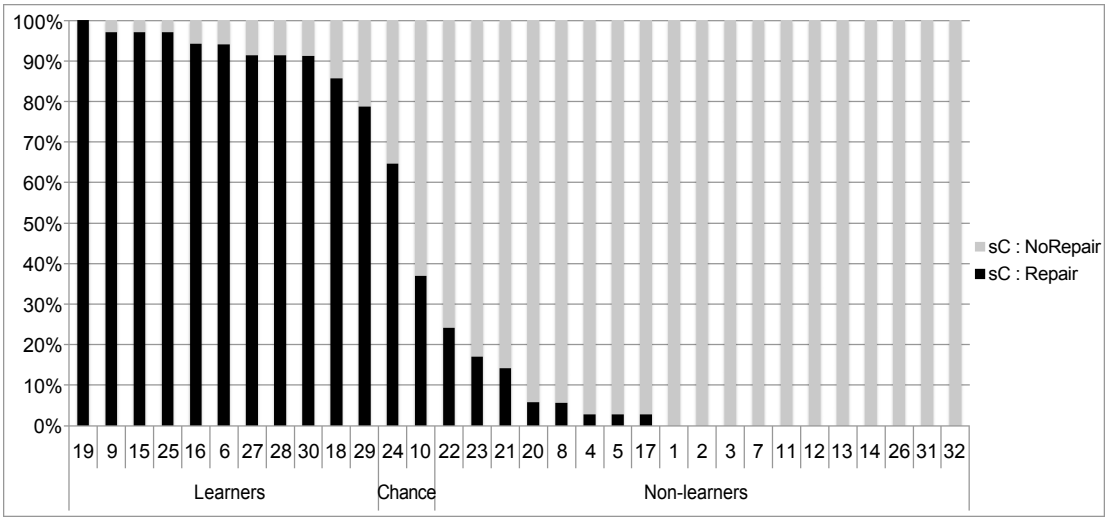
5. Results

Prediction 1 was tested by examining whether participants repaired sC initial words in the judgement task, regardless of what type of repair they used. Participants fell into three groups, which we label 'learners', 'non-learners' and 'chance performers', as determined by a binomial test. Figure 2 shows that there were 11 learners, who repaired sC clusters over 78% of the time; the performance of each learner was significantly higher than chance (ps ≤ 0.001). There were 19 non-learners, who repaired sC clusters less than 25% of the time; the performance of each was significantly lower than chance (ps ≤ 0.002). Finally, there were 2 chance performers, whose behaviour was neither significantly higher (participant 24) ($p = 0.061$) nor significantly lower (participant 10) ($p = 0.088$) than chance.

The finding that a reasonably large number of participants fell into the learner group supports prediction 1. These individuals are able to successfully learn using the available IPE. However, the large number of non-learners indicates that while IPE is present in the ambient data, it is not accessible to all learners, at least not after a short period of exposure.

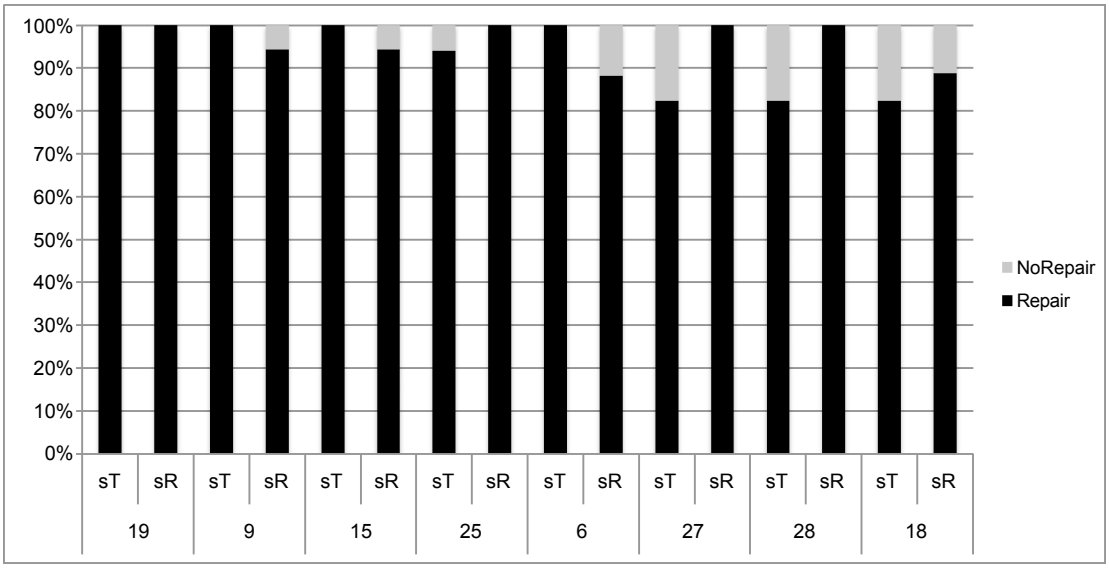
Prediction 2 was tested by considering not only whether the participants repaired the sC clusters but the type of repair they used. Recall that, in addition to the BP repair of prothesis (*skuta* → [iskuta]), there are three other possible repairs for sC clusters: anaptyxis (*skuta* → [sikuta]), deletion (*skuta* → [suta] or [kuta]), and metathesis (*skuta* → [sukta]). All the evidence provided in the dialogue pointed toward prothesis being the appropriate repair. Of the participants in the group of learners (see Figure 2), all repairs (except for a single instance of anaptyxis) involved prothesis. Repairs made by participants in the groups of non-learners and chance performers were more varied, with instances of all three other types of repairs. Prediction 2 is thus supported, but once again, only for the learners.

Figure 2. Responses to all sC-initial words: Repair versus NoRepair.



Prediction 3 was tested by examining the results of the 16 participants who were assigned to the NoSonorant condition. Recall that they were exposed to the dialogue that contained only s+stop clusters, all of which underwent repair. Of these 16 participants, 8 fell into the group of learners, so only their results speak to prediction 3. These 8 learners should repair s+sonorant clusters to the same extent that they repair s+stop, even though they have no evidence as to the well- or ill-formedness of the former cluster type. A glance at Figure 3 suggests that these participants appropriately generalized to repair s+sonorant words as well as s+stop words. The results of a paired t-test confirm that their behaviour for the two types of clusters was not significantly different ($t = 1.8825$, $df = 7$, $p = 0.1018$). Prediction 3 is thus supported.

Figure 3. Responses of learners in the NoSonorant condition: s+stop (sT) vs. s+sonorant (sR) words.



Finally, prediction 4 was tested by looking at whether participants who repaired sC clusters also repaired other clusters in word initial position, specifically CL. We expected that no overgeneralization would occur since, in both dialogues, the participants received evidence that repair was only necessary for sC. Even if speakers failed to notice this, we would not expect CL to undergo repair, given that sC

and CL clusters have different representations, as shown earlier in (1). Focussing again on the 11 learners, aside from a single instance of repair from one participant, there was no overgeneralization to repair CL type words. Prediction 4 is therefore strongly supported.[4]

The results summarized above appear to support the utility of IPE for second language learning. However, we must rule out the possibility that the participants are answering based on previous knowledge of Portuguese, Spanish or similar languages. To examine this possibility, we asked the participants what they thought the L1 of the speakers in the dialogue was, once it was revealed to them that it was not Samoan. Seven participants from the group of 11 learners, six from the group of 19 non-learners, and one of the two chance performers guessed that the language was either Portuguese or Spanish.[5] All other participants either guessed other languages that do not treat sC in the same way as BP or chose not to guess. While this profile shows that we cannot definitively rule out the possibility that the results may have been influenced by knowledge gained from exposure to Portuguese or Spanish, or Portuguese- or Spanish-accented English (e.g., through the media), we are reassured that the participants who guessed that the language was Spanish or Portuguese belonged to both the learner and non-learner/chance performer groups. Even for those learners who guessed that the language was Portuguese or Spanish, we cannot be sure that this was because of epenthesis before sC rather than because of some other aspect of the accent of the dialogue speakers (e.g., prosody).

6. Conclusion

When learning a subset grammar, not all evidence is equally effective. Direct positive evidence is sometimes present in the ambient data, but evidence of this sort is not always available or accessible to learners. Negative evidence is either selectively provided depending on the learning environment (direct), or requires a considerable amount of data and time to be effective (indirect). In this study, we have shown that participants in an experimental setting can use indirect positive evidence to acquire a subset grammar in a relatively short period of time (seven minutes).

Our study has also shown that participants who only received evidence for the ungrammaticality of s+stop clusters in BP were able to generalize to repair s+sonorant clusters as well. Application of a pattern they had learned to a wider set of data than they received evidence for indicates that (i) participants did not complete the task by analogy, in spite of the short amount of exposure; and (ii) participants extended the pattern consistent with cross-linguistic constraints on the well-formedness of sC clusters.

In conclusion, although the utility of IPE in naturalistic language learning remains to be explored, the results of our experiment hold promise that learners can rely on this type of evidence to facilitate or accelerate their acquisition of a subset grammar.

References

Broselow, Ellen & Daniel Finer. 1991. Parameter setting in second language phonology and syntax. *Second Language Research* 7(1). 35-60.

Cardoso, Walcir. 2008. When input frequency patterns fail to drive learning: The acquisition of sC onset clusters. In Andreia S. Rauber, Michael A. Watkins & Barbara O. Baptista (eds.), *New Sounds 2007: Proceedings of the Fifth International Symposium on the Acquisition of Second Language Speech,* 67-85. Florianópolis, Brazil: Federal University of Santa Catarina.
Available at: http://www.nupffale.ufsc.br/newsounds/Papers/7.Cardoso_Walcir.pdf

Clements, George N. 1990. The role of the sonority cycle in core syllabification. In John Kingston & Mary Beckman (eds.), *Papers in laboratory phonology I: Between the grammar and physics of speech*, 283-333. Cambridge: Cambridge University Press.

[4] Many participants incorrectly overgeneralized epenthesis to words that began with singleton /s/. We expect that exposure to a longer dialogue would be needed to retreat from this sort of error.

[5] Only three participants thought that the language was Portuguese, rather than Spanish: one learner and two non-learners, and one of these non-learners guessed both Portuguese and Spanish.

Goad, Heather. 2011. The representation of sC clusters. In Marc van Oostendorp, Colin Ewen & Keren Rice (eds.), *The Blackwell companion to phonology,* 898-923. Oxford: Wiley-Blackwell.

Goad, Heather. 2012. sC clusters are (almost always) coda-initial. *The Linguistic Review* 29(3). 335-73.

Goldsmith, John. 1990. *Autosegmental and metrical phonology.* Oxford: Blackwell.

Hulst, Harry van der. 1984. *Syllable structure and stress in Dutch.* Dordrecht: Foris.

Kaye, Jonathan. 1992. Do you believe in magic? The story of *s*+C sequences. *SOAS Working Papers in Linguistics and Phonetics* 2. 293-313.

Kaye, Jonathan, Jean Lowenstamm and Jean-Roger Vergnaud. 1990. Constituent structure and government in phonology. *Phonology* 7. 193-231.

Lightbown, Patsy M. & Nina Spada. 2006. *How languages are learned,* 3rd edn. Oxford: Oxford University Press.

Mateus, Maria Helena & Ernesto d'Andrade. 2000. *The phonology of Portuguese.* Oxford: Oxford University Press.

Pinker, Steven. 1984. *Language learnability and language development.* Cambridge, MA: Harvard University Press.

Pygame 1.9.1. 2009. Pygame. Available at: www.pygame.org.

Saleemi, Anjum P. 1992. *Universal grammar and language learnability.* Cambridge: Cambridge University Press.

Schwartz, Bonnie D. & Rex A. Sprouse. 1996. L2 cognitive states and the Full Transfer/Full Access model. *Second Language Research* 12(1). 40-72.

Schwartz, Misha & Heather Goad. 2015. Indirect positive evidence in the acquisition of a subset grammar. Submitted.

Sound eXchange. 2013. SourceForge. Available at: sox.sourceforge.net.

Steriade, Donca. 1982. *Greek prosodies and the nature of syllabification.* Cambridge, Mass: MIT dissertation.

Trapman, Mirjam & Rene Kager. 2009. The acquisition of subset and superset phonotactic knowledge in a second language. *Language Acquisition* 16(3). 178-221.

White, Lydia. 2003. *Second language acquisition and universal grammar.* Cambridge: Cambridge University Press.

Proceedings of the 6th Conference on Generative Approaches to Language Acquisition North America (GALANA 2015)

edited by Laurel Perkins, Rachel Dudley, Juliana Gerard, and Kasia Hitczenko

Cascadilla Proceedings Project Somerville, MA 2016

Copyright information

ISBN 978-1-57473-468-3 library binding

Ordering information

Orders for the library binding edition are handled by Cascadilla Press.
To place an order, go to www.lingref.com or contact:

Cascadilla Press, P.O. Box 440355, Somerville, MA 02144, USA
phone: 1-617-776-2370, fax: 1-617-776-2271, sales@cascadilla.com

Web access and citation information

This entire proceedings can also be viewed on the web at www.lingref.com. Each paper has a unique document # which can be added to citations to facilitate access. The document # should not replace the full citation.

This paper can be cited as:

Schwartz, Misha and Heather Goad. 2016. Indirect Positive Evidence in the Acquisition of a Subset Grammar in Phonology. In *Proceedings of the 6th Conference on Generative Approaches to Language Acquisition North America (GALANA 2015)*, ed. Laurel Perkins et al., 102-109. Somerville, MA: Cascadilla Proceedings Project. www.lingref.com, document #3210.