Reverse Engineering the L1 Filter:
Bagging the Elusive Construct of Intake Frequency

New Sounds 2013

JOHN ARCHIBALD
UNIVERSITY OF VICTORIA

- With a *nod* to Lewis Carroll's "*The Hunting of the Snark: An Agony in Eight Fits*"

Just the place for a Snark! the Bellman cried,

As he landed his crew with care;

Supporting each man on the top of the tide

By a finger entwined in his hair.

Fit #1: Introduction

Input vs. Intake

- Input: The linguistic environment
- Intake: The subset of the linguistic environment processed by a learner at a given time
- (Corder, 1967; VanPatten, 1996; Carroll, 2001)

Why Hunt for Intake? Frequency?

- It's a mythical beast that might help us to explain certain properties of L2 grammars (such as developmental paths)

Input Frequency

- Type
- Token
- L1 environment
- L2 environment
- Input counting is not monolithic

The Challenge

- To avoid circularity:
  - Q: why is it accurate?
  - A: because it was intake.
  - Q: how do you know it was intake?
  - A: because it is accurate.

Why is Intake Frequency Elusive?

- We can directly observe the stimulus (the input)
- We can directly observe the response (the output)
- We need a theory for the grammar
- We need a theory for which input becomes intake

What Do We Need to Explain? (the Explanandum)

- Properties (such as behavioural accuracy) of L2 comprehension and production
- One of the most basic facts about second language acquisition is that many L2 learners have difficulty producing and perceiving certain L2 sounds accurately

What Can Explain This?
(The explanans)

- L1 transfer (Trofimovich & Baker, 2006)
- Amount of experience (Bohn & Flege, 1992)
- Amount of L2 use (Guion, Flege, Liu & Yeni-Komshian, 2000)
- Age of learning

- orthography (Hayes-Harb et al. 2010; Escudero, & Wanrooi, 2010)
- frequency (Davidson, 2006)
- probability (Wilson & Davidson, 2009)
- attention (Guion & Pederson, 2007; Schmidt, 1990)
- training (Wang, Jongman & Sereno, 2003)

What's the Way in?

- Early-acquired if:
  - less-marked?
  - attended to?
  - more frequent?
  - orthographically encoded?

- What filters the input?

A Tangent on Filters

- H. Petard (1938). A contribution to the mathematical theory of big game hunting. American Mathematical Monthly.

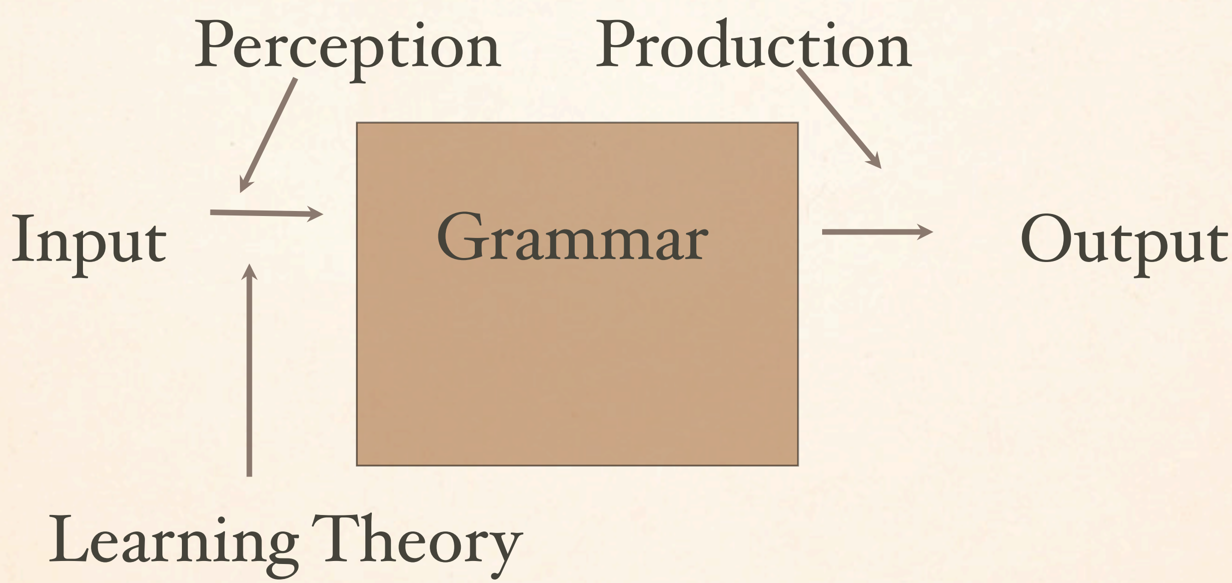
- *The thermodynamics method.* We construct a semi-permeable membrane, permeable to everything except lions, and sweep it across the desert.

- We may need another technique

Fit # 2: Acquiring New Elements

- Similarity is a good predictor of perceptual assimilation in vowels (Escudero & Vasilev, 2011)
- I'm going to focus more on consonants (and differences)

- Much of the work from my lab has focussed on whether you can acquire ‘stuff’ in the L2 which is absent from your L1


Perception
Production
Input
Grammar
Output
Learning Theory

Orwell's Problem

- In the face of such abundant evidence, how can we not learn?
- In the face of all the input, we can learn new things
- But it's not all acquired at once
- Some stuff gets through earlier or faster
- Why?

Cross-linguistic Speech Perception

- There is, of course, a rich history examining these questions:
  - Flege's SLM
  - Best's PAM (L2)
- A {θ} might be produced as a {t}
- An {ü} might perceived as an {u}

- These models have tended to focus on non-representational aspects of SLA
- They generally address acoustic/phonetic space as the locus of both diagnosis and explanation

DMAP

- Direct Mapping from Acoustics to Phonology (Darcy et al., 2012)
- detection of acoustic cues triggers changes to the phonological feature hierarchy
- but we might find a lexical contrast and assimilation in a categorization task

- we must consider both L2 phone categories and the acquisition of phonological representations

Input is Necessary…

- Obviously, second language learners must be exposed to input in the target language to acquire the relevant structures.
- However, it is not the case that learners merely acquire what they are exposed to. (See Cardoso's studies on frequency and markedness.)

...but not sufficient

- Learners can acquire some things that are not directly encoded in the speech stream (e.g., traces, moraic consonants, syllable weight, extrametricality, and perhaps counterintuitively *features*).
- This is an example of Plato's Problem: acquiring elements for which there is little evidence in the input

- And even if your L1 has the relevant feature, the cues to that feature may be different in the L2
- For example, the Voice feature in English is cued very reliably by the lengthening of the preceding vowel, (e.g., *bead/beat*). Final glottal vibration (actual voicing) can be suppressed entirely (Keyser & Stevens, 2006).
- This reminds us that feature acquisition is a *learning* problem not just a *noticing* problem; acquisition is not just perceptual assimilation

Acquiring New Structure

- Two basic mechanisms:
  - Re-deployment of L1 structures for novel means
  - Robust phonetic cues to influence the processing of L2 input leading to the acquisition of new structure

A Design Perspective

- If we were designing our processor, we would build in the properties of the filter
- First, let through L1 sounds
- Then let through sounds that are very unlike L1 sounds
- Etc.

We're not Designers, We're Hackers

- We've tried hard to make this design approach work but let's consider another perspective

Fit # 3: Reverse engineering

- Let’s look at what gets through and try to determine the source code of the filter

What's inside the machine?

- universal principles
- markedness
- L1 grammar
- a learning algorithm
- what else?

- Yes, we are committing mentalism

What Comes Out?

- What phonological features tend to show accurate performance? (Gonzalez, 2011)

New segments based on L1 feature can get through

[CORONAL]	L1 Mandarin/ L2 English L1 Japanese/L2 Russian	/l/-/ɹ/ /l/-/r/
[voice]	L1 Korean/L2 English L1 Japanese/L2 Russian	/f/-/v/ /ʂ/-/ʐ/
[continuant]	L1 Korean/L2 English	/p/-/f/ /b/-/v/

{anterior}	L1 English/ L2 Czech	/c/-/t/ /ɟ/-/d/

•

- In all of these cases, the role of robustness, or syllable position is attenuated
- [L1 feature]>>[cue]//[position]

Inaccurate Perception

- Of course, the literature contains examples of cases where lack of an L1 feature leads to inaccurate L2 perception

{CORONAL}	L1 Japanese/L2 English	/l/-/ɹ/
{vibrant}	L1 Japanese/L2 Russian	/l/-/r/
{pharyngeal}	L1 English/L2 French	/ɹ/-/ʀ/

- Though reported as problematic, many of the discrimination results were quite good (60-80% accurate)
- Factors such as L2 proficiency level are important

The Remaining Possibility

- Accurate perception based on non-L1 features
- I.e., what can override the L1 feature filter?

•

{CORONAL}	L1 Japanese/L2 English Codas	/l/-/ɹ/
{vibrant}	L1 Japanese/L2 Russian (Advanced)	/l/-/r/
{strident}	L1 Japanese/L2 English	/s/-/θ/

[strident]	L1 Japanese/ L2 English L1 French/L2 Japanese	/s/-[θ/ /f/-/ɸ/
[continuant]	L1 French/L2 English	/θ/-/t/

- In these cases, robustness is critical
- {cue} & {position} interact

[OCP Continuant]

- Enochson (2012) argued that sequences which disagree in continuancy are produced more accurately than those which agree
- she ascribes this to a representational constraint
- the heightened accuracy could also arise from the robustness of [continuant] as an input cue

- we also see this with features [long] (Summerell, 2007); [click] (Best, et al., 1988)
- These cases rely on either a feature that is perceptually salient (e.g. [continuant] (Stevens & Keyser, 1989) or located in a position where cues are enhanced (e.g. English liquids in codas; Wright 2004)

Robust Phonetic Cues

- Following Wright, we can account for why certain segments are processed more accurately than other segments
- Or why certain positional variants (sometimes onsets, sometimes codas) are processed more accurately
- Their phonetic properties may make them more accessible to the phonological parser

- It's all out there in the *input* but what becomes *intake* first?

Robust Cues

- redundancy of cues
- auditory impact of cues
- resistance of cues to environmental masking

- “a robustly encoded signal is more likely to survive signal degradation or interference in reception”
- it is more likely to become intake
- what starts as a property of the signal, becomes a property of the representation
- by “surviving degradation” a string is more likely to become lexicalized (or phonologized) in the L2

- thus contrasts with redundant cues, which can resist environmental masking, and survive listener distractions, are more likely to be encoded
- I operationalize “listener distraction” to include L1 transfer effects like perceptual assimilation

Cues

- information in the acoustic signal that allows the listener to apprehend a phonological contrast
- Release bursts are aperiodic (5-10ms duration)
- they are subject to environmental masking though

Cues to Voicing

- periodicity
- VOT
- closure duration
- preceding vowel properties
- This is grammar, not just noticing or filtering

- cue strength can affect the reliable recovery of the segmental sequence
- thus it is related to accurate processing and “intake”

Evidence

- We will look at 4 case studies

Fit # 4: [constricted glottis]

- Gonzalez (2011) looks at the acquisition of Yucatec Mayan ejectives by NS of Spanish
- Spanish lacks the [constricted glottis] feature
- Can they acquire it in L2 Yucatec Maya?
- AX auditory discrimination task
- Forced choice picture selection task

- NNS not significantly different from NS in onset position
- However they *are* significantly different from the NS in coda position
- The recoverability cues for ejectives are much subtler in coda position

- Ejectives are robust due (in part) to their dual release bursts (oral & glottal).

Onsets exploded

- Within the onsets, though there are differences that I won’t explore in depth in terms of accuracy of perception:
  - k’/p’ > t’/tʃ’ > ts’

Codas Exploded

- And note the pattern in codas:

    - tʃ’ > ts’ > k’ >’ p’ > t’

- not all exemplars of [CG] are parsed at the same time
- Onset, non-strident stop: boost intake frequency
- Coda, strident stop: boost intake frequency
- These are grounded typologically and phonetically
- Perceptual accuracy paves the way for grammatical restructuring and the phonologicization of [constricted glottis]

Fit # 5: [spread glottis]

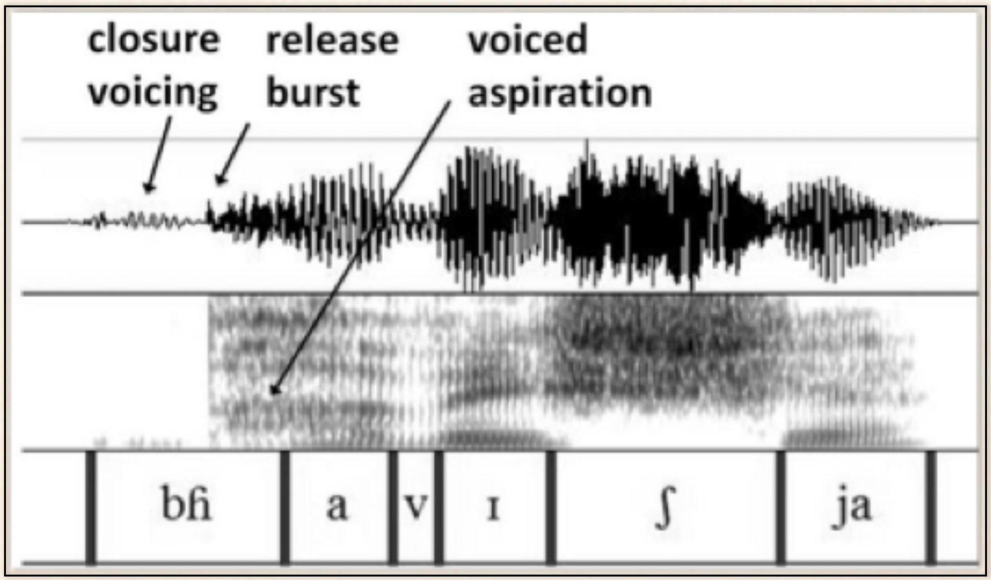
- Jackson (2009)
- Perception of Hindi voiced aspirated stops by NS of English and French
- Assumes (following Salmons & Iverson) that English has [spread glottis] while French has [voice]
- English: short lag vs. long lag
- French: pre-voiced vs. short lag

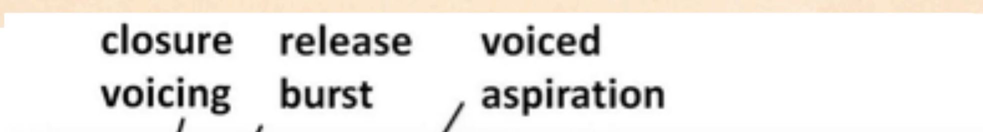
Results of ABX task

	{voice}	{spread glottis}	both
English	68.9	83.9	85.9
French	79.6	63.5	78.8

- French subjects were significantly better than English subjects on contrasts involving {voice} alone
- English subjects were significantly better than French subjects on contrasts which involved {spread glottis} alone
- Yet both groups were able to accurately perceive the voiced aspirated stops (which involve contrasts not based on the L1 features)
- This may well be due to the robust transitional cues available in onset position

- A synthesized discrimination task (Jackson 2011) revealed that NNS were sensitive to release burst and voiced aspiration but not closure-voicing duration (though NSers were)
- I.e., they were sensitive to the transitional cues but not the internal cue


closure voicing
release burst
voiced aspiration
bɦ
a
v
ɪ
ʃ
ja


closure voicing
release burst
voiced aspiration

Fit # 6: Non-Robust Cues

Non-Robust Cues

- Mah (2011)
- NS of French acquiring English [h]
- A Mis-Matched Negativity ERP paradigm
- Subjects could perceive [h] on auditory tasks but showed no MMN response on lexical tasks
- Furthermore, there was no N400 response for semantic anomalies such as "hair" and "air"

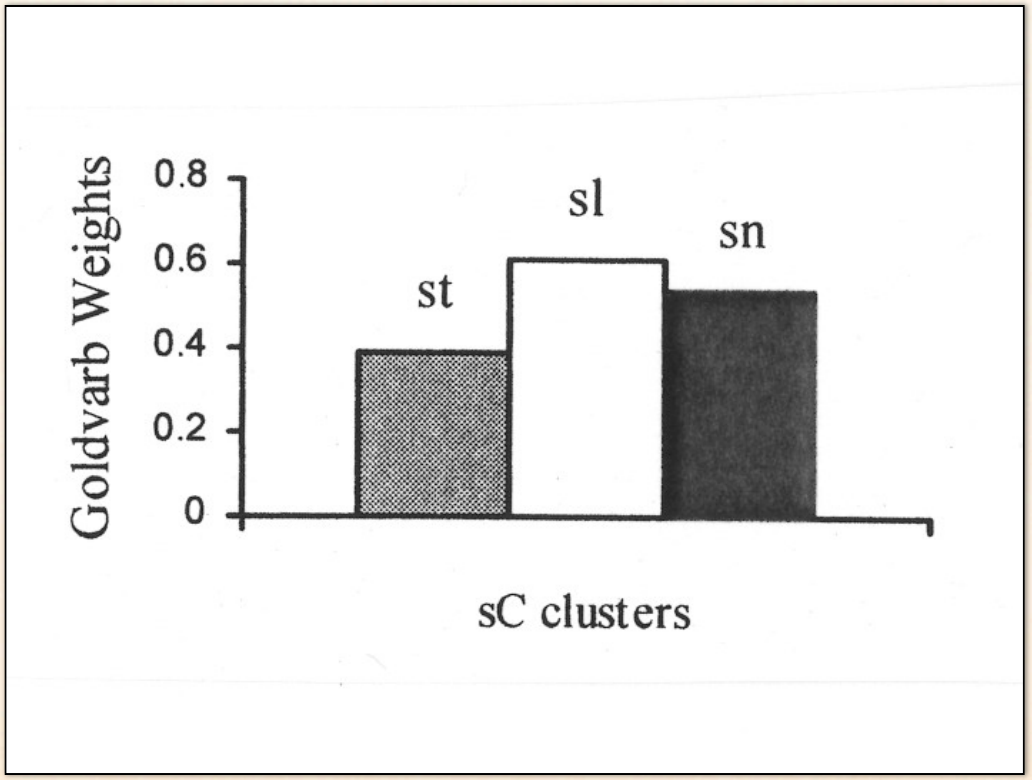
- She argues that there is a representational problem connected to /h/ and aspiration

- I would argue that these data show that the contrast is more difficult to acquire (yet not impossible) due to the non-robust phonetic cues marking the contrast (and in this case ‘internal’ cues)

Fit # 7: Clusters

- Release burst also helps to account for the accuracy patterns described in the acquisition of consonant clusters by Brazilian Portuguese learners of English (data from Cardoso)

Production Patterns

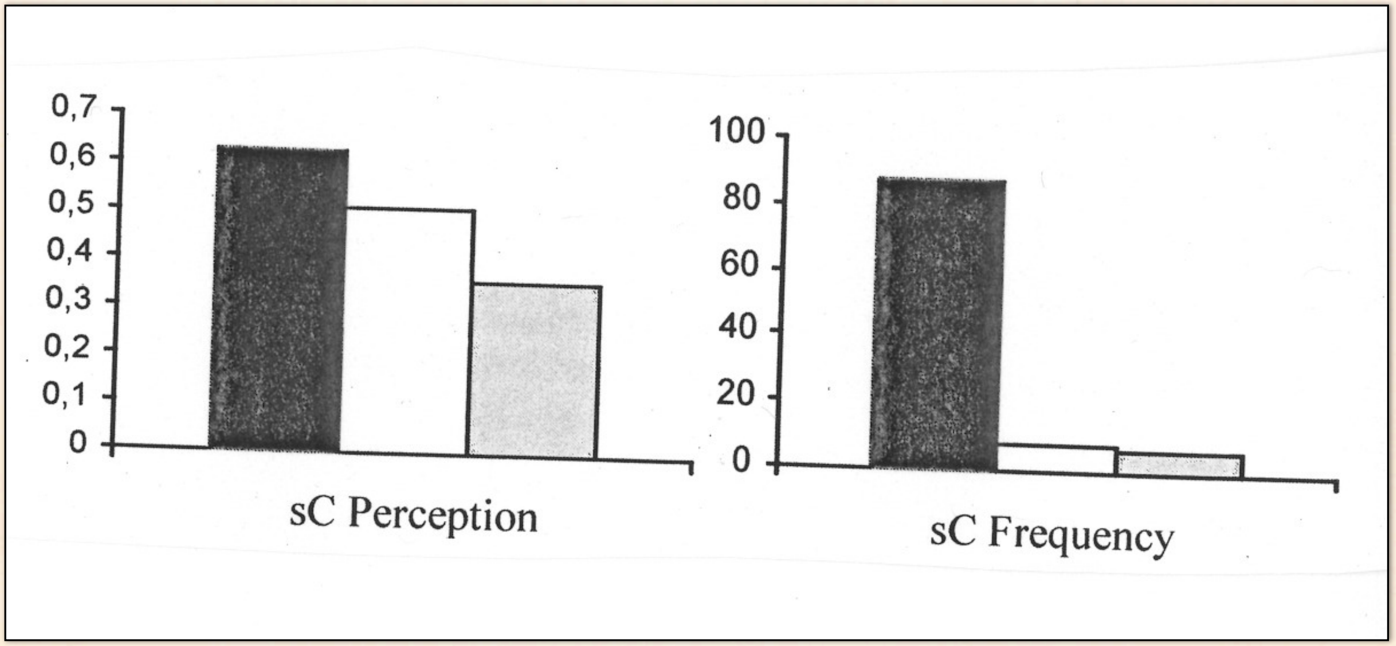


Production

- Most accurate on least marked
- Least marked is also the least frequent

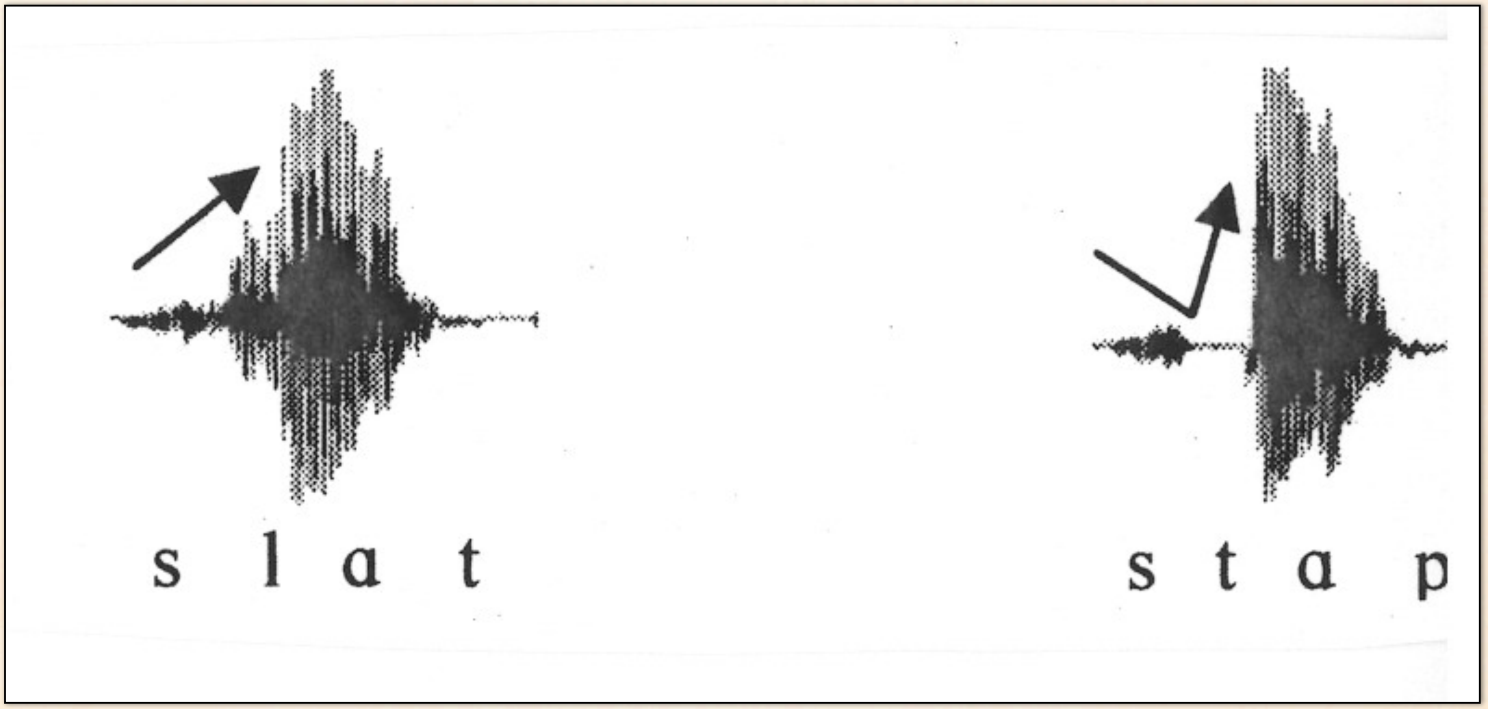
- So markedness explains production accuracy better than input frequency

Perception Patterns



- But perception accuracy appears to be correlated with input frequency
- However, there is another factor to be considered

Perception Accuracy & Release Burst



- Wilson & Davidson (2009) also explore this approach in explaining cluster production (more robust cues are preserved)

Fit # 8: A Synthesis

Phonetics or Phonology as explanans?

- When we look at results of such comparisons as
  - Japanese NS acquiring English [ɹ] (e.g. Brown): low accuracy
  - Japanese NS acquiring Russian [r] (e.g. Larson Hall): high accuracy
- We can see that phonetic properties can influence phonological grammars

Harmony As Faithfulness

- We can also model this learning in a Harmony-as-Faithfulness approach (Howe & Pulleyblank 2004)
- Preserve more robust contrasts

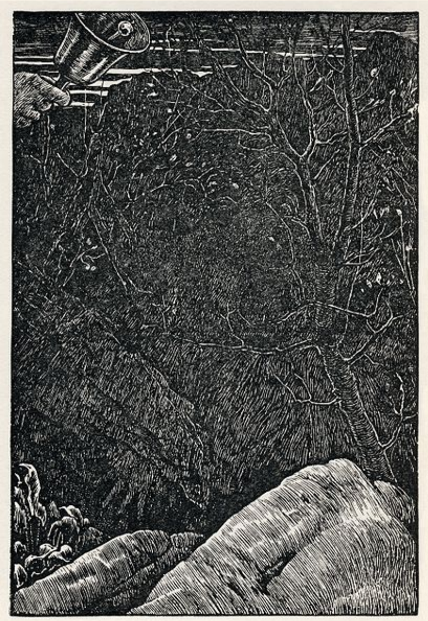
- Flemming (2012) ranks constraint violations not constraints
- Jesney & Tessier (2011) introduce harmonic biases in constraint weighting
- And thus, we bring perception, production, grammar and learning together

Learning Algorithm

- Initial State: High ranked markedness for new segments
- As the grammar changes, new segments are allowed (via markedness demotion)

- Release bursts determine
  - which items boost intake frequency
  - which markedness constraints are demoted to be interleaved with Faithfulness constraints
- Production: preserve more robust cues
- Perception: parse more robust cues

- Perception: Influenced by intake frequency (that elusive Snark)



The Tracks of the Snark

- [long], [strident], [vibrant], [continuant], [constricted glottis], [murmur], [click]
- enhancement: certain features in certain positions
- each of these adds a boost to the frequency counter; certain input is privileged to become intake

Conclusion

- This doesn't discount any of the other components of the input filter:
- L1
- markedness
- input frequency
- attention
- training
- orthography

- but, we need to add the arrow of intake frequency to our SLA quiver
- Learning is mitigated by intake frequency which is, in turn, modulated by robust transitional cues

- *They sought it with thimbles, they sought it with care;*
- *They pursued it with forks and hope;*
- *They threatened its life with a railway-share;*
- *They charmed it with smiles and soap.*

Intake frequency

- These specific case studies allow us to deduce some of the properties of the input filter
- By examining the tracks, we learn about the nature of the system which created them.

As with much science, with data,
a mythical beast may turn out
to be not as elusive
as we thought.

References

- •Archibald, J. (2005). Second language phonology as redeployment of L1 phonological knowledge. *CJL* 50(1/2/3/4): 285-314.
- •Atkey, S. (2001). The acquisition of non-native segmental contrasts: a look a English speakers' acquisition of Czech palatal stops. New Sounds xxxx.
- •Avery, P. & W.J. Idsardi (2001). Laryngeal dimensions completion and enhancement. In T. Hall, ed. *Distinctive Feature Theory*. Mouton. Pp. 41-70.
  •Cardoso. W. (2007). The development of sC onset clusters in interlanguage: markedness vs. frequency effects. *GASLA Proceedings*. Cascadilla Press.)
  •Cardoso, W. , P. John & L. French (2009). The variable perception of /s/ + coronal onset clusters in Brazilian Portuguese English. In M. Watkins, A. Rauber & B. Baptista, eds. *Recent Research in Second Language Phonetics/ Phonology*. Cambridge Scholars Publishing. Pps. 203-233.
- • Darcy, I., et al. (2012). Direct mapping of acoustics to phonology: On the lexical encoding of front rounded vowels in L1 English-L2 French acquisition. *SLR* 28(1): 5-40.
- •Davidson, L. (2006). Phonology, phonetics, or frequency: Influences on the production of non-native sequences. *Journal of Phonetics*, 34: 104-137.
- •Enochson, K. (2012). The effect of continuance on the L2 production of onset clusters. *GALANA* 5. Kansas.
- •Escudero, P. & P. Vasilev (2011). Cross-language acoustic similarity predicts perceptual assimilation of Canadian English and Canadian French vowels. *Journal of the Acoustical Society of America* 130(5: 277-283.
- •Flemming, E. (2012). Violations are ranked, not constraints: A revised model of constraint interaction in phonology. Rutgers colloquium.
  •Gonzalez, A. (2011). *Conflict Resolution in the Spanish SLA of Yucatec Ejectives: L1, L2, and Universal Constraints.* Ph.D. dissertation. University of Calgary.
  •Howe, D. & D. Pulleyblank (2004). Harmonic scales as faithfulness. *Canadian Journal of Linguistics*. 49(1): 1-50.

••Jackson, S. (2009). *Non-Native Perception of Laryngeal Features*. M.A. Thesis. University of Calgary.

••Jackson, S. (2011). Voicing and aspiration in the production and perception of Hindi laryngeal stops. PhD candidacy paper. University of Calgary.

••Jesney, K. & A.-M Tessier (2011). Biases in Harmonic Grammar: The Road to Restrictive Learning. *NLLT* 29(1): 250-290.

•Iverson, G. & J. Salmons (1995). Aspiration and laryngeal features in Germanic. *Phonology* 12: 369-396.

••Larson-Hall, J. (2004). Predicting perceptual success with segments: a test of Japanese speakers of Russian. *SLR* 20 (1): 33-76.

••Nogita, A. & Y. Fan (2012). Not vowel epenthesis: Mandarin and Japanese ESL learners' production of English consonant clusters. *Working Papers of the Linguistics Circle of the University of Victoria* 22(1): 1-26.

••Fumiko Summerell. The L2 Acquisition of Japanese Length Contrasts. Supervisor. 2007.

••Tessier, A.-M., T. Sorenson Duncan & J. Paradis (2012). Developmental trends and L1 effects in early L2 learners' onset cluster production. *Bilingualism: Language & Cognition.*

- •Vanderweide, T. (2005), *Cue-Based Learning and the Acquisition of Pre-Vocalic Clusters*. Ph.D. dissertation. University of Calgary.
- •Vaux, B. (2006). What L2 phenomena reveal about phonological cognition. *North American Phonology Conference* 4. Montreal,

•Wright, R. (2004). A review of perceptual cues and cue robustness. In B. Hayes et al., eds. *The Phonetic Bases of Markedness.* CUP.

- Thanks to all my wonderful students over the years, and to Darin Flynn, and Steve Winters for their discussion of these issues.

- Thank you for your attention

- johnarch@uvic.ca

University of Victoria
Humanities

Borges' Taxonomy

1. those that belong to the Emperor,	8. those included in the present classification,
2. embalmed ones,	9. those that tremble as if they were mad,
3. those that are trained,	10. innumerable ones
4. suckling pigs,	11. those drawn with a very fine camelhair brush,
5. mermaids,	12. others,
6. fabulous ones,	13. those that have just broken a flower vase,
7. stray dogs,	14. those that from a long way off look like flies.

From the Celestial Emporium
of Benevolent Knowledge