L2 Phonology at the Interfaces

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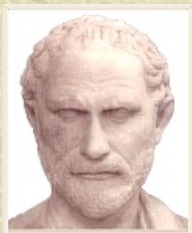
International Symposium on Monolingual and Bilingual Speech

2017



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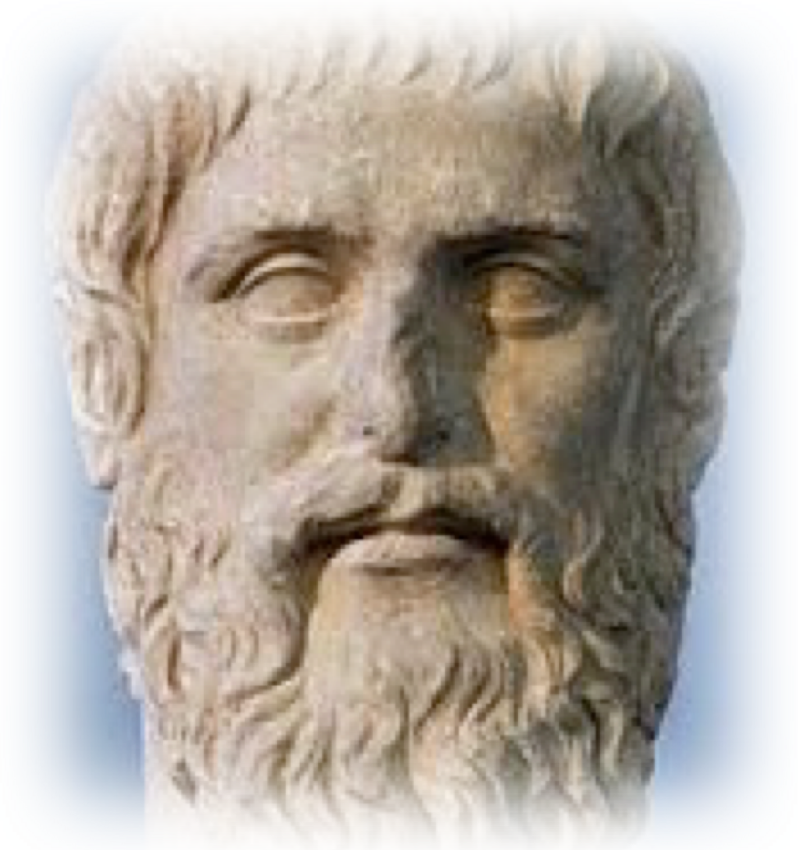
SLA Theory

- Facing 3 epistemological challenges

Plato's Problem



Knowing things that are not found in the environment

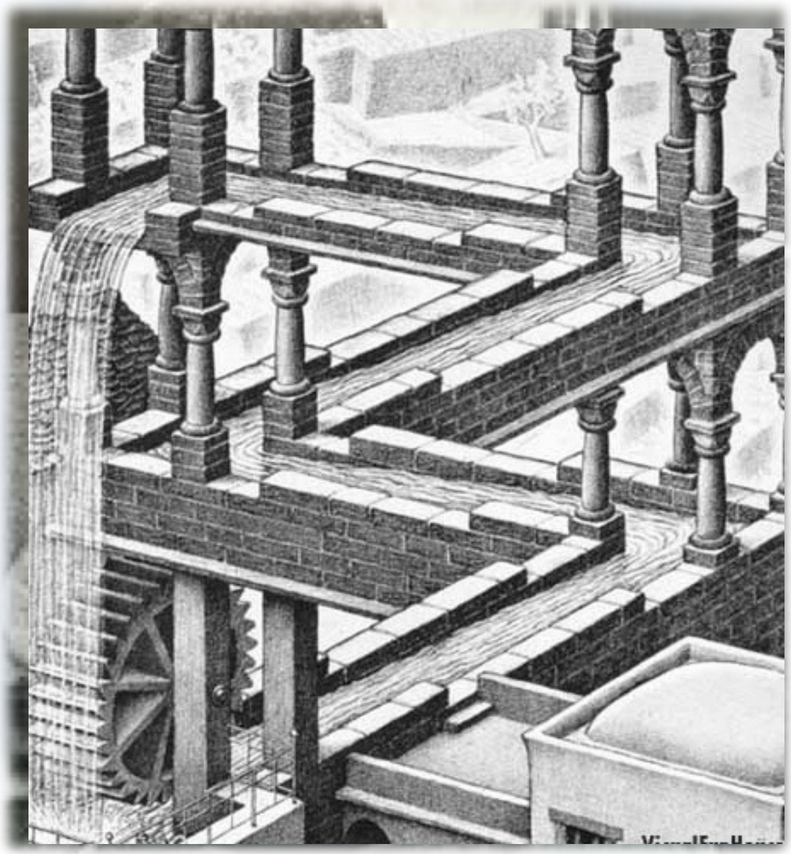
- Poverty of the Stimulus
- Codas
- Moras
- Traces
- Extrametricality

Orwell's Problem

***Not* knowing things that are frequent in the environment**

- Evidence for Evolution
- Evidence for Climate change
- [θ]

Escher's Problem



The challenge of Augmented Reality

- Perceiving things that aren't in the acoustic (or visual) input
- Illusory vowels

Our Goal: A Unified Model of SLA

- Domain-specific hierarchical representations which are consistent across interfaces
- And a processor to drive performance and learning

- See Archibald (2017a) for broader discussion

Representational (aka Indirect) Realism

- Essentialism
  - versus Externalism (Bresnan & Ford, 2010);
  - or Emergentism (MacWhinney & O'Grady, 2015)
- Phonology as cognition (Hale & Reiss, 2000)

Relevant Interfaces

- Phonetics
- Morphology
- Syntax

Rampant Heterogeneity: Mix and Match Theory

- Understandably, each domain can have its own rich literature and vocabulary

Phonetics

- "If the duration of the closure extends beyond 50 ms, the intraoral pressure reaches a steady value equal to the subglottal pressure, and the glottal airflow decreases to essentially zero."

  --Stevens, (2000: 328)

Phonology

- "This stochastic OT grammar….will be translated into an ordinal OT ranking…by randomly choosing a one-time value for each constraint from under the probability curve."

  --Tessier, (2016: 370)

Morphology

- “There is a well-known hierarchy of grammatical persons in the [Algonquian] languages that determines the direct and inverse forms of the transitive verb. We may represent this hierarchy as follows: 2 > 1 > 3 > 3', which means that second person takes precedence over first, and these two take precedence over third proximate, which in turn takes precedence over third obviative”

  --Dawe-Sheppard and Hewson, (1990:1)

Syntax

- "We argue that impoverished versions of T and *v* in VSO clauses lack the probe features involved in subject agreement, EPP, object shift and nominative/accusative valuation with Xhosa SVO sentences."

  --Carstens & Mletshe (2015)

- But what are the commonalities?
- What if we could bring it all together…

A single engine

Noted Interface Phenomena

- Variability in production
- Indeterminate knowledge
- Bottleneck of morphosyntactic accuracy (despite acquisition of core ('narrow') syntax and semantics)

Interfaces Reveal Architecture

- Single grammatical engine for phonology, morphology, and syntax
- Consistent with Bottleneck Hypothesis (Slabakova, 2014) – extended to ‘Narrow’ Phonology

Narrow Phonology

- There is much evidence to show that L2 phonological categories can be acquired.
  - Phonemes
  - Syllable structure
  - Vowel harmony
  - Stress

The Unifying Theme Today

- The import and centrality of L2 phonology to SLA theory; part of GenSLA
- Successful L2 spell-out of categorical, representational phonology at key modular interfaces

The Centrality of Phonology

- Now, you'd think talking about the importance of phonology at an international speech conference would be like

Coals to Newcastle

Architecture of an Interface

- Phonology/Morphology
- Phonology/Phonetics
- Phonology/Syntax

It All Begins With: Morphology

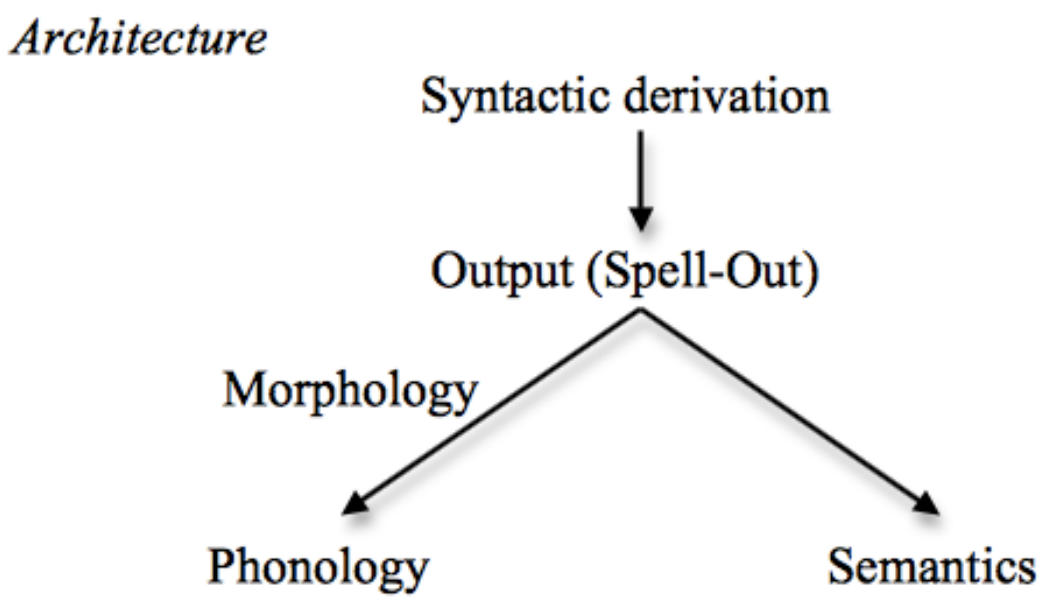
- "The idea that a large part of the phonological grammar operates in ways that are utterly indifferent to or incompatible with the system for generating complex objects is suspicious, or at the least unfortunate… ….rather than assuming that morphosyntax and morphophonology might be fundamentally different….it should be assumed that there is no extreme difference between these facets of grammar."

--Embick (2010)

Properties of Distributed Morphology (DM)

- Functional morphemes are bundles of features (e.g., [past]) in the syntax which, via Vocabulary Insertion (VI), are spelled out phonologically.
- There is competition for allomorph selection but, crucially, no competition between complex objects (as in OT).

- A syntactic derivation is sent to Spell Out which is then sent to both PF (Phonetic Form) and LF (Logical Form)



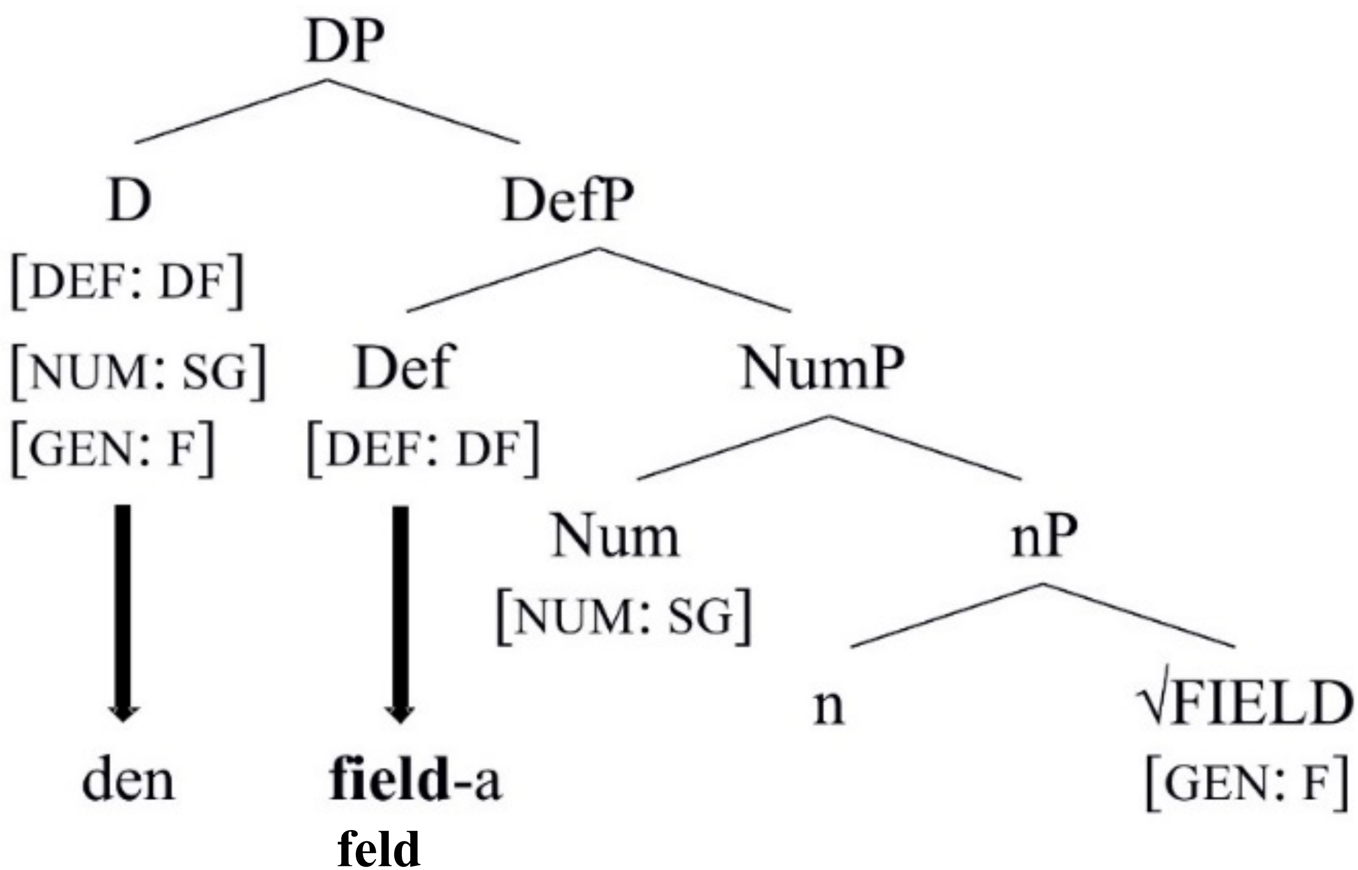
Properties of Distributed Morphology (DM)

- There is a matrix of features on the syntactic terminal node and various Vocabulary Items would compete for insertion by seeing which affix matched the most features.

Properties of Distributed Morphology (DM)

Roots

- The store (of category-neutral roots) contains no phonological information (reminiscent of *lemmas* which have conceptual structure but no phonological structure)
- √*dog* or √*chien* or √σκύλος
- Grammatical categories are established in the syntax via functional heads such as *v* or *n*.


DP
D
[DEF: DF]
[NUM: SG]
[GEN: F]
DefP
Def
[DEF: DF]
NumP
Num
[NUM: SG]
nP
n
√FIELD
[GEN: F]
den
field-a
feld

DM & Language Mixing

- Alexiadou et al. (2015) look at heritage Norwegian speakers in the U.S. who can mix English roots with Norwegian affixes
  - Så **play**-de dom **game**-r

    then play-PAST they game-INDEF.PL

    Then, they played games.

DM & Language Mixing

- The affixes come from the terminal nodes on a Norwegian syntactic structure (note V2)
- Note, though, that an L2 root can get inserted into an L1 syntactic skeleton
- Archibald (2016) suggested that roots can be subject to the same competition in bilinguals.

DM Redux

- Consistent with Libben’s (2000) Homogeneity Hypothesis, the DM lexicon is non-selective
- See also Hilderman (2017) for an instantiation of DM in Sharwood Smith’s MOGUL to account for intra-word codeswitching.

Competition for Root Insertion

- Haugen & Siddiqi (2013) argue that there is competition for roots and therefore the root is part of the Vocabulary list (see also Marantz (1995) on late Root insertion).
- We also see evidence for this in the psycholinguistics of bilingual root insertion.

Bilingual Competition

- Studies on the non-selective bilingual lexicon (e.g. Dijkstra et al, 1999)

Interlingual Homophones	**Interlingual Homographs**
e.g. English/Dutch [lif] ‘leaf’/ ‘dear’	e.g. English/Dutch “glad” [glæd]/[xlat]
-slower (inhibited) activation	-faster activation
-don’t share a root -same spell out	-don’t share a root -different spell out

Monolingual Competition

- Studies on polysemy (e.g. Pylkännen et al. 2006) show that different senses of a polyseme have shorter M350 latencies. Berretta, Fiorentino & Poeppel, 2005) show that polysemy is facilitative and homonymy is inhibitive in a LDT.

Polysemes	**Homophones**
e.g. The *paper* is owned by Murdoch. The *paper* was written by Elena.	e.g. He fell off the river *bank*. She opened an account at the *bank*.
-faster activation	-slower activation
-share root -same spell out	--don't share root -same spell out

Interlingual Allomorphs

- What are traditionally called *translation equivalents*.

Interlingual Allomorphs

e.g. √*dog* and √*chien*

-share root (bilingual root competition)
-different spell-out
-polysemy in bilingual speech context

The Role of Phonology

- “Translation equivalent primes (both cognate and non-cognates) ---aka *interlingual allomorphs*---produce facilitation via their shared meaning representation.”

  --Nakayama et al. (2013)
- Like polysemy – they share a root

The Role of Phonology

- Consider the phonological comparisons translation equivalents between Japanese/English:
  - Cognate: /remoN/ ‘lemon’
  - Non-cognate: /josei/ ‘woman’
- When activating the same root, the phonological overlap facilitates recognition

Phonology & the Lexicon

- Phonology is central to understanding the representation and processing of the multilingual lexicon
- DM is the architecture that captures multilingual root competition

Affixes

- Abrahamsson (2003) presents some classic data on the acquisition of coda consonants in L2 Swedish morphology by L1 Mandarin speakers
- His data involve, I would argue, not a functional principle of *recoverability,* but rather, a DM feature-bundle style analysis

Swedish ‘r’s

- *If [r] is part of a lexical stem it will be pronounced more accurately than [r] that is part of present tense or plural affixes*.
- Retention of an ‘r’ in lexical forms helps *recoverability* more than the retention of ‘r’ in inflected forms because there are *redundant cues* to things like tense and plural.

Present Tense	Plural	Monomorphemic
kasta-r ‘throw[s]’	sko-r ‘shoes’	dyr ‘expensive’
gå-r ‘walk[s]’	bil-ar ‘cars’	hår ‘hair’

All the subjects had significantly more errors for multimorphemic words than for monomorphemic words; it’s not *just* phonology.

- The difference in error patterns between inflected versus uninflected forms implicates syntactic features in the explanation.
- But what of the differences between performance on [past] versus [plural]?
- Remember Abrahamsson invokes a functional explanation: unique markers are retained more than redundant markers.
- But, as he admits, it is not easy to tell whether Tense or Plural is more redundant in Swedish.

- Prosodic Transfer Hypothesis (Goad & White, 2006; Lardiere, 2007) can't explain the difference between the suppliance of the two morphemes

Accuracy

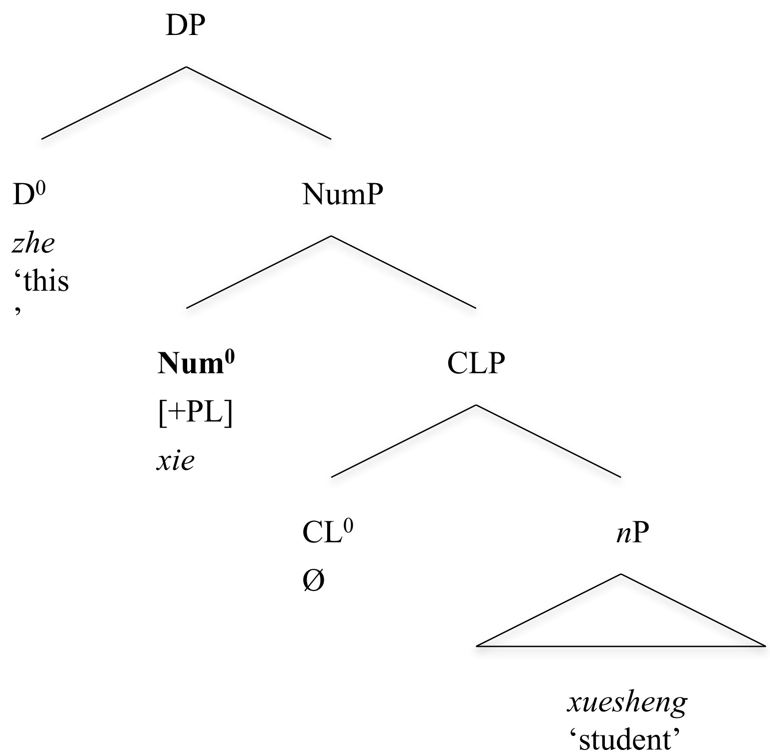
- The L2 Swedish (L1 Mandarin) subjects are more accurate on Plural than they are on Present

A DM Transfer Analysis

- The *singular* Number head is null, but *plural* [+PL] must be marked morphologically. (Yang, 2005).

The underlying plural feature is available for L2 spell out.

‘these students’



A DM Transfer Analysis

- Mandarin doesn't have Tense but rather Aspect, so (as is well discussed in the literature) there is clearly a learning task here; it does have [finiteness], though
- Mandarin learners have difficulty with Tense (Hawkins & Liszka, 2003)

Phonology & Morphemes

- Phonology is central to the understanding of the spell out of L2 morphemes
- DM is the architecture that captures late insertion of L2 morphemes (and intraword codeswitching –Stefanich (in progress))

The Phonetics Interface

- Illusory Vowels

Perceptual Illusions & Phonology

- Studies from a number of L1s (Japanese - Dupoux; Matthews & Brown, Korean- Kabak & Idsardi, Brazilian Portuguese – Cardoso; Cabrelli Amaro) reveal perceptual illusions
- In production, subjects insert an epenthetic vowel between the obstruents
  - baseball ➔ basubaru
- Japanese: does not allow obstruent consonantal sequences word medially:

  *ac.tor

- But this happens in perception too
- When exposed to a string like [ebzo], the Japanese subjects *hear* [ebɯzo] whether or not there is a vowel present (Dupoux, et al. 1999): Japanese (72% illusory vowel); French (10% illusory vowel)

Thai

- Thai does not allow onset clusters either
- It *does* allow medial clusters (like 'ac.tor')
- But Thai (unlike Japanese) L1 subjects (since Thai allows medial obstruent strings) do NOT hear an illusory vowel medially (Matthews & Brown)
- When they are presented with [ebzo], they hear [ebzo]

- Kabak & Idsardi (2007) show that this phenomenon of vowel epenthesis is mediated by phonological structure (specifically *Coda*) not just by linear adjacency

sC Onset Perception

- There is a cottage industry looking at sC clusters in SLA

Structural Properties

L1	sC Onsets	Branching Onsets	Branching Codas	Errors
Japanese	No	No	No	72%
Thai	No	No	No	60%
Brazilian Portuguese	No	Yes	No	50%
Persian	No	No	Yes	??

This is not a simple task.

Structural Properties

L1	sC Onsets	Branching Onsets	Branching Codas	Errors
Japanese	No	No	No	72%
Thai	No	No	No	60%
Brazilian Portuguese	No	Yes	No	50%
Persian	No	No	Yes	**15%**

But the Persian subjects are very good!

Why?

- Persian does not allow branching onsets
- Persian allows branching codas up to two consonants
- Persian codas can violate Sonority Sequencing

--Archibald & Yousefi (2017)

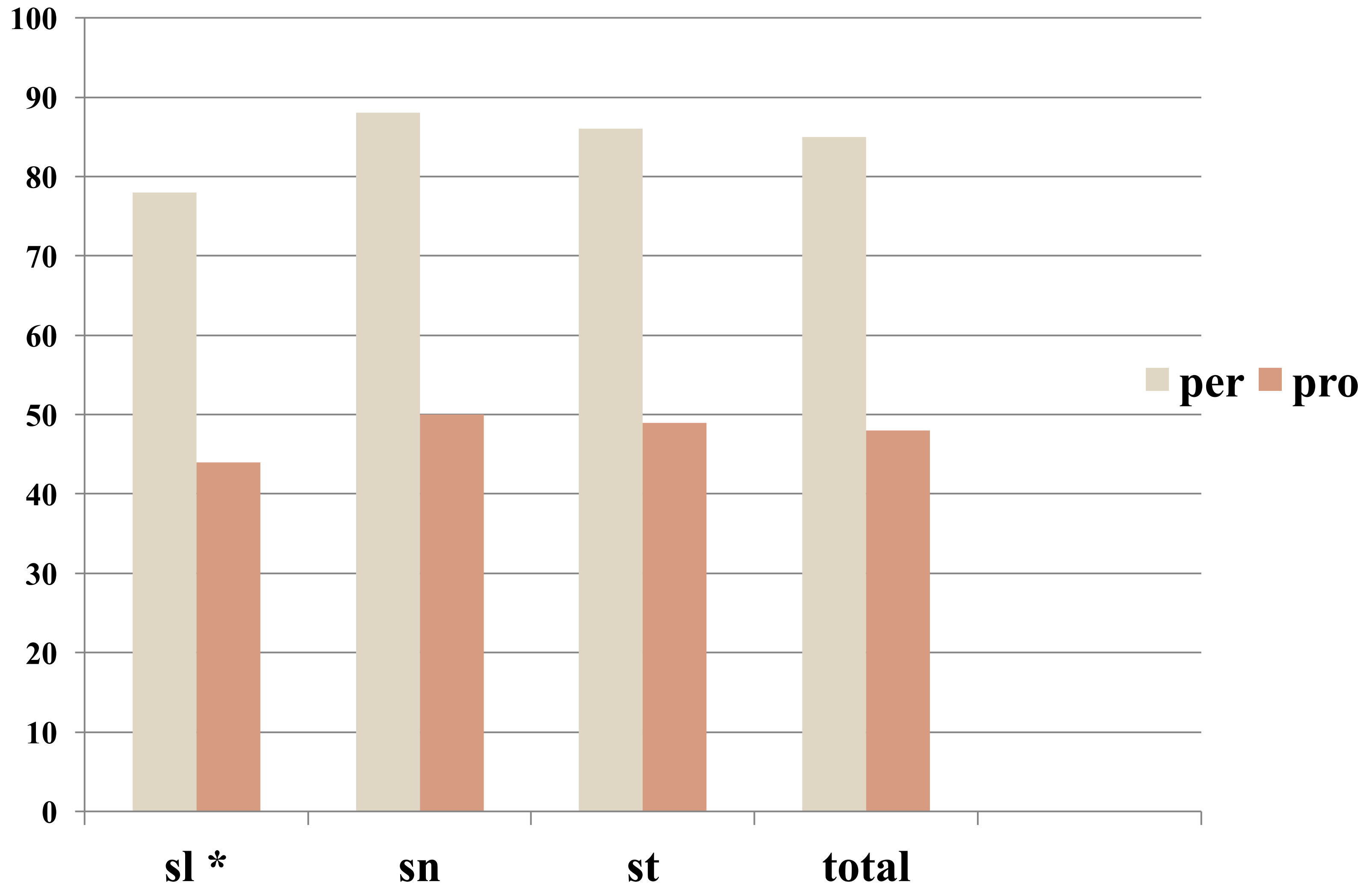
- Persian has marked coda clusters (e.g. [tm] , [br]) with *rising* sonority (MSD = -5)
- English has marked onset clusters (e.g. [st]) with *falling* sonority (MSD = -1)
- Codas are more marked than onsets
- L2 English is a subset of L1 Persian setting

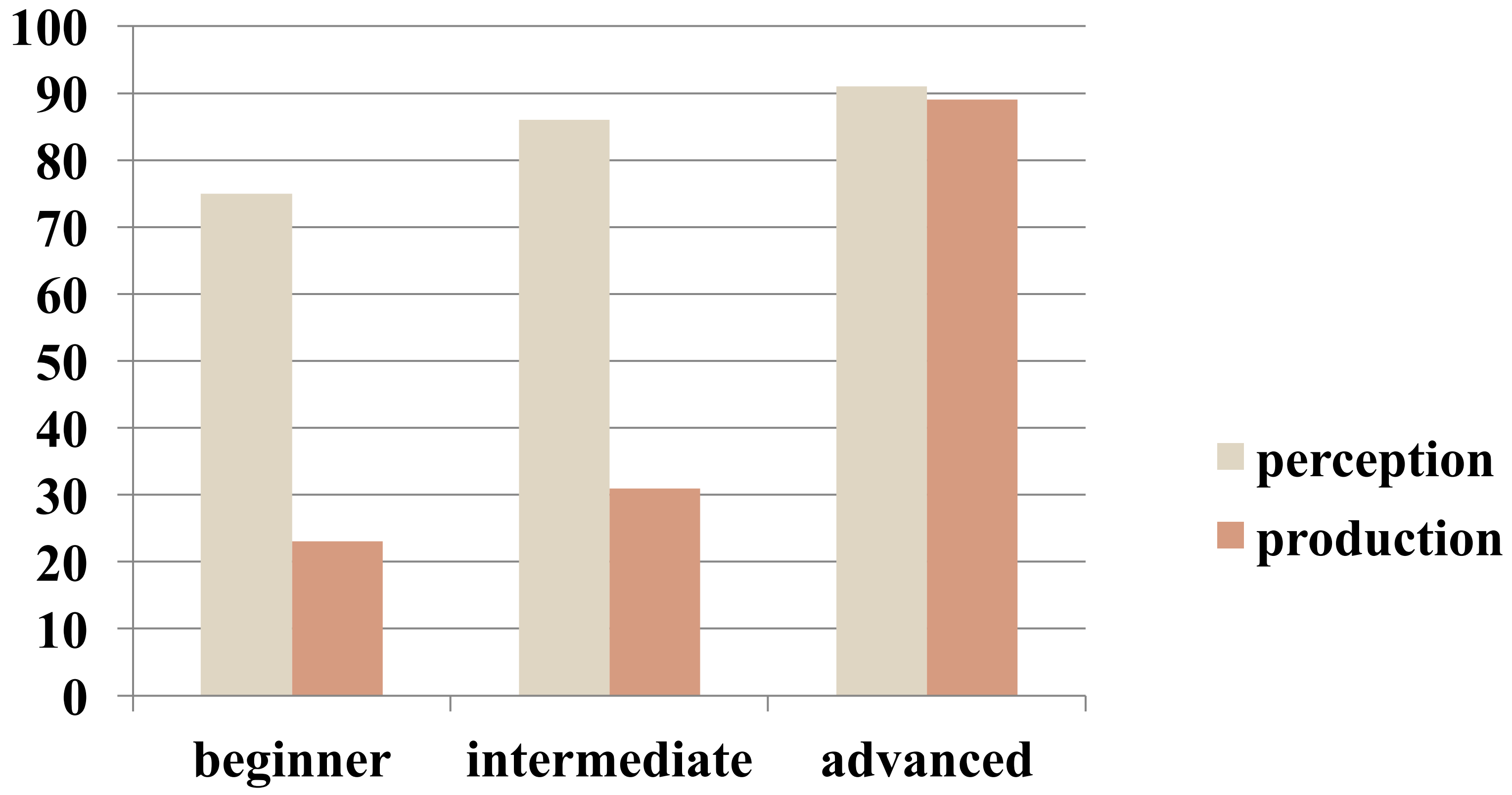
Redeployment Hypothesis

- Based on Archibald (2006)
- Persian L1 subjects transfer their marked L1 coda knowledge to be able to acquire the L2 English marked sC onset structures
- Both marked strings are characterized by a *negative* sonority distance

- Identification Task
  – a forced choice identification experiment
- Discrimination Task
  – discriminate between /s/ and /es/ word-initally via an ABX discrimination task.

Accuracy of perception and production of /sl/, /sn/, and /st/




100
90
80
70
60
50
40
30
20
10
0
beginner
intermediate
advanced
perception
production

Representational Realism

- The grammar – not production, not linear adjacency, not direct and accurate storage of the input stream– explains the observed *perception* patterns
- consistent with domain-specific (not general executive cognitive) representations (Blanco-Elorrieta, E., & L. Pylkännen (2016) for language switching)

Production is different

- Language control in production recruits *domain-general* regions (dorsolateral prefrontal regions bilaterally) which are also implicated in non-language switching tasks
- while perception recruits *language-specific* regions (anterior cingulate cortex) which is not implicated in a non-language switching task.

Illusory Vowels

- The perceptual illusions are part of *grammar* (consistent with Cabrelli Amaro et al., 2017)
- The produced epenthetic vowels (i.e. for the Persian L1 speakers), on the other hand, are under cognitive executive control.

Phonology & Perception

- Phonology is central to understanding the phenomenon of illusory vowels in production and perception
- Executive control can be separate from phonology

The Syntax Interface

- L2 syntax also reveals the centrality of phonology

Syntax

- Languages have two strategies for forming WH questions:

- **English** (Movement): **Whom** should Bob call?
- **Japanese** (*in situ*): Mito ga **nani o** katta no?
  Mito-Nom what-Acc bought +Q
  'What did Mito buy?'

- Richards (2010, 2016) argues that these are two strategies
- to achieve *contiguity*;

(a) **English**: linear adjacency of C (+Q) and WH

(b) **Japanese**: (i) phonetic boost on the WH element, and

(ii) lack of prosodic boundaries between WH and +Q in sentences like (1) compared with (2) where we compare **bolded** objects, and *italicized* minor phrases

- Naoya wa **nani** o *nomiya de nonda* no?
  ナオヤは、何を飲み屋で飲んだの？
  What did Naoya *drink at the bar*?

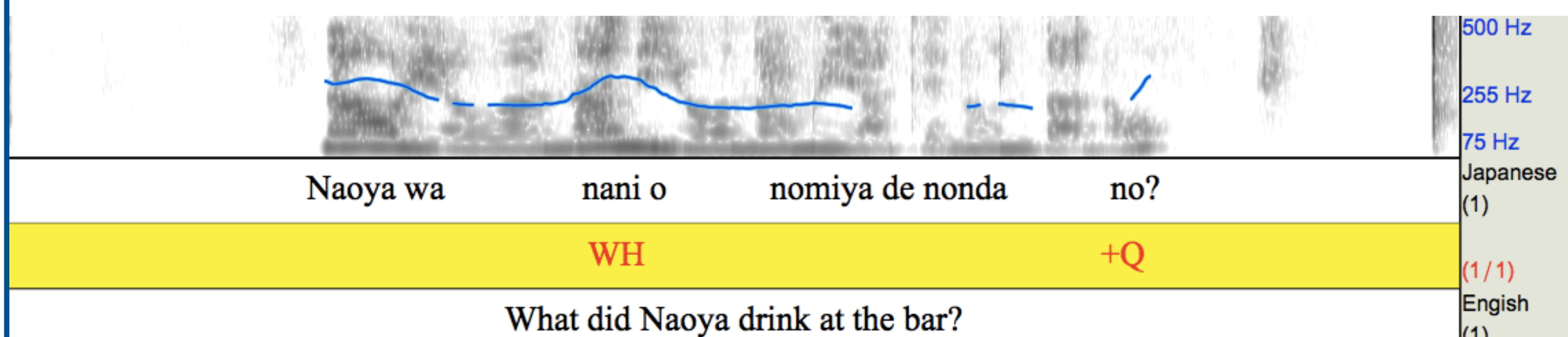
- Naoya ga **nanika** o *nomiya de nonda*.
  ナオヤが、何かを飲み屋で飲んだ。
  Naoya *drank* **something** *at the bar*.

Operational Question

- Will *non-native* speakers of Japanese show (a) a phonetic boost of the WH words, and (b) a lack of prosodic boundaries between WH and C?

- **Subjects**
- N= 16. Nine self-assessed Advanced L2 learners of Japanese (4 male; 5 female). Seven Intermediate (4 female; 3 male). 12 NS of English; 4 NS other languages
- The L1 factor did not affect pitch boost data ($p=0.7634$).
- **Task**
- Rehearse in advance, and read out-loud 19 Japanese sentences (WH; Y/N; declarative)

--building on Archibald (2017b)


500 Hz
255 Hz
75 Hz
Naoya wa
nani o
nomiya de nonda
no?
Japanese
(1)
WH
+Q
(1 / 1)
What did Naoya drink at the bar?
English
(1)

Pitch Boost

- What of Richard's first prediction, that there should be Higher pitch on WH words compared to DPs?

  17. Noboru wa **piza o** mottekitandesu ka?
  ノボルは、ピザを持って来たんですか？
  Did Noburo bring **pizza**?

  19. Tarō wa **nani o** mottekitandesu ka?
  タローは、何を持って来たんですか？
  What did Taro bring?

NNS Pitch Average

Sentence 17	DP Direct Object	234 Hz Average
Sentence 19	WH Direct Object	228 Hz Average

NNS Pitch Average

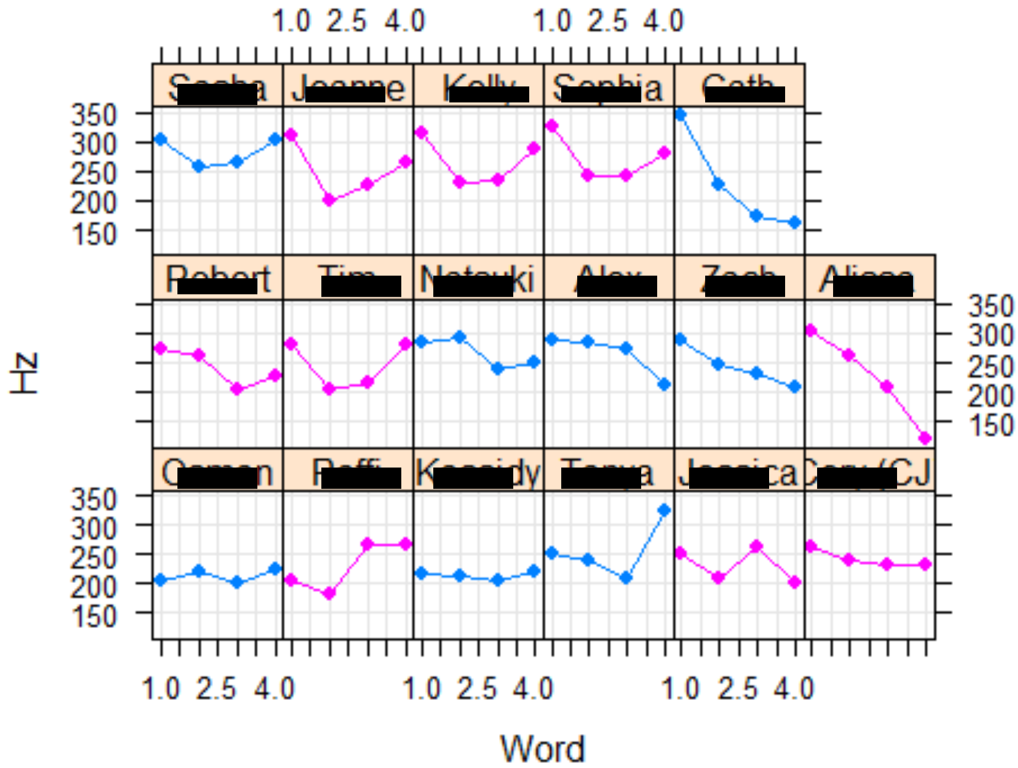
DP Direct Object All Sentences	208Hz Average
WH Direct Object All Sentences	201Hz Average

- A range of statistical tests (Paired t-tests (p=0.475), Generalized Linear Mixed Effects models, all showed that there was *no* significant difference between the pitch on WH words and the pitch on DPs.
- The NNS L2 phonetic implementation was *not* nativelike.

Prosodic Structure

- What of the second prediction about phonological structure?
- On 2 key minimal-pair sentences, subjects, showed no prosodic rises (i.e., no prosodic boundaries) between the WH word and the Question particle.

WH [Word 1 Word 2 Word3] +Q



Pitch in the Wh-*Domain*

Subject #	Nanio WH	Nomiya-de	Nonda	No [+Q]
1	141 Hz	103 Hz	108 Hz	140 Hz
15	327	242 Hz	242 Hz	280 Hz

- Note the level pitch between WH and C ([+Q]). For these speakers, we posit the following structures (from Richards, 2010):

  [DP wh [DP [VP]] C
  (MinP) (MinP)
  (MinP) ← Wh domain

- The WH and the C are **not** separated by prosodic boundaries.

- The subjects clearly show a nativelike pattern:

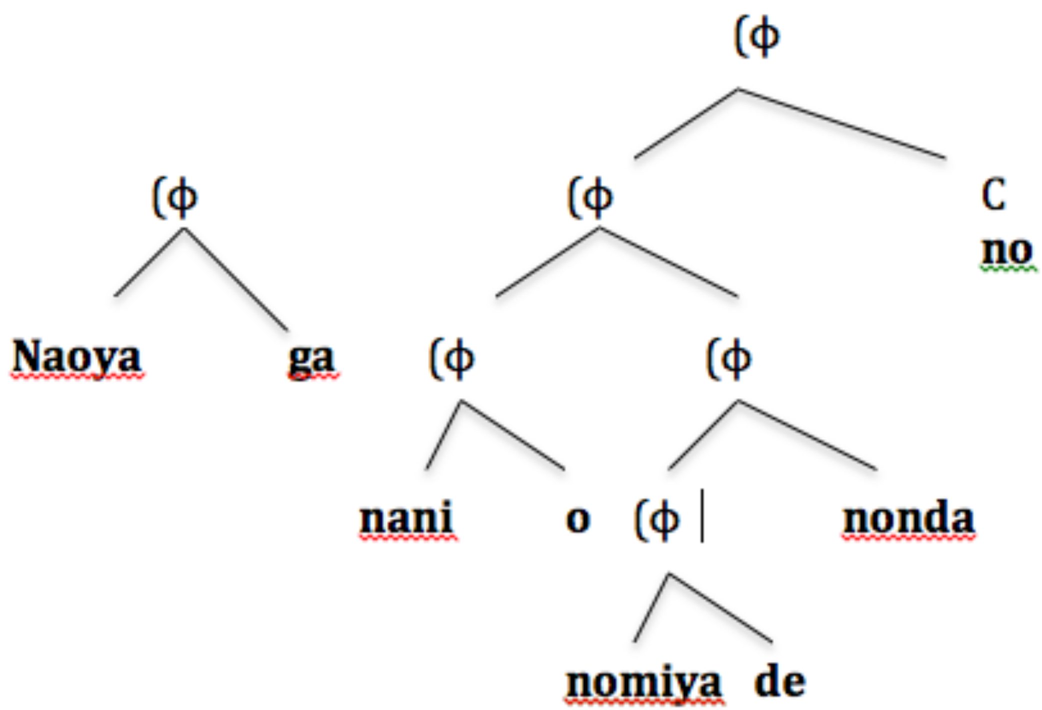
  High pitch **WH** > no phrase boundaries > high pitch **+Q**

Statistical Results

- A Linear Mixed Effects model with speakers as random effects an Word and Sex as fixed effects was fitted to the data.
- A second LME showed that Proficiency was not significant; even the Intermediate subjects were good.

- However, word *position* within the *Wh*-domain (word1, word2, word3) WAS significant (p= .001 for all comparisons)
- There was a significant decline in pitch at each position between the WH and +Q

WH	Word 1	Word 2	Word 3	+Q


(φ
(φ
(φ
C
no
Naoya
ga
(φ
(φ
nani
o
(φ
nonda
nomiya
de

- Taken together, these data indicate that the *phonology* of the L2ers is representationally nativelike while the *phonetic* implementation is not.

- Consistent with Elfner (2015), these L2 prosodic domains appear to be derived directly from the syntactic structure.
- Thus, these data suggest that IL grammars follow the premises of Match Theory (Selkirk, 2011).
- L2ers are not transferring L1 structures but are actually acquiring targetlike Syntax.

- Note that these IL grammars show evidence of phonological recursion (a hot topic)
- The grammars show the phonology mirrors complex syntax – in fact, is a *diagnostic* of syntactic structure
- These are not 'shallow' grammars (*contra* Clahsen & Felser, 2010)

Phonology & Syntax Interface

- L2 learners are able to acquire categorical phonological markers of complex syntax
- These recursive phonological phrases are not easily read of the input (and are not taught in class)
- Such complex interface properties are acquired by classroom learners (with fairly minimal input) potentially vitiating input-driven accounts.

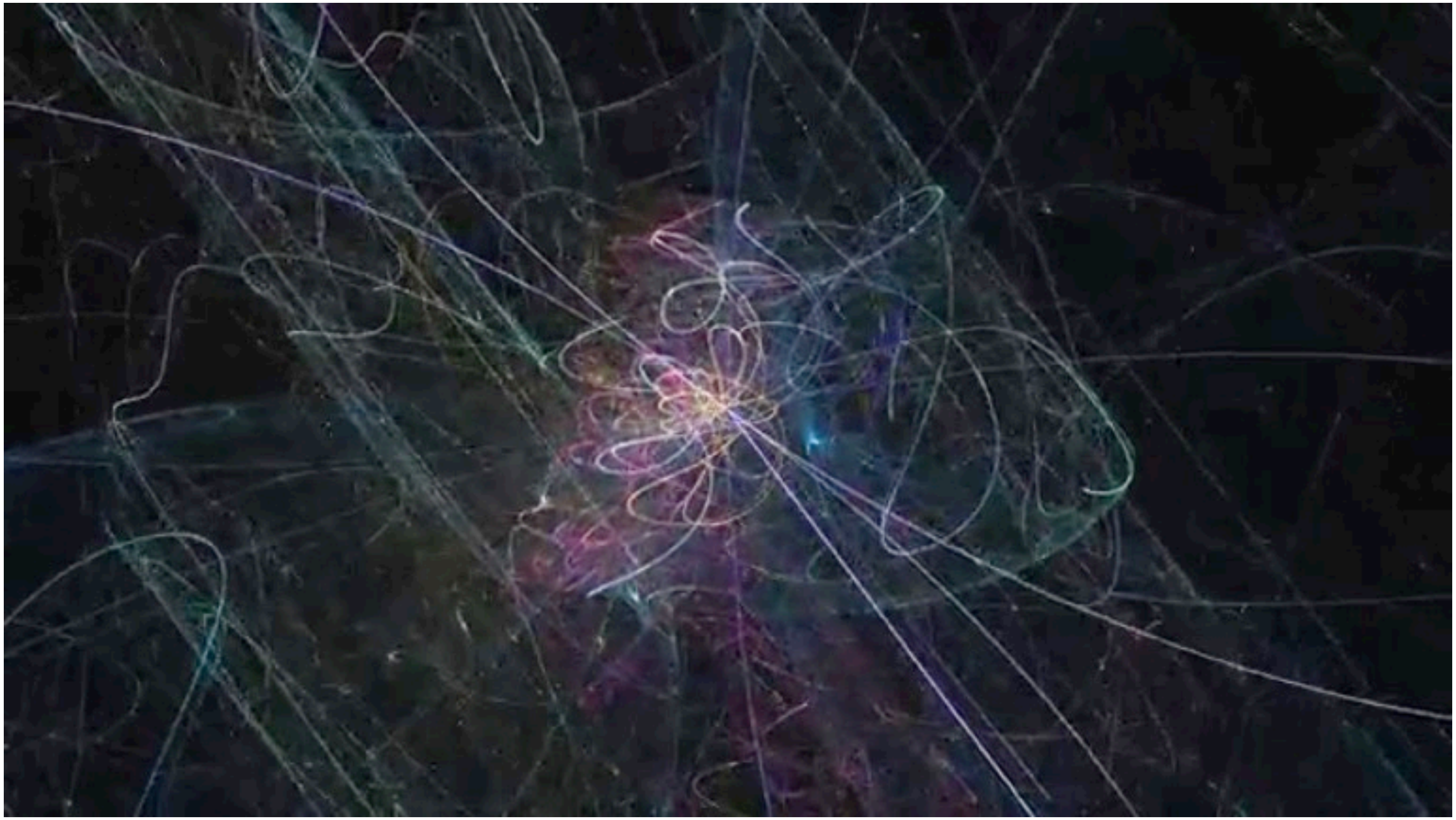
Summing Up

- No rampant heterogeneity necessary
- Parsimony (Occam) and evidence all lead us to Homogeneity; the Single Engine
- No special machinery for bilinguals
- L2ers learn and process categories and merge them into complex hierarchies

- One theme of this conference is bilingual *speech*
- As L2 speech researchers, we need to recognize the complexity of representation and computation of phonological knowledge that *underlies* bilingual speech

- L2 phonology is:
  - a key component of all modular interfaces;
  - a key pillar of GenSLA
- these interface phenomena *can* be acquired
- And we can meet our epistemological challenges.

A Single Engine; A Common Thread



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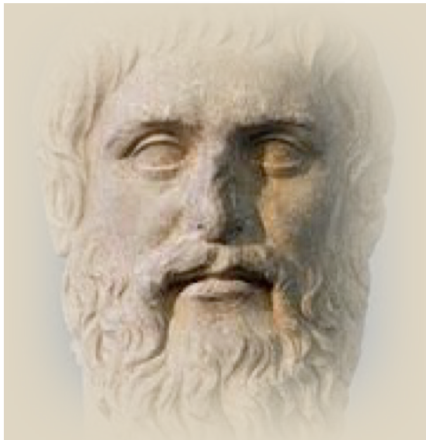

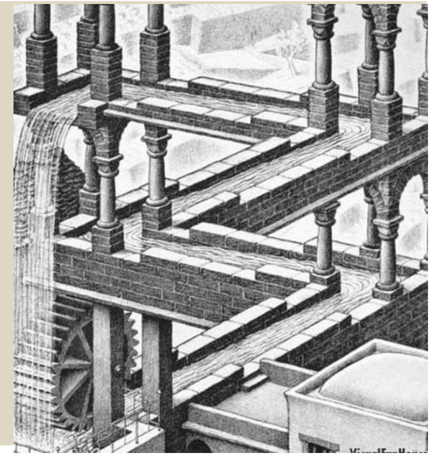

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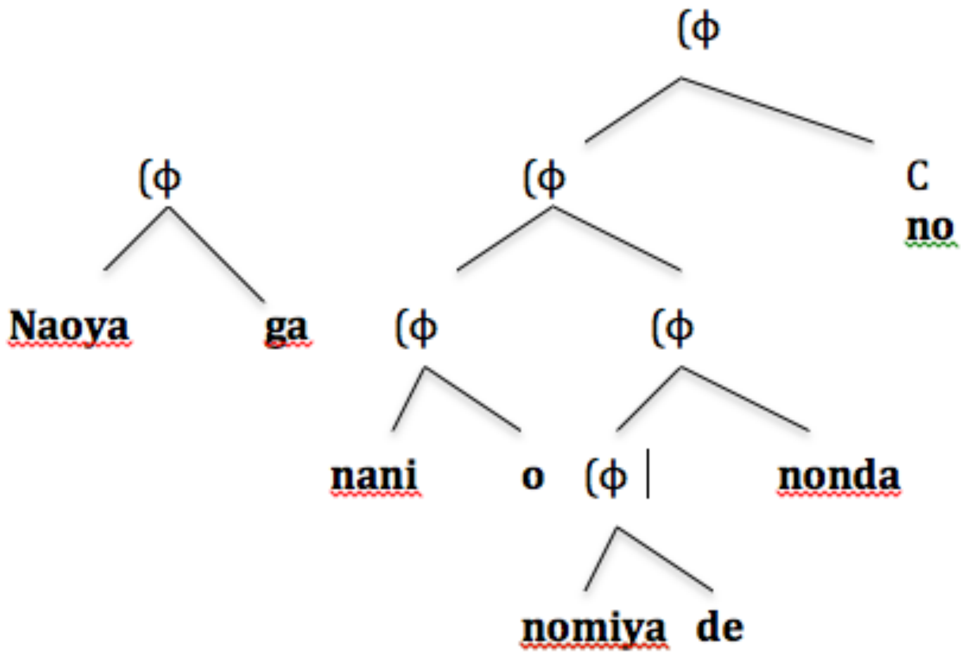
Evolution

- There is much current discussion on the evolution of human language (Berwick & Chomsky, 2016)
- The evolution of the grammatical property of *recursion* is central (and controversial) – Wolfe (2016); Everett (2005)

Phonological recursion

- Phonological recursion is discussed less often but is just as central

Prosodic Word Tree



(11) L*H$_P$ L* H$_P$ H* H*L$_P$

[[[Also jetzt steht]$_P$ [[links]$_P$ [der Gorilla]$_P$]$_P$ [[rechts]$_P$ [neben dem Gorilla]$_P$]$_P$

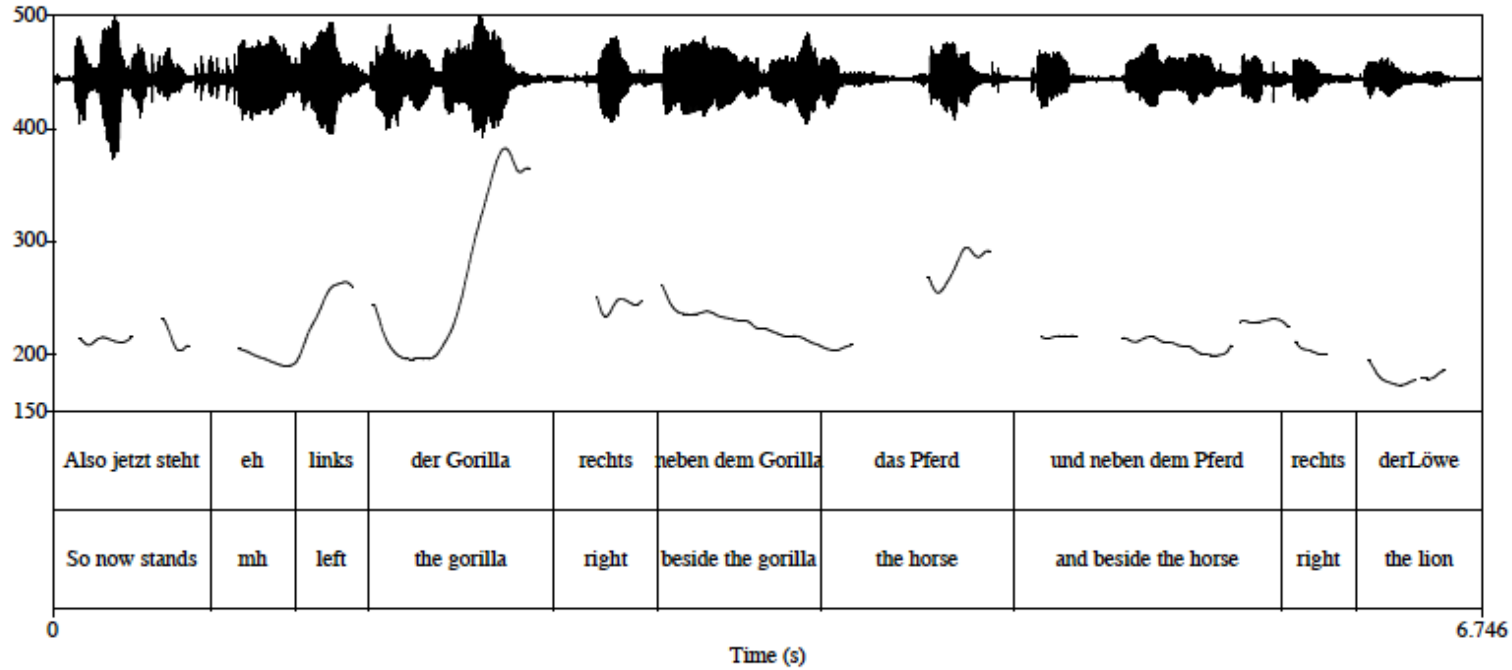
so now stands left the gorilla right beside the gorilla

L*H$_P$ L*H$_P$ H*L$_P$ H*L$_I$

[das Pferd]$_P$]$_P$ [[und neben dem Pferd]$_P$ [rechts]$_P$ [der Löwe]$_P$]$_P$]$_I$

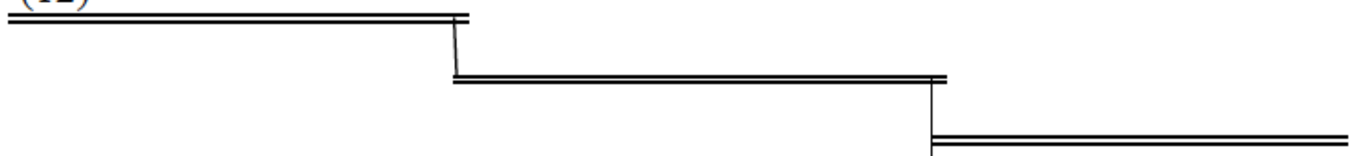
the horse and beside the horse right the lion

‘So now the gorilla is standing to the left; the horse is standing to the right beside the gorilla; and the lion is standing beside the horse to the right.’



500
400
300
200
150
Also jetzt steht
eh
links
der Gorilla
rechts
neben dem Gorilla
das Pferd
und neben dem Pferd
rechts
derLöwe
So now stands
mh
left
the gorilla
right
beside the gorilla
the horse
and beside the horse
right
the lion
0
6.746
Time (s)

(12)



[*also steht jetzt links der Gorilla*]$_{P1}$

[*rechts neben dem Gorilla das Pferd*]$_{P2}$

[*und neben dem Pferd rechts der Löwe*]$_{P3}$

The Phonetics Interface II

- Intake Frequency

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)

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.

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

Robust Cues

- “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

Ejectives

- Gonzalez (2014) 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 in terms of accuracy of perception:

k'/p' > t'/tʃ' > ts'

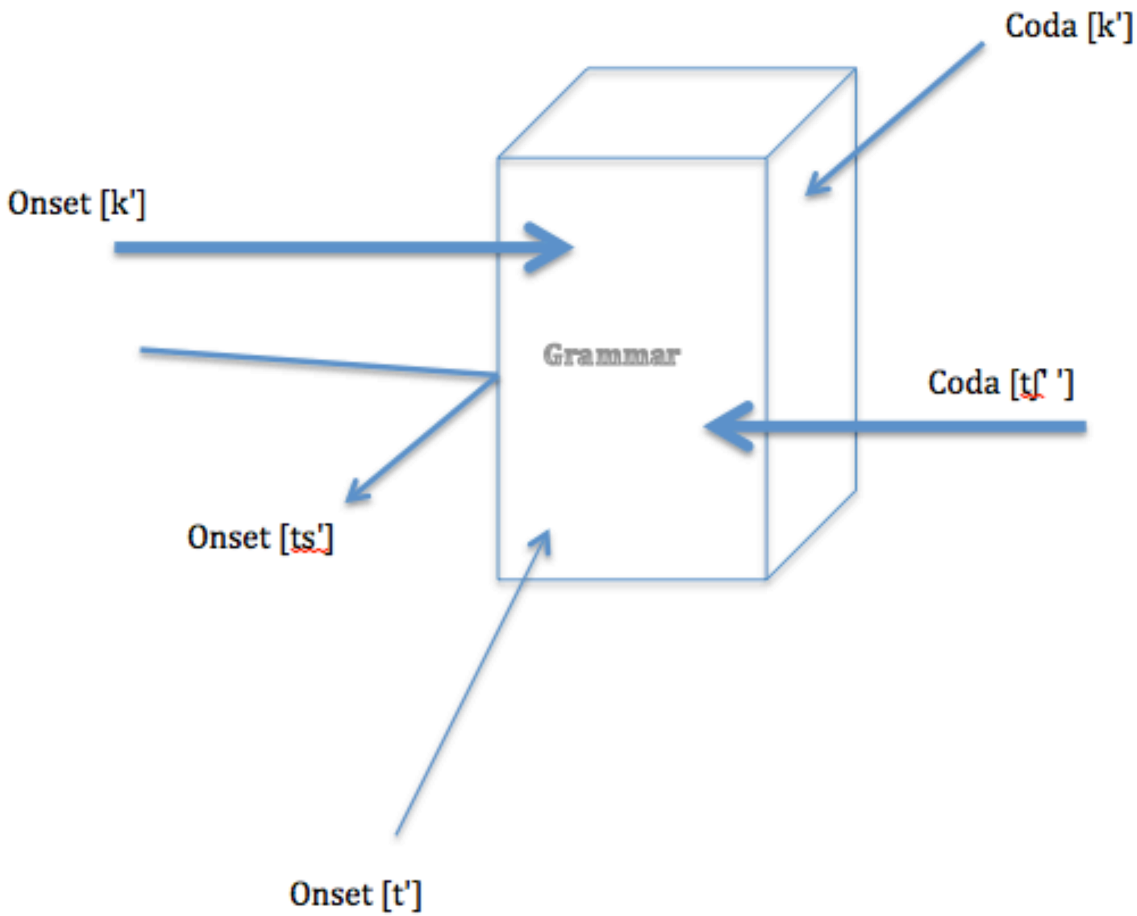
Codas Exploded

- And note the (almost reverse) pattern in codas:

tʃ’ > ts’ > k’ > p’ > t’

- not all exemplars of {constricted glottis} 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]


Coda [k']
Onset [k']
Grammar
Coda [tʃ' ']
Onset [ts']
Onset [t']

- Learning is mitigated by intake frequency which is, in turn, modulated by robust transitional cues
- Elements which become intake earlier are represented in the lexical entry earlier

Phonology & Processing

- Phonetic properties are central to understanding the developmental path of acquiring new phonological categories
- Gradient processing does not necessitate gradient storage