

Department of Second Language Studies
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Individual Differences in Acquisition of Second Language Phonology

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Thank you

- Kate Nearing for her invaluable help in testing and coding participants' data
 - David Pisoni and Kathleen Bardovi-Harlig for their support of this research
 - all our participants for subjecting themselves to several hours of very difficult tests
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Individual differences

- Observed in all domains of L2 acquisition
 - Syntax, morphology,...
 - Phonology
 - Not well understood
 - Cause of the differences
 - Exact extent of differences
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Foreign accent or L2 phonology

- Factors influence how well the pronunciation and representation of the sound system of L2 will be acquired
 - Age of first exposure (younger = better)
 - L1 usage (less = better)
 - length of exposure (longer = better)
 - But individual differences are observed even when all those factors are controlled
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(Neuro-)Cognitive components

- Indeed, in language acquisition (in general), other factors play a role too
 - „Aptitude to learn languages“ (Carrol & Sapon 1959)
 - Motivation (Moyer 1999)
 - Cognitive flexibility (less left-lateralized: Schneiderman & Desmarais 1988)
 - Anatomical differences (Golestani et al., 2007)
 - **Working memory** (phonological short-term memory)
 - *quantity of storage*: (Atkins & Baddeley, 1998; Papagno & Vallar 1995)
 - *quality of storage*: (Gathercole & Thorn, 1998; L2: Majerus et al., 2008)
 - *complex span*: (L2: Miyake & Friedman, 1998)
 - **Vocabulary size** (for L1, Munson et al., 2005)
 - **Attention control** (Guion & Pedersen 2007; Segalowitz 1997)
 - **Processing speed** (Salthouse 1996)
- Their role for *phonological acquisition* is not clearly understood

Our study

- Conducted to examine factors linked to individual variation in L2 phonology
- 1) Establish a measure, an individual „profile“ of phonological acquisition
 - Find tasks sensitive to overall proficiency
 - Reflect a level of acquisition in phonology (overall group differences)
 - And sensitive enough to show individual differences also within groups
- 2) Obtain cognitive measures
 - See if they correlate w. L2 phonology performance



Phonological acquisition

- Can be measured in different ways
 - Foreign accent judgments
 - Acoustic analyses of productions
 - Phonological processing or perception data
 - Foreign accent judgments are too global
 - what particular non-native element in the foreign-accented speech causes a strict or lenient foreign accent judgment?
 - Using production data alone is insufficient
 - because it is not clear to what extent production is a reflection of what the learner has acquired about the phonological system of a second language
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Phonological processing (perception)

- We conducted the study to develop a way to measure „phonological acquisition“ via perception data
- Measure the extent of L2 phonological knowledge at different levels
 - **Segmental** → ABX categorization task
 - **Phonotactic** → lexical decision task
(involving consonant-clusters in non-words)
 - **Suprasegmental** → sequence repetition
(involving stress patterns)

Measures of cognitive abilities

- We measured the following :
 - Working memory (both in L1 and L2)
 - Attention control (in L2)
 - Processing speed (in L1)
 - Vocabulary size (in L1 and L2)
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Participants

- 2 groups of Korean native speakers living in Bloomington
 - Less than 1 year (short Length of Residence)
 - Longer than 2 years (long Length of Residence)
 - Verify that tasks are sensitive to (phonological) acquisition levels
 - Length of exposure to spoken English is one critical variable for phonological acquisition (Flege & Liu 2001)
 - 1 group of English native speakers to establish native-like level of performance
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Control variables

- Besides L1 and Length of Residence:
 - Chronological age
 - Age of arrival to the US
 - Amount of L2 use in daily interactions
 - Motivation to learn English
 - 8 questions about their feelings, such as
 - “I enjoy learning new words and new ways of saying things in English”
 - “I want to improve my pronunciation of English”
 - 1 = strongly disagree; 11 = strongly agree
-

Demographics

	Length of Residence (months)	current age (yrs)	age of arrival (yrs)	current L2 use (%)	average motivation (1-11)
Long LoR :	49.5 (24-100)	30.5 (23-47)	25.6 (17-41)	56.5 (5-80)	8.9 (7.5 – 10.3)
Short LoR :	3.9 (2-10)	24.2 (20-37)	23.6 (20-36)	36.7 (10-90)	8.2 (7.2 – 10.3)
P (2-tailed t-test) :	0.0001	0.051	0.47	0.08	0.12

Both groups are reasonably well matched in all measures, except LoR
Native speakers are matched in age (average 24 years)

Remainder of the talk and predictions

- Presentation of the methods for perception tasks
 - Group Results
 - We expect group differences to verify that the tasks can be taken as a measure of „acquisition“
 - Native speakers = baseline
 - Individual scores
 - We expect individual variation within each group
 - Brief overview: administration of cognitive tasks
 - Results and correlation data with individual phonological scores
 - Conclusions, questions
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Methods: 1.

Perception tasks

Segmental

- **vowel and consonant** contrasts (contrastive in English, not in Korean)

- [l – i, U – u, e – ae]

- [l-r, p-f]

- Conti

(male voice)

A

{silence}

p e bod

p@ p iik

(male voice)

B

{silence}

p ae bod

p@ f iik

(female voice)

X

p e bod

p@ f iik

response

A

B

- **Categorization task ABX**

- Different voices (male female)

- Disyllabic non-words

- Mixed blocks (total of 7 possible contrasts)

- Speeded



Phonotactic

- **Consonant Clusters** (English: yes Korean: no)
 - „perceptual epenthesis“ described as a perceptual mechanism to repair illegal cluster words
 - „sokdo“ is heard as the word „sokudo“ by Japanese listeners (Dupoux et al. 1999)
 - Does perceptual epenthesis have consequences at the lexical level?
 - will L2 learners actually encode English cluster words such as „proud“ with an epenthetic vowel (something like „pUroud“) ?
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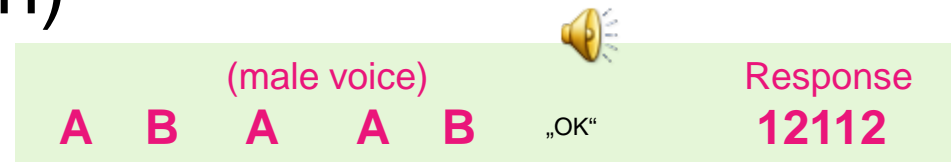
If they do,

- A cluster word (e.g. “proud”) will be activated through hearing a non-word that contains an epenthetic vowel (e.g. “pUroud”)
 - Here: no need for perceptual repair (the stimulus is „legal“ according to Korean phonotactics)
 - Lexical decision task: If „pUroud“ activates the cluster word „proud“ (= „yes“ answer), we reason that they may not have overcome perceptual epenthesis and encoded „proud“ as „pUroud“
- Speeded lexical decision task (~ 160 items)
 - Epenthetic vowel „U“ (e.g. p**U**roud for „proud“)
 - Control vowel „i“ (e.g. bi**l**ood for „blood“)

Suprasegmental

- Suprasegmental: **Word stress** (lexical in English, not in Korean)

● Condition		A	B
○ Phoneme:		tíbu	tígu
○ Stress:		míban	mibán



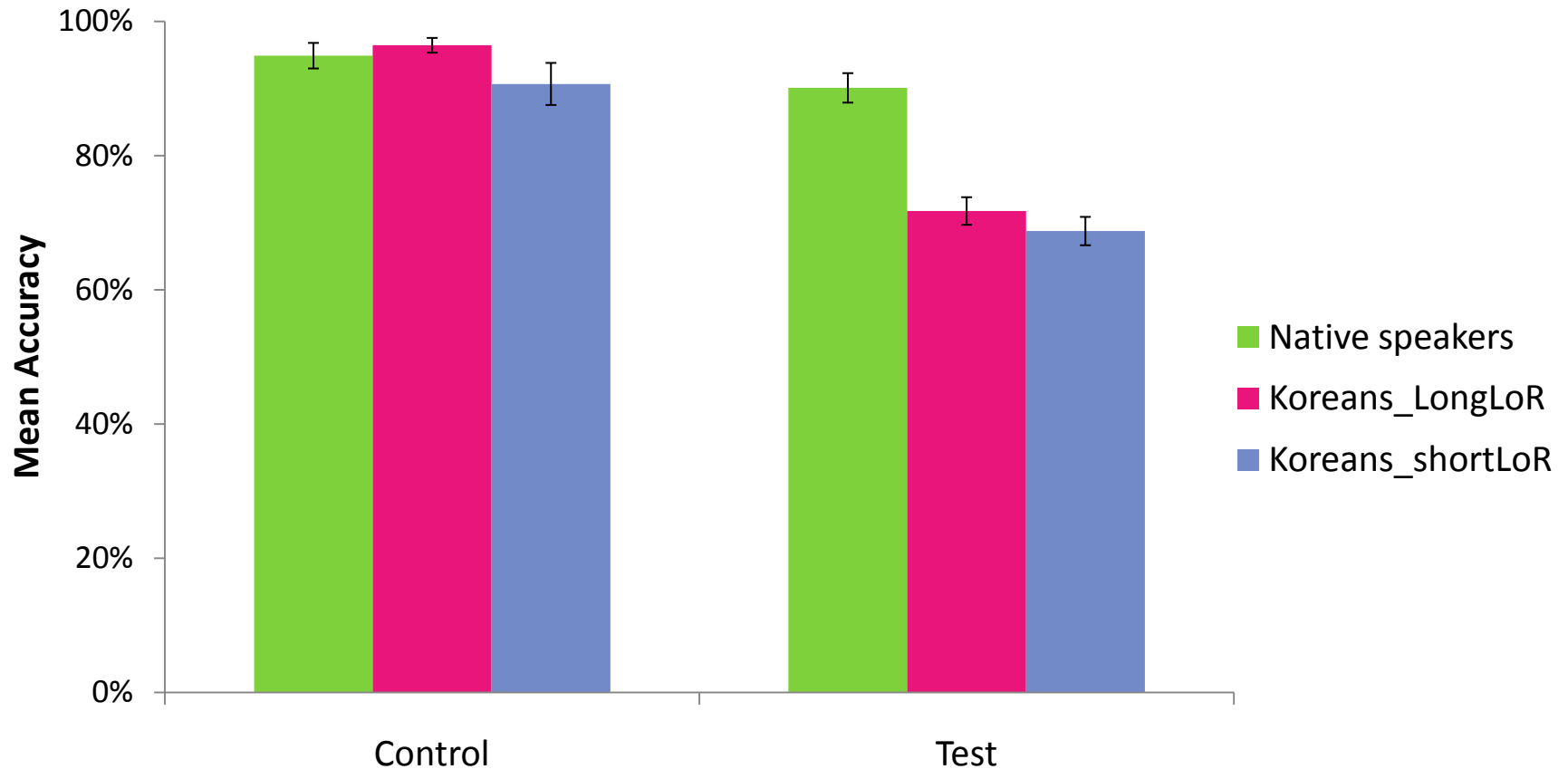
- Sequence repetition (Dupoux et al., 2008)
 - AABA^{„OK“} → answer 1121
 - sequence lengths: 2, 4, 5
- 5 physically different tokens for each item
- ISI = 0 ms
- Response delayed with „OK“

Results

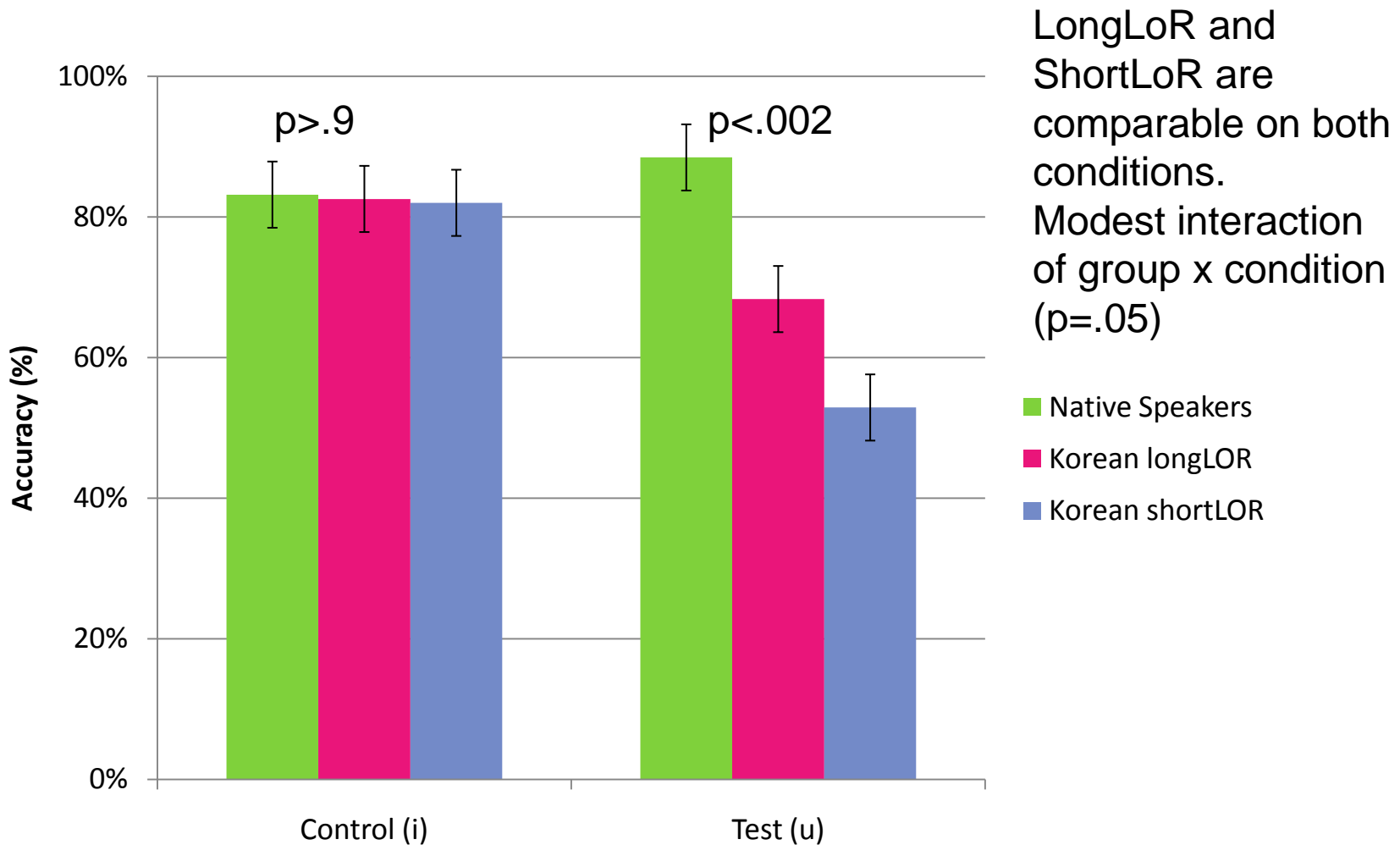
Perception tasks

ABX results

1. control condition: no difference between groups
2. test condition: No difference between LongLoR and ShortLoR, large difference with native speakers



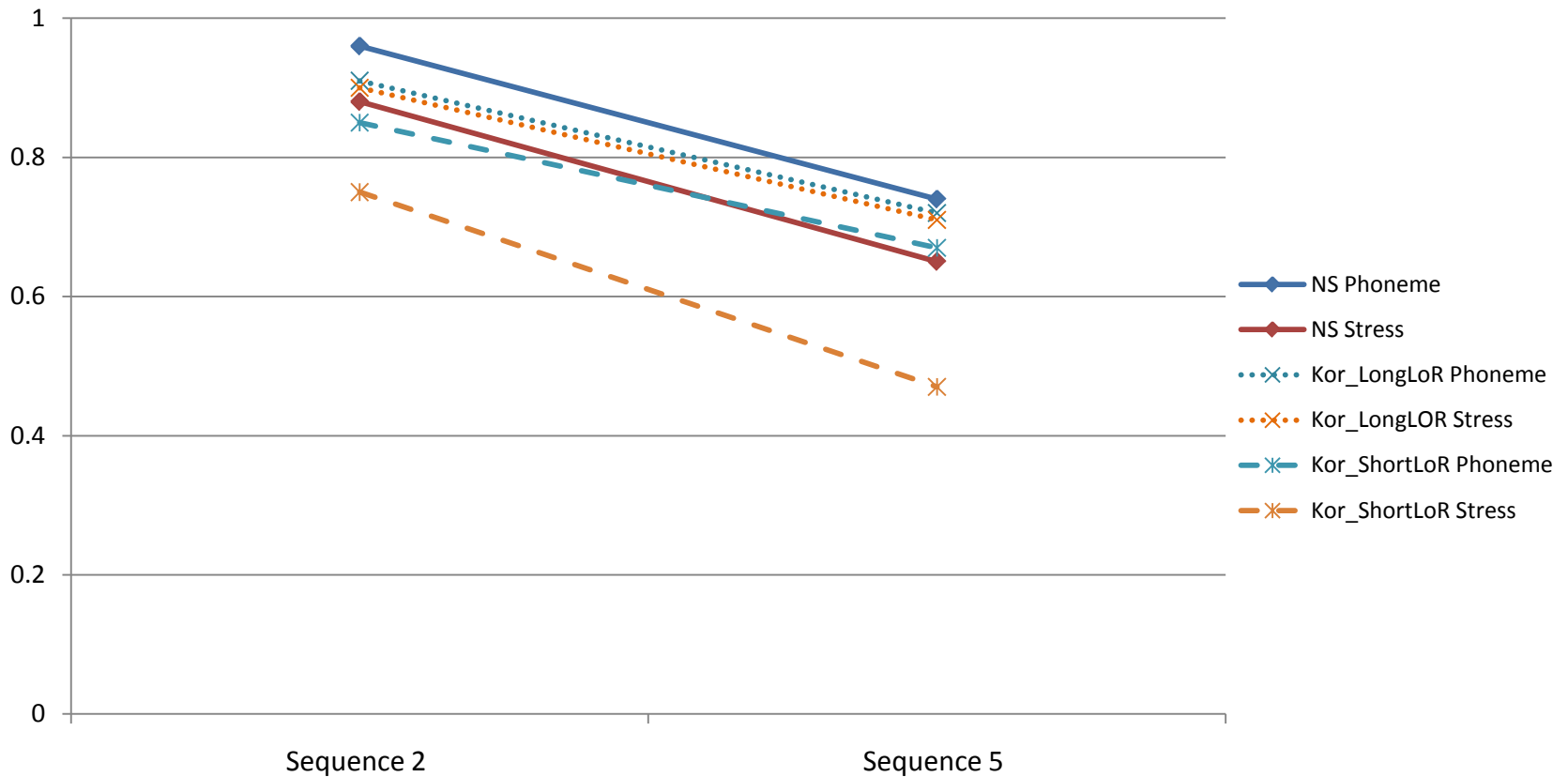
Results: phonotactics in the lexicon



Anova comparing group (NS vs. NNS) and condition:
main effect of group ($p < .01$), of condition ($p < .02$), and interaction ($p < .001$)
Performance on a given condition varies according to group

Results: suprasegmental

All three groups on both conditions



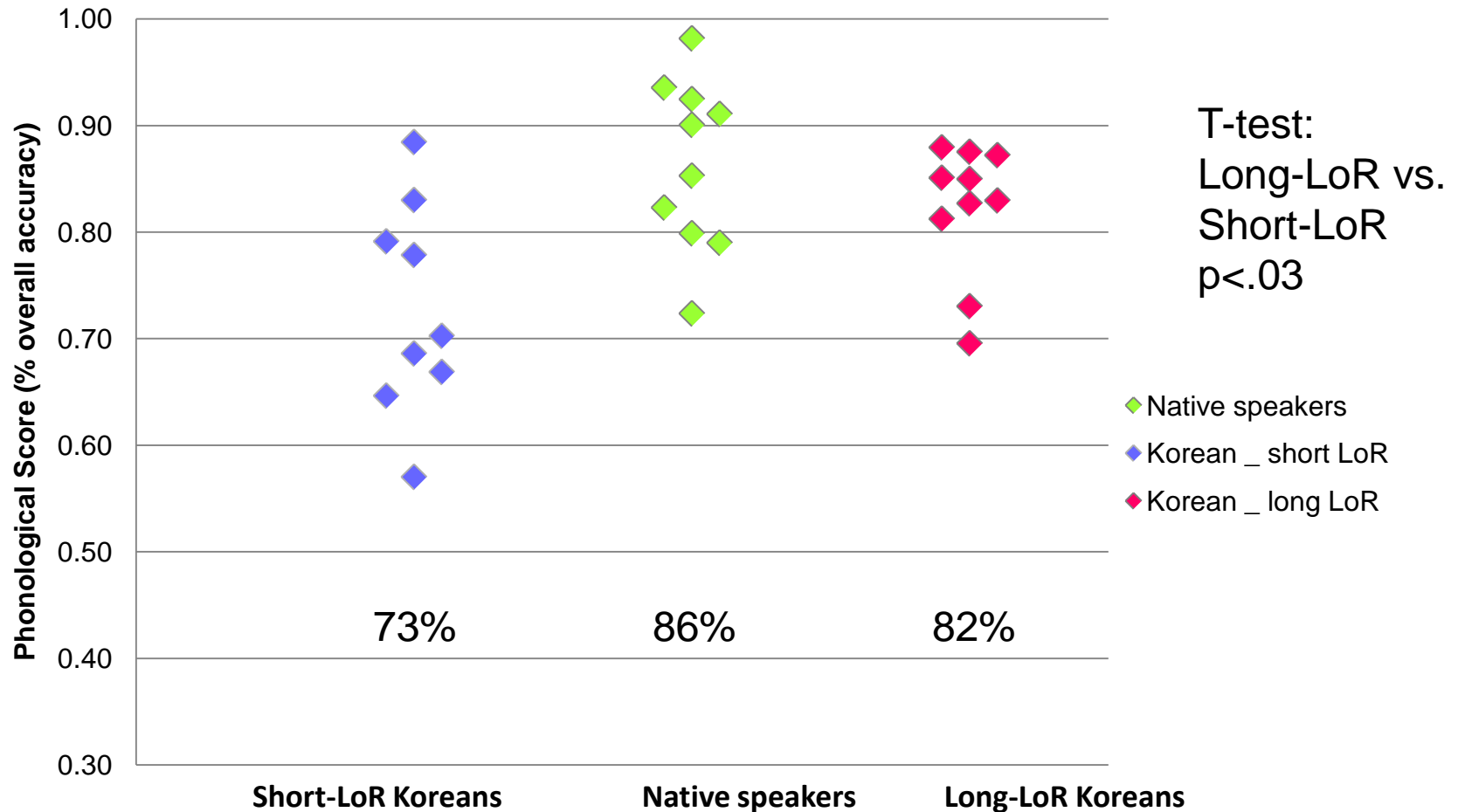
One subject excluded in the short-LoR group

Results: suprasegmental

- Modest interaction of subgroup and condition ($p=.06$)
 - Effects of condition are different on each subgroup
- Lack of interaction between subgroup and sequence
 - Each group's performance declines similarly across the sequence lengths
- Effect of condition ($p<.05$) for both NS and short-LOR, but not for long-LOR (they process both as accurately)
- At sequence 5, both Korean groups perform equally on the phoneme condition, but not on the stress condition
 - Effect of group is significant for the stress condition only

Individual profiles: phonological scores

Average over all test and control conditions in the 3 perception tasks



1 subject excl (short-LoR) who was below 2SD from the mean on 2 out of 3 perception tasks

Methods: 2.

Cognitive measures

Details: 12 cognitive measures

- Working memory (both in L1 and L2)
 - Forward/backward digit span } → storage capacity
 - Forward/backward non-word span } → storage capacity
 - Sentence repetition with last word recall → complex span
 - Paired-Associates → storage quality
- Attention control (in L2)
 - Speeded decision task involving shifting attention to a specified dimension of the auditory stimuli (e.g. „Male Voice?“ or „Real word?“)
- Processing speed (in L1)
 - Naming all three features of 30 geometric forms as quickly as possible (e.g. Big Red Square, Small Blue Triangle, etc...)
- Vocabulary „size“ (in L1 and L2) → lexical retrieval
 - Boston Naming task (accuracy and speed)

Results of the cognitive measures

- All measures were collected in individual sessions
 - Session 1: L1 working memory, processing speed, vocabulary size L1, background questionnaire
 - Session 2: (hearing test), L2 working memory, attention, vocabulary size L2, perception + production
- Data manually coded for working memory, processing speed and background questionnaires
- Perception, vocabulary and attention were computerized
- Production is still being evaluated
- Both non-native groups were comparable on all measures (except L1 and L2 digit span)



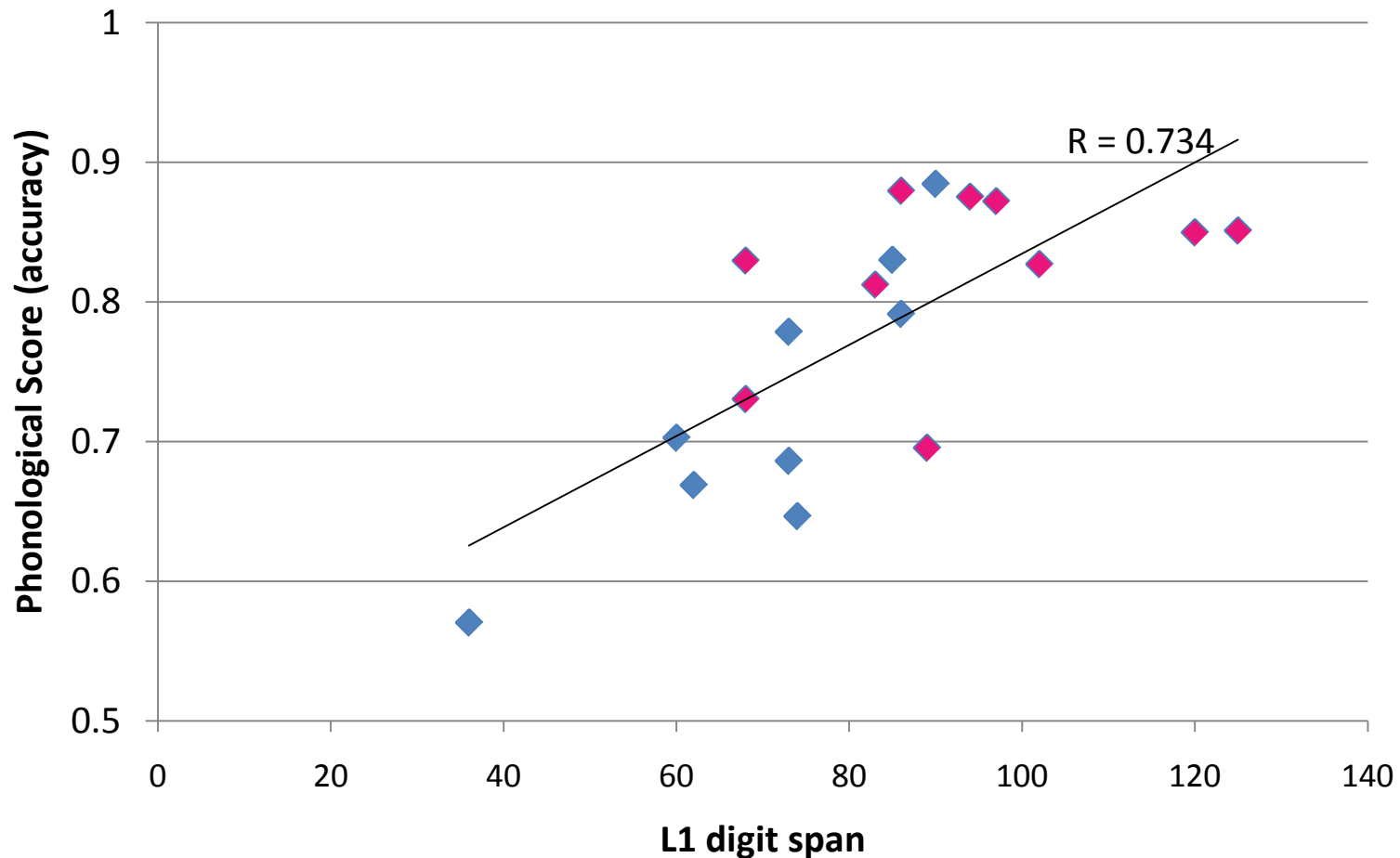
Correlations

- Performed on the „phonological score“ for all 20 Korean subjects (regardless of group)
- Considering all measures

- 2 strongest are:

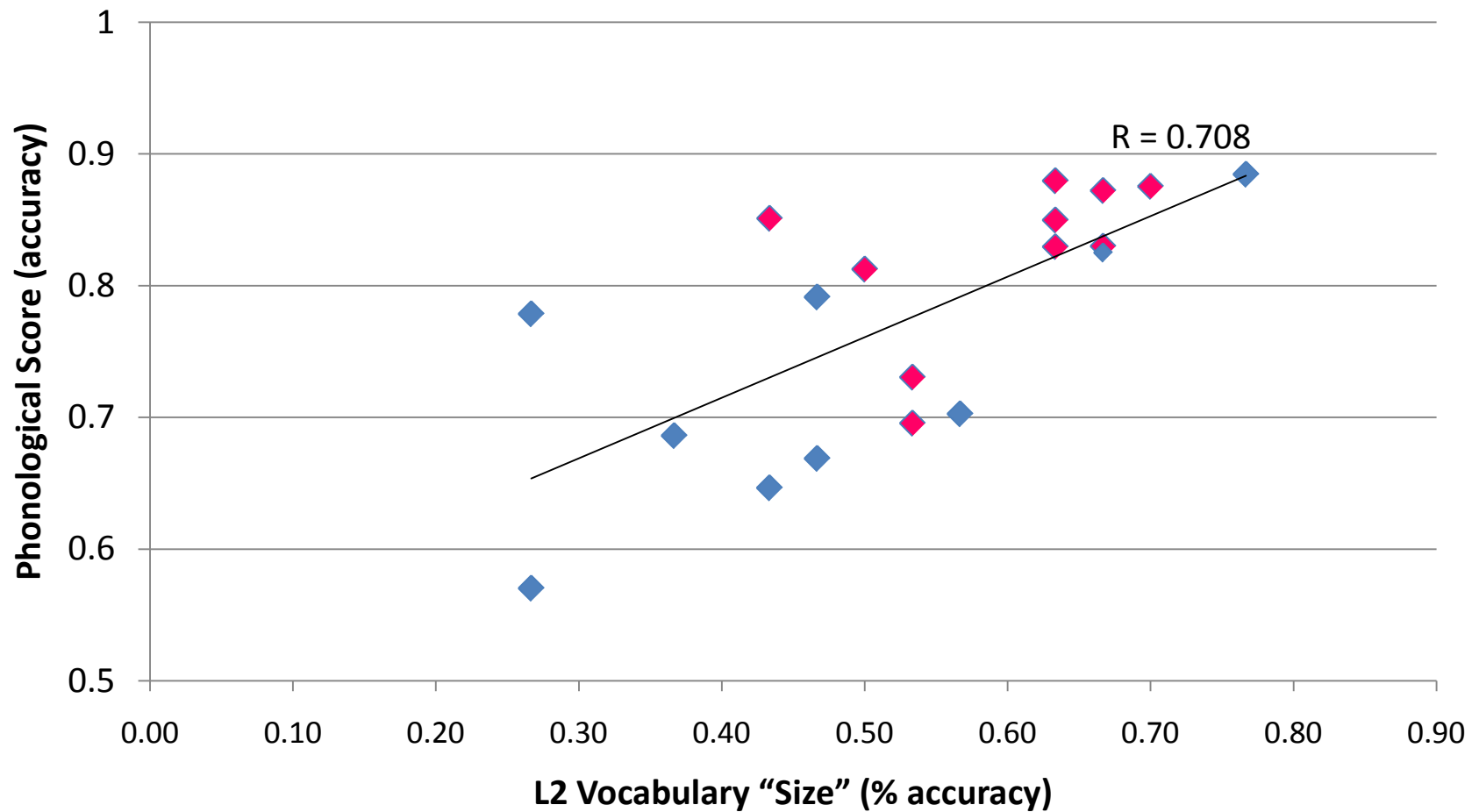
	r coeff.	p. value
L1 digit span	.734**	0
L2 Lexical retrieval	.708**	0.001

Correlation with L1 digit span



Digit span is not the traditional span of 5 or 8. Here: Number of correctly repeated digits over forward and backward digit tasks. Maximum value is 208 (a „perfect“ score with digit span of 10 is equivalent to 104)

Correlation with L2 lexical retrieval



L1 digit and L2 lexical retrieval are modestly correlated ($r=.460$, $p<.05$)

Phonological score also correlates
with:

Measure	r coeff.	p. value
L2 digit span	.661**	0.002
Processing speed	.614**	0.005
Paired associates (L2)	.580**	0.009
L2 sentence recall	.544*	0.016
L1 sentence recall	.539*	0.017
Attention (RT)	-.509*	0.026
L1 nonword span	.484*	0.036

But not significantly with:

	r	p
L1 lexical retrieval	0.426	0.069
L2 nonword span	0.421	0.073

Specific tasks (test conditions) correlate with different cognitive measures.

- **ABX** correlates mostly with L2 digit and non-word span measures, with processing speed and lexical retrieval (accuracy)
- **Sequence repetition** (stress) is strongly correlated with the WM measures, since it relies heavily on WM. It also shows correlation with attention, L2 lexical retrieval, but not processing speed.
- **Lexical decision**, interestingly, does not correlate with any of the cognitive measures (WM, proc speed, attention) but does with lexical retrieval, in particular: naming speed in L1 (not accuracy). Our most recent production data (vowels) also correlates with performance in the lexical decision task.

Conclusions

- All measures of L1 working memory correlate with phonological score
 - All but 1 measures of L2 working memory (with the exception of nonword span) correlate with phonological scores
 - Processing speed and attention (only the reaction times, not the accuracy scores) also correlate
 - L2 lexical retrieval ability is important, but L1 is not (likely a ceiling effect).
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Discussion

- Perception data are valid: show acquisition
 - Group differences on 2 perception tasks
- But are also sensitive to within-group individual differences
- Those differences correlate very strongly with our working memory measures and L2 lexical retrieval, as well as processing speed.
 - Attention is less clear, and L1 lexical retrieval doesn't seem to be related to L2 phonological acquisition
- A longitudinal study would allow to see if those cognitive variables can „determine“ the outcome in phonological acquisition

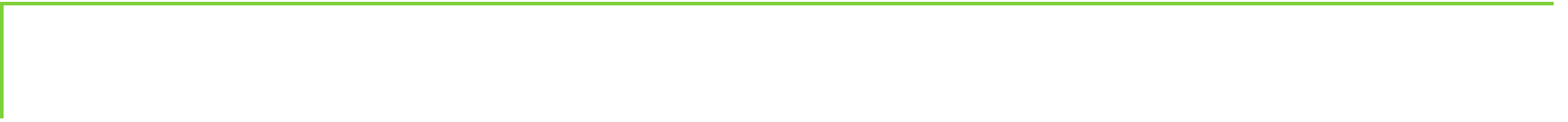
Further questions

- Perception alone is not the whole picture
 - Combine with production data and see whether a higher score in perception is linked with a less accented production
 - Analysis of vowels, consonants, clusters, etc.
 - Foreign-accentedness judgments
 - If not, it might be even more interesting to see what cognitive measures correlate stronger with production and less with perception
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THANK YOU!

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- L2 vocabulary size does not correlate with any of the 5 demographic measures:
 - LoR
 - L2 Usage
 - Motivation
 - AoA
 - Age
 - But does with
 - Processing speed, paired associates (.47, .45), L2 digit span (.65), L1 digit span, and RT in attention.
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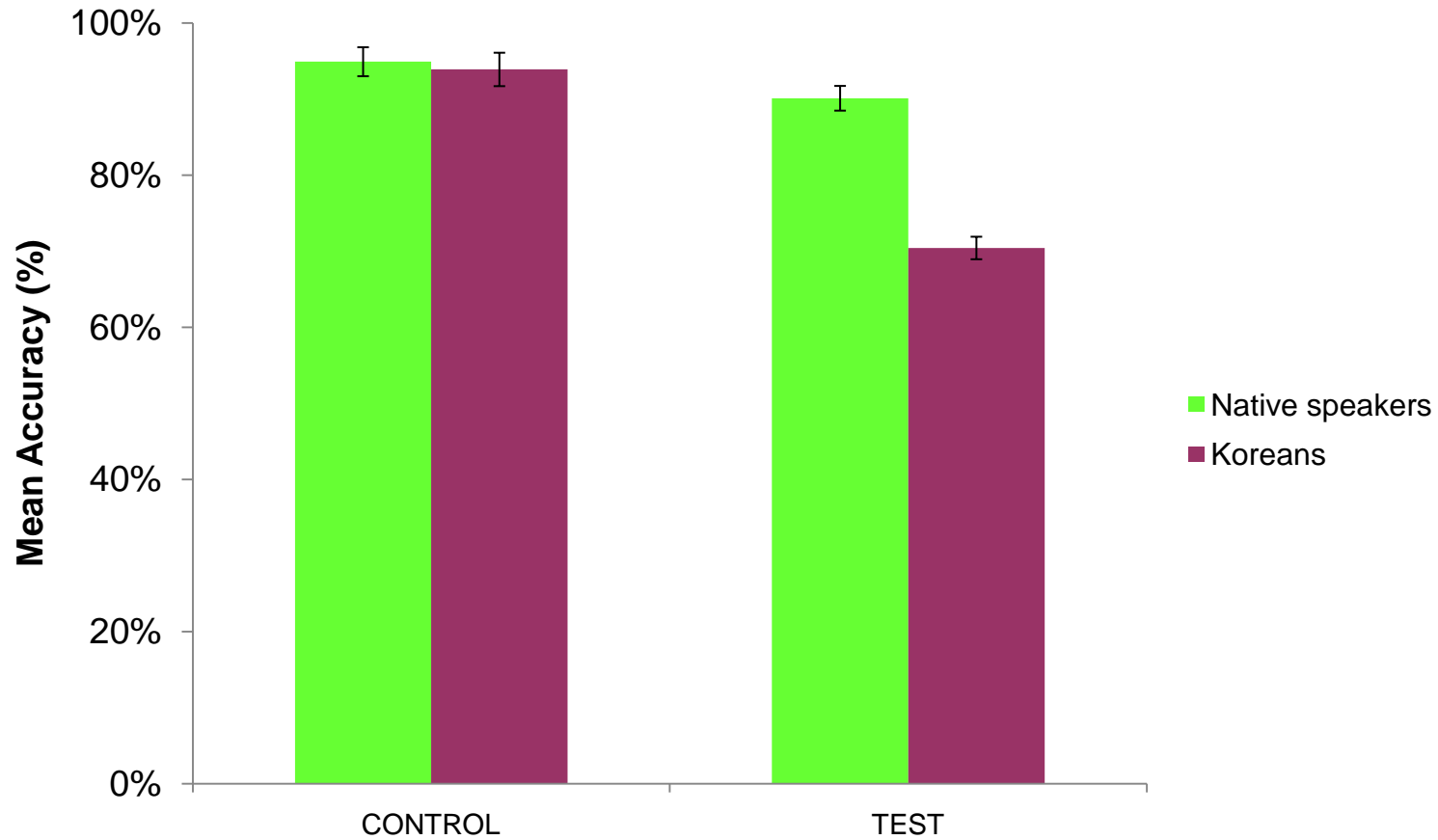
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- L1 digit span correlates with
 - L2 digit span
 - L2 recall
 - (L1 recall and L2 paired associates, $p=.059$)
 - L2 vocabulary size
 - (Not L1 vocabulary size)
 - None of the 5 demographic measures
-

-
- L2 digit span correlates with all other L2 WM
 - Processing speed is correlated
 - With all L2 WM measures
 - With 1 out of 3 L1 WM measures (recall)
 - With vocabulary size in L1 and L2
 - Does not correlate with any of the demographic measures
-

ABX (details)

- 3 vowel contrasts, 2 consonant contrasts, 2 ctrl.
 - 9 vowel items: 3 nonwords x3 vowels: **i-I, u-U, E-ae**
 - 6 consonant items: 3 nonwords x2 consonants: **p-f, r-l**
 - 9 control items (6+3) : **i-o, s-t**
- Consonantal environment & position controlled
 - bilabial, dental, velar
 - e.g. p_V_bod, n_V_d@n, g_V_k@rt
 - Onset, medial or coda position
 - e.g. #C_astik, t@ga_C#, p@_C_i:k
- 24 pairs with 4 orderings: 96 trials

Results: ABX



No difference between LongLOR and ShortLOR, large difference with native speakers

Sequence repetition (Dupoux et al. 2001, 2008)

- Condition A B
 - Phoneme: túku túpu; kúpi kúti
 - Stress: píki pikí; númi numí

- Sequence repetition

- AABA → answer 1121
- sequence lengths: 1, 2, 3, 4, 5, 6

- Short-term memory

1 =  

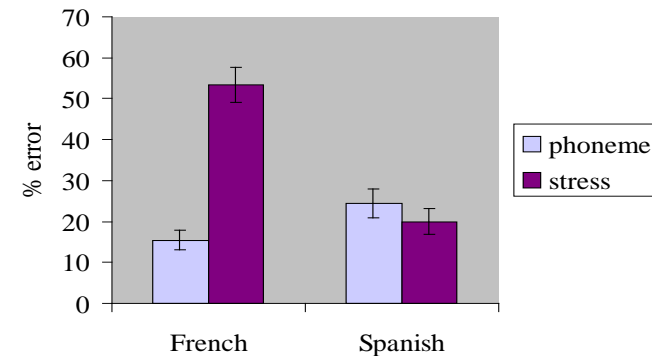
2 =  

trial example (4):  

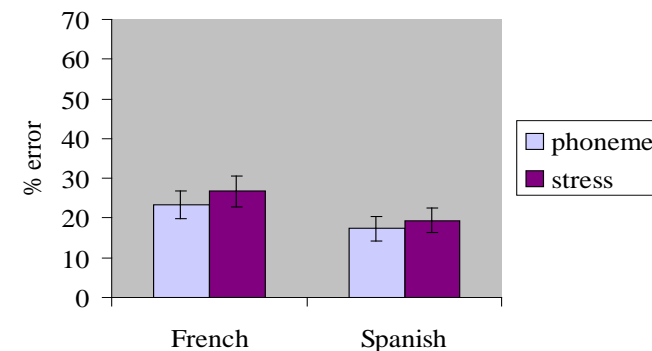
trial example (6): 

Sequence repetition

6 tokens per item

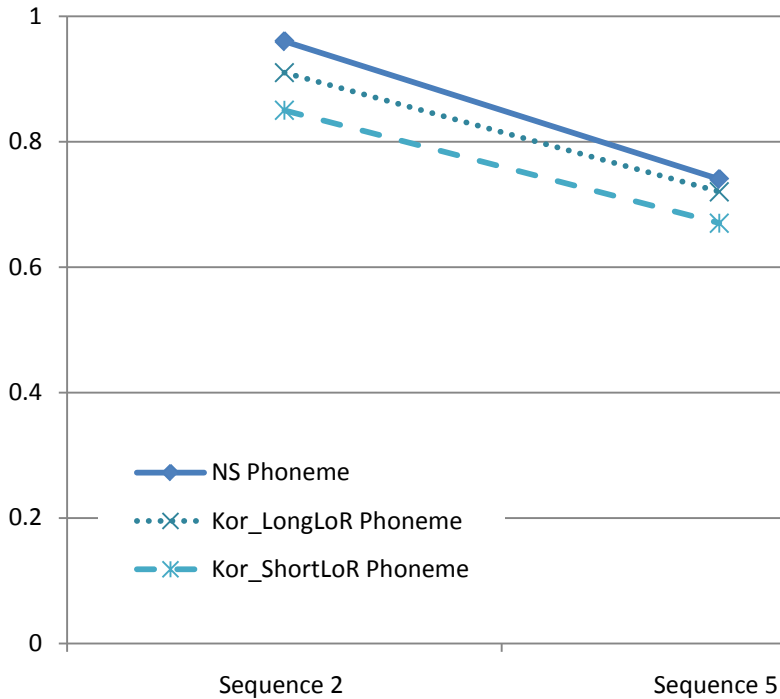


1 token per item

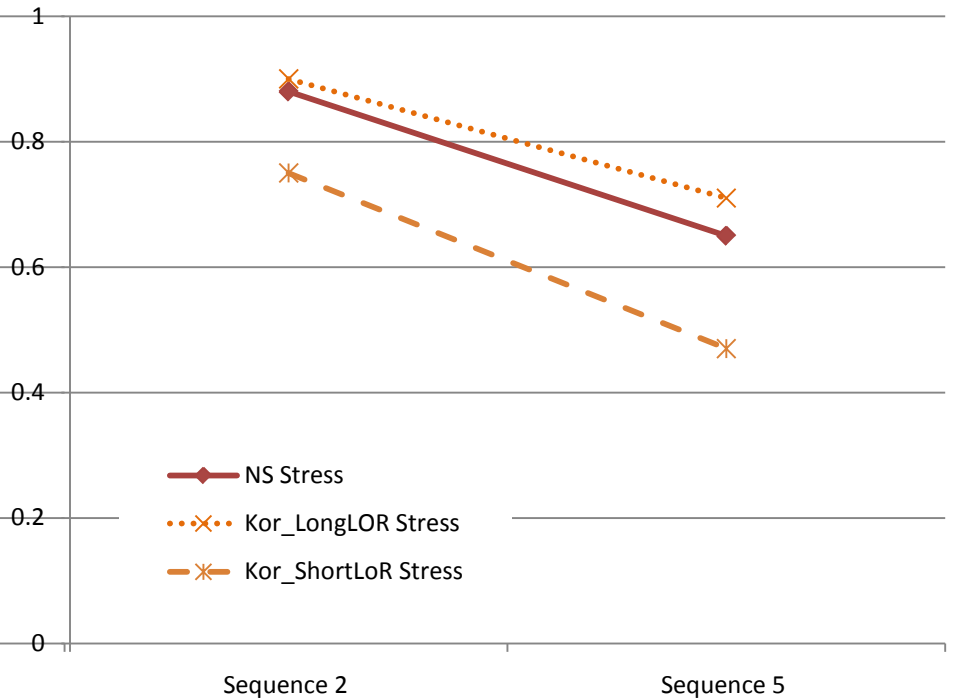


Results: suprasegmental

All three groups on "Phoneme"



All three groups on "Stress"



One subject excluded in the short-LoR group

Attention task

- RT in „baseline“ condition, and in „switch“ condition

Average RT	baseline (sd)	switch (sd)
Americans	910 (122)	973 (120)
Koreans (long-LOR)	783 (90)	830 (97)
Koreans (short-LOR)	961 (199)	1030 (208)

Comparisons on cognitive tasks: native speakers vs. Koreans

L1 Working Memory	digit span	nw-span	recall	processing sp. (acc./60)
Americans	73.9	21.0	41.4	
Koreans long-LOR	93.2	28.9	32.6	46.3
Koreans short-LOR	72.7	29.1	32.5	43.3

L2 Working Memory	digit span	nw-span	recall	paired assoc (mx 36)
Americans				
Koreans long-LOR	66.0	17.8	33.1	18.6
Koreans short-LOR	46.9	14.6	32.5	16.2

Lexical retrieval & Naming speed	Accuracy L1	Accuracy L2	Naming speed: L1	Naming speed: L2
Americans	0.92		1035	
Koreans long-LOR	0.83	0.59	1129	1689
Koreans short-LOR	0.82	0.47	1236	1622

