2009/06/13

한국언어학회

Optimality Theory

Overview

- Rule-based model
- OT basics
- Variation
- Experimental approaches

What is phonology?

- **Sound patterns** (of human languages)
  - **Alternation**
  - **Static**

Alternation patterns in English

- **t-ɾ**
  - write [rait]
  - writ-er [raiɾ ər]
- **s-z-əz**
  - dog-[z], book-[s], bus-[əz]

Analysis of t-ɾ alternation in early generative phonology

- **Rule** (tapping or flapping)
  - t → ɾ / V __ V

- **Derivation**

UR	/rait/	/rait-ər/
Tapping	--	ɾ
SR	[rait]	[raiɾər]

(UR = Underlying R, SR = Surface R)

Analysis of s-z-əz alternation in rule-based model

- **Rule** (Voicing assimilation)
  - /z/ → [-voice] / [-son, -voice]__ #
- **Rule** (V-epenthesis)
  - ∅ → ə / [+sibilant] __ [+sibilant]

Derivation: s-z-əz alternation

UR	book-/z/	dog-/z/	bus-/z/
V-epen	--	--	ə
VoiAssi	s	--	--
SR	book-[s]	dog-[z]	bus-[əz]

Static sound patterns in English

❖ **What *sounds* and *sound sequences* are allowed in words / morphemes?**

	sounds	sound sequences	Examples
Allowed	p, t, k, b, d, g, m	dz#, pt#, #bl	adz, concept, blame
Disallowed	ö, ü, x, β, !	*ds#, *pd#, *#bd	*a[ds], *conce[pd], *[bd]ame

Early generative phonology model

❖ **Why p, t, k, b, d, g, m … allowed?**

- **English phoneme inventory**
  - { p, t, k, b, d, g, m … }
  - Notice: ö, ü, x, β, ! … are excluded

❖ **Why *ds#, *pd#… disallowed?**

- **Morpheme Structure Constraint (MSC)**
  - *[-son, αvoice][-son, -αvoice]#

Static patterns in Early generative phonology model

- English **phoneme inventory**
  - { p, t, k, b, d, g, m … }

- **Morpheme Structure Constraint** (MSC)
  - *[-son, αvoice][-son, -αvoice]#

- **phoneme inv → MSC**
  - ***[V, -back, +round]**
  - (/ö, ü/ are not allowed to occur.)

The basic structure of phonology (Early generative phonology)

Underlying R ← MSC / phoneme inv

↓

↓ ← Rules

↓

Surface R

- Alternation: rule
- Static patterns: MSC
- Phonologists' job: discover right rules (and rule orderings)

Duplication Problem

- Alternations often occur for the purpose of obeying static morpheme internal generalizations.

- book-[s], *book-[z] → Voicing Assim R
- concept, adz, *ads → MSC

➢ **Two different devices are used to capture the same generalizations.**

Conspiracy

- Several formally distinct rules or conditions work towards achieving the **same target structure**.
  - CC → CC
  - CVC (V-epen: ∅ → V / C__C)
  - ∅C (C-del: C → ∅ / __ C)

Hiatus avoidance in Korean Verb inflection

- 먹-다 먹-어
- 막-다 막-아
- 쓰-다 /s’ɨ-ə/ [s∅ə] stem-V del
- 자-다 /ca-a/ [ca] Degemination
- 주-다 /cu-ə/ [cwə] Glide Formation

A summary of problems for early generative phonology

- Duplication
- Conspiracy
- Extrinsic rule ordering

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Optimality Theory

- Prince, Alan & Paul Smolensky (1993/2004) *Optimality Theory: Constraint Interaction in Generative Grammar*.

- McCarthy, John & Alan Prince (1993) *Prosodic Morphology I: constraint interaction and satisfaction*.

Optimality Theory

- Constraints are the primary content of the grammar.
- No rules at all.
- Constraints explain both static and alternation patterns.

Basic scheme

- **Markedness constraint (on the output)**
- **Faithfulness constraint: input = output**
- **The actual output** is the one that best satisfies the constraints, i.e. **optimal output.**
- ***GEN* generates *every conceivable output* corresponding to the input.**

Traditional rule-based model: conveyer belt system

UR → Rule$_1$ → Rule$_2$ →…→ Rule$_n$ → SR

↑

MSC

Optimality Theory

UR / input

↓

Gen

↓

$cand_1$, $cand_2$, $cand_3$ …

↓

Eval: ranked constraints

↓

SR / optimal output

Optimality Theory

UR /bʌs-z/

↓

Gen

↓

bʌsz, bʌsəz, bʌz, bʌnz, sʌbz …

↓

Eval: ranked constraints

↓

SR [bʌsəz]

OT analysis:

(i) alternation: book[s], dog[z],

(ii) static: adz, concept

- **Constraint**
  - Markedness: *[-son, αvc][-son, -αvc]#
  - Faithfulness: ID(vc) (“do not change voicing value”)

- **Ranking:**
  - *[-son, αvc][-son, -α vc]# >> ID(vc)

Tableaux

alternation

book-/z/	*[αvc][-αvc]#	ID(vc)
i. book[z]	*!	
ii. ☞ book[s]		*

static

/æds/	*[αvc][-αvc]#	ID(vc)
i. æds	*!	
ii. ☞ ædz		*

Richness Of The Base (ROTB)

- No language-specific limitations on possible underlying forms.
- Everything is thus explained by constraint interaction, i.e., the grammar.
- No phoneme inventory & MSC.

Conspiracy:
(i) CC → ∅C, (ii) CC → CVC

Constraint

- **Markedness: *CC**
- **Faithfulness:**
  - **Max-C** ("don't delete C")
  - **Dep-V** ("don't insert V")

•	CC → CC	Max-C, Dep-V >> *CC
•	CVC	*CC, Max-C >> Dep-V
•	∅C	*CC, Dep-V >> Max-C

Tableau: CC → CVC

/apka/ → [apəka]

/apka/	*CC	Max-C	Dep-V
i. apka	*!		
ii. ☞ apəka			*
iii. a∅ka		*!	

Constraint evaluation

- ***Violable*.**
  - **For the satisfaction of the dominant constraint, lower-ranked constraints must be sacrificed.** **Cf. Constraints in traditional theories**
- ***Strict Domination***
  - **violation of higher-ranked constraints cannot be compensated for by satisfaction of lower-ranked constraints.**

Strict Domination

	C1	C2	C3
Cand 1	*!		
☞ Cand 2		*	*

Typology in OT

- In OT, constraints are basically universal. Thus, typology = individual language.
- Language-specific differences must be due to the difference in the rankings.
- OT analyses make typological predictions by reranking constraints of different types (factorial typology).

Overview

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Variation in phonological theory

- Coetzee, Andries & Joe Pater (2008) The place of variation in phonological theory.

Variation

Free variation

- Different pronunciations for same morpheme / word
- los*t* ~ los∅ (books)

Lexical variation

- same pronunciation for same morpheme / word

  ìnf[ə]rmátion vs. cònd[ɛ]nsátion

Variation in Phonology

- **Early generative phonology: variation is often ignored or simplified.**

- **Recent approaches: attempt to explain occurrence of variants & their frequency.**

Free Variation in OT

- **Partially Ordered Constraints theory (Kiparksy (1993) and Anttila (1997 et seq.))**

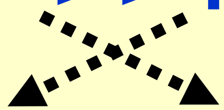
Approaches with Numerically-valued constraints

- **Stochastic OT (Boersma & Hayes 2001)**
- **Harmonic Grammar (HG)**

An OT analysis of English final t/d deletion: e.g., los(t)

- **Markedness constraint:**
- ***Ct#** ("No word-final consonant cluster ending in a coronal stop")

- **t/d deletion:** ***Ct# >> Max-C**



- **No deletion:** **Max-C >> *Ct#**

Tableau: /lɔst/ [lɔst] ~ [lɔs∅]

/lɔst/	Dep-V	Max-C	*Ct#	*Complex_Coda
i. ☞ lɔst			*	*
ii. ☞ lɔs∅		*		
iii. lɔsət	*!			

- Tie in ranking: X
- Free ranking: O

Partially Ordered Constraints theory: Anttila's model

- Strata for constraints
- Strict ranking for constraints in separate strata
- Free ranking within strata

English (hypothetical grammar 1)

- Strata 1: Dep-V
- Strata 2: Max-C, *Ct#
- Strata 3: *ComplexCoda

Predictions about frequency (gr 1)

English (hypothetical grammar 1)

- Strata 1: Dep-V
- **Strata 2: Max-C, *Ct#**
- Strata 3: *ComplexCoda

Strata 2: only 2 possible rankings

- Max-C >> *Ct# → lɔst in 50%
- *Ct# >> Max-C → lɔs∅ in 50%

English (hypothetical grammar 2)

- Strata 1: Dep-V
- Strata 2: Max-C, *Ct#, *ComplexCoda

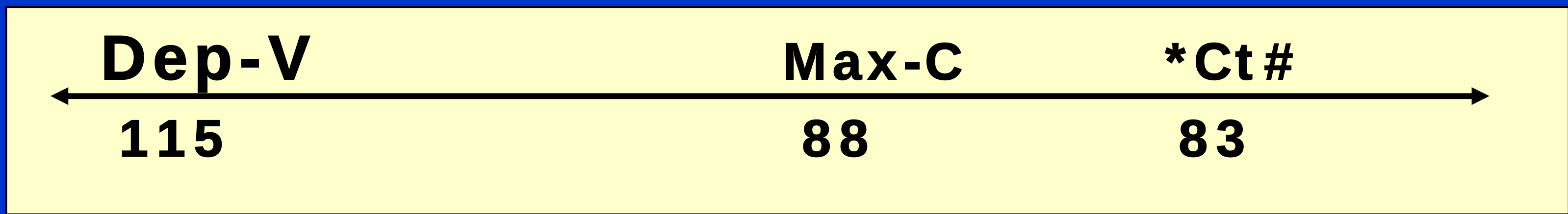
6 possible rankings	Optimal output
Max-C >> *Ct# >> *Comp	lɔst
Max-C >> *Comp >> *Ct#	lɔst (2/6 = 33%)
*Ct# >> Max-C >> *Comp	lɔs∅
*Ct# >> *Comp >> Max-C	lɔs∅
*Comp >> Max-C >> *Ct#	lɔs∅
*Comp >> *Ct# >> Max-C	lɔs∅ (67%)

One disadvantage

- Cases where the probability distribution between two variants is strongly skewed in favor of one of them
- ex. 99% deletion vs. 1% retention.
- 100 rankings are needed. Only one of them must favor one variant. → Unlikely

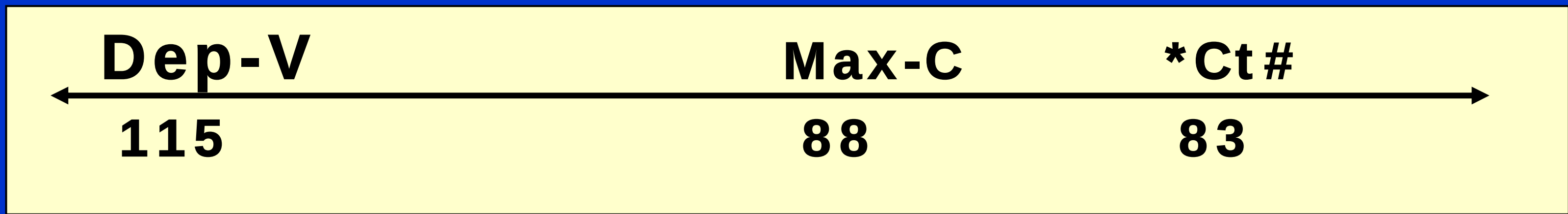
Stochastic OT

- Constraint evaluation: no difference from standard OT
- A difference from standard OT: speakers do not memorize the constraint ranking, but constraint "score" (ranking value).



Stochastic OT

- Each time the grammar is used to evaluate a candidate set, the values are converted to a corresponding ranking:
- Dep >> Max-C >> *Ct#
- Optimal output = [lɔst]



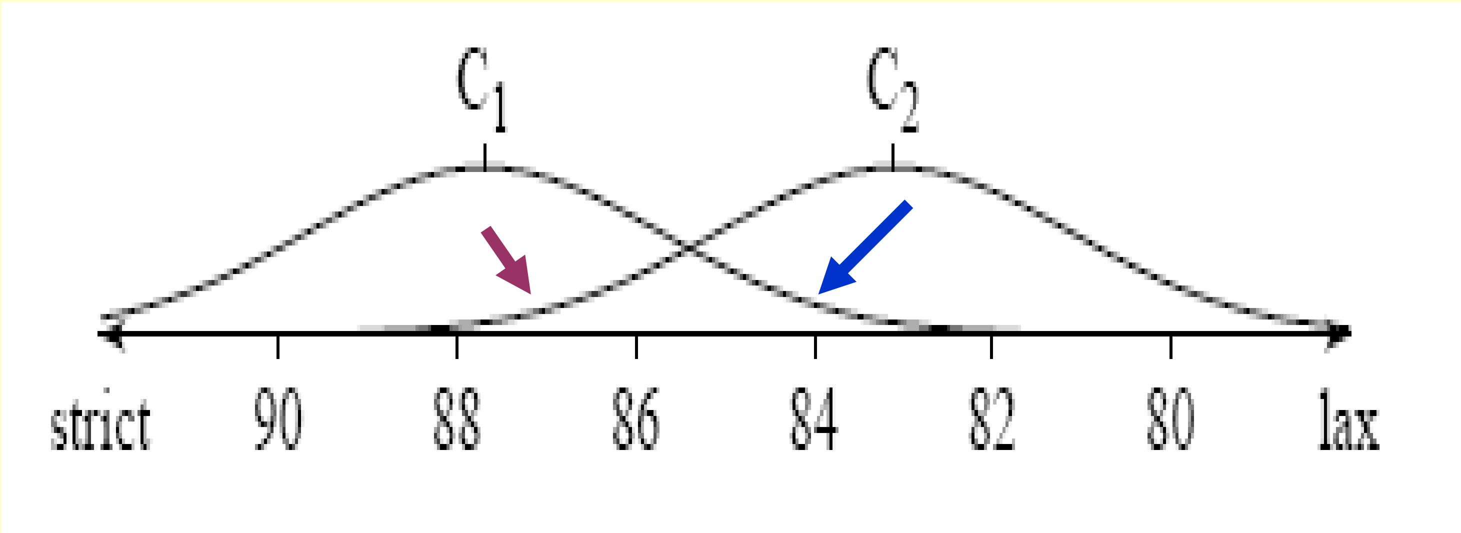
Stochastic OT

- **Noisy evaluation:**
- **Before transforming the numerical values into a ranking, each one is perturbed by adding a (+ / -) number, taken from a normal distribution.**

Dep-V	Max-C	*Ct#
115+2	88-5	83+3
(117)	(83)	(86)

- **Ranking: Dep >> *Ct# >> Max-C**
- **Optimal output = [lɔs∅]**

Stochastic OT



- C_1 = Max-C, C_2 = *Ct#
- Max-C >> *Ct#: 95% [lɔst]
- *Ct# >> Max-C: 5% [lɔs∅]

Stochastic OT

- Advantage over POC:
  - ✓ Skewed probability distributions are possible.

(Nosy) Harmony Grammar

- **No ranking**
- **Constraint weights are adopted to indicate the importance of one constraint relative to others.**

A weighted constraint tableau

	2	1	H
/ lɔst /	*Ct#	Max-C	
i. ☞ lɔs∅		-1	-1
ii. lɔst	-1		-2

- **Harmony:** the **sum** of the weighted constraint scores.
- **Variation:** **noise** in constraint values (like in Stochastic OT)

Free Variation in OT

- Partially Ordered Constraints theory
- Stochastic OT
- Harmonic Grammar (HG)

Lexical variation

Lexically, not phonologically, conditioned variation

- **English vowel reduction**
  - còmp[ə]nsátion   cómp[ə]nsate
  - cònd[ɛ]nsátion   condénse
  - ìnf[ə]rmátion   infórm
- **Lexical strata in Japanese**

Constraints active in Japanese

- **SyllStruc:** NoComplexOns, CodaCond…

  *sma, *ebzo

- ***VcdGem:**

  "No voiced obstruent geminates"

  *abba, *dd, *gg

- **No-[p]**

  "no (single) [p]",

  nippoN 'Japan', *paka, *nipoN.

- **PostNasVoi**

  "Post-nasal obstruents must be voiced",

  tombo 'dragonfly', *tompo.

Lexical strata in Japanese
(Ito & Mester 1995)

	Yamato (native)	Sino-Japanese	Foreign	Unassimilated Foreign
SyllStruc	○ *sma *ebzo	○	○	○
***VcdGem**	○ *agga	○	○	doggu
No-[p]	○ *paka	○	sepaado peepaa	
PostNasVoi	○ *anta	sampo, hantai	kompyuutaa, santa	

Lexically specific rankings

in Japanese (multiple co-grammars)

Yamato (native)	Sino-Japanese	Foreign	Unassimilated Foreign
SyllStruc	SyllStruc	SyllStruc	SyllStruc
*VcdGem	*VcdGem	*VcdGem	**Faith**
No-[p]	No-[p]	**Faith**	***VcdGem**
PostNasVoi	**Faith**	**No-[p]**	**No-[p]**
Faith	**PostNasVoi**	**PostNasVoi**	**PostNasVoi**

OT analysis
(w/ lexically specific rankings)

/sampo/ Yamato: *[sampo], [sambo]
Sino-J: [sampo], *[sambo]

Yamato

/sampo/	Syll Struc	*Vcd Gem	No-[p]	PostNas Voi	Faith: ID(vc)
i. sampo				*!	
ii. ☞ sambo					*

OT analysis
(w/ lexically specific rankings)

/sampo/ Yamato: *[sampo], [sambo]
Sino-J: [sampo], *[sambo]

Sino-Japanese

/sampo/	Syll Struc	*Vcd Gem	No-[p]	Faith: ID(vc)	PostNas Voi
i. ☞ sampo					*
ii. sambo				*!	

Lexical variation in OT

- Lexically specific rankings (co-grammars)
- Lexically specific constraints

Lexically specific constraints
(a single grammar)

- **Replication** or **cloning** of **Faithfulness** constraints, each indexed for a vocabulary stratum
  - Faith / Yamato
  - Faith / Sino-Japanese
  - Faith / Assimilated-Foreign
  - Faith / Unassimilated-Foreign

(single) Ranking in Japanese

- Syllstruc
  - Faith / Unassimilated-Foreign
- *VcdGem
  - Faith / Assimilated-Foreign
- No-[p]
  - Faith / Sino-Japanese
- PosNasVoi
  - Faith / Yamato

OT analysis
(w/ lexically specific constraints)

/sampo/ Yamato: *[sampo], [sambo]
Sino-J: [sampo], *[sambo]

/sampo/$_{Yamato}$	…	No-[p]	Faith/S-J	PostNasVoi	Faith/Y
i. sampo$_{Y}$				*!	
ii. ☞ sambo$_{Y}$					*

/sampo/$_{Sino\text{-}J}$	…	No-[p]	Faith/S-J	PostNasVoi	Faith/Y
i. ☞ sampo$_{S\text{-}J}$				*	
ii. sambo$_{S\text{-}J}$			*!		

lexically specific ranking vs. lexically specific constraint

- One disadvantage of lexically specific rankings:

  → Massive duplication of constraints required by lexical exceptions

Overview

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- ✓ Variation
- Experimental approaches

Experimental approaches to OT

- Experiments are increasingly popular in phonological theorizing.
- This is also true of OT.

Purposes of Experiments in OT

- Testing alternative analyses within OT, comparing OT vs. non-OT analyses,
- Justifying a constraint and constraint ranking, testing OT hypotheses, and
- Providing (variation) data for OT analysis

- Today's topic. OT hypothesis about **typological markedness**.

Typological (un)markedness: language universals

- Some patterns recur across languages.
- "Typologically unmarked patterns"

❖ Why do certain patterns recur?

➢ **OT: constraints are universal.**

- Constraints responsible for language universals are part of individual speakers' mental grammar.

Nature vs. Nurture

- Nature: e.g. OT

- Nurture: e.g. Evolutionary Phonology
- Speakers simply know regularities concerning words in their own language.
- Language universals are not mentally represented.

Nurture: Evolutionary Phonology

- Why FORM_UNMARKED > FORM_MARKED across languages?

- FORM_MARKED is more frequently mispronounced or misperceived than FORM_UNM.

How to test the two views: Nature vs. Nurture

3 possible patterns

	FORM_UNM,		FORM_MARKED
(i) Lg A	O	>	O
(ii) Lg B	O		X
(iii) Lg C	X		X
None	X		O

❖ Do speakers have relative cognitive preference of FORM_UNM over FORM_MARKED?

➢ OT: Yes in all A, B & C.

➢ EP: Yes in A & B, but No in C.

Main research question

- Do speakers know universal patterns of linguistic elements which are absent from their language?

- OT: Yes
- EP: No

One recent experimental study addressed this question.

- Berent, Iris, Tracy Lennertz, Jongho Jun, Miguel Moreno and Paul Smolensky (2008)
- Language universals in human brains. *PNAS* 105.14.

Berent, Lennertz, Jun, Moreno & Smolensky (2008)

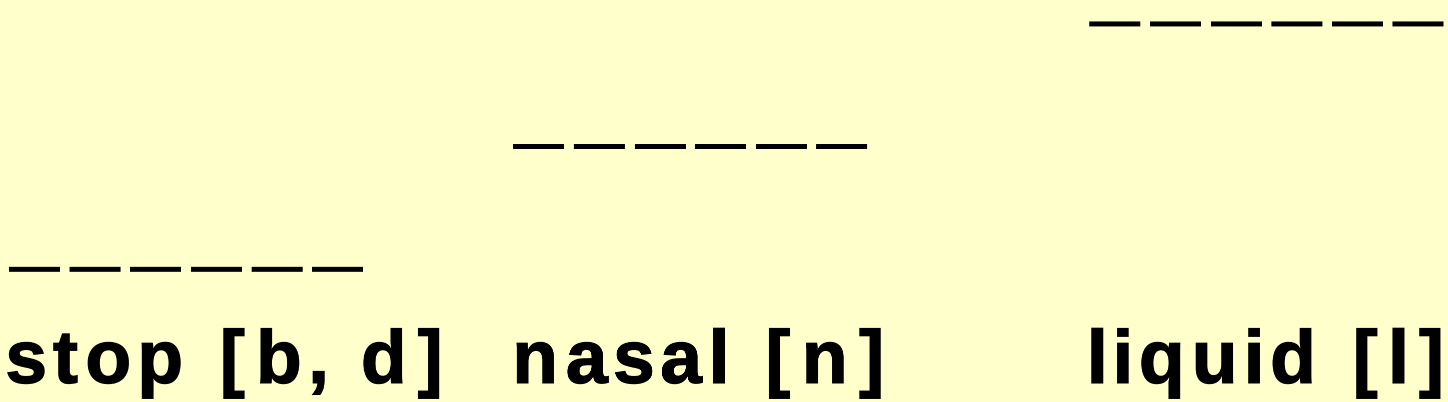
- Language universals on #CC

  blif > bnif > bdif > lbif

- Korean with almost no #CC

- Hypothesis: Korean speakers prefer typologically favored #CC.

Sonority sequencing universals:
blif > bnif > bdif > lbif



- Large rise: blif ↗
- Small rise: bnif ↗
- Plateau: bdif →
- Fall: lbif ↘

How to investigate speakers' sensitivity to unattested #CC?

- Phonological repair in the perception (and production) of unattested sequences: e.g., tla → tela, snow

- Prediction: marked onsets should be more likely to cause repair than less marked ones.
- Onset markedness: bl > bn > bd > lb
- Repair: blif → belif < bnif → benif

Experiments

Stimuli

- Mono-syllabic: blif, bnif, bdif, lbif
- Di-syllabic: belif, benif, bedif, lebif

- Experiment 1: syllable count
- Experiment 2: Identity judgment

Exp 1: syllable count

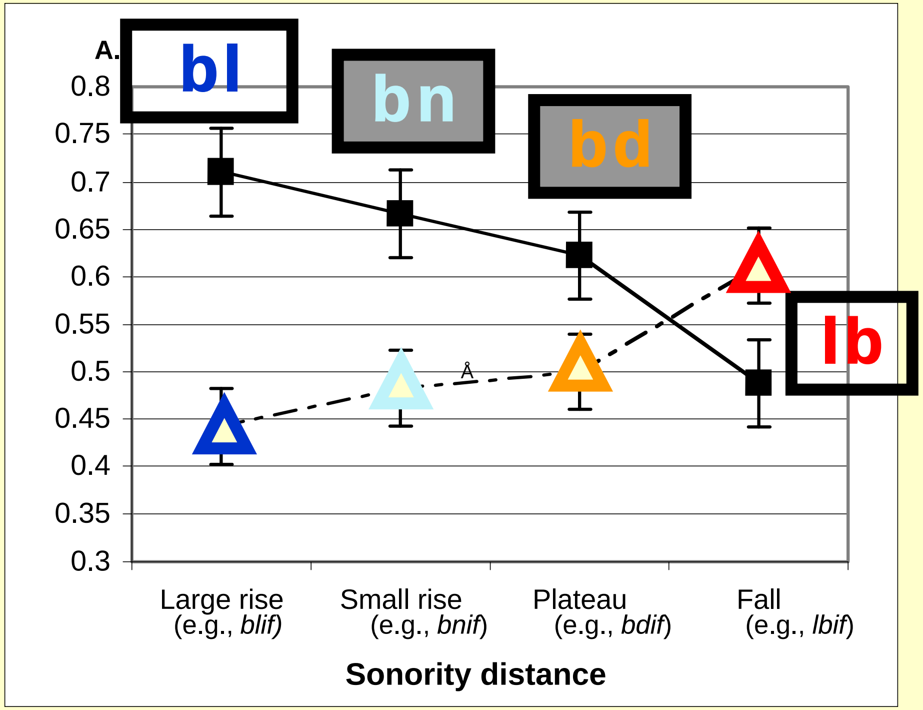
❖ One or two syllables?

Audio stimuli

- Mono-syllabic: blif, bnif, bdif, lbif
- Di-syllabic: belif, benif, bedif, lebif

Results of Exp 1 (syllable count): Proportion correct

- **mono-syllabic ▬, di-syllabic: ▲**



Exp 2: identity judgment

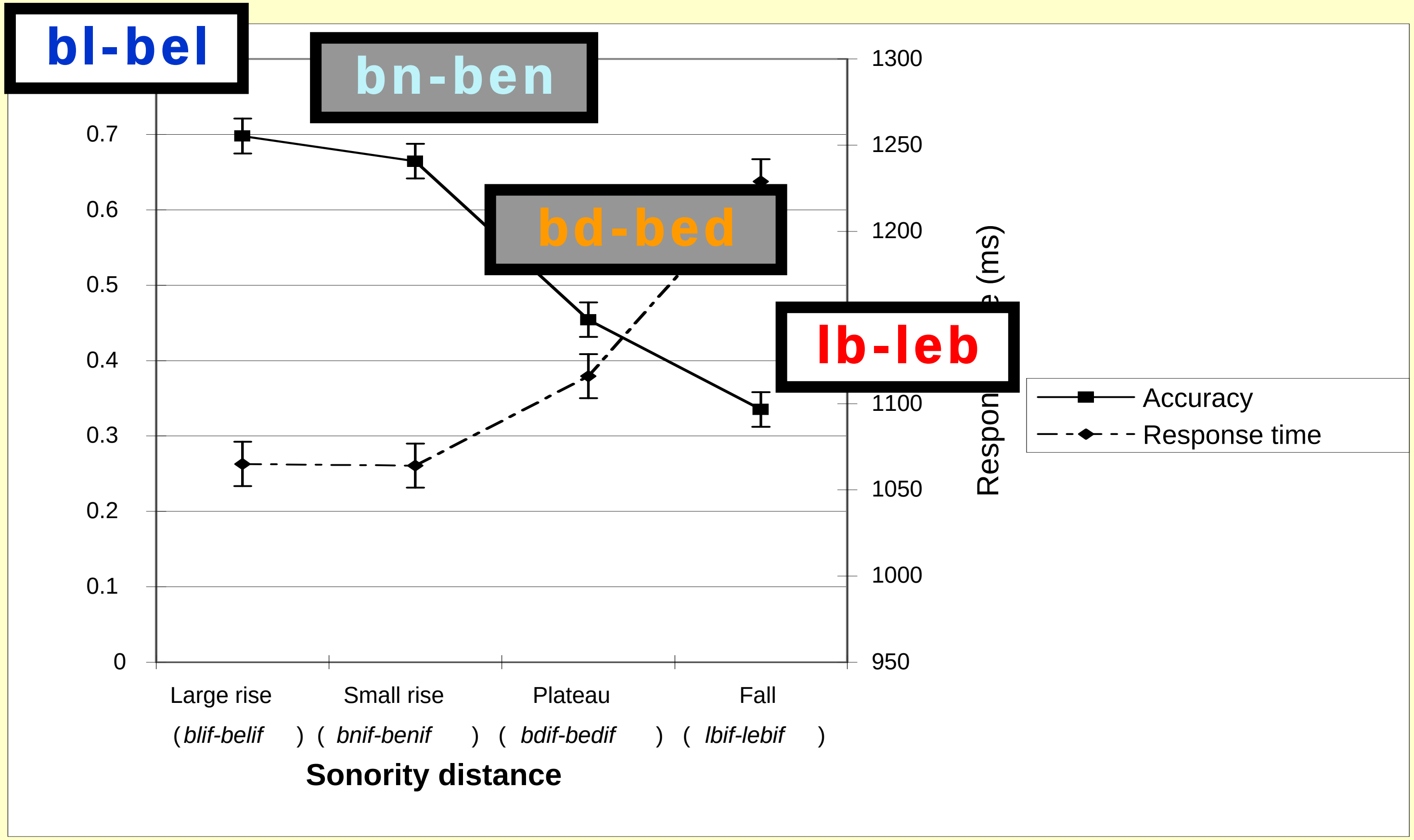
- Are these two identical?

Audio stimuli

- Identical: blif-blif, lbif-lbif
- Repair related: blif-belif, lbif-lebif

Results of Exp 2 (identity judgment)

- **Accuracy ▬, response time: ♦**



Findings confirm the hypothesis

More marked in typology
→ More errors in the experiment

Alternative 1: Misperception (auditory failure)

- **Errors of Mono-syl stimuli (Exp 1):**

  blif < **bn**if < **bd**if < **lb**if

- **Difficulty in auditory perception**

  blif < **bn**if < **bd**if < **lb**if

- **Accuracy with identical items was nearly perfect: lbif–lbif, lebif-lebif**
- **Errors of di-syl stimuli (Exp 1):**

  belif > **ben**if > **bed**if > **leb**if

- **belif - blif ???   lebif – lbif ?**

Alternative 2: Mispronunciation

(Motor) difficulties in pronunciation

- **Errors** of Mono-syl stimuli (Exp 1):

  blif < **bn**if < **bd**if < **lb**if

- **Difficulty** in pronunciation

  blif < **bn**if < **bd**if < **lb**if

- Participants did not articulate the sequences overtly.
- **Errors** of di-syl stimuli (Exp 1):

  belif > **ben**if > **bed**if > **leb**if

Conclusion

- Adult human brains possess knowledge of universal properties of linguistic structures absent from their language.

- consistent with OT.

Limitations of the conclusion

- Based on the investigation of only a few languages such as Korean (and English).
- How speakers of different languages converge on the same universal knowledge remains to be seen.

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감사합니다

Thank you