

Individual Differences in Executive Function and Phonological Processing: Implications for L2 Speech Acquisition.

(Friday 10 June 2016 13.40-16.10)

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It is well established that people differ considerably in their ability to learn new languages, especially in the area of phonological processing. Recent research investigating individual differences in phonological processing suggest that factors other than well-studied predictors of success in L2 speech learning, such as age of onset of L2 learning or input quality and quantity, may be at the source of these differences, including cognitive abilities. In general, the mechanism assumed to underlie the relationship between executive functioning and phonological learning is that a more efficient executive control facilitates phonological processing by freeing resources or reducing interference (Lev-Ari & Peperkamp, 2013; Darcy, et al. 2015), which in turn might facilitate phonological acquisition. However, studies differ widely in the presence or strength of these relationships perhaps due to the variety of tasks and populations studied. Generalizations are difficult to make, and the specific mechanisms that underlie the relationships are not well understood.

Understanding the link between executive function and phonological processing is crucial from both a pedagogical and theoretical perspective. For example, an aptitude-by-treatment interaction approach can be made more effective in instruction and assessment by matching the design of tasks to learners' individual differences in executive function. From a theoretical perspective, it is important for models of language processing and language acquisition to understand what makes certain learners talented at acquiring L2 speech and thus provide an account of phonological processing and L2 speech learning that is inclusive of individual variability.

The goal of this special session is to further our knowledge of the complex interactions underlying the relationships between executive function and phonological processing. In particular, the focus of the empirical contributions to this session target under-explored areas of individual differences and phonological processing, such as the role of individual differences in native production on phonetic drift in production training (Kartushina, Hervais-Adelman, Frauenfelder, & Golestani), the impact of individual differences in perception on production (Holliday), and the role of cognitive abilities such as verbal fluency and phonological short-term memory (Broersma, Choi, & Dedi), attention (Safronova & Mora) and executive functions (Reiterer) on L2 learners' speech perception and production skills. A discussion paper following the presentation of the empirical studies (Trofimovich) will discuss the implications of research on individual differences for L2 speech learning theories and L2 pronunciation teaching.

This session hopes to encourage fruitful discussion about the specific and joint contribution of individual differences in executive function and other individual and contextual factors to L2 speech learning and seeks to motivate further research of its implications for pedagogy and current models of language processing and acquisition. The session will include a final 20-minute general discussion.

References:

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- Lev-Ari, S., & Peperkamp, S. (2013) Low inhibitory skill leads to non-native perception and production in bilinguals' native language. *Journal of Phonetics*, 41, 320-331.

Timing:

- 13:40-13:50: Introduction (Isabelle Darcy & Joan C. Mora)
13:50-14:10: Talk 1 (Natalia Kartushina, Alexis Hervais-Adelman, Ulrich H. Frauenfelder, Narly Golestani)
14:10-14:30: Talk 2 (Jeff J. Holliday)
14:30-14:50: Talk 3 (Mirjam Broersma, Jiyoun Choi, Dan Dediu)
14:50-15:10: Talk 4 (Elena Safronova, Joan C. Mora)
15:10-15:30: Talk 5 (Susanne Reiterer)
15:30-15:50: Talk 6 (Pavel Trofimovich)
15:50-16:05: Panel Discussion
16:05-16:10: Wrap up, thank you and closing

Outline**13:40-13:50: Introduction****Isabelle Darcy¹ and Joan C. Mora²****(¹Indiana University and ²Universitat de Barcelona)*****Individual Differences in Executive Function and Phonological Processing: Implications for L2 Speech Acquisition.***

In recent years, we have seen a rapidly growing amount of research on individual differences in phonological processing and on the learner skills that might be at the source of these differences, including cognitive abilities. Across studies, we find evidence that phonological processing (encompassing both production and perception) is impacted by executive functions such as working memory, inhibitory control, and attention control. In general, the mechanism assumed to underlie these relationships is that a more efficient executive control facilitates phonological processing by freeing resources or reducing interference, which in turn might facilitate phonological acquisition. However, studies differ widely in the presence or strength of these relationships and generalizations are difficult to make, and the specific mechanisms that underlie the relationships are not well understood and might as well extend beyond the domain of executive functioning. The goal of this special session is to further our knowledge of the complex interactions underlying the relationships between executive function and phonological processing. This session hopes to encourage fruitful discussion about the specific and joint contribution of individual differences in executive function and other individual and contextual factors to L2 speech learning and seeks to motivate further research of its implications for pedagogy and current models of language processing and acquisition.

13:50-14:10: Talk 1**Natalia Kartushina, Alexis Hervais-Adelman, Ulrich H. Frauenfelder, Narly Golestani
(University of Geneva, Switzerland)*****How and why learning to produce non-native sounds affects native production.***

L2 learning can affect native phonetic production, with drift of native sounds either towards (Chang, 2013) or away (Fowler et al., 2008) from similar non-native ones. Here, we test whether short phonetic production training affects native production, and whether aspects of individual differences in native production can explain the amount of such drift.

Twenty monolingual native French speakers were trained to produce two novel vowels: the Danish /ɔ/ and the Russian /i/. On each trial, participants repeated the target vowel and received immediate visual feedback showing the location, in F1/F2 space, of their production along with that of the target vowel. Each vowel was repeated 600 times over 3 days. The acoustic position and compactness (i.e., inverse of variability) of the non-native vowels and of the acoustically closest respective French /o/ and /ø/, /y/, /i/ were assessed before and after training.

Training improved the production accuracy and compactness of non-native vowels on average by 19% and 38%, respectively. After training, there was a drift in the position of the French /ø/ and a trend for such a drift for the French /y/ vowel toward the Russian /i/, but no effect on the French /i/. For the French /ø/, the amount of drift was related to pre-training individual compactness of this vowel. The position of the French /o/ did not change overall relative to the Danish /ɔ/, however, training-related changes in F1/F2 between the two vowels were correlated. Training did not change the native vowel compactness. Results show that L1 categories of novice learners drift towards newly learnt non-native ones even after very short lab training, and that speakers with more robust native category representations are less susceptible to such L2 influences. Thus, even native phonetic production is dynamic and susceptible to modifications, but more research is needed on the circumstances and individual differences underlying them.

References

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- Fowler, C. A., Sramko, V., Ostry, D. J., Rowland, S. A., & Hallé, P. (2008). Cross language phonetic influences on the speech of French–English bilinguals. *Journal of Phonetics*, 36(4), 649–663.

14:10-14:30: Talk 2

Jeffrey J. Holliday

(Korea University, South Korea)

Individual differences in perceptual assimilation, phonological equivalence, and L2 production

It has been previously shown that L1 speakers of Mandarin (with a two-way stop contrast) who are learning Korean (with a three-way stop contrast) implement the word-initial Korean stop contrast using different strategies (Holliday, 2015). To the extent that L2 segmental production is driven by perceptual targets (Flege, 1995), and that L2 learners' perception of speech sounds is shaped by phonological experience (Best & Tyler, 2007), we expect different production strategies of word-initial Korean stops to reflect individual differences in perception as well.

Word-initial Korean lax stops are produced with long-lag VOT and a low f₀, and contrast with Korean aspirated (long-lag VOT/high f₀) and tense (short-lag VOT/high f₀) stops. In this study, Korean lax stop productions from 11 Mandarin speakers were acoustically analyzed and compared with their performance on two other tasks: a perceptual assimilation task in which Korean stops were auditorily classified as Mandarin stop categories, and a transcription task in which orthographically presented Korean words were transcribed in Mandarin.

Five subjects consistently transcribed Korean lax stops as Mandarin aspirated stops, two subjects transcribed them as consistently unaspirated, and four subjects transcribed them inconsistently. These results generally agreed with their perceptual assimilation behavior: those who transcribed them as aspirated were more likely to assimilate them to a Mandarin aspirated category, and those who transcribed them as unaspirated were more likely to assimilate them that way. Then, the correlation between the percentage of lax stops assimilated to an unaspirated category and the mean normalized distance between the VOT of each subject's lax and tense stop productions was assessed using Kendall's tau coefficient. The correlation was weak ($\tau = -0.147$), and non-significant ($p = .532$). These preliminary results suggest that the mapping between L2 perceptual and production targets may differ widely across individual L2 learners.

References

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14:30-14:50: Talk 3

Mirjam Broersma, Jiyoun Choi, Dan Dediu
(Radboud University, The Netherlands)

Learning to perceive novel phonetic contrasts: The role of verbal fluency and phonological short-term memory.

Previous research has shown that learners differ widely in the success with which they learn to perceive novel phonetic contrasts. Similarly, they differ widely in various aspects of executive functioning. The relationship between the two, however, has yet remained unclear. We investigate this relationship by training listeners to perceive novel, difficult to distinguish phoneme contrasts and assessing their performance in relation to two components of executive function, namely: verbal fluency (including both phonetic and semantic fluency), and phonological short-term memory. 70 native speakers of Dutch participated in a series of training and test sessions, during which they were trained to perceive the Korean three-way lenis-fortis-aspirated contrasts /p-p*-ph/, /t-t*-th/, and /k-k*-kh/, which are difficult for them to distinguish. Discrimination and identification tests were used to assess their performance during five (pre- and post-training) test moments on three separate days with one-week intervals. Further, in a verbal fluency test, participants had to name as many words as possible in one minute from a semantic category (namely animals) for semantic fluency, and from a phonetic category (namely starting with an /m/) for phonetic fluency. A nonword-repetition task was used to measure phonological short-term memory.

Results showed that there were strong individual differences in the success with which participants learned to perceive the novel phoneme contrasts, as well as in the scores on the executive functions tests. The relation between the scores on the phoneme perception tests and the tests of executive functioning will be discussed, addressing the questions whether verbal fluency and phonological short-term memory are correlated with phoneme perception at particular stages of learning (pre-, between, or post-training), and with particular test types (discrimination versus identification). This study thus aims to elucidate how executive functioning, in particular verbal fluency and phonological short-term memory, affect the acquisition of novel phoneme contrasts.

14:50-15:10: Talk 4

Elena Safronova, Joan C. Mora
(Universitat de Barcelona, Spain)

Memory and Attention in the Perception of L2 Vowel Contrasts.

L2 learners vary in their ability to accurately perceive L2 sound contrasts. Besides age of onset of L2 learning, L2 exposure and use, individual differences in cognitive ability may explain variation in perceptual learning. We investigated the relationship between individual differences in acoustic memory (AM), phonological memory (PM) and attention control (AC) and L2 perceptual phonological competence.

Participants were 45 adult Catalan-dominant Catalan-Spanish bilingual EFL learners. Their memory capacity was measured as identification accuracy rates in two serial recognition tasks comprising pairs of sequences of speech stimuli presented at increasing item lengths. The AM task was based on frequency-rotated speech stimuli (Scott et al., 2000), whereas the PM task contained sequences of L1-Catalan nonwords (Cerviño-Povedano & Mora, 2011). The AC task auditorily presented participants with Catalan vowels (/i, e, ε, a, ɔ, o, u/) in alternating runs (Rogers & Monsell, 1995; Segalowitz & Frenkiel-Fishman, 2005) that switched predictably between length (short vs. long) and speaker voice (male vs. female). AC scores were obtained from accuracy and response latencies at switch and non-switch trials. Accuracy scores in a categorical ABX vowel discrimination task targeting

English /i/-/ɪ/, /ɪ/-/ε/, /ɑ/-/ʌ/, /ɑ/-/æ/ and /ʌ/-/æ/ was used as the dependent measure of L2 perceptual phonological competence.

Correlation analyses indicated modest relationships between ABX perceptual accuracy and AM ($r=.299$, $p<.05$), PM ($r=.291$, $p<.05$) and AC ($r=.314$, $p<.05$). The results suggest that higher short-term memory capacity for acoustic and phonological information and lower ability to inhibit irrelevant acoustic cues may predict more accurate perception of L2 vowel contrasts. Standard regression analyses showed that AM, PM and AC altogether accounted for 18% of variance in L2 vowel discrimination, suggesting that cognitive skills contributed to learners' development of L2 phonetic categories, partly explaining inter-learner variation in L2 phonological attainment. The role of cognitive ability in the attainment of L2 perceptual phonological competence is discussed.

References

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15:10-15:30: Talk 5

Susanne Reiterer

(University of Vienna, Austria)

Individual differences in oral language skills (pronunciation aptitude) and the relationship to cognitive factors and executive functions

This paper provides an overview of 4 studies with similar designs. Individuals vary strongly in their cognitive and linguistic abilities (Reiterer et al., 2011), but it is less clear to what extent linguistic and cognitive abilities correlate, share similar grounds.

We conducted several studies focusing on language aptitude for oral speech imitation (imitating unknown sentences in Hindi), alongside with collateral "general cognitive or executive" factors: non-verbal IQ, verbal IQ, auditory working memory (WM), executive functions, and reading speed. Hypothesis: general cognitive abilities only partly correlate with oral phonetic-linguistic abilities. Study one investigated 138 German subjects involving Hindi imitation, nonverbal/verbal IQ, Simon task (executive functions) and reading speed (Reiterer et al., 2011; Hu et al. 2013; Dogil and Reiterer, 2009). Second study, 41 German natives relating speech imitation to singing ability and auditory WM (Christiner and Reiterer, 2013, 2015). Third study focused on sex differences in speech imitation and collaterally tested 64 Germans on non-verbal / verbal IQ measures (Wucherer and Reiterer, 2016). Last study investigated 30 Iranians' speech imitation abilities and auditory WM (Ghafoorian and Reiterer, 2016).

Results: In all studies ($N= 273$) we found strong and significant correlations between auditory WM and speech imitation ability (r from 0.3-0.8, $p<.05$). No other cognitive or executive functions correlated with the speech imitation, not even the "hottest candidate" of reading speed, which could be termed an "oral flexibility" measure. Neither non-verbal, verbal IQ, nor executive functions yielded any significant correlations in all of the sub-studies. This leads to the tentative conclusion that a shared "processing mode" or sensory channel might influence individual differences: the bigger the distance between processing channel (i.e. auditory-motor domain for speech imitation and visuo-abstract domain for non-verbal), the less the cognitive and linguistic

abilities are related. However, this does not explain the uncorrelated nature of speech imitation and reading speed capacity, since they might share the same output channel, like in singing and speech imitation, two highly related skills.

References

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15:30-15:50: Talk 6

Pavel Trofimovich

(Concordia University, Canada)

Individual differences in second language speech learning: Implications for theory and practice.

Adult second language (L2) learning, and the acquisition of L2 speech perception and production in particular, is generally associated with great inter-individual variation. As a result, much of recent empirical work, which includes research featured in this colloquium, has focused on documenting and explaining individual differences in a variety of cognitive, experiential, and social factors which give rise to variability in adult L2 users' speech perception and production performance. In this presentation, I will critically review recent empirical and theoretical advances in understanding the role of individual differences in L2 speech learning, drawing on several theoretical views, including cognitive processing perspectives, dynamic systems theory, and social-educational frameworks. I will argue that individual differences are not just a source of "noise" in L2 speech learning but rather are integral elements of learning, and that a viable theory of L2 speech learning should centre on and account for inter-individual variation. I will conclude by providing suggestions for further research into individual differences in L2 speech learning and by discussing implications of empirical research on individual differences for pronunciation teaching.

15:50-16:05: Panel Discussion

Presenters & Audience

16:05-16:10: Wrap up, thank you and closing