International Child Phonology Conference 2015

Conference Program

June 24-26, 2015
http://www.ucs.mun.ca/~icpc2015/

Department of Linguistics
Faculty of Arts

MEMORIAL UNIVERSITY

Welcome to ICPC 2015

Welcome to ICPC 2015! During the next few days, we hope you enjoy the setting of Memorial University and St. John's for what promises to be a series of compelling discussions on child phonology and phonological development.

Over the last number of years, ICPC has evolved from a more local meeting centred in the USA to an international conference, with recent destinations such as Memphis (USA), York (England), Minneapolis (USA), Nijmegen (The Netherlands), Missoula (USA), and it is now taking place in St. John's, Canada.

While the conference has kept its relatively small size, it continues to maintain a high level of quality and relevance, in a friendly setting with methodological and theoretical open-mindedness as its bedrock. This year again, the program affords a broad and enticing variety of posters and oral presentations addressing current issues in child phonology, various methods of empirical investigation, and analyses based on different theoretical approaches. Also following the ICPC tradition, the program includes studies coming from educational as well as clinical perspectives. We are thus in a position to enjoy the benefits of both naturalistic and experimental methods, and analyses from a wide range of languages and populations of learners.

While building the program, we strived to group the presentations by themes. We also organized the conference so as to leave as much time as possible for discussion between participants. The first day is the fullest, so as to get everything into motion. We also planned plenty of time for the poster session, in order for our poster presenters to benefit from as much feedback as possible. The poster session is followed by an update from the PhonBank project, where we will also seek feedback concerning the way forward.

The conference dinner will take place at YellowBelly, a local brewery with an excellent and varied restaurant menu. We will welcome you at YellowBelly at 18h30 this Thursday with (vegetarian) nachos as appetizers. Each table can then order their own dinner as the evening unfolds.

With Friday afternoon wide open, we also hope to engage in some recreational activities with those who can stay around. Weather permitting, we will do our best to facilitate whatever you might fancy. Depending on how many people are interested and on car availability, we may also be able to plan a whale-watching tour out of Bay Bulls. Please talk to us on the organizing team and we will help you get the most out of your stay!

Last, but not least, information about (wi-fi) email and internet access is provided in your conference package. Thank you for respectfully keeping your laptops and other devices fully muted throughout the presentation sessions.

Wishing you an enjoyable and enriching conference,

The ICPC 2015 Organizing Committee

The ICPC 2015 Organizing Committee

Undergraduate Students
Alice Brun-Newhook
Alex Cucinelli
Kasi Humber
Patricia Boudreau
Sarah Dunbar

Graduate Students
Alyson Judd
Brittany Sobol
Daniel Barbour
Erica Davis
Hannah Little
Huyen Vu
Suzanne Power
Sarah Blackmore
Sarah Martin

Faculty Members
Julie Brittain
Maureen Scheidnes
Phil Branigan
Paul De Decker
Sara Mackenzie
Yvan Rose

Administrative Support
Peggy Nixon
Margaret McKeever

Conference Sponsors
Faculty of Arts, Memorial University
Faculty of Science, Memorial University

Table of Contents

Conference Program

	Wednesday, June 24th	Thursday, June 25th	Friday, June 26th
08:30	**Registration, Coffee, tea, morning treats**	**Registration, Coffee, tea, morning treats**	**Registration, Coffee, tea, morning treats**
	Early childhood development Chair: Benjamin Munson	Later childhood development Chair: Jessica Barlow	Bilingualism Chair: Ghada Khattab
09:00	Introductory remarks • Carrie Dyck, Associate Dean (Research and Graduate Studies), Faculty of Arts • Phil Branigan, Head, Department of Linguistics	Developmental differences in the effect of production on word-learning Tania Zamuner Elizabeth Morin-Lessard Stephanie Strahm Mike Page	Are baby-talk words shaped by biomechanical constraints on articulation? Mits Ota Barbora Skarabela Judit Fazekas Lovisa Wihlborg
09:30	Sources of phonological complexity in one child's lexical avoidance Anne-Michelle Tessier Kayla Day	Microvariation trajectories in children's nonword repetitions Sharon Inkelas Keith Johnson	Context and task effects on English past tense marking: The case of bilinguals Jessica Barlow Sonja Pruitt-Lord Philip Combiths
10:00	Consonant harmonies and acquisition of natural classes Christophe dos Santos Naomi Yamaguchi Sophie Kern	Pre-schoolers' categorisation of speakers by phonological variables Ella Jeffries Paul Foulkes Carmen Llamas	The role of between-language interaction in the diagnosis of phonological disorders in bilingual children Leah Fabiano-Smith
10:30	**Break**	**Break**	**Break**
	Early childhood development Chair: Jessica Barlow	Later childhood development Chair: Anna Sosa	Wrapping up
11:00	Isolated words in input to infants: A critical wedge? Marilyn Vihman Tamar Keren-Portnoy Robin Lindop-Fisher	Using pupillometry to study early lexical representations Katalin Tamási Cristina McKean Adamantios Gafos Barbara Hoehle	**Business meeting**
11:30	Using spontaneous child data as a proxy for frequencies in the adult targets Ghada Khattab Shaima Al-Qattan	The relationship between early lexical and phonological development: What we can learn from children with atypical phonology Carol Stoel-Gammon	**Closing remarks**
12:00	**Lunch (2 hours)**	**Lunch (2 hours)**	

	Language disorders Chair: Christophe dos Santos	
14:00	Cluster simplification in a nonword repetition study of Russian children with SLI Darya Kavitskaya Sharon Inkelas	**Poster session**
14:30	Grammatical conditioning in the development of phonological productions Kelly Burkinshaw	**(See posters titles and authors below)**
15:00	Identification of subclasses of children with speech sound disorders using the PCC, PWP intersect Alycia Cummings Alexia Larson	[Coffee will be available throughout the poster session]
15:30	**Break**	
	Acoustic analysis Chair: Mits Ota	PhonBank update and discussion
16:00	Motor-acoustic mappings shape child phonology: evidence from a circular chain shift Tara McAllister Byun Adam Buchwald	Phon and PhonBank support toward acoustic and clinical studies Yvan Rose Gregory Hedlund
16:30	Listener bias in categorical and continuous measures of children's production of fricatives Benjamin Munson	

Posters

1.	Differential effects of motor and phonetic variability on speech production in children with SLI	Sara Benham Lisa Goffman
2.	Direction of coarticulation in vowel-fricative sequences in L1-German children	Felicitas Kleber
3.	Measuring the relationship between lexical and phonological ability in 2- and 3-year olds	Brooke Santos Anna Sosa
4.	Phonological development in a bilingual Arabic-English speaking child with bilateral cochlear implants: A longitudinal case study	Manal Sabri Leah Fabiano-Smith
5.	Rhotic vowel production in young children with and without speech sound disorders: Acoustic analysis	Hyunju Chung Jaslyn Dunger Janice Bedard Karen Pollock
6.	The effect of common versus uncommon speech substitutions on the recognition and processing of words	Breanna Krueger Holly Storkel Jacquelyn Vorndran Laura Neenan
7.	The impact of language experience on a non-word repetition task: Testing bilingual children	Jeanie Morry Maureen Scheidnes
8.	Tongue shape complexity of correct and distorted rhotics in school-age children	Jonathan Preston Patricia McCabe Mark Tiede Douglas Whalen
9.	Who needs early intervention? A phonological screening tool for young children with cleft palate	Line Dahl Jørgensen
10.	Babbling as a potential predictor of difficulty in segmental acquisition	Kayla Day

Abstracts

Sources of phonological complexity in one child's lexical avoidance

Anne-Michelle Tessier Kayla Day

University of Alberta

Many case studies of phonological acquisition report evidence of lexical avoidance (or *lexical selection*), whereby very young learners not only fail to produce complex structures, but also fail to attempt target words that contain them (e.g. Ferguson and Farwell, 1975; Menn, 1983; Vihman, 1993; Schwartz and Leonard, 1982; Storkel, 2004). Lexical avoidance can be understood from at least two differing theoretical perspectives on phonological acquisition. One view holds that learners select target words which match their child-specific phonological templates (e.g. Vihman and Velleman, 2002; Wauquier, 2014), and so avoid whatever complex structures they cannot yet produce. Another possibility is that lexical avoidance can be derived directly within a phonological grammar (e.g. van Oostendorp, 2009). If this grammatical view is couched within Optimality Theory, lexical avoidance should only emerge from interacting phonological pressures, rather than as the result of a word's cumulative phonological complexity (c.f. Farris-Trimble, 2009).

This study focuses on one source of production complexity – the move from one word to multi-word utterances – as some studies suggest that a child's restricted phonological system can delay the onset of multi-word phrases (Donahue, 1986, also Waterson 1978). Here, we consider whether the increased complexity of longer utterances can lead to avoidance, and if so whether those structures avoided can be grammatically explained.

To answer these questions, we compare one-word vs. multi-word utterances (1WU vs. MWU) in spontaneous English speech from Rowan (a child in PhonBank's Davis corpus). Beginning with Rowan's first MWUs at 1;03.25, the corpus provides 26 sessions up to age 2;10 with a total of 3,059 utterances. These were divided into the two utterance types -- 1WUs like car, and MWUs like *fast car* – and a third group of reduplicated utterances (*car car car*). We focus here on the early development of MWUs, between 1;05 and 2;3 (Table 1). For each stage and utterance type, we compared the frequency with which Rowan attempted word targets containing various complex structures, including longer words, larger syllables and difficult consonants and sequences.

Across multiple potential sources of complexity, the only clear source of lexical avoidance was target word length. Between 1;05-2;1, MWUs were less likely to contain multi- syllabic targets compared to 1WUs (2a). In contrast, the proportion of attempted complex onsets (2b) was unaffected by utterance size (cf. 3a-b). Table 4 shows that this avoidance is gradient (see also Adam and Bat-El 2009): 1WUs are maximally 2 syllables while many MWUs are bigger, but bigger words are still under-represented in MWUs. We also examined the possible confound that MWUs include mono-syllabic function words, absent from 1WUs; removing these function words lessens but does not eliminate the avoidance effect.

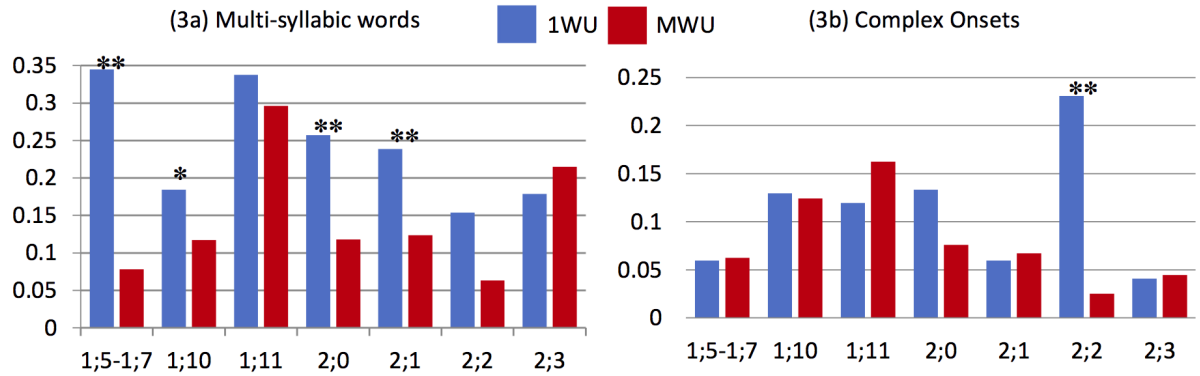
This asymmetry in lexical avoidance provides evidence for a grammatical account, since adult phonologies do impose restrictions on maximal phrase size (de Lacy, 2004), but interactions between utterance length and e.g. onset complexity is unattested. More generally, these results indicate an extended role for lexical avoidance into multi-word production stages – and also illustrate that, for the learner, not all phonological complexity is created equal.

Table 1: Number of each utterance type

	1;5-1;7	1;10	1;11	2;0	2;1	2;2	2;3	TOTAL
1WU	403	255	468	105	67	13	49	1360
MWU	25	60	133	79	98	32	131	558
Redups	251							251

(2) *Raw data*		*1;5-1;7*	*1;10*	*1;11*	*2;0*	*2;1*	*2;2**	*2;3*
a) 1WU	Multi-σ words/total words	139/403	47/255	158/468	27/105	16/67	2/13	8/49
MWU	Multi-σ words/total words	5/64	17/145	104/351	28/237	35/283	5/79	65/382
b) 1WU	CompOnsets/total words	24/403	33/255	56/468	14/105	4/67	3/13	2/49
MWU	CompOnsets/total words	4/64	18/145	57/351	18/237	19/283	2/79	17/382

* note small sample size; see below



** indicates significantly different ($p < 0.01$) on chi-square test

Selected References

Adam, G. and O. Bat-El. 2009. When Do Universal Preferences Emerge in Language Development? The Acquisition of Hebrew Stress. *Brill's Annual of Afroasiatic Languages and Linguistics* 1. 255–282. De Lacy, John. 2004. Markedness Conflation in Optimality Theory. Phonology 21(2). 145-199.

Donahue, M. 1986. Phonological Constraints on the Emergence of Two-Word Utterances. *Journal of Child Language* 13(2). 191–208.

Farris-Trimble, A. W. 2009. Weighted Constraints and Faithfulness Cumulativity in Phonological Acquisition. In J. Chandlee, M. Franchini, S. Lord & G.-M. Rheiner, (eds.) *BUCLD 33 Proceedings* 151-162.

Ferguson, C. & C. B. Farwell. 1975. Words and Sounds in Early Language Acquisition. *Language* 51. 419–439.

Menn, L. 1983. Development of Articulatory, Phonetic, and Phonological Capabilities. In B. Butterworth (ed.), *Language Production*, vol. 2, 1–49. London: Academic Press.

Schwartz, R. G. and L. B. Leonard. 1982. Do Children Pick and Choose? An Examination of Phonological Selection and Avoidance. *Journal of Child Language* 9. 319–336.

Storkel, H. L. 2004. Methods for Minimizing the Confounding Effects of Word Length in the Analysis of Phonotactic Probability and Neighborhood Density. *JSLHR* 47: 1454–1468.

Velleman, S. L. and M. M. Vihman. 2002. Whole-word Phonology and Templates: Trap, Bootstrap, or Some of each? *Language, Speech, and Hearing Services in Schools* 33. 9–23.

Vihman, M. 1993. Variable Paths to Early Word Production. *Journal of Phonetics* 21(1/2). 61–82.

van Oostendorp, M. 2009. *The Phonology of the Unspeakable*. Talk slides available at: http://www.vanoostendorp.nl/pdf/090124edinburgh.pdf

Are baby-talk words shaped by biomechanical constraints on articulation?

Mits Ota Barbora Skarabela Judit Fazekas Lovisa Wihlborg
University of Edinburgh

Across languages, speech directed to infants and young children contains register-specific lexical items such as choo-choo and tummy. The origins and functional motivations of such 'baby-talk words' remain a matter of controversy. One hypothesis is that baby-talk words descend from proto-words in the early stages of language evolution, preserved in modern day parent-child interaction because of their phonetically simple structure (MacNeilage & Davis, 2004). Phonetic simplicity in this context has been interpreted specifically within the Frame/Content theory (MacNeilage, 1998). According to this model, biomechanical constraints on tongue movement favor three intrasyllabic CV co-occurrence patterns, namely labial-central, coronal-front and dorsal-back (MacNeilage & Davis, 2000). MacNeilage and Davis (2004) analysed Ferguson's (1964) sample of baby-talk words from six languages, and demonstrated that the observed-to-expected ratios of these CV co-occurrence patterns are indeed higher than chance (i.e., 1.0). However, this analysis does not address the more critical prediction that tendencies toward these CV patterns should be stronger in baby-talk words than in the regular lexicon of these languages, nor does it test two other predictions that the Frame/Content theory makes — compared to adult words, baby-talk words should have a higher proportion of 'canonical' CV syllables with an oral or nasal stop, and more labial-vowel-coronal (LC) intersyllabic sequences than coronal- vowel-labial (CL) sequences. The purpose of this study was to test these predictions.

A sample of baby-talk words was collected from 10 languages (Basque, Czech, English, Finnish, French, Greek, Hungarian, Japanese, Mandarin, and Swedish) by asking native informants to name baby-talk words in 8 commonly referenced semantic categories (e.g., kinship, sleeping, eating). The resulting database consisted of 351 words, with each language contributing at least 22 items (mean: 35). Each baby-talk word was matched with their adult counterpart (e.g., choo-choo with train, tummy with stomach) to generate a list of regular vocabulary items as a baseline.

Results show that baby-talk words have a higher proportion of canonical CV syllables than in their adult word counterparts (Table 1). The data also replicate the result of MacNeilage and Davis (2004) in that the three biomechanically-privileged CV patterns have a higher-than-expected incidence in baby-talk words. However, this tendency was not stronger in baby-talk words than in adult words (Table 2). Similarly, although LC sequences were overall more frequent than CL sequences in baby-talk words, the preference (measured as the observed/expected ratio difference between LCs and CLs) did not differ systematically between baby-talk words and adult words (Table 3).

In sum, while our analysis shows that baby-talk words exhibit all the biomechanically-motivated phonetic tendencies predicted by the Frame/Content theory, it does not support the prediction that baby-talk words are more compliant to these constraints than adult words, with the exception that they have more canonical CV syllables. If baby-talk words reflect accommodation for the articulatory limitations of infants and young children, the accommodation seems to be confined to the CV structure of syllables rather than a wholesale shift toward a gesturally simpler sequential organization of segments.

Table 1. Proportions of CV syllables with oral or nasal stops (%).

Language	Adult words	Babytalk words
Basque	45	40
Czech	32	52
English	16	77
Finnish	42	61
French	22	57
Greek	41	61
Hungarian	16	42
Japanese	46	42
Mandarin	31	38
Swedish	19	54
Mean	35	52

Note: Paired $t(9) = 3.42$, $p < 0.01$

Table 2. Average observed/expected ratios of labial-central, coronal-front and dorsal-back CV co-occurrence patterns

Language	Adult words	Babytalk words
Basque	0.77	1.06
Czech	1.47	1.02
English	1.52	1.04
Finnish	1.11	0.89
French	1.40	0.46
Greek	0.90	0.92
Hungarian	1.09	1.64
Japanese	0.85	1.39
Mandarin	1.28	1.70
Swedish	0.96	1.08
Mean	1.13	1.12

Note: Paired $t(9) = 0.095$, $p = 0.93$

Table 3. Differences in observed/expected ratios for labial-coronal (LC) sequence vs. coronal-labial (CL) sequence (LC minus CL)

Language	Adult words	Babytalk words
Basque	1.58	0.37
Czech	0.21	0.32
English	0.83	0.21
Finnish	0.00	-0.01
French	-0.14	0.11
Greek	-0.09	0.56
Hungarian	-3.89	0.00
Japanese	-0.13	-0.03
Mandarin	1.00	0.36
Swedish	-0.51	0.21
Mean	-0.11	0.21

Note: Paired $t(9) = 0.73$, $p = 0.48$

References

Ferguson, C. A. (1964). Baby talk in six languages. American anthropologist, 66, 103-114.

MacNeilage, P. F. (1998). The frame/content theory of evolution of speech production. *Behavioral and Brain Sciences*, 21, 499-511.

MacNeilage, P. F., & Davis, B. L. (2000). On the origin of internal structure of word forms. *Science*, 288, 527-531.

MacNeilage, P. F., & Davis, B. L. (2004). Baby talk and the emergence of first words. *Behavioral and Brain Sciences*, 27, 517-518

Consonant harmonies and acquisition of natural classes

Christophe dos Santos
INSERM & Université François-Rabelais de Tours

Naomi Yamaguchi
CNRS & Université Sorbonne Nouvelle Paris 3

Sophie Kern
Laboratoire Dynamique du Langage (CNRS-Univ. de Lyon)

Consonant harmony (CH), in adult languages, is relatively infrequent amongst languages of the world (Hansson, 2010) and also strongly constrained: it is generally regressive and limited to a few numbers of phonological features (Rose et al, 2004). In child language, CH is a common phenomenon and it is not bound by one direction or by specific phonological features (e.g. dos Santos, 2007). Most of the previous studies on CH in child language consider this phenomenon as unified (e.g. Berg, 1992; Rose, 2000; Pater et al., 2003; Bat-El, 2009).

However, pattern production variety prompted us to propose the existence of two distinct phenomena that we call *filling consonant harmony* and *uniformizing consonant harmony*. In the first case, the harmony would be due to the fact that one of the two natural classes of the word is not yet acquired. In the second case, the harmony would be due to not yet mastered co-occurrence of two different natural classes within the word (e.g. Gerlach, 2010). In order to properly study child CH, we must first know if the involved natural classes are acquired in the child's system. Based on this assumption, we propose a methodology in two steps: the first step consists in studying the acquisition of natural classes, and the second step consists in studying consonant harmonies. For this study, we used data collected within the project "PREMS: Influence of phonological development and input on first words" (n° ANR- 11-BSH2-0009). Spontaneous productions of four monolingual French-speaking children followed longitudinally between one and two years old were analyzed using, in a first stage, PHON (Rose et al, 2006; Rose et MacWhinney, 2014). We established for each of these children, the order of acquisition of three major natural classes for manner and place of articulation, namely: oral stops, fricatives and nasals for natural classes of manner and labials, coronals and dorsals for natural classes of place. This first step was based on strict criteria concerning the selection of target consonants: selected consonants were only the ones found in CV words or, in CVCV words where the two consonants shared the same natural class. With these criteria, more than 25000 target consonants belonging to lexical words were analyzed. For the analysis of CH, we selected only CVCV words and analyzed the 1388 CH found in this corpus.

Our assumption about the existence of two distinct consonant harmonies with their own pattern, was confirmed by the results obtained using our rigorous methodology. When a natural class is not yet acquired, we found that CH could be either progressive or regressive. The direction is link to the position of the not yet acquired natural class. These *filling* CH reflect the general acquisition of the consonant system. At another level, when natural classes are acquired, consonant harmonies tend to be only regressive, like CH found in adult languages. These *uniformizing* CH reflect another stage of the phonological development, which is the mastery of different types of consonant co-occurring within the same word.

References

Berg, T. (1992). Phonological harmony as a processing problem. *Journal of Child Language,19*(2), 225-257.

Bat-EL, O. 2009. Harmonic domains and synchronization in typically and atypically developing Hebrew-speaking children. *Language Sciences, 31*, 117-135.

Gerlach, S. (2010). *The acquisition of consonant feature sequences: Harmony, metathesis and deletion patterns in phonological development*. Ph.D. Dissertation, University of Minnesota.

Hansson, G. Ó. (2010). *Consonant Harmony: Long-Distance Interaction in Phonology.* Berkeley, CA: University of California Press. Revised version of Hansson (2001).

Pater, J. & A. Werle. (2003). Direction of assimilation in child consonant harmony. *Canadian Journal of Linguistics/Revue canadienne de linguistique,* 48(3/4), 385-408.

Rose, S. & R. Walker. (2004). A typology of consonant agreement as correspondence. *Language*, 80, 475-531.

Rose, Y. (2000). *Headedness and Prosodic Licensing in the L1 Acquisition of Phonology*. Ph.D. Dissertation, McGill University.

Rose, Y. & B. MacWhinney. 2014. The PhonBank Project: Data and Software-Assisted Methods for the Study of Phonology and Phonological Development. In J. Durand, U. Gut & G. Kristoffersen (eds.), *The Oxford Handbook of Corpus Phonology* (p. 308-401). Oxford: Oxford University Press.

Rose, Y., MacWhinney, B., Byrne, R., Hedlund, G., Maddocks, K., O'Brien, P. & T. Wareham. (2006). Introducing Phon: A Software Solution for the Study of Phonological Acquisition. In D. Bamman, T. Magnitskaia & C. Zaller (eds.), *Proceedings of the 30th Annual Boston University Conference on Language Development* (p. 489-500). Somerville, MA: Cascadilla Press.

Santos, C. dos (2007). *Développement phonologique en français langue maternelle: Une étude de cas*. Ph.D. Dissertation, Université Lumière Lyon 2.

Isolated words in input to infants: A critical wedge?

Marilyn Vihman Tamar Keren-Portnoy Robin Lindop-Fisher

University of York University College London

The importance for early lexical development of hearing words in isolation as compared with having to segment them from running speech continues to be heatedly debated (e.g., Aslin et al., 1996, Brent & Siskind, 2001, Fernald & Hurtado, 2006; Lew-Williams et al., 2011; Junge et al., 2012). Although several studies have shown that by 12 months infants are able to segment the speech stream with the help of distributional cues, this need not be the primary way that infants learn words. Brent and Siskind (2001) demonstrated that isolated-word frequency in input speech better predicts later word use than word frequency overall, for example, while a recent study of onomatopoeia has shown that these words, which make up a sizable proportion of the first words produced by many children, are typically produced in isolation in infant-directed speech (Laing et al., under review).

We tested the effects on lexical learning, in 12-month-olds, of hearing words in isolation vs. sentence-finally. A picture book with unfamiliar words presented either in isolation or sentence-finally was prepared for parents to read to their infants daily for 3 weeks. Infants were then tested using the Head-turn Preference Procedure, contrasting words trained *in isolation* or *sentence-finally* with *untrained words* (with all test words presented in a list, as isolated words). Experiment 1, with a 3-way comparison, produced only marginally significant results, showing a tendency for the isolated words to be better learned. In Experiments 2 and 3 each infant was tested on only one contrast, (a) trained *in isolation* vs. *untrained* or (b) trained *sentence-finally* vs. *untrained*. In Experiment 2 (again with lists of isolated words) infants showed better recognition, in comparison with untrained words, (a) for words trained in isolation (Fig. 1, $t(15) = 3.49$, $p = .003$) but not (b) for words trained *sentence-finally* (Fig. 2, $t(15) = 0.36$, $p = .72$). In Experiment 3 the two groups of infants were tested on trained vs. untrained words with the words embedded in short passages at test (thus requiring segmentation in all cases at test). Under these conditions infants failed to show significantly longer listening to either trained or untrained words.

Although the proportion of isolated-word use reported for IDS ranges from only 9% (Aslin et al., 1996; Brent & Siskind, 2001) to 39% (van de Weijer, 1998), there is reason to believe that these words play a disproportionate role in word learning. Specifically, they may *initiate* the process of segmentation, first supporting infant recognition of words that require no segmentation from strings, and only later, increasing responses to known words in longer strings (for evidence of the time-course of infant segmentation, in the lab, of words known from home and untrained in the lab, see DePaolis et al., 2011: The same words recognized in isolation in the lab at 11 months are recognized when embedded in sentences only at 12 months). Our study provides further evidence that isolated words may afford a 'critical wedge' into the speech stream.

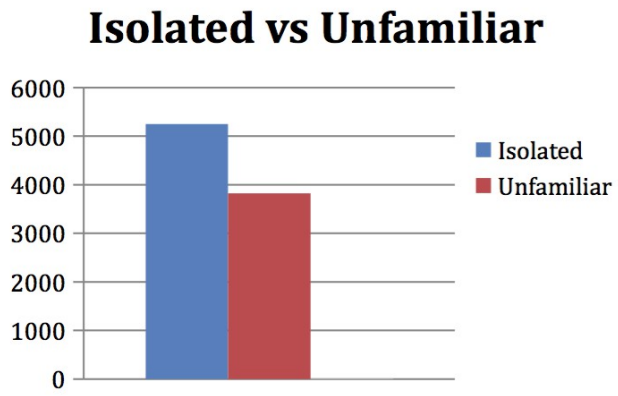


Figure 1. Exp. 2a: Mean looking times to words trained in isolation vs. untrained words (both presented as lists of isolated words).

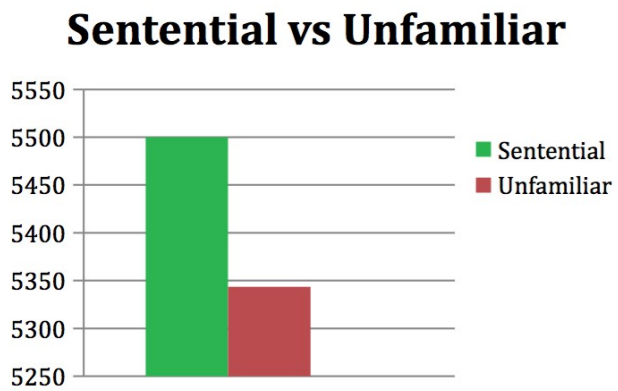


Figure 2. Exp. 2b: Mean looking times to words trained sentence-finally vs. untrained words (both presented as lists of isolated words).

References

Aslin, R. N., Woodward, J. Z., LaMendola, N. P. & Bever, T. (1996). Models of word segmentation in fluent materinal speech to infants. In J. L. Morgan & K. Demuth (eds.), *Signal to Syntax*. Mahwah, NJ: Lawrence Erlbaum Associates.

Brent, M. R. & Siskind, J. M. (2001). The role of exposure to isolated words in early vocabulary development. *Cognition*, 81, B33-B44.

DePaolis, R. A., Vihman, M. M. & Keren-Portnoy, T. (2014). When do infants begin recognizing familiar words in sentences? *Journal of Child Language*, 41, 226-239. Fernald, A., & Hurtado, N. (2006). Names in frames: Infants interpret words in sentence frames faster than words in isolation. *Developmental Science*, 9, F33-F40.

Junge, C., Kooijman, V., Hagoort, P. & Cutler, A. (2112). Rapid recognition at 10 months as a predictor of language development. *Developmental Science*, 15, 463-473.

Laing, C., E., Vihman, M. M. & Keren-Portnoy, T. (under review). The role of onomatopoeia in language development: A prosodic analysis of infant-directed speech.

Lew-Williams, C., Pelucchi, B. & Saffran, J. R. (2011). Isolated words enhance statistical learning by 9-month-old infants. *Developmental Science*, 14, 1323-1329.

Weijer, J. van de (1998). *Language input for word discovery*. (v. 9). Nijmegen: MPIP.

Using spontaneous child data as a proxy for frequencies in the adult targets

Ghada Khattab Shaima Al-Qattan

Newcastle University

This is the first exploration of consonant frequency in the speech of children acquiring Kuwaiti- and Lebanese Arabic. In many of the word's languages, salient aspects of the ambient language have been shown to influence the child's initial progress in language acquisition (Munson, 2001; Vihman, 2014); one way to probe salience is by looking at the frequency of occurrence of sounds, syllable structures, and work shapes in both adult to adult and child directed speech. In Arabic there is a complete lack of such statistics from adult corpora or from child-directed speech, leading to a lack of adequate information on type and token frequency of occurrence of sounds and of their phonological salience/prominence in the early stages of speech acquisition. This paper explores the frequency of targeted consonants in the speech of 70 typically developing children who were sampled from each of the Kuwaiti and Lebanese Arabic-speaking population and aims to relate these to the target-like acquisition of these consonants. The children were aged 1;4 and 3;7 and gender-balanced. Spontaneous speech samples were obtained from audio and video recordings of the children while interacting with their parent for 30-minutes. Results show a general similarity between type and token frequency of target consonants, and a general correlation between high frequency and early acquired sounds and structures. However, complexity plays a major role in target-like realisation regardless of frequency, creating 4 categories of sounds which vary depending on these two dimensions. Potential influences such as selectivity, acoustic salience and articulatory properties are considered in the interpretation of results. The outcomes of this study provide essential knowledge about the frequency of Arabic phonological segments, which forms the first step towards constructing an ecologically valid standardised phonological test for Arabic speaking children.

Cluster simplification in a nonword repetition study of Russian children with SLI

Sharon Inkelas Darya Kavitskaya

University of California, Berkeley

This paper reports on consonant cluster simplification in a nonword repetition study involving two matched Russian-speaking child populations, one typically developing (TD; n=9) and one with SLI (n=9). Subjects were matched for age and all had IQs in the normal range. The 144 stimuli include 108 target words beginning and ending with CC and CCC clusters, some of which are phonotactically impermissible in Russian, as exemplified in Table 1. The specific phenomenon reported in this paper is cluster simplification by deletion (CC → C, or CCC → CC or C).

Results: TD children were slightly more accurate than SLI children; for both groups, the likelihood of an entirely accurate production was lower if the word contained a consonant cluster, as in Table 2. Errors in cluster production included deletion, epenthesis, metathesis, assimilation, dissimilation, and substitution. This study focuses on deletion, a common repair for both groups of children. As seen in Table 3, TD and SLI subjects exhibited cluster simplification at similar rates, showing higher deletion rates from coda than from onset clusters. Adjacency to a vowel is a strong predictor of which consonant in a CC cluster will be preserved, if either is deleted. Table 4 shows figures for target words containing CC clusters which exhibit deletion of one C.

Implications: This study has several important implications. First, as documented for a related population by Kavitskaya et al. (2011), the differences in production patterns between TD and SLI children are essentially quantitative, not qualitative. Children with SLI exhibit a higher error rate overall, but the main tendencies are similar. Our results support the view that the phonological deficit in individuals with SLI involves decreased phonological short-term memory, not a restriction to the most unmarked (CV) syllable structure (Marshall et al. 2002).

A second implication of this study is that it is important to consider languages with a diverse set of onset and coda clusters when formulating theories of cluster reduction. Previous studies of cluster simplification in the productions of young children have found a tendency to preserve the obstruent in onset clusters and the sonorant in coda clusters; Bernhardt & Stemberger (1998), Gerlach (2010) suggest this may be due to universal syllable markedness. However, much of the relevant data are drawn from Germanic languages (primarily English), with tightly restricted cluster possibilities. Russian is much more permissive: onset and coda clusters can increase or decrease in sonority. If syllable markedness determines the identity of the consonant surviving a cluster simplification process, consonant type, not position, should be the main predictor. Our interpretation of the tendency to accurately reproduce the vowel-adjacent member of a cluster is that children are most accurate at producing those chunks of the target word for which they have established, well-practiced production routines; in this case, CV and VC chunks. Our findings thus have broader implications for the relationship between lexical storage and production grammars (see e.g. Becker & Tessier 2011; McAllister Byun, Inkelas & Rose 2013).

Token	Onset/Coda	Sonority in cluster	Lexical frequency of cluster
bvota	onset	rising	non-existent
krata	onset	rising	frequent
rboka	onset	falling	non-existent
rtopa	onset	falling	frequent

Table 1. Examples of nonwords with CC onset clusters, by sonority and lexical frequency

Word accuracy	All words	Words with clusters
TD	50.5%	40.8%
SLI	45.2%	35.3%

Table 2. Word accuracy for children with TD and SLI children

Rate of deletion in clusters	All	Coda only	Onset only
TD	32.3%	41.0%	23.7%
SLI	34.0%	44.7%	22.4%

Table 3. Rate of deletion in clusters for TD and SLI children

Position of deleted C	C_1 survives in C_2C_1V	C_1 survives in VC_1C_2	V-adjacent C survives
TD	92.86%	75.32%	81.5%
SLI	58.82%	77.53%	72.3%

Table 4. Position of deleted consonant in cluster for TD and SLI children

Works cited

Becker, Michael & Anne-Michelle Tessier. 2011. Trajectories of faithfulness in child-specific phonology. *Phonology* 28(2). 163–196.

Bernhardt, Barbara Handford & Joseph P Stemberger. 1998. *Handbook of phonological development: from the perspective of constraint-based nonlinear phonology*. San Diego: Academic Press.

Gerlach, Sharon. 2010. The acquisition of consonant feature sequences: harmony, metathesis and deletion patterns in phonological development. University of Minnesota PhD dissertation.

Kavitskaya, D., M. Babyonyshev, T. Walls, and E. Grigorenko. 2011. Investigating the effects of phonological memory and syllable complexity in Russian-speaking children with SLI. *Journal of Child Language* 38: 979–998.

Marshall, C., Ebbels, S., Harris, J. & van der Lely, H. 2002. Investigating the impact of prosodic complexity on the speech of children with Specific Language Impairment. *UCL Working Papers in Linguistics* 14: 43–68.

McAllister Byun, Tara, Yvan Rose and Sharon Inkelas. 2013. Explaining child-specific cophonology with a grammar of articulatory reliability: the A-Map model. Poster presented at *Phonology 2013*.

Grammatical conditioning in the development of phonological productions

Kelly Burkinshaw

University of Calgary

The literature on infant speech perception commonly highlights how domain-general, probabilistic learning mechanisms may contribute to language acquisition. Models based on these mechanisms capture infants' learning of acoustic categories and simple word shapes (Saffran, Aslin & Newport 1996; Aslin, Jusczyk & Pisoni 1998). Within the realm of speech production, the picture is however not as clear. While children's babbles gradually evolve from articulatorily- predictable vocalizations into forms which match the statistical properties of the ambient language (MacNeilage & Davis 1990; Kern & Davis 2009; Vihman 1996), production patterns in later words cannot always be captured statistically (Demuth 2007). Multilinear models of phonological representation typically better capture these patterns, and suggest a level of grammatical conditioning which transcends statistical influences (Rose 2009).

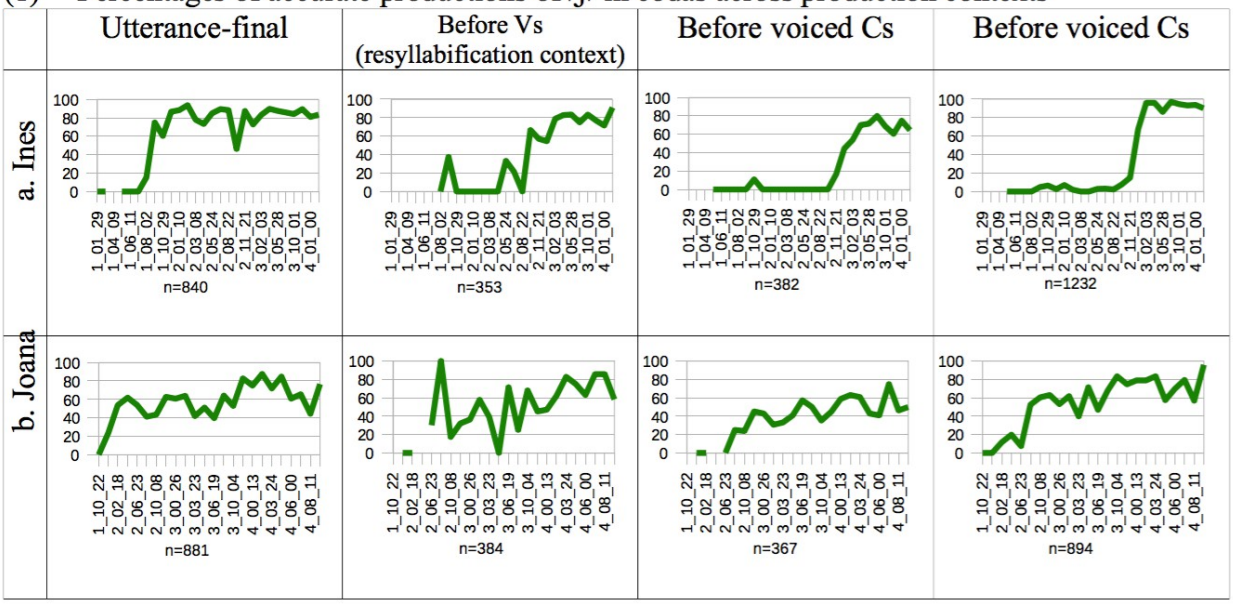
In this paper, I explore representational effects based on production data on the acquisition of European Portuguese. This language provides ideal testing grounds for teasing apart statistical vs. grammatical conditioning because of the relative complexity of its phonological alternations. I focus on a rule of external sandhi: word-final consonants undergo resyllabification into the onset of vowel-initial words following them, where they also undergo allophonic variation. For example, word-final /ʃ/ is resyllabified and pronounced [z] in phrases such as mas agora /mɐʃ ɐˈgɔɾɐ/ → [mɐ zɐˈgɔɾɐ].

From a lexical perspective, the acquisition of word-final consonants in Portuguese is thus contingent on the child's grammatical (phonological) learning of the sandhi rule. Conversely, failure to learn the rule also takes away the key to interpreting the pattern of allophonic variation affecting word-final consonants across contexts. I verify both of these logical scenarios through systematic, qualitative and quantitative comparisons of longitudinal case studies documenting Inês and Joana, monolingual first language learners of Portuguese. I begin by showing, through an independent pattern of positional fricative stopping, that Inês learned the sandhi system very early in the development of her phonological system. As predicted under a grammatical account, she also acquired her word-final consonants in stage-wise, categorical fashion, evidenced by the abrupt developmental stages observed across positions, in (1a).

In contrast to Inês, Joana did not display any evidence that she acquired the sandhi rule. As predicted, she also developed her system of word-final consonants in a gradient fashion, as illustrated in (1b) and exemplified through the variability she displayed within similar words and phonological contexts in (2). I interpret this latter behaviour as the result of probabilistic learning, which she engaged into in the absence of the grammatical key to the puzzle.

These data provide a clear example of how children can use phonological knowledge to bootstrap their lexical representations. Under the hypothesis that Joana represents a less advanced stage in the acquisition of Portuguese (because of her later and incomplete acquisition), these results also suggest that children transition from probabilistic to grammatical modes of data processing, as they acquire the relevant categories and category distributions of the ambient language. This matches similar transitions observed in infant speech perception behaviours, which reveal the acquisition of language-specific categories (Johnson & Jusczyk 2001; Thiessen & Saffran 2003).

(1) Percentages of accurate productions of /ʃ/ in codas across production contexts



(2) Joana's productions of word-final /ʃ/

Orthography	UR	IPA Target	IPA Actual	Age
mas eu	mɐʃ͡ew	mɐˈzew	mɐˈʒew	3;3.23
mas eu	mɐʃ͡ew	mɐˈzew	mɐˈʒew	3;3.23
mas eu	mɐʃ͡ew	mɐˈzew	mɐʃ͡ew	3;3.23
mas eu	mɐʃ͡ew	mɐˈzew	mɐˈze	3;3.23
depois a	dɨˈpojʃ ɐ	dɨˈpoj zɐ	ˈpojʒ ɐ	4;0.13
depois a	dɨˈpojʃ ɐ	dɨˈpoj zɐ	ˈpoj zɐ	4;0.13

References

Aslin, R., P. Jusczyk & D. Pisoni. 1998. Speech and Auditory Processing during Infancy. *Handbook of Child Psychology: Cognition, Perception, and Language*. New York: Wiley.

Demuth, K. 2007. The Role of Frequency in Language Acquisition. Frequency Effects in Language Acquisition, 528–538. Berlin: Mouton de Gruyter.

Johnson, E. & P. Jusczyk. 2001. Word Segmentation by 8-month-olds: When Speech Cues Count More than Statistics. *Journal of Memory and Language* 44(4). 548–567.

Kern, S. & B. Davis. 2009. Emergent Complexity in Early Vocal Acquisition: Cross-linguistic Comparisons of Canonical Babbling. Approaches to Phonological Complexity, 353–375. Berlin: Mouton de Gruyter.

MacNeilage, P. & B. Davis. 1990. Acquisition of Speech Production: The Achievement of Segmental Independence. *Speech Production and Modeling*, 55–68. Dordrecht: Kluwer.

Rose, Y. 2009. Internal and External Influences on Child Language Productions. *Approaches to Phonological Complexity*, 329–351. Berlin: Mouton de Gruyter.

Saffran, J., R. Aslin & E. Newport. 1996. Statistical Learning by 8-Month-Old Infants. Science 274(5294). 1926–1928.

Thiessen, E. & J. Saffran. 2003. When Cues Collide: Use of Stress and Statistical Cues to Word Boundaries by 7- to 9-Month-Old Infants. *Developmental Psychology* 39(4). 706–716.

Vihman, M. 1996. *Phonological Development: The Origins of Language in the Child*. Oxford: Blackwell.

Identification of subclasses of children with speech sound disorders using the PCC, PWP intersect

Alycia Cummings Alexia Larson

University of North Dakota

A better understanding of the underlying mechanisms of developmental speech sound disorders (SSD) has the potential to greatly impact speech treatment outcomes. That is, it is possible that there are different subtypes of SSD, and characterizing the children correctly from the outset may allow for the administration of more effective treatment procedures. One common approach to characterizing children with SSD is to use a severity rating. The severity of SSD is often characterized using the Percentage of Consonants Correct (PCC) (Shriberg & Kwiatkowski, 1980, 1982); an alternate measure is the Proportion of Whole Word Correctness (PWP) (Ingram, 2002). PWP accuracy levels tend to be higher than those of the PCC due to the credit given for vowel productions and consonant substitutions, but there is a linear relationship between the two measures (Babatsouli, Ingram, & Sotiropoulos, 2014). This relationship has led to a new measure that combines the two: the PCC, PWP Intersect (Ingram, 2012).

This study examined the relationship between consonant correctness and word complexity in 24 children with SSD (mean age = 4.80 years) and 24 typically developing (TD) children (mean age = 5.09 years). Specifically, the PCC, PWP Intersect was used in an attempt to identify different groups of children who may have delayed and/or disordered speech sound production abilities. Two different measures of speech sound production were used to generate PCC, PWP Intersect values: the Goldman-Fristoe Test of Articulation, 2nd ed. (GFTA) (Goldman & Fristoe, 2000) and the Nonword Repetition Task (NRT) (Dollaghan & Campbell, 1998). Children were assigned to Linear or Nonlinear PCC, PWP Intersect groups based on their productions of words on the GFTA and NRT. Children in the Linear group demonstrated a linear increase in word production accuracy, in that words designated as shorter and less complex were produced with greater accuracy than longer, more complex words. Alternatively, children in the Nonlinear group produced more complex words with greater accuracy than some of the less complex words. Based on previous PCC, PWP Intersect findings (Knodel, 2012; Purinton & Ingram, 2014), it was predicted that children with SSD who demonstrated Nonlinear PCC, PWP Intersect patterns could be identified as having a speech sound “disorder” while children with SSD who had a Linear Intersect pattern could be identified as having a speech sound “delay”.

Group differences will be examined using repeated measure ANOVAs for the GFTA and NRT data. Additionally, the relationship between the PCC, PWP Intersect measures and traditional clinical outcome measures will be examined in simple linear regressions. Results will provide information regarding the clinical utility of the PCC, PWP Intersect, especially as it is used with children with SSD.

References

Babatsouli, E., Ingram, D., & Sotiropoulos, D. (2014). Phonological word proximity in child speech development. Chaotic Modeling and Simulation (CMSIM), 3, 295–313.

Dollaghan, C. A., & Campbell, T. F. (1998). Nonword Repetition and Child Language Impairment. Journal of Speech, Language, and Hearing Research, 41(5), 1136–1146.

Goldman, R., & Fristoe, M. (2000). Goldman-Fristoe Test of Articulation, 2nd ed. Minneapolis, MN: Pearson.

Ingram, D. (2002). The measurement of whole-word productions. Journal of Child Language, 29(4), 713–733.

Ingram, D. (2012). A comparison of two measures of correctness: PCC & PWP. Presented at the Annual meeting of the American Speech-Language-Hearing Association, San Diego, CA.

Knodel, R. (2012). A comparison of two measures of phonological assessment in children (Thesis under the direction of David Ingram). Arizona State University, Phoenix, AZ.

Purinton, K., & Ingram, D. (2014). The interaction of word complexity and consonant correctness in Spanish speaking children. Presented at the International Child Phonology Conference, Missoula, MT.

Shriberg, L. D., & Kwiatkowski, J. (1980). Natural process analysis (NPA) a procedure for phonological analysis of continuous speech samples. New York: Wiley.

Shriberg, L. D., & Kwiatkowski, J. (1982). Phonological Disorders III: A Procedure for Assessing Severity of Involvement. Journal of Speech and Hearing Disorders, 47(3), 256. doi:10.1044/jshd.4703.256

Motor-acoustic mappings shape child phonology: Evidence from a circular chain shift

Tara McAllister Byun Adam Buchwald

New York University

Chain shift, in which interacting phonological processes cause successive changes along some dimension (A→B; B→C), is a topic of perennial interest in the speech development literature (e.g. Jesney, 2007, Dinnsen, Green, Gierut, & Morrisette, 2011). Here we present an apparent case of *circular chain shift* (A→B; B→A) in the phonology of a typically developing child, WK. WK inserted [t] after initial coronal fricatives (*sick* →[stɪk]), but also reduced initial homorganic s-stop clusters (*stick* →[sɪk]). Neither formal models nor performance factors alone can readily account for such a pattern.

To elucidate the underlying pressures, we conducted acoustic and statistical analyses of initial /s/ and /st/ tokens collected in structured speech tasks over a two-month period of intervention. WK's output was variable, with 52% application of epenthesis and 30% application of cluster reduction in the first session (Figure 1). The occurrence of epenthesis increased and reduction decreased over time.

We measured minimal pairs *sick-stick* and *sir-stir* to look for covert contrast in WK's output (Table 1). We found no significant differences between underlying and derived categories (e.g. /st/→[st] versus /s/→[st]). However, there was a significant difference in fricative duration between surface clusters and singletons, independent of underlying or derived status. Contrary to expectations from adult speech, [s] in cluster contexts was significantly longer than singleton [s]. The long duration of /s/ in surface clusters suggests that WK realized these with a less-than-typical degree of coarticulatory overlap. Previous accounts have argued that homorganic clusters are late-emerging due the motor difficulty posed by a sequence of slightly different movements of a single articulator (Bates et al., 2002). The coarticulated transition from a sibilant to a vowel has also been characterized as problematic for children's articulatory control capabilities (McAllister Byun, 2011). A minimally-coarticulated [s:t] sequence can be seen as a solution to the articulatory challenge WK faced from both /sV/ and /st/ sequences realized with typical gestural overlap. We thus posit that [s:t] was WK's production target for both underlying /s/ and /st/ during the period in question. Because this motor plan was not yet stable, deletion of one gesture occurred periodically, yielding singleton [s]; this was coded as a correct production when the underlying target was /s/ and as cluster reduction when the target was /st/. However, a purely performance-based account cannot explain why WK would not target [s] directly, since that motor plan was available to him.

We contend that the phenomenon becomes interpretable in the context of an exemplar- based grammar in which specific motor plans are linked to their acoustic consequences, with an index of the relative stability of motor plans (e.g. McAllister Byun, Inkelas & Rose, 2013). Given WK's long history of output errors affecting /s/, the likelihood of a successful /s/→[s] mapping remained low enough that [s:t]—which is motorically simpler/more stable and also acoustically quite similar—represented a more harmonic output target for /s/. We argue that only a grammar enriched with this detail about motor-acoustic mappings could account for puzzles like WK's apparent circular shift.

Figure 1. Realization of /s/ and /st/ targets over time

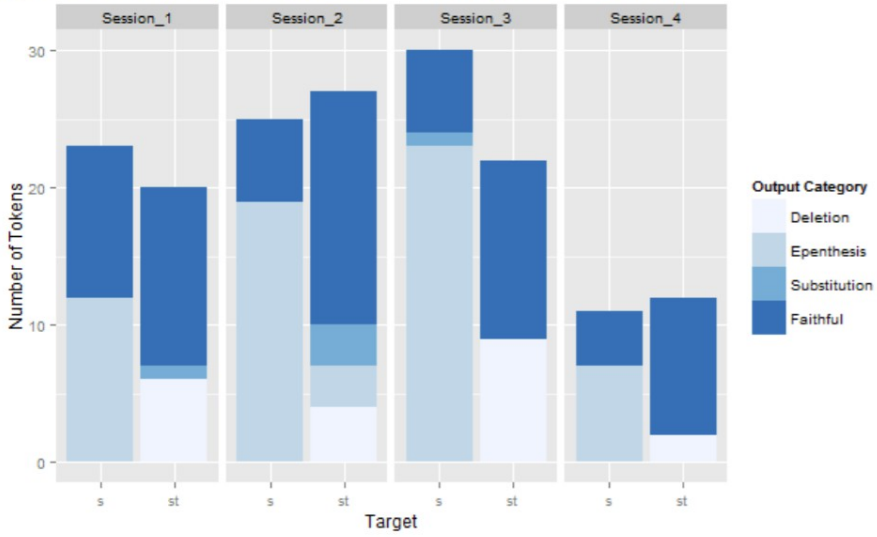


Table 1. Measurements of /s/-/st/ minimal pairs. All measurements reported in *ms*.

Target	Realized with initial [s]		Realized with initial [st]			
	N	Mean fricative duration (SD)	N	Mean fricative duration (SD)	Mean closure duration (SD)	Mean VOT (SD)
sir	5	249 (57)	10	416 (154)	109 (53)	25 (8)
stir	2	229 (20)	12	380 (199)	149 (91)	26 (10)
sick	9	249 (82)	22	346 (90)	203 (167)	18 (7)
stick	8	231 (57)	12	345 (100)	223 (137)	13 (5)

Fricative duration was significantly longer for surface clusters than singletons ([st]-[s]), $t(78)=4.395$, $p < .0001$. Comparisons based on underlying targets (/st/-/s/) were not significant (all $p > .40$).

References

Bates, S.A.R., Watson, J.M.M. & Scobbie, J. M. (2002). Context conditioned error patterns in disordered systems. In M. Ball & F. E. Gibbon (eds.), *Vowel Disorders*, pp. 145-185. London: Butterworth Heinemann.

Boersma, P., & Hayes, B. (2001). Empirical tests of the Gradual Learning Algorithm. *Linguistic Inquiry* 32, 45-86.

Dinnsen, D. A., Green, C. R., Gierut, J. A., & Morrisette, M. L. (2011). On the anatomy of a chain shift. *Journal of Linguistics*, 47, 275-299.

Jesney, K.C. (2007). Child chain shifts as faithfulness to input prominence. In A. Belikova, L. Meroni, M. Umeda (eds.), *Proceedings of the 2nd Conference on Generative Approaches to Language Acquisition, North America*, pp. 188-199. Somerville, MA: Cascadilla Press.

McAllister Byun, T. (2011). A gestural account of a child-specific neutralisation in strong position. *Phonology*, 28, 371-412.

McAllister Byun, T., Inkelas, S., & Rose, Y. (2014). Parallels in speech acquisition and loss as evidence for a grammar of articulatory reliability. Talk presented at *NELS* 45, Cambridge, MA.

Listener bias in categorical and continuous measures of children's production of fricatives

Benjamin Munson

University of Minnesota

Acoustic studies of children's speech suggest that phonological development involves the progressive differentiation of contrasts that are initially merged in production. Li (2012) showed that two-year old English- and Japanese-acquiring children's productions of /s/ and /ʃ/ overlap greatly in the acoustic dimensions that differentiate adults' productions of those sounds. Throughout the preschool years, /s/ and /ʃ/ become gradually more different from one another in these same acoustic dimensions. Munson, Edwards, Schellinger, Beckman, and Meyer (2010) showed that Visual-Analog Scaling (VAS) techniques can be used to elicit a continuous perceptual judgment of how /s/- or /θ/-like a child's fricative is. In that study, children's productions of /s/ and /θ/ were presented to listeners. These stimuli included sounds whose acoustic characteristics varied continuously from those of a canonical /s/ to those of a canonical /θ/. Listeners were asked to rate the sound on by clicking on a line anchored with the text "the 's' sound" and "the 'th' sound." Individual listeners' VAS ratings were found to be both continuous and to correlate well with the acoustic characteristics of the stimuli. Similar findings for the /s/-/ʃ/, /t/-/k/ and /d/-/g/ contrasts are presented in Munson, Johnson, and Edwards (2012) and Julien and Munson (2012). These findings and other suggest that VAS can be used to assess continuous variation in children's speech.

The purpose of the current study is to examine how robust VAS rating of children's speech are in different listening conditions, and to contrast the effect of listening condition on VAS ratings of children's speech to the effect on binary categorization judgments of the same stimuli. In the first task, children's productions of /s/ and /ʃ/ were played in the presence of various levels of background noise. Previous research using VAS (Diamond & Munson, 2013) showed that VAS ratings of these sounds were very stable across three SNRs. This presentation will contrast Diamond and Munson's findings with those of a study in progress that examines whether binary categorizations of sounds as /s/ or /ʃ/ are similarly stable across SNRs.

In the second task, ratings of children's productions of /s/ and /θ/ were elicited from listeners in two conditions. In one condition, judgments of /s/ and /θ/ were interleaved with judgments of a categorical linguistic variable, namely, identifying the vowel that came after the fricative. In another condition, /s/ and /θ/ judgments were interleaved with judgments of an indexical variable, identifying the child's sex. Kaiser, Munson, Li, Holliday, Beckman, Edwards, and Schellinger (2009) conducted this experiment using VAS ratings of /s/ and /θ/. They hypothesized that more continuous VAS ratings of /s/ and /θ/ would be elicited in the indexical condition than in the vowel-judgment condition. Kaiser et al. found that judgments of /s/ and /θ/ were similarly continuous across the two conditions. This presentation will contrast Kaiser et al.'s findings with those of a study in progress that examines whether binary categorizations of sounds as /s/ or /θ/ are similarly stable across the two conditions.

References

Diamond, E., & Munson, B. (2013). *The Influence of Background Noise on the Perception of Phonetic Detail in Children's Speech*. Poster presentation at the American Speech-Language-Hearing Association, Chicago, IL.

Munson, B., Edwards, J., Schellinger, S.K., Beckman, M.E., & Meyer, M.K. (2010). Deconstructing Phonetic Transcription: Covert Contrast, Perceptual Bias, and an Extraterrestrial View of *Vox Humana*. *Clinical Linguistics and Phonetics, 24*, 245-260.

Munson, B., Johnson, J., & Edwards, J. (2012). The Role of Experience in the Perception of Phonetic Detail in Children's Speech: A Comparison of Speech-Language Pathologists with Clinically Untrained Listeners. *American Journal of Speech-Language Pathology, 24*, 124-139.

Julien, H. & Munson, B. (2012). Modifying Speech to Children based on their Perceived Phonetic Accuracy. *Journal of Speech, Language, and Hearing Research*, 55, 1836-1849.

Kaiser, E., Munson, B., Li, F., Holliday, J., Beckman, M., Edwards, J., & Schellinger, S. (2009). Why do adults vary in how categorically they rate the accuracy of children's speech? *Journal of the Acoustical Society of America, 125*, 2753 [abstract].

Developmental differences in the effect of production on word-learning

Tania Zamuner	Elizabeth Morin-Lessard	Stephanie Strahm	Mike Page
University of Ottawa	Concordia University	University of Ottawa	University of Hertfordshire

As children learn language, they spontaneously imitate the gestures and words of their caretakers (Bannard et al., 2013; Meltzoff & Moore, 1977). Speech productions have been examined from different perspectives in language processing, especially from the view of language development (DePaolis et al., 2011; Ettlinger et al., 2014). However, few studies have systematically examined and controlled for the effect of speech production on word learning. This work explores the impact of production on the development of lexical representations, by investigating how production affects recognition for newly learned non-words. We investigated adults' and children's recognition of CVC non-words learned under two conditions: Produced or Heard during training.

Participants were university students (n = 30, M_{age} = 20 years), and children aged 4-6 years (n = 20). The current study used a within-subjects design, with a training phase of non-words and their visual referents, followed by a test phase. During training, half of the non-words were produced by participants and half of the non-words were heard only. At test, participants saw two trained images on an eyetracking screen and were asked to look at a target. The proportion of looking to the target (vs. the distractor) in 100 ms time bins after the target onset was analyzed using a growth curve analysis (Mirman et al., 2008), to assess differences in looking and in the steepness of the looking curve over time. Adult and child data were analyzed separately because of developmental differences in eye movements.

In adults, there was a statistically significant effect of Condition (Produced, Heard) on the linear term, indicating that the slope of Heard targets was less steep than that for Produced targets (*Estimate* = -1.25, *SE* = 0.52, p = .02). This suggests that there was a more linear relationship for Produced compared to Heard target non-words. For children, the slope of Heard targets was more steep than that for Produced targets (*Estimate* = -2.70, *SE* = 0.77, $p < .01$), indicating that there was increasingly more looks to Heard targets compared to Produced targets over time.

Adult participants successfully learned both Produced and Heard non-words, as indicated by looks to the target by the end of the trial. Moreover, adults were faster at recognizing new words that were produced compared to heard during training. This is consistent with the hypotheses that production strengthens newly formed lexical representations. The opposite pattern was found in children, who were better at recognizing non-words that were just heard rather than produced during training. This suggests that production may not always show improved learning effects depending on the developmental stage of the learner and the difficulty of the task, as seen in other domains of language development modelled in PRIMIR (Processing Rich Information from Multi-dimensional Interactive Representations; Curtin et al., 2011). We are currently testing children aged 7 to 8, to determine at what point in development production provides an advantage for newly formed lexical representations.

References

Bannard, C., Klinger, J., & Tomasello, M. (2013). How selective are 3-year-olds in imitating novel linguistic material? *Developmental Psychology, 49*(12), 2344-2356.

Curtin, S., Byers-Heinlein, K., & Werker, J. F. (2011). Bilingual beginnings as a lens for theory development: PRIMIR in focus. *Journal of Phonetics, 39*, 492-504.

DePaolis, R. A., Vihman, M. M., & Keren-Portnoy, T. (2011). Do production patterns influence the processing of speech in prelinguistic infants? *Infant Behaviour and Development, 34*, 590–601.

Ettlinger, M., Lanter, J., & Van Pay, C. K. (2014). Learning to remember by learning to speak. *Developmental psychology, 50*(2), 431.

Meltzoff, A. N., & Keith Moore, M. (1994). Imitation, memory, and the representation of persons. *Infant behavior and development, 17*(1), 83-99.

Mirman, D., Dixon, J.A., and Magnuson, J.S. (2008). Statistical and computational models of the visual world paradigm: Growth curves and individual differences. *Journal of Memory and Language, 59*(4), 475-494.

Microvariation trajectories in children's nonword repetitions

Sharon Inkelas Keith Johnson

University of California, Berkeley

This study uses a novel paradigm to study microvariation in 13 children's consecutive imitations of nonwords in order to elucidate the trajectories of phonological acquisition over short time intervals.

It is well-known that young children do not show uniform improvement in their phonological accuracy, instead often exhibiting a U-shape: initial accuracy yields to inaccuracy, resolving to a final accurate state. The inaccurate state is hypothesized to correlate with increased analytical sophistication (e.g. Vihman 2009) and/or the overgeneralization of grammatical patterns (e.g. Menn 1981, inter alia). It is unclear, however, whether the U-shape trajectory develops over short time intervals for individual words, or whether it is only observable by comparing cross-sections of a child's overall productions observed over longer intervals, as in most longitudinal studies.

The present study analyzes short-term change in productions of individual novel words. We use a variant of Gathercole & Baddeley's (1989) nonword learning paradigm, previously applied to the study of short-term phonological memory and phonetic variation (Edwards, Beckman & Munson, 2004). Our innovation was to ask children (age range 3;11-5;5, average 4;10) to repeat the same word five times in a row, prompted each time by the same audiovisual stimulus. The target words ranged in phonotactic probability from -5.24 to -3.77 (log of summed position-specific biphone probability). 91 repetition sets, yielding 455 forms, were recorded and transcribed.

The results show a mix of trajectories in which neither steady improvement nor the familiar U-shape predominate. For whole words, subjects showed monotonic improvement in production accuracy in only 8% (7) of repetition sets. (A comparable number of repetition sets (8) showed monotonic regression, with no improvement.) Many individual consonants or vowels showed monotonic improvement across five repetitions (37), but they were outnumbered by segments which became less accurate (44). The most common segment pattern overall was oscillation. In 40 cases, an initially inaccurate segment improved, then regressed; in 36 cases, an initially accurate segment regressed, then improved —the standard U-shape pattern. There were also some "W"-shapes, with multiple oscillations between accurate and inaccurate states.

Much of the non-monotonicity in our data has a 'tradeoff' character: increased accuracy in one part of a word is offset by decreased accuracy in another (an observation also made about naturalistic data by e.g. Ferguson and Falwell 1975). Of the 37 monotonically improving segment trajectories we observed, 92% were accompanied by a regressive trajectory elsewhere in the word. An illustration is target [tʰɛˈboʊn], produced by one subject as [tʰɪˈboʊn], [tʰɪˈboʊn], [tʰɪˈboʊn], [tʰɛmˈboʊn], [nɛmˈboʊn]. Increased vowel accuracy in repetition #4 coincides with anticipatory consonant harmony. The relationship between these offsetting developments lies, we conjecture, in processing complexity. On this view, change, including improvement, comes at a processing cost, casting doubt on theoretical models in which phonological acquisition consists primarily in using feedback from output-target mismatches to gradually increase faithfulness to the target form (e.g. Prince & Tesar 2000, Becker & Tessier 2011, McAllister Byun et al. 2013). Our data suggest that an adequate model of acquisition must incorporate processing complexity thresholds as well.

References

Becker, Michael & Anne-Michelle Tessier. 2011. Trajectories of faithfulness in child-specific phonology. *Phonology* 28(2). 163–196.

Edwards, J., Beckman, M.E., & Munson, B. 2004. The interaction between vocabulary size and phonotactic probability effects on children's production accuracy and fluency in nonword repetition. *Journal of Speech, Language, and Hearing Research*, 47, 421-436.

Ferguson, Charles A. & Carol B. Farwell. 1975. Words and sounds in early language acquisition. *Language*, Vol. 51, No. 2. (Jun., 1975), pp. 419-439.

Gathercole, Susan & Alan Baddeley. 1989. Evaluation of the role of phonological STM in the development of vocabulary in children: A longitudinal study. *Journal of Memory and Language* 28, 200-213.

McAllister Byun, Tara, Yvan Rose and Sharon Inkelas. 2013. Explaining child-specific cophonology with a grammar of articulatory reliability: the A-Map model. Poster presented at *Phonology* 2013.

Tesar, Bruce and Paul Smolensky. 2000. *Learnability in Optimality Theory*. Cambridge, MA: MIT Press.

Vihman, M. M. 2009. *Word learning and the origins of phonological system*. In S. Foster-Cohen (ed.), Advances in language acquisition. Luton: Macmillan.

Pre-schoolers' categorisation of speakers by phonological variables

Ella Jeffries Paul Foulkes Carmen Llamas

University of York

Adults can categorise speakers via variable properties of speech, for example inferring regional accent from a speaker's segmental pronunciations. How and when such abilities emerge is poorly understood. There is some evidence that young children can distinguish segmental variables. Floccia et al. (2012) conclude that 20-month-olds raised in a rhotic environment were only able to recognise familiar words spoken with a rhotic accent. Floccia et al. (2009) found that 5-7-year-olds were unable to group speakers into a local versus a non-local accent group. However, this study used sentence stimuli, and thus grouping decisions cannot be narrowed down to particular segmental features.

Many important sociolinguistic skills are also developing in pre-school children. Ages 3-4 are 'critical' for language learning in general, including the learning of variation (Roberts and Labov 1995). In speech production this includes learning the pronunciation norms of the speech community, including social and style-shifting patterns (Foulkes et al. 1999, Smith et al. 2007, Barbu et al. 2013).

The present study takes another step towards understanding the process by which pre-school children learn to group speakers by the segmental variables that separate regional accents. 20 nursery children from York participated in an accent grouping game. Children were presented with a set of visual stimuli consisting of two cartoon character mothers and five 'lost babies'. Each character spoke a short sentence containing one vowel variable that distinguishes northern from southern accents (Table 1). The children's task was to identify which babies belonged to which mother, according to how they spoke. The stimuli were designed with three levels of difficulty, depending on whether the same word and/or phoneme was spoken.

The study addresses the following questions:

1. can 3-4 year-olds group speakers by phonological variables indexing regional accents (difficulty level 1)?
2. can they do this when the phoneme is embedded in different words (difficulty level 2)?
3. can they group speakers using different phonemes (difficulty level 3)?
4. to what extent do these abilities vary with age, sex and input from different regional accents?

The results found that overall, the children scored above chance (50%) for each difficulty level (DL) but that their performance decreased from DLs 1 to 3. An age improvement was found between the 3 and 4-year-olds. Whereas the 4-year-olds consistently scored above chance in each DL, the 3-year- olds' scores showed a lot more variability (see Figure 1). The girls scored higher than the boys in general but the boys had a much more wide spread of scores, particularly in DL3. There was a higher performance in all DLs by those who had no Yorkshire parents, as opposed to those who had at least one parent from Yorkshire.

These results are interpreted through a usage-based model of language acquisition (Tomasello 2003) in which experienced exemplars are stored on encounter and then later accessed in speech processing (Foulkes and Hay in press). The results from this study support previous findings that hearing multiple speakers helps create more robust phonological categories in language acquisition (c.f. Logan et al.'s 1991 study on Japanese L2 learners of English).

Table 1: Difficulty levels of stimuli, with example words from the experiment

Difficulty level	Phoneme/word used by mother and children	Example			
		Mother		Children	
		North	South	North	South
1	Same phoneme embedded in the same word	[a] [b**a**skɪt]	[ɑ:] [b**ɑ**:skɪt]	[a] [b**a**skɪt]	[ɑ:] [b**ɑ**:skɪt]
2	Same phoneme embedded in different word	[a] [p**a**θ]	[ɑ:] [p**ɑ**:θ]	[a] [g**a**s]	[ɑ:] [g**ɑ**:s]
3	Different phoneme embedded in different word	[a] [**a**ftənu:n]	[ɑ:] [**ɑ**:ftənu:n]	[e:] [k**e**:k]	[eɪ] [k**eɪ**k]

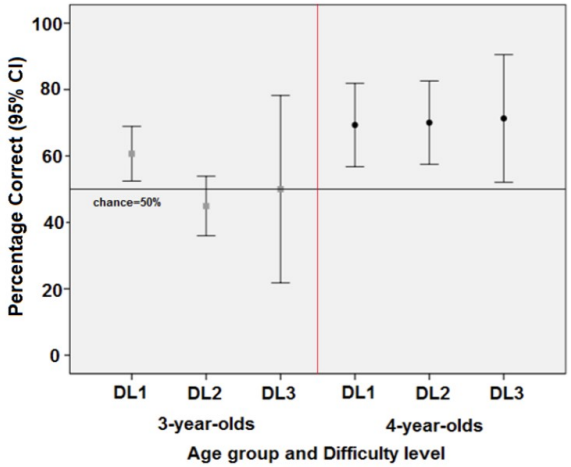


Figure 1: Correct answers for each DL, divided by age group

References

Barbu, S., Nardy, A., Chevrot, J.-P., & Juhel, J. (2013). Language evaluation and use during early childhood: Adhesion to social norms or integration of environmental regularities? *Linguistics*, 51(2), 381-411.

Floccia, C., Butler, J., Girard, F., & Goslin, J. (2009). Categorization of regional and foreign accent in 5-to 7 year-old British children. *International Journal of Behavioral Development, 33*(4), 366-375.

Floccia, C., Delle Luche, C., Durrant, S., Butler, J., & Goslin, J. (2012). Parent or community: Where do 20- month-olds exposed to two accents acquire their representation of words? *Cognition, 124*(1), 95-100.

Foulkes, P. & Hay, J. (in press, due 2015). The emergence of sociophonetic structure. To appear in B. MacWhinney & W. O'Grady (eds.) *The Handbook of Language Emergence* (pp. 292-313). Oxford: Blackwell.

Foulkes, P., Docherty, G. J., & Watt, D. (1999). *Tracking the emergence of sociophonetic variation*. Paper presented at the Proceedings of The 14th International Congress of Phonetic Sciences, 1–7 August 1999, San Francisco.

Logan, J.S., Lively, S.E. & Pisoni, D.B. (1991). Training Japanese listeners to identify English /r/ and /l/: A first report. *The Journal of the Acoustical Society of America*, 89(2): 874-886.

Roberts, J., & Labov, W. (1995). Learning to talk Philadelphian: Acquisition of short a by preschool children. *Language Variation and Change, 7*(01), 101-112.

Smith, J., Durham, M., & Fortune, L. (2007). “Mam, my trousers is fa'in doon!”: Community, caregiver, and child in the acquisition of variation in a Scottish dialect. *Language Variation and Change, 19*, 63-99.

Tomasello, M. (2003). Constructing a language: *A usage-based theory of language acquisition.* Harvard University Press.

Using pupillometry to study early lexical representations

Katalin Tamási, University of Potsdam
Cristina McKean, Newcastle University
Adamantios Gafos, University of Potsdam
Barbara Hoehle, University of Potsdam

Recent findings indicate that early lexical representations contain sub-phonemic information: When presented with known words, children are sensitive to manner, place and voicing feature changes (Mani and Plunkett, 2011; White and Morgan, 2008). However, due to the methodological challenges in child language research, the level of detail and the factors that influence detailedness in early words have not yet been fully explored. This work introduces a novel method for investigating early lexical representations: pupillometry. Previous research has shown that children's pupil dilation is associated with increased cognitive load in general (Jackson and Sirois, 2009), and incongruency detection in particular (Hochmann and Papeo, 2014).

Building on those findings, we used pupil dilation to study the level of detail encoded in early lexical representations. We employed pupillometry with 30-month-old German children. In each trial, we presented an image followed by either its correctly pronounced auditory label or a mispronounced version thereof. By systematically manipulating the number of feature changes ranging from zero to three features in the onset (e.g., baby ~ paby ~ taby ~ shaby, respectively), we tested whether featural distance predicted the degree of pupil dilation.

Our results support the existence of a relationship between featural distance and pupil dilation: Words that deviate more from the correct form (e.g., differing by two and three features) were associated with a larger degree of pupil dilation than words that deviated less (e.g., differing by one feature) and correct word forms. This result indicates that children are sensitive to featural distance and, as such, it corroborates previous work that found early words to contain sub-phonemic detail. Thus, we establish the potential use of pupillometry in child language research. We furthermore discuss two significant lexical factors that modulate the size and time-course of pupil dilation: degree of familiarity with the word and lexical neighborhood density.

First, we asked: to what degree and in what way do children's pupillary responses differed with respect to their degree of familiarity with the lexical item. We found that words reported to be produced by the children (= familiar words) exhibited the following pattern: Two- and three-feature deviations were associated with larger pupillary response than one-feature deviation, which in turn was associated with larger pupil dilation than the correct pronunciation (c.f., Figure 1). On the other hand, featural distance did not predict pupil responses related to unfamiliar words, possibly due to their shallow (or non-existent) lexical representations (c.f., Figure 2). Indeed, the correct form of unfamiliar words elicited the strongest pupillary reaction, indicating increased cognitive effort. Second, lexical neighborhood density also contributed to how featural distance affected pupil dilation in familiar words. Namely, dense neighborhoods attenuated the effect of featural distance, resulting in smaller pupil dilations overall as well as smaller range (compare Figure 3, showing words with fewer neighbors to Figure 4, depicting words with more neighbors). We discuss our results and consider their implications for theories of language acquisition, including the PRIMIR framework (Werker and Curtin, 2005).

Appendix

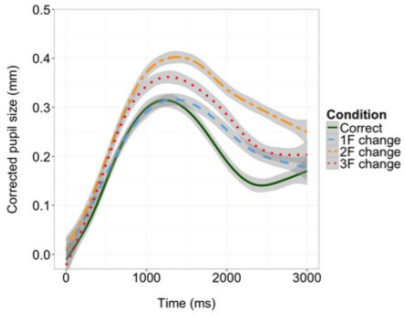


Figure 1: Pupil size change, familiar words

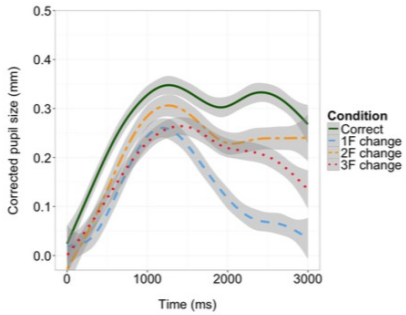


Figure 2: Pupil size change, unfamiliar words

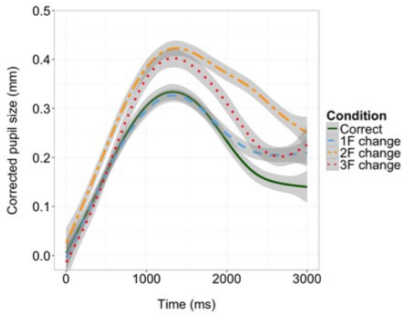


Figure 3: Pupil size change, familiar low-neighborhood-density words

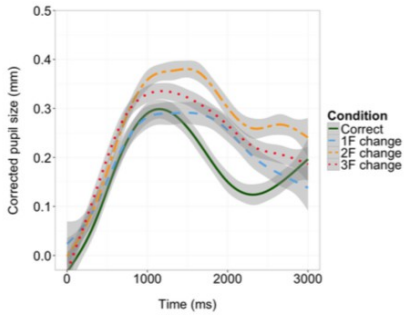


Figure 4: Pupil size change, familiar high-neighborhood-density words

Statistically significant contrasts ($t > 1.96$) were obtained using linear mixed effects models with featural distance and neighborhood density as fixed effects, participants and items as random effects with maximal random effects structure, and mean and maximum pupil dilation as outcome variables. Converging results were found with wavelet-based models.

References

Hochmann, J.-R. and Papeo, L. (2014). The invariance problem in infancy a pupillometry study. *Psychological science*, 25(11):2038–2046.

Jackson, I. and Sirois, S. (2009). Infant cognition: going full factorial with pupil dilation. *Developmental Science*, 12(4):670–679.

Mani, N. and Plunkett, K. (2011). Phonological priming and cohort effects in toddlers. *Cognition*, 121(2):196–206.

Werker, J. F. and Curtin, S. (2005). Primir: A developmental framework of infant speech processing. *Language Learning and Development*, 1(2):197–234.

White, K. S. and Morgan, J. L. (2008). Sub-segmental detail in early lexical representations. *Journal of Memory and Language*, 59(1):114–132.

The relationship between early lexical and phonological development: What we can learn from children with atypical phonology

Carol Stoel-Gammon

University of Washington

The relationship between lexical and phonological acquisition has been a topic of interest to linguists and child phonologists since publication the seminal study by Ferguson and Farwell (1975) who documented a link between the words that appear in a child's early vocabulary and the phonological form of those words. Based on an analysis of the first 50 words acquired by three children, Ferguson & Farwell posited that children (at least some children) choose words for their productive vocabulary based on the phonological properties of the consonant(s) of the adult target and on their own production abilities – specifically, children tend to select words with consonants that they are capable of producing. This notion of "lexical selection" has been supported by both observational and experimental studies (see Stoel-Gammon, 2011, for a summary) and has led to the hypothesis that young children have a tacit knowledge of their own phonological abilities. Menn (1976) suggested that, in addition to lexical selection, some children exhibit a pattern of "lexical avoidance" of words containing consonants not in the child's repertoire; for example, she reported that "Jacob" had no b-initial words in his vocabulary at 18 months, in sharp contrast to the majority of English-speaking children typically have 10 or more b-initial words at their first 50 words (Stoel-Gammon, 1998). Interestingly, when Jacob produced his first b-initial word, "bye-bye" (at 19 months), the consonants were both [d]s. Instances of lexical avoidance are difficult to document because there are many reasons why particular words may be lacking in a child's early lexicon.

Studies of lexical acquisition in children with atypical phonological development can enhance our understanding of the relationship between children's phonological abilities and their lexical selection/avoidance patterns. This paper presents findings from studies of toddlers with cleft palate (CP). This population is interesting because, prior to surgery to repair the cleft palate, infants are unable to achieve velopharyngeal closure needed for the production of stop consonant, and prelinguistic vocalizations of infants with CP contain a high proportion of sonorants (nasals, glides, vowels, liquids) and few supraglottal stops Even after the cleft has been repaired (usually by 15 months), stop consonants tend to occur less frequently and are produced with more errors (Estrem & Broen, 1989; Hardin-Jones & Chapman, 2014; Salas-Provance et al., 2003).

Early lexical development was examined by three research teams who analyzed the phonologies and early vocabularies of toddlers with CP (English: Estrem & Broen, 1989; Hardin-Jones & Chapman, 2014; Danish: Willadsen, 2013). All three studies reported that the vocabularies included a high proportion of sonorant-initial target words and a low proportion of words with initial stops. When the productive vocabularies of the CP toddlers were compared with those of children with typical development, the differences were striking: the CP groups had significantly more words beginning with sonorants, whereas their typically developing peers had a much higher proportion of stop-initial words. These findings will be related to our notions of lexical selection and avoidance and of children's awareness of their own phonological abilities.

References

Estrem, T. & Broen, P. (1989). Early speech production of children with cleft palate. *Journal of Speech and Hearing Research*, 32, 12-23.

Ferguson, C.A. & Farwell, C. (1978). Words and sounds in early language acquisition: Initial consonants in the first 50 words. *Language*, 51, 419-439.

Hardin-Jones, M. & Chapman, K. (2014). Early lexical characteristics of children with cleft lip and palate. *The Cleft Palate-Craniofacial Journal*, 51 (6), 622-631.

Menn, L. (1976). Pattern, control and constraint in beginning speech: A case study in the development of word form and word function. Unpublished doctoral dissertation.

Salas-Provance, M., Kuehn, D., & March, J. (2003). Phonetic repertoire and syllable characteristics of 15-month-old babies with cleft palate. *Journal of Phonetics*. 31, 23-38.

Stoel-Gammon, C. (1998). Sounds and words in early language acquisition: The relationship between lexical and phonological development. In R. Paul (Ed.) *Exploring the Speech-Language Connection* (pp. 25-52). Baltimore: Paul H. Brookes Publishing Co.

Stoel-Gammon, C. (2011). Relationships between lexical and phonological development in young children. *Journal of Child Language*. 38, 1-34.

Willadsen, E. (2013). Lexical selectivity in Danish toddlers with cleft palate. *The Cleft Palate-Craniofacial Journal*, 50 (4), 456-465.

Context and task effects on English past-tense marking: The case of bilinguals

Jessica Barlow Sonja Pruitt-Lord Philip Combiths

San Diego State University

Phonological context is implicated in children's overt marking of grammatical morphemes in English. Indeed, researchers have found that children are more likely to omit grammatical morphemes on consonant-final versus vowel-final stems (e.g., Polite, 2011; Pruitt & Oetting, 2009; Song, Sundara, & Demuth, 2009). Less attention has been given to the following phonological context. Though some researchers have shown that plural and third-person-singular morphemes are more likely to be marked utterance-finally as compared to utterance-medially (Barlow & Pruitt-Lord, 2014; Song et al., 2009; Sundara, Demuth, & Kuhl, 2011; Theodore, Demuth, & Shattuck-Hufnagel, 2011), conflicting results have been reported for whether and how phonological context impacts morpheme accuracy (Barlow & Pruitt-Lord, 2014; Ettlinger & Zapf, 2011; Polite, 2011; Pruitt & Oetting, 2009; Theodore et al., 2011). Several factors may be associated with these conflicting results, including morpheme type, linguistic background, and task, to name a few (Barlow & Pruitt-Lord, 2014; Paradis, 2005; Polite, 2009; Oetting et. al, 2012). Importantly, no known study has evaluated the effects of following context for the regular past tense morpheme in English.

In this study, we further investigate such morpho-phonological interactions by evaluating the role of phonological context on bilingual children's accuracy on the English past-tense morpheme on three tasks. Twelve typically-developing Spanish-English bilingual preschool children participated (6 female, mean age 53 months, range 46-56 months). Average maternal education was less than a high school degree (M = 10.6 years). On average, children heard English 45% of the time and spoke English 34% of the time at home. Typical development was confirmed by parent and teacher report. Children scored in the typical range on a parent report of overall development and two subtests of a non-verbal measure of cognition. Data were generated from a video elicitation probe, the past-tense probe from the Test of Early Grammatical Impairment (Rice & Wexler, 2001), and spontaneous language samples.

Accuracy on regular past-tense verb forms was evaluated by task, preceding context, and following context. Of 218 forms analyzed, 96 (44%) were correctly marked. The effect of task approached significance, $F(2, 212) = 2.57$, $p = .08$. There was a significant main effect of preceding context, $F(1, 212) = 5.83$, $p < .05$, whereby past tense was more accurate after a vowel than a consonant. Moreover, there was a significant context-by-task interaction, $F(2, 212) = 9.27$, $p < .05$, such that, for the video probe, past tense was more accurate after a consonant than a vowel. The main effect of following context approached significance, $F(1, 162) = 2.75$, $p = .10$, whereby past tense was more accurate before a consonant than a vowel.

The results highlight the importance of considering task effects when analyzing child language, regarding both morpheme accuracy and effects of phonological context. Additionally, a combinatorial effect of surrounding context may impact past-tense marking, as has been suggested for other grammatical forms (e.g., Barlow & Pruitt-Lord, 2014). We consider these factors, as well as language background and lexical factors, in our discussion of directions and challenges for future research.

The role of between-language interaction in the diagnosis of phonological disorders in bilingual children

Leah Fabiano-Smith

University of Arizona

Due to developmental differences between monolinguals and bilinguals caused by between-language interaction (Fabiano-Smith & Goldstein, 2010a; 2010b), traditional measures of phonological ability could misrepresent the level of phonological skill in bilingual children. This presentation will report the results of three preliminary studies examining the performance of bilingual preschoolers on traditional phonological measures that might be susceptible to between-language interaction within the context of the PRIMIR model (Curtin, Byers-Heinlein, & Werker, 2011).

To begin, previous studies have examined Percent Consonants Correct (PCC) in the productions of bilingual children and have found that monolinguals and bilinguals differ on this measure (Gildersleeve-Neumann et al., 2008; Fabiano-Smith & Goldstein, 2010a; 2010b). To investigate further, Fabiano-Smith and Redden (2013) examined eight bilingual Spanish- English speaking children, ages 3;9 – 4;9, on measures of PCC derived from a single word test. Children who exhibited the highest levels of consonant accuracy were monolingual English- speaking children. Bilingual children might not differ significantly from monolingual children on gross measures of consonant accuracy when examined by group; however, when mean ranks or more discrete measures of phonological accuracy are examined, bilingual preschoolers are exhibiting consonant accuracy that is lower than that of their monolingual peers in English.

The second measure we examined was accuracy of stops and fricatives in the context of the allophonic rule, the Spanish stop-spirant alternation. MacLeod and Fabiano-Smith (2014) examined the Spanish productions of eight Spanish-English-speaking preschoolers on the stop-spirant alternation. Fabiano-Smith, Oglivie, Maiefski, and Schertz (2015) performed a quasi-longitudinal study examining children ages 2;4 – 8;2 on their productions of stops and spirants to determine age of acquisition and influence on English via substitution errors and acoustic analyses. Both studies found that bilingual children exhibited a developmental trajectory for this rule that differs from their monolingual peers. Data on the percent occurrence of Stopping of Fricatives will be presented for both studies to illustrate evidence of between-language interaction.

Finally, Initial Consonant Deletion is considered a disordered error pattern cross- linguistically. Interestingly, Gildersleeve, Davis, and Stubbe (1996), Wing and Flipsen (2010), Goldstein (2001), and Anderson (1987) found that some bilingual Spanish-English speaking children omitted initial sounds in words, an error thought to be disordered in the speech of English-speaking children. Fabiano-Smith and Cuzner (in preparation) analyzed the Spanish single word samples of eight typically-developing bilingual Spanish-English speaking children and four bilingual children with suspected speech sound disorders, ages 2;9 – 5;3, to determine if the cause for this error was (1) linguistic in nature (i.e., caused by the internal structure of Spanish, specifically syllable structure), or (2) caused by its phonetic context (i.e., influenced by the sounds that follow it). The results of this study yielded that initial consonant deletion takes place in younger bilingual children but does not occur frequently in the Spanish productions of either typically-developing bilingual children or in bilingual children with speech sound disorders during the preschool years. Therefore, knowledge of developmental information on initial consonant deletion is typical (or not) aids in appropriate diagnosis of Spanish-speaking children with speech sound disorders.

References

Curtin, S.; Byers-Heinlein, K, & Werker, J. (2011). Bilingual beginnings as a lens for theory development: PRIMIR in focus. *Journal of Phonetics, 39* (4). 492-504.

Fabiano-Smith, L. & Cuzner, L. (in preparation). Initial consonant deletion in Spanish-speaking children: Difference or disorder? Manuscript in preparation.

Fabiano-Smith, L. & Goldstein, B. (2010b). Phonological acquisition in bilingual Spanish- English speaking children. *Journal of Speech, Language, and Hearing Research, 53*. 1-19.

Fabiano-Smith, L. & Goldstein, B. (2010a). Early, middle, and late developing sounds in monolingual and bilingual children: An exploratory study. *American Journal of Speech-Language Pathology, 19*. 1-12.

Fabiano-Smith, L., Oglivie, T., Maiefski, O., & Schertz, J. (2015). Acquisition of the stop-spirant alternation in bilingual Mexican Spanish-English speaking children: Theoretical and clinical implications. *Clinical linguistics & phonetics,* (0), 1-26.

Gildersleeve-Neumann, C. E., Kester, E. S., Davis, B. L., & Pena, E. D. (2008). English speech sound development in preschool-aged children from bilingual English–Spanish environments. *Language, Speech, and Hearing Services in Schools, 39*(3), 314-328.

MacLeod, A. A., & Fabiano-Smith, L. (2014). The acquisition of allophones among bilingual Spanish-English and French-English 3-year-old children. *Clinical linguistics & phonetics,* (0), 1-18.

Redden, K. & Fabiano-Smith, L. (2013, June). Percentage Consonants Correct (PCC) as a diagnostic measure with bilingual Spanish-English speaking children. Poster presentation at the *Symposium for Research on Child Language Disorders* (SRCLD). Madison, WI.

Wing, K. J., & Flipsen Jr, P. (2010). Phonological Disorders in Spanish Speaking Children: Accounting for the Mexican Dialect (Doctoral dissertation, Idaho State University).

Differential effects of motor and phonetic variability on speech production in children with SLI

Sara Benham Lisa Goffman

Purdue University

Introduction:

While children with specific language impairment (SLI) are diagnosed based on morphosyntactic ability, deficits in phonology and in speech motor and fine and gross motor skill frequently co-occur. There is much debate regarding the nature of SLI, and whether associated profiles of weakness should be included in theoretical accounts of the disorder, as well as in diagnosis and treatment. Our objective was to assess how phonological, motor, and morphosyntactic performance patterns in children with SLI.

Methods:

Participants included 23 preschoolers with SLI and 21 typical peers, aged 48-72 months. Children with SLI met exclusionary criteria (Leonard, 2014), including typical hearing and nonverbal IQ. All were monolingual English speakers. Each participant was administered a developmental testing battery to assess (a) phonological performance; (b) fine and gross motor skills; (c) speech motor ability related to oral motor structure and function; (d) expressive language ability, including analysis of use of grammatical morphemes.

The experimental phase consisted of a non-word learning task conducted over the course of 3 sessions. In each session, participants imitated CVCCVC non-words, which were controlled for phonotactic probability and neighborhood density. While imitating productions, articulatory movement trajectories were tracked using an optical motion capture system. Lip aperture (*upper lip-lower lip*) variability was calculated using the spatiotemporal index (STI). Phonetic accuracy and variability were assessed using broad transcription.

Results and Discussion:

There were striking group differences in terms of phonetic accuracy, fine and gross motor ability, and speech motor performance, with children with SLI performing significantly below typical peers in all areas. Surprisingly, 87% of the children with SLI were found to present with a co-occurring speech disorder, and 95% of the children with SLI also demonstrated functional oral motor deficits. Language performance positively correlated with severity of speech disorder, indicating that deficits in the speech production system are closely aligned with language impairment.

One might speculate that the relationship between oral motor ability and phonetic accuracy is influenced by the stability of the speech motor system, where a high degree of kinematic variability would correspond with low phonetic accuracy. However, findings from this study indicate the contrary, revealing that children with SLI who demonstrate low phonetic accuracy display lower articulatory variability. Considering that both children with SLI and those with typical language improve their phonetic accuracy over the course of the three sessions, one possible conclusion for this finding is that a variable speech system is indicative of a less rigid system that is amenable to learning novel phonological sequences, consistent with a dynamical systems account. Alternatively, higher-order processes (e.g., procedural learning and sequencing) supporting both linguistic and non-linguistic skills may be at the core of the deficit represented by SLI. Theoretical accounts need to integrate this relationship between speech motor skill and phonology in children with SLI.

References

Bankson, N. W., & Bernthal, J. E. (1990). *Bankson Bernthal Test of Phonology*. Chicago, IL: Riverside Press.

Brumbach, A., & Goffman, L. (2014). Interaction of language processing and motor skill in children with specific language impairment. *Journal of Speech, Language, and Hearing Research*, 57, 158-171.

Greenslade, K. J., Plante, E., & Vance, R. (2009). The diagnostic accuracy and construct validity of the Structured Photographic Expressive Language Test— *Preschool. Language, Speech, and Hearing Services in Schools*, 40(2), 150-160.

Henderson, S. E., Sugden, D. A., & Barnec, A. L. (2007). *Movement Assessment Battery for Children - Second Edition* (MABC-2). London, U.K.: Pearson Assessment

Leonard, L. B. (2014). *Children with specific language impairment*. Cambridge, MA: MIT Press.

Leonard L. B., Miller C., Gerber E. (1999). Grammatical morphology and the lexicon in children with specific language impairment. *Journal of Speech, Language, and Hearing Research*. 42, 678–689.

Robbins, J., & Klee, T. (1987). Clinical assessment of oropharyngeal motor development in young children. *Journal of Speech and Hearing Disorders*, 52, 271-277.

Smith, A., Goffman, L., Zelaznik, H., Ying, G., & McGillem, C. (1995). Spatiotemporal stability and patterning of speech movement sequences. *Experimental Brain Research*, 104, 493-501.

Thelen, E. & Smith, L.B. (2006) Dynamic Systems Theories. In *Handbook of Child Psychology, Volume 1, Theoretical Models of Human Development, 6th Edition*, William Damon (Editor), Richard M. Lerner (Volume editor), 258-312.

Vuolo, Goffman, & Zelaznik, in preparation.

Direction of coarticulation in vowel-fricative sequences in L1-German children

Felicitas Kleber

Ludwig-Maximilian-Universität München

German has a phonemic /s/-/ʃ/ contrast, the two phonemes being among the last sounds that typically developing L1-German children acquire phonetically (Fox-Boyer, 2009). The contrast is acoustically distinguished by means of differences in the spectral centre of gravity (fricative noise), which varies also as a function of vocalic context: e.g. in the vicinity of rounded vowels /s/ becomes more [ʃ]-like. The fricatives on the other hand affect the degree of lip rounding in vowels. Coarticulation within /ɪʃ/-sequences, for instance, may result in one of two assimilation directions: /ʃ/ may either become more like the German fricative /ç/ (progressive assimilation) or /ɪ/ is realized with rounded lips (regressive assimilation) possibly resulting in a merger with German /ʏ/. The aims of this study were (1) to examine the degree and the direction of coarticulation between two age groups of L1-German children, and (2) to compare a subset of the data with adult data to test whether the amount of coarticulation decreases with age – as predicted in Nittrouer et al. (1989).

Three repetitions each of the following four words were elicited from eleven younger (4;1–5;1 years) and nine older (5;4–6;3 years) children in a picture naming task: Kissen (/kɪsən/, 'cushion'), küssen (/kʏsən/, 'to kiss'), mischen (/mɪʃən/, 'to shuffle (cards)), and Muschel (/mʊʃəl/, 'seashell'). We measured the second formant at the temporal midpoint of the first vowel and the fricative noise. We then calculated the log. Euclidean distance ratio of each vowel and of each fricative to two speaker-specific /ɪ/ and /ʊ/ centroids and /s/ and /ʃ/ centroids, respectively. A repeated measures ANOVA with F2 as the dependent variable showed significant main effects for Sibilant ($F[1,18] = 545.1$, $p < 0.001$) and Lip rounding ($F[1,18] = 189.6$, $p < 0.001$) and a significant interaction between these two, but no Age effect (Fig. 1). A second repeated measures ANOVA with Noise as the dependent variable showed again significant effects for Sibilant ($F[1,18] = 47.0$, $p < 0.001$) and Lip rounding ($F[1,18] = 12.0$, $p < 0.01$) and a significant interaction between Age*Sibilant*Rounding ($F[1,18] = 4.6$, $p < 0.05$). Both age groups produced the /s/-/ʃ/ contrast by means of differences in fricative noise (Fig. 2). /ɪ/ before /ʃ/ was generally realized as [ʏ] although younger children show a greater tendency towards /ɪ/-realizations (Fig. 1) which may be associated with the more [s]- like fricatives in mischen (Fig. 2).

A comparison of the children's /ɪs/ and /ɪʃ/ tokens with /ɪs/ and /ɪʃ/ words produced by 22 female adults revealed that the progressive influence of /ɪ/ on the /s-ʃ/-distinction decreases with increasing age (Fig. 3, bottom row; see also Nittrouer et al., 1989). However, the regressive influence of /ʃ/ on /ɪ/ did not decrease in the older children of this study. Only adults showed diminished regressive assimilation (Fig. 3). This finding demonstrates the necessity of incorporating the direction of coarticulation when modelling the acquisition of coarticulatory patterns (Kühnert & Nolan, 1999). Syllable vs. segment-based accounts of children's speech production will be discussed (e.g. Nittrouer et al., 1989).

Fig. 1: Log. Euclidean distance ratios of unrounded (white) and rounded (grey) vowels to /ɪ/ in *Kissen* and /ʊ/ in *Muschel*. Negative values indicate vowels with higher F2 and positive values vowels with lower F2; a value of zero corresponds to a point equidistant between *Kissen* and *Muschel*.

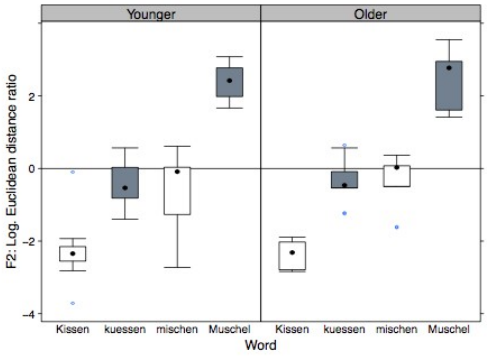


Fig. 2: Log. Euclidean distance ratios of /s/ (white) and /ʃ/ (grey) tokens to /s/ in *Kissen* and /ʃ/ in *Muschel*. Negative values indicate more [s]-like tokens and positive values more [ʃ]-like tokens; a value of zero corresponds to a point equidistant between *Kissen* and *Muschel*.

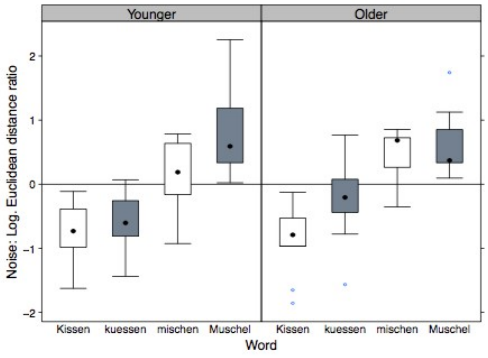
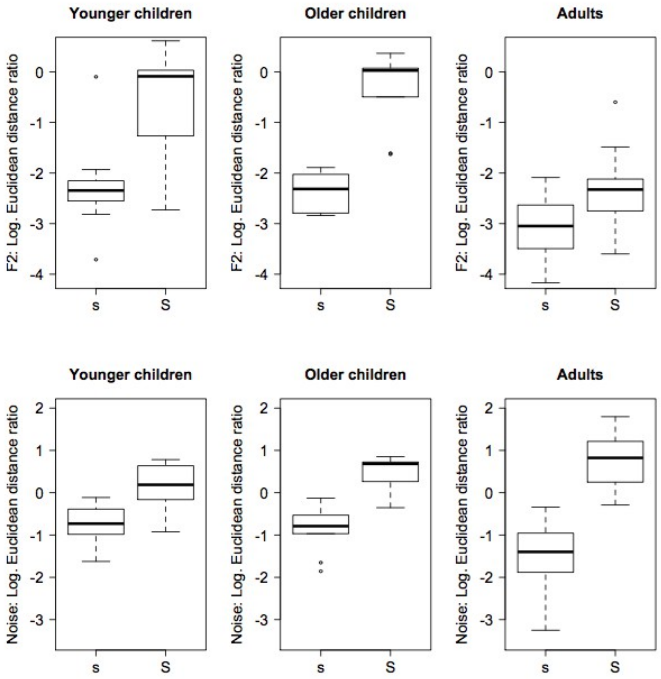


Fig. 3: Log. Euclidean distance ratios of each/ɪ/ token to /ɪ/ in *Kissen* and /ʊ/ in *Muschel* (top) and of each /s/ and /ʃ/ token to /s/ in *Kissen* and /ʃ/ in *Muschel* (bottom) separately for /s/ (s) and /ʃ/ (S) in younger and older children and adults.



References

Fox-Boyer, A. (2009). *Kindliche Aussprachestörungen: phonologischer Erwerb, Differenzialdiagnostik, Therapie*. Idstein: Schulz-Kirchner

Kühnert, B. & Nolan, F. (1999). The origin of coarticulation. In W.J. Hardcastle and N. Hewlett (eds.), *Coarticulation: theory, data, techniques*. Cambridge: Cambridge Universtiy Press.

Nittrouer, S., Studdert-Kennedy, M. & McGowan, R. (1989). The emergence of phonetic segments: evidence from the spectral structure of fricative-vowel syllables spoken by children and adults. *Journal of Speech, Language, and Hearing Research* 32, 120–132.

Measuring the relationship between lexical and phonological ability in 2- and 3-year-olds

Brooke Santos Anna Sosa

Northern Arizona University

Previous studies have identified a strong relationship between lexical and phonological development in young children. (Stoel-Gammon, 2010). Specifically, lexical and phonological ability are often commensurate; children with larger vocabularies have more advanced phonological ability while children with smaller vocabularies have more limited phonological systems. Smith et. al. (2006) found that in lexically precocious children aged 2;0, phonological ability is more accurately predicted by vocabulary size than by the child's age. This is in line with the findings of Rescorla and Ratner (1996) that 2-year-olds with specific expressive language impairment produced fewer vocalizations and used a smaller variety of speech sounds and syllable shapes than their typically developing peers of the same age, suggesting a pattern of delayed phonological development. Vocabulary size was also found to predict phonemic sensitivity in 2 -year olds (Schwarz et. al., 2014). In spite of these findings, speech-language-pathologists have traditionally relied on established age-related norms when diagnosing and treating speech sound disorders, while treating vocabulary ability as a separate, unrelated factor.

The current study seeks to determine whether the relationship between lexical and phonological development is still present in typically developing preschool aged children and whether it can be identified using standardized clinical assessments of expressive and receptive vocabulary, articulation, and phonology. Participants in this study were 71 typically developing children (33 males and 38 females) aged 2;6-3;11. Data collection occurred in a single-60 minute session or two 30-minute sessions in a quiet room, and all sessions were audio recorded. Expressive and receptive vocabulary were assessed using widely-available measures: the *Peabody Picture Vocabulary Test, 4th Ed*. (Dunn & Dunn, 2007), and the *Expressive Vocabulary Test, 2nd Ed.* (Williams, 2007). The children's articulation and phonological ability were assessed using the Sounds-in-Words portion of the *Goldman Fristoe Test of Articulation, Second Edition* (Goldman & Fristoe, 2000) and the *Khan-Lewis Phonological Analysis, 2nd Ed.* (Khan & Lewis, 2002). The children's productions of all stimulus words were transcribed from audio recordings, and their performance was scored using Pearson's computer-based ASSIST Scoring Software. In addition, participants' performance on the *KLPA-2* was analyzed according to the types of errors exhibited: distortions, deletions, substitutions, and atypical phonological processes. The relationship between expressive and receptive vocabulary, overall articulation and phonology scores, and the occurrence of individual error types are explored. It is hoped that the information gathered in this study can be used as a starting point for collecting normative data on the expected relationship between lexical and phonological ability, with potential future application as a simple and clinically practical aid in the diagnosis and treatment of children with speech sound disorders.

References

Dunn, L. & Dunn, D. (2007). *Peabody Picture Vocabulary Test, Fourth Edition.* Minneapolis: Pearson.

Goldman, R. & Fristoe, M. (2000). *Goldman Fristoe Test of Articulation 2.* Minneapolis: Pearson

Khan, L. M. L., & Lewis, N. P. (2002). *Khan–Lewis. Phonological Analysis, 2nd Ed.* Circle Pines, MN: American Guidance Service.

Rescorla, L., & Ratner, N. B. (1996). Phonetic profiles of toddlers with specific expressive language impairment (SLI-E). *Journal of Speech, Language, and Hearing Research*, 39(1), 153-165.

Schwarz, I. C., Burnham, D., & Bowey, J. A. (2006). Phoneme sensitivity and vocabulary size in 2½-to 3-year-olds. In *Proceedings of the 11th Australian International Conference on Speech Science & Technology* (pp. 142-147).

Smith, B. L., McGregor, K. K., & Demille, D. (2006). Phonological development in lexically precocious 2-year-olds. *Applied Psycholinguistics*, 27(03), 355-375.

Stoel-Gammon, C. (2011). Relationships between lexical and phonological development in young children. *Journal of child language*, 38(01), 1-34.

Williams, K.T. (2007). *Expressive Vocabulary Test, Second Edition*. Minneapolis: Pearson.

Phonological development in a bilingual Arabic-English speaking child with bilateral cochlear implants: A longitudinal case study

Manal Sabri Leah Fabiano-Smith

University of Arizona

Phonological development in Spanish-English speaking bilingual children has been the focus of recent studies (Hambly, Wren, McLeod, & Roulstone, 2012). Recent studies have also looked at the phonological development in children with cochlear implants (Ertmer & Goffman, 2011; Ertmer et al., 2012; Serry & Blamey, 1999).

However, very few studies have examined phonological development in bilingual Arabic-English speaking children (Khattab, 2006); specifically, there are no studies to date on phonological development in bilingual Arabic-English speaking children with bilateral cochlear implants. Knowledge of phonological development in Arabic-English speaking children with cochlear implants will help to establish a developmental trajectory for this population, determine severity of disorder, and plan course of treatment. This longitudinal study followed a 3;5 year-old bilingual Arabic-English female with bilateral cochlear implants for 12 months. She was diagnosed with profound bilateral sensorineural hearing loss at 9 months of age, and was implanted in her right ear at 13 months and in her left ear at 18 months of age. Speech samples were collected monthly in both languages for 12 months, and was alternated between single word tests and connected speech samples.

Data were collected and phonetically transcribed by native language speakers. Phon software (Rose et al., 2006) was used to segment, transcribe and analyze speech samples. Data from both languages were used to compare her phonological development to her hearing- age matched peers and her chronologically-age matched peers in English and in Arabic. Phonological development was also compared with monolingual English speaking children with cochlear implants. Additionally, the study highlighted cross-linguistic effects that were observed in her developmental trajectories.

Preliminary results show that the child's phonetic inventories in both languages were age appropriate; however, percent consonants correct (PCC) was below age level in both languages and a range of phonological patterns including final consonant deletion (FCD), lateralization, and cluster reduction were observed Figures (1-4). Clinical implications of these findings will be discussed and theoretical implications will be discussed within the context of the Processing Rich Information from Multidimensional Interactive Representations (PRIMIR) (Curtin, Byers-Heinlein, & Werker, 2011).

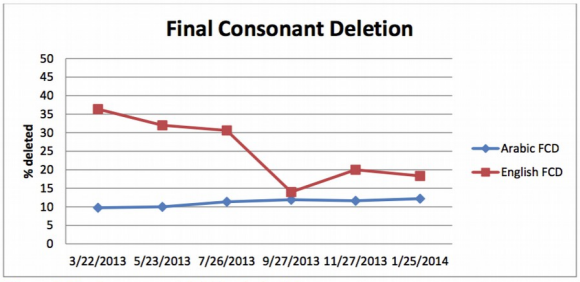


Figure 1: Final consonant deletion in both languages

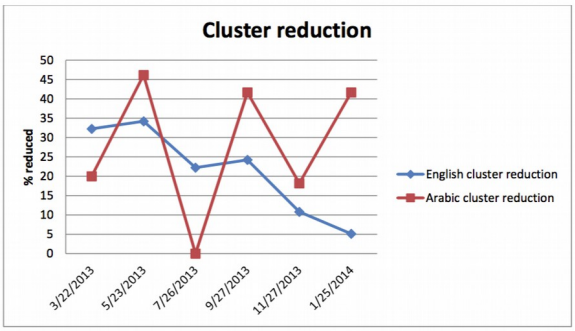


Figure 2: Cluster reduction

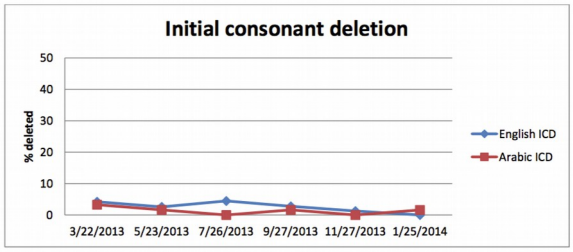


Figure 3: Initial consonant deletion

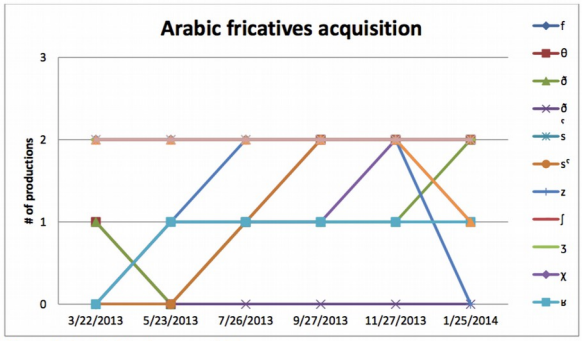


Figure 4: Arabic fricatives acquisition

References

Amayreh, M. M., & Dyson, A. T. (1998). The acquisition of Arabic consonants. *Journal of Speech, Language, and Hearing Research, 41(3)*, 642-653.

Curtin, S., Byers-Heinlein, K., & Werker, J. F. (2011). Bilingual beginnings as a lens for theory development: PRIMIR in focus. *Journal of Phonetics, 39(4)*, 492-504.

Ertmer, D. J., & Goffman, L. A. (2011). Speech Production Accuracy and Variability in Young Cochlear Implant Recipients: Comparisons With Typically Developing Age-Peers. *Journal of Speech, Language, and Hearing Research, 54,* 177-189.

Ertmer, D. J., Kloiber, D. T., Jung, J., Kirleis, K. C., & Bradford, D. (2012). Consonant production accuracy in young cochlear implant recipients: developmental sound classes and word position effects. *American Journal of Speech-Language Pathology / American Speech-Language- Hearing Association, 21(4),* 342-53.

Hambly, H., Wren, Y., McLeod, S., & Roulstone, S. (2013). The influence of bilingualism on speech production: A systematic review. *International Journal of Language & Communication Disorders, 48(1)*, 1-24.

Khattab G. Phonological acquisition by Arabic-English bilingual children. In: Hua, Z; Dodd, BJ, ed. *Phonological Development and Disorders in Children: A Multilingual Perspective.* Clevedon: Multilingual Matters Ltd, 2006, pp.383-412.

Rose, Yvan, Brian MacWhinney, Rodrigue Byrne, Gregory Hedlund, Keith Maddocks, Philip O'Brien & Todd Wareham. 2006. Introducing Phon: A Software Solution for the Study of Phonological Acquisition. In David Bamman, Tatiana Magnitskaia & Colleen Zaller (eds.), *Proceedings of the 30th Annual Boston University Conference on Language Development.* Somerville, MA: Cascadilla Press. 489-500.

Serry, T. A., & Blamey, P. J. (1999). A 4-year investigation into phonetic inventory development in young cochlear implant users. *Journal of Speech, Language, and Hearing Research, 42(1)*, 141-154.

Rhotic vowel production in young children with and without speech sound disorders: Acoustic analysis vs. perceptual transcription

Hyunju Chung, KyungHee University
Jaslyn Dunger, Janice Bedard, Karen Pollock, University of Alberta

Many children with typical speech development (TDS) and most children with speech sound disorders (SSD) experience difficulty with accurate production of rhotic vowels[1,2]. Previous studies of rhotic vowels in children with SSD have typically focused on stressed vocalic [ɝ] and children over 6 years of age[3,4]. The purpose of the current study was to examine the relationship between perceptual judgments of accuracy and acoustic characteristics of rhotic vowels produced by 2- to 6-yr-old children learning Western Canadian English, a rhotic dialect. Rhotic vowels in six different phonetic contexts (stressed and unstressed rhotic monophthongs [ɝ] and [ɚ], and rhotic diphthongs /ɪ͡ɚ/, /ɛ͡ɚ/, /ɔ͡ɚ/, and /ɑ͡ɚ/) produced in real words were phonetically transcribed using *LIPP* software[5] and analyzed acoustically.

Participants included 36 children, 19 with TDS, 15 with SSD, and 2 with a history of SSD and speech sound intervention but no current difficulties with speech sound production. All but two children fell into one of three groups based on the perceived accuracy (based on phonetic transcriptions) of their productions of rhotic consonants (PCC-r) and rhotic vowels (PVC-r). Children in Group A showed high (>75) accuracy for both PCC-r and PVC-r, whereas those in Group B showed high accuracy for PVC-r but low (<20) accuracy for PCC-r. Groups A and B consisted of children with TDS or a history (but not a current diagnosis) of SSD. Children in Group C were those with low accuracy (<20) on both PCC-r and PVC-r and included all of the children with SSD and some with TDS. Error patterns based on phonetic transcriptions were reported in a previous paper; therefore the current paper focuses on the acoustic characteristics of the children's rhotic vowel productions.

For acoustic analyses, the first three formant frequencies as well as vowel duration were extracted using a custom speech analysis program created in *MATLAB6*. The F3 of Groups A & B (rhotic vowel accuracy >75) showed traces of rhoticity even for productions that were transcribed as incorrect. For Group C (rhotic vowel accuracy <20%) F3 showed no clear trace of rhoticity. TDS12 showed some hints of rhoticity, but the patterns were not clear; this could suggest that she was beginning to learn how to make rhotic sounds by dropping F3. SSD06 had a unique pattern of errors on his rhotic vowels; he produced /ɝ, ɚ, ɪ͡ɚ/ as [ɛ͡ɚ] and /ɔ͡ɚ/ as [ɑ͡ɚ]. Thus, although many of his productions were incorrect, they were always rhotic, and this was reflected in the acoustic measures of his productions.

Additional analyses are underway and include acoustic validation of proposed rhotic vowel error pattern categories based on phonetic transcriptions (e.g., rhotic diphthong reduction as in [bɛ] for "bear" vs. derhoticization as in [bɛ͡ʊ] for "bear," or dehroticization to a back round vowel as in [bɛ͡ʊ] for "bear" vs. derhoticization to a mid central vowel as in [bɛ͡ə] for "bear"). Findings highlight the importance of using acoustic analysis to supplement perceptual judgments of accuracy and error type.

Table 1. Number of participants by diagnostic group, age, and rhotic accuracy group

Diagnostic Group	Age	Group A	Group B	Group C	Outliers		Total
					SSD06	TDS12	
TDS	2	1	1	2	-	1	5
	3	1	3	1	-	-	6
	4	3	0	2	-	-	5
	5	4	0	0	-	-	4
		9	4	5	0	1	19
SSD	3	0	0	3	1	-	3
	4	0	0	6	-	-	6
	5	0	0	2	-	-	2
	6	0	0	3	-	-	3
		0	0	14	1	0	15
History of SSD	3	1	-	-	-	-	1
	4	1	-	-	-	-	1
		2	-	-	-	-	2
Total		11	4	19	1	1	36

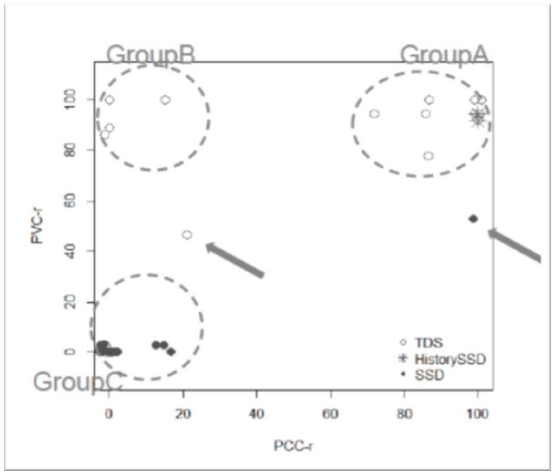


Figure 1. Participant groups based on rhotic accuracy (PVC-r and PCC-r).

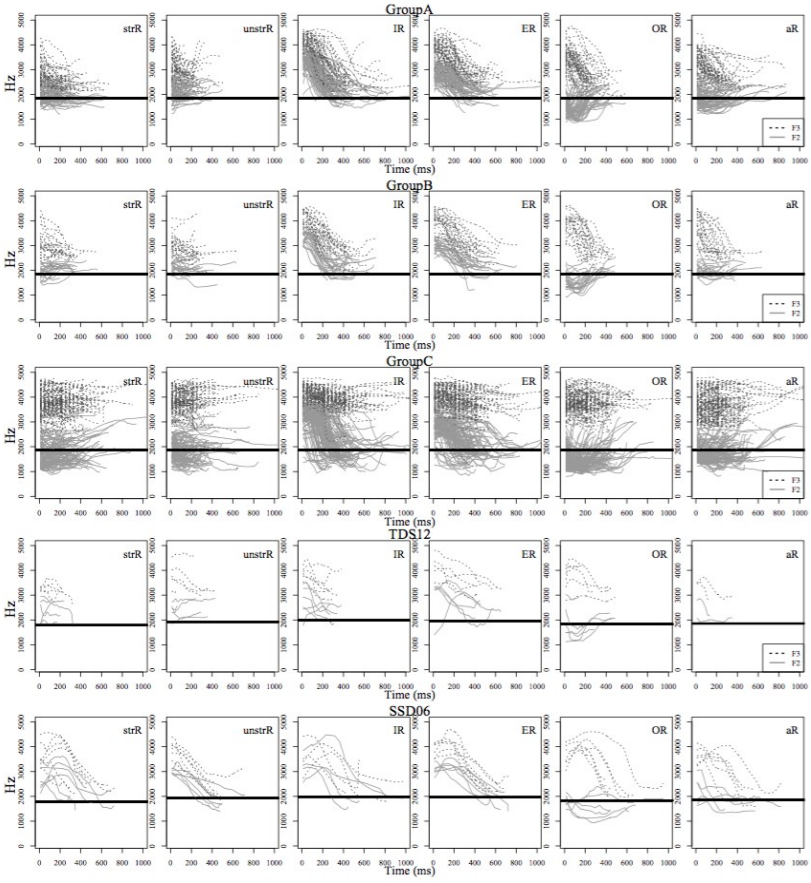


Figure 2. F2 and F3 (Hz) spectral movement patterns of six rhotic vowels (strR = /ɝ/, unstrR = /ɚ/, IR = /ɪ͡ɚ/, ER= /ɛ͡ɚ/, OR = /ɔ͡ɚ/, aR = /ɑ͡ɚ/) produced by each group of children and the two outliers. Black dotted line represents F3 (Hz) and grey solid line represents F2 (Hz). The thick solid black line indicates the average minimum F3 values of each target vowel produced by female adults, reported in Chung & Pollock[7] (strR (/ɝ/): 1787Hz, unstrR (/ɚ/): 1925Hz, IR (/ɪ͡ɚ/): 1982Hz, ER (/ɛ͡ɚ/): 1832Hz, OR (/ɔ͡ɚ/): 1832Hz, aR (/ɑ͡ɚ/): 1856Hz).

References

[1]Smit, A. B., Hand, L., Freilinger, J. J., Bernthal, J. E., & Bird, A. (1990). The Iowa Articulation norms project and its Nebraska replication. *Journal of Speech and Hearing Disorders, 55(4)*, 779-798.

[2]Hodson, B.W., & Paden, E.P. (1991). *Targeting intelligible speech* (2nd ed.). Austin, TX: Pro-Ed.

[3]Klein, H.B., Grigos, M.I., Byun, T.M., & Davidson, L. (2012). The relationship between inexperienced listeners' perceptions and acoustic correlates of children's /r/ productions. *Clinical Linguistics and Phonetics, 26(7)*, 628-645.

[4]Shriberg, L.D., Flipsen, P., Karlsson, H.B., & McSweeny, J.L. (2001). Acoustic phenotypes for speech-genetics studies: an acoustic marker for residual /ɝ/ distortions. *Clinical Linguistics & Phonetics, 15(8)*, 631-650.

[5]Oller, D. K., & Delgado, R.E. (2006). Logical International Phonetics Program (LIPP) (Version 2.10) [Computer software]. Miami, Florida: Intelligent Hearing Systems.

[6]Morrison, G. S., & Nearey, T. M. (2011). Formant Measurer: Software for efficient human-supervised measurement of formant trajectories [Software release 2011-05-26].

[7]Chung, H., & Pollock, K. (2014). Acoustic characteristics of adults' rhotic monophthongs and diphthongs. *Communication Sciences & Disorders, 19(1)*, 1-7.

The effect of common versus uncommon speech substitutions on the recognition and processing of words

Breanna Krueger Holly Storkel Jacquelyn Vorndran Laura Neenan

University of Kansas

The purpose of the present study is to explore the perception of misarticulated speech by preschool children. Preschoolers are able to understand and process speech that contains variability, such as accent and dialect differences, but it is uncertain whether they understand words containing phoneme substitutions as phonetic variants of their intended referents or as new words. Furthermore, it is uncertain if experience with a substitution type influences recognition and processing of words containing misarticulations.

In the first ongoing experiment, we showed children a two alternative forced-choice display with pictures of novel objects and real objects. They heard tokens containing canonical productions of a word (e.g. “leaf), common substitutions (e.g. “weaf”), or uncommon substitutions (e.g. “yeaf”). Children were asked to click on the picture of the word they heard. Their selections, reaction times and mouse trajectories were measured. To date, 5 preschoolers have participated with data collecting still continuing. Children chose real objects significantly more in canonical conditions than in substitution conditions. Within substitution conditions, children chose real objects significantly more when hearing common misarticulations (e.g. “weaf”) than uncommon misarticulations (e.g. “yeaf”). Reaction time trends indicated faster responding in canonical conditions compared to substitution conditions. Trends in mouse trajectories suggested that mouse movements were more direct for canonical conditions than substitution conditions. These preliminary results suggest that children are able to identify words containing misarticulations as phonetic variants of the target but that there is a processing cost. In addition, identification is influenced by experience with misarticulation. These results suggest flexibility in perception, but it is possible that the preschoolers were biased toward selecting real objects. Therefore, we are conducting a second companion experiment with the same auditory stimuli, but with a different visual display.

Nine preschoolers were trained to choose between a real object and a “blank” (a white square). The blank served as a way for participants to reject the real object without assigning the presented label to a specific object. Again, the preschoolers’ picture selections, response times and mouse trajectories were measured. The results of Experiment 2 paralleled those of Experiment 1. Specifically, preschoolers chose real objects significantly more for canonical productions than for substitutions, and showed a tendency to choose real objects more for common substitutions than for uncommon substitutions. For reaction time, preschoolers’ responses showed no appreciable trends at this time. Finally, the trend for mouse trajectories showed that mouse movements may be more direct in canonical conditions than substitution conditions, and potentially more direct for common substitutes than uncommon substitutes. Although data collection is ongoing, the present results suggest that preschoolers perceive words containing misarticulations as phonetic variants of target words, although there may be a processing cost. Moreover, children’s recognition of misarticulations as phonetic variants of target words is influenced by experience.

The impact of language experience on a non-word repetition task: Testing bilingual children with little L2 exposure

Jeanie Morry Maureen Scheidnes

Memorial University

Poor performance on tasks involving the repetition of non-words has been shown to be a clinical marker of specific language impairment (SLI) in children (e.g., Girbau & Schwartz, 2008). As such tasks do not use meaningful language, they can be an effective means of testing phonological processing skills while eliminating vocabulary familiarity (Thordardottir & Brandeker, 2013). Non-word repetition (NWR) tasks can be especially useful in bilingual contexts; standardized tests normed to monolingual populations tend to over-identify typically developing (TD) bilingual children as having SLI because of overlapping language performance (e.g., Bedore & Peña, 2008). However, NWR tasks are not necessarily immune to the effects of linguistic experience.

Gutiérrez-Clellen and Simon-Cereijido (2010) found that the clinical accuracy of a NWR task based on a single language was lower than that of two - one based on each language of bilingual children (Spanish and English in this case). In other words, a NWR task based on the phonotactics of only one of a bilingual's languages was not enough to rule out SLI in TD bilinguals, even if it was their dominant language. Could a single non-word repetition task that includes elements common to the two languages in question be the key to differentiating TD bilingual children from those with SLI?

A task of this nature, the LITMUS-NWR-FRENCH (Language Impairment Testing in Multilingual Settings, COST Action, 2011) could offer insight into this question. This particular test aims to reduce the effect of language-specific knowledge by building non-words from phonological units common to many languages (Ferré & dos Santos, to appear), thus reducing bias against typically developing bilinguals who need more time to master the phonotactics of the language of least exposure. Complexity increases at the syllabic structure level, including clusters that are found in both English and French (Table 1). A previous study using this task found that TD English-French bilingual children living in France (Bi-TD) performed very well - nearly on par with their monolingual French-speaking peers (Table 2). The present study expands on these results by testing 10 children between the ages of 6;8-7;4 with L1 English and are acquiring L2 French in an immersion school in St. John's, Newfoundland (Bi-IMRS). These learners have less exposure than do the children living in France, but it is predicted that they will perform just as well due to the test's composition.

Preliminary analysis of our results show that these children, despite only having 2 years of exposure to French, performed very well —near ceiling, in fact— on this task (Table 3). This could indicate that incorporating common linguistic phonological elements and structures allows children to better display their linguistic competencies across both languages. Further analysis of this data will compare these results to those of bilingual English-French children with SLI to determine whether the task would mistakenly identify them as typically developing.

Table 1: Task Details (modified from Ferré & dos Santos, to appear)

	Number of Items	Syllable Types	Examples
Control Items	13	CCV, sCV, CVC, CV.CV	[kla], [spu], [faku]
Low Complexity	12	Disyllabic with CC clusters, CVC syllables and trisyllabic CV.CV.CV	[paklu], [kifus], [kifapu]
Medium Complexity	36	Addition of CCV and CVC syllables in disyllabic and trisyllabic non-words; CCVC, CVCC and sCCV monosyllabic	[flukif], [klaf], [pifukas], [plal], [kuspa]
High Complexity	10	CCVCs, CCVsC, CV.CVL.CV, sCV.CV.CV, CV.CVs.CV	[pliks], [skapufi], [fikuspa]
Total	**71**		

Table 2: Results of Bi-TD (mean age 6;9, SD 1;1) children in France

Speaker	Percent Word Exact Match	Speaker	Percent Word Exact Match
ALB	95.77	**LEG**	97.18
AND	92.95	**LIC**	76.05
CLR	83.09	**MAH**	88.73
FAS	92.95	**RAM**	71.83
GED	92.95	**SAC**	92.95
KOS	97.18	**SAH**	90.14

Table 3: Results of Bi-IMRS children in NL

Speaker	Percent Word Exact Match	Speaker	Percent Word Exact Match
AHE	87.32	**LAE**	94.36
CRA	91.54	**LOT**	88.73
EES	91.42	**MRE**	90.14
JOS	94.36	**NOR**	91.54
KTP	91.42	**SAL**	92.95

References

Bedore, L. M., & Peña, E. D. (2008). Assessment of bilingual children for identification of language impairment: Current findings and implications for practice. *International Journal of Bilingual Education and Bilingualism, 11*(1), 1-29.

COST Action IS0804. (2001) *COST Action IS0804*. <http://www.bi-sli.org>.

Ferré, S., & dos Santos, C. (to appear). Un test de répétition de non-mots pour évaluer la phonologie des enfants bilingues. *Revue de Linguistique et de Didactique des Langues (Lidil), 51*.

Girbau, D., & Schwartz, R. G. (2008). Phonological working memory in Spanish-English bilingual children with and without specific language impairment. *Journal of Communication Disorders, 41,* 124-145.

Gutiérrez-Clellan, V. F., & Simon-Cereijido, G. (2010). Using nonword repetition tasks for the identification of language impairment in Spanish-English-speaking children: Does the language of assessment matter? *Leaning Disabilities Research & Practice, 25*(1), 48-58.

Thordardottir, E., & Brandeker, M. (2013). The effect of bilingual exposure versus language impairment on nonword repetition and sentence imitation scores. *Journal of Communication Disorders, 46*, 1-16.

Tongue shape complexity of correct and distorted rhotics in school-age children

Jonathan Preston	Patricia McCabe	Mark Tiede	Douglas Whalen
Syracuse University	University of Sydney	Haskins Laboratories	Haskins Laboratories/CUNY Graduate School

Rhotic phonemes are among the latest to develop in American English speaking children (Smit, Hand, Freilinger, Bernthal, & Bird, 1990) and are also among the most frequently misarticulated sounds in individuals with residual speech sound errors. One potential reason for the difficulty in acquiring this class of sounds is the complex lingual configuration required. Typical articulation of rhotics in adults requires the formation of three constrictions in the vocal tract: slight lip rounding, a pharyngeal constriction with the tongue root retracting in a posterior direction, and an oral constriction with the tongue tip, blade, or anterior dorsum approximating the hard palate (Delattre & Freeman, 1968).

Ultrasound imaging of the tongue has recently been used as an effective method for describing tongue shape. However, comprehensive description and quantification of rhotic tongue shapes in normal and disordered productions in children is limited. Gick et al. (2008) argued that errors on English liquids are commonly characterized by simplification of tongue shape and a lack of differentiation of the anterior and posterior tongue. Recently, Klein et al. (2013) reported that children's /r/ productions that that were most likely to be rated as perceptually incorrect were those in which the tongue was highly curved and had a posterior peak.

In the present study, 26 native speakers of Standard American English between 10-14 years of age participated. Thirteen children in the typical speech (TS) group had no history of speech or language disorders, achieved a standard score of at least 100 on the Goldman-Fristoe Test of Articulation-2 (Goldman & Fristoe, 2000). The Residual Speech Error (RSE) group consisted of 13 children who scored below 75 on the GFTA-2; all had clinically significant errors as determined by scores below 20% accuracy on probes for rhotics in various word positions. The RSE group completed the experimental task before and after a period of 7 hour long therapy sessions treating rhotics.

An Aloka SSD-100 ultrasound was used to collect mid-sagittal images of the tongue as participants read the sentence *Let Robby cross Church Street*, which was repeated a minimum of 12 times. Based on the acoustic signal, the appropriate video frame was identified for the 4 rhotics in each production. The contour of the tongue was traced by placing up to 10 anchors.

Four listeners independently scored 4680 tokens as 0=off target and 1=perceptually correct production. Listeners were in unanimous agreement on 3520 tokens, which serve as the basis for the tongue shape analysis.

Data have been collected and analysis is ongoing. We are in the process of exploring multiple methods of quantifying tongue shape complexity, including the number of inflection points in the contour (with more inflection points indicating greater tongue shape complexity). We will explore several hypotheses including:

1. Tokens rated by listeners as "correct" will have significantly more complex tongue shapes than tokens rated as "incorrect." Similarly, the TS group would have more complex tongue shapes than the RSE group
2. For the RSE group, tongue shape complexity will increase following therapy.

References

Delattre, P., & Freeman, D.C. (1968). A dialect study of american r's by x-ray motion picture. *Linguistics, 6*(44), 29-68. doi: 10.1515/ling.1968.6.44.29

Gick, B., Bacsfalvi, P., Bernhardt, B.M., Oh, S., Stolar, S., & Wilson, I. (2008). *A motor differentiation model for liquid substitutions in children's speech.* Paper presented at the Proceedings of Meetings on Acoustics.

Goldman, R., & Fristoe, M. (2000). *Goldman Fristoe test of articulation - second ed*. Circle Pines, MN: AGS.

Klein, H.B., McAllister Byun, T., Davidson, L., & Grigos, M.I. (2013). A multidimensional investigation of children's /r/ productions: Perceptual, ultrasound, and acoustic measures. *Am J Speech Lang Pathol, 22*(3), 540-553. doi: 10.1044/1058-0360(2013/12-0137)

Smit, A.B., Hand, L., Freilinger, J.J., Bernthal, J.E., & Bird, A. (1990). The Iowa articulation norms project and its Nebraska replication. *Journal of Speech and Hearing Disorders, 55*(4), 779-797.

Who needs intervention? A phonological screening tool for children with cleft palate

Line Dahl Jørgensen

University of Copenhagen

Children with cleft palate +/- cleft lip (CP) are at risk of speech and language delay. It is important to identify children with difficulties as early as possible in order to offer appropriate intervention. Conversely, it is also vital to avoid unnecessary intervention which both adds to the burden of care for the family and to socioeconomic cost.

Although there is a strong relationship between early sounds and syllable shapes and later speech and language skills in children without CP,[1] the picture is less clear when it comes to children with CP. However, number of oral consonants, different oral consonants, oral stops, velar consonants, and alveolar consonants have been found to predict later speech and language proficiency.[2 3]

Traditionally, early speech production has been evaluated by thorough phonetic transcription of a large number of utterances occurring during spontaneous interaction between child and caregiver. This is, however, a time-consuming and thus expensive procedure. Furthermore, it has been shown to overestimate the size of the child's consonant repertoire.[4]

Ramsdell and her colleagues[4] found that naturalistic listening in which caregiver judgment is simulated in the laboratory is a valid way of estimating a child's consonant repertoire when compared to both caregiver report and phonetic transcription. Lieberman and Lohmander[5] also found that a speech language pathologist's clinical impression of a child's consonant inventory during interaction with a caregiver correlated well with phonetic transcription.

As part of a larger intervention study of young children with CP, this study aims at developing and evaluating a screening procedure for young children with CP in order to determine which children need early intervention. Naturalistic listening is used for evaluating consonant inventory, and children are assigned to +/- need for intervention based on their use of specific phonological categories known as early predictors of later speech and language difficulties in children with CP. To determine the external validity of this procedure, it is compared to experienced speech and language pathologists'(SLPs) clinical judgment of whether or not a child with CP needs early intervention.

A group of 20 children with CP between 17 and 24 months of age will be video recorded for 45 minutes during natural play with a caregiver. Three SLPs trained in a naturalistic listening procedure will evaluate all video recordings, and inter and intra reliability will be calculated. Two SLPs with many years of experience working in cleft clinics will evaluate the video recordings and give their clinical opinion on each child's need for early intervention. Cases of disagreement will be solved through consensus listening and discussion.

Good agreement between the raters in the naturalistic listening procedure, and a strong correlation between the children selected for intervention with the screening procedure and the clinical opinion of experienced SLPs could indicate that the screening procedure is a valid tool for identifying children with CP who need early intervention. Poor agreement might indicate insufficient training. Weak correlation could indicate that SLPs refer children for intervention due to other parameters than the phonological categories in which case the screening procedure might need adjustment.

References

1. Olswang, L. B, Rodriguez, B. & Timler, G. (1998). Recommending intervention for toddlers with specific language learning difficulties: we may not know all the answers, but we know a lot. *American Journal of Speech Language Pathology, 7*(1), 23–32.
2. Chapman, K. L. & Willadsen, E. (2011). The development of speech in children with cleft palate. In Lohmander, A. Howard, S. (eds.). *Cleft Palate Speech. Assessment and Intervention* (pp. 23–36). Wiley- Blackwell.
3. Klintö, K., Salameh, E.-K., Olsson, M., Flynn, T., Svensson, H., & Lohmander, A. (2014). Phonology in Swedish-speaking 3-year-olds born with cleft lip and palate and the relationship with consonant production at 18 months: Phonology in 3-year-olds born with cleft palate. *International Journal of Language & Communication Disorders, 49*(2), 240–254. doi:10.1111/1460-6984.12068
4. Ramsdell, H. L., Oller, D. K., Buder, E. H., Ethington, C. A., & Chorna, L. (2012). Identification of Prelinguistic Phonological Categories. *Journal of Speech Language and Hearing Research, 55*(6), 1626. doi:10.1044/1092-4388(2012/11-0250)
5. Lieberman, M., & Lohmander, A. (2014). Observation is a valid way of assessing common variables in typical babbling and identifies infants who need further support. *Acta Paediatrica, 103*(12), 1251–1257. doi:10.1111/apa.12776

Babbling as a potential predictor of difficulty in segmental acquisition

Kayla Day

University of Alberta

Researchers have been investigating possible relationships between children's babbled utterances (non- meaningful word-like utterances) and their phonological development over the last three decades (e.g. Oller 1980; Stoel-Gammon & Cooper 1984; Stark 1980; Vihman, Ferguson & Elbert 1986). Often this research examines the transition period between babbling and early word productions, and broad similarities across babbles and word productions have been documented. More recently, research into the segmental properties of babbles suggests that there is a high degree of cross-linguistic universality in properties of the segmental content produced (Kern & Davis 2009). These trends were reported over broad categories, such as major places of articulation, as opposed to individual segments. The current research attempts to identify a possible role for babbled utterances in early phonological development by comparing the segmental development of sounds which are or are not produced in babbled utterances. Based on data from two English-speaking children (English-Davis corpus, PhonBank), it will be argued that the segmental content produced in children's babbles may serve as a predictor for certain aspects of their segmental development. It will also be demonstrated that many of the broad trends previously found in babbled utterances are supported by the current study, and that aspects of these broad trends apply across babbles and early word productions. However, this research will also show evidence which supports a more fine-grained analysis of babbled utterances, considering the actual segments themselves as opposed to only the broad articulatory categories.

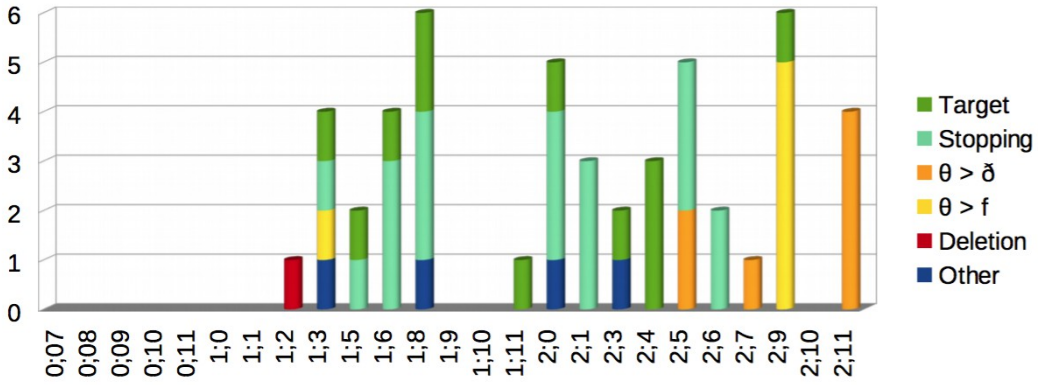
The current study argues that the segmental inventory produced by children in their babbled utterances may serve as a prediction of what segments will be easily or systematically acquired in their meaningful productions. Both children examined here produced the vast majority of sounds in their babbled utterances before the segments were attempted in meaningful words. While this trend is not necessarily surprising for articulatorily simple sounds (such as stops), even more difficult sounds (e.g. affricates) appeared in babbles before being attempted in words. Both children also demonstrated difficulty acquiring segments in the onsets of meaningful words which were not first produced in babbled utterances. One child, Cameron, displayed an especially striking pattern in her attempt to acquire [θ] (the only English phoneme she never produces in babbles, see Figure 1) where not only was she unable to acquire this difficult segment, it was the only segment for which she did not develop a systematic substitution pattern across her documented segmental development (Figure 2). These patterns may suggest that babbling serves as a sort of articulatory practice (Inkelas & Rose 2007) for the sounds of the child's language, helping the child discover how to match characteristics of the ambient signal with the physical reality of articulation.

To explore this possibility the segmental development of each child across the babbling and word production stage will be explored. I will demonstrate that the absence of a segment in babbled utterances could potentially indicate a future difficulty in the child's segmental development. I will also explore potential theoretical implications for these findings.

Figure 1: Cameron's Inventory of Babbled Onsets

	0;07	0;08	0;09	0;10	0;11	1;00	1;01	1;02	1;03	1;05	1;06	1;08	1;09	1;10	1;11	2;00	2;01	2;03	2;04	2;05	2;06	2;07	2;09	2;10	2;11
b	2	182	290	144	487	264	331	201	173	19	6	4	0	6	1	3	2	3	1	3	1	1	4	1	26
d	60	110	385	304	208	170	106	100	98	19	9	9	4	10	5	4	7	1	1	8	0	9	2	7	31
g	20	54	113	56	134	102	120	66	56	15	4	4	0	2	1	11	0	0	0	2	0	0	1	1	1
p	0	0	0	6	8	9	5	0	14	14	4	2	2	3	1	0	0	0	1	6	0	2	10	0	0
t	0	0	6	2	1	6	5	2	7	5	3	4	4	3	2	3	3	0	0	0	6	0	9	0	1
k	2	7	20	6	6	11	2	6	6	9	4	6	4	2	0	1	0	1	0	4	0	3	0	3	0
ʔ	1	0	3	2	2	14	24	14	7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
m	1	37	40	27	133	40	49	68	50	3	3	3	1	3	0	6	1	0	0	4	0	0	1	1	4
n	75	76	36	77	109	72	58	40	81	12	2	9	4	2	2	9	0	0	2	11	0	3	5	7	3
ŋ	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
β	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
v	0	7	4	1	9	1	2	1	2	0	0	0	0	1	0	0	0	0	0	1	0	0	0	3	0
f	0	0	0	0	0	0	1	1	5	0	0	0	2	1	0	0	0	0	0	1	0	2	0	1	2
ð	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
θ	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
z	0	1	3	0	0	1	1	5	1	4	0	0	0	0	0	0	0	0	0	1	0	0	0	0	2
s	0	0	0	0	0	1	0	1	4	6	0	8	1	4	1	1	0	0	2	1	0	3	1	0	0
ʒ	0	0	0	0	0	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
ʃ	0	0	0	0	0	1	0	1	0	4	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
h	8	10	28	18	12	7	6	58	39	8	14	5	0	5	1	0	0	0	1	0	0	1	1	3	6
ʤ	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
ʤ	0	0	1	0	1	11	0	5	1	0	0	2	0	1	0	0	0	0	0	0	0	0	0	0	0
ʧ	0	0	0	0	0	2	0	5	0	2	0	0	0	1	1	1	0	0	0	0	0	0	0	0	0
j	4	15	154	70	165	57	35	36	79	9	1	3	2	3	0	0	0	1	0	0	0	0	0	1	10
w	2	57	92	82	116	96	158	143	199	16	6	8	5	8	3	0	2	2	1	6	2	10	4	2	6
l	0	31	30	51	5	27	16	0	2	1	0	1	0	0	0	0	0	0	0	1	0	0	1	3	0
ɹ	0	0	1	0	0	1	0	2	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
r	0	0	0	0	0	2	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Figure 2: Cameron's Development of [θ] in Onsets of Word Productions



References

Inkelas, Sharon & Yvan Rose. 2007. Positional Neutralization: A Case Study from Child Language. *Language* 83(4). 707–736.

Kern, Sophie & Barbara L Davis. 2009. Emergent Complexity in Early Vocal Acquisition: Cross Linguistic Comparisons of Canonical Babbling. In Ioana Chirotan, Christophe Coupé, Egidio Marisco & Fran\ccois Pellegrino (eds.), *Approaches to Phonological Complexity*, 353–375. Berlin: Mouton de Gruyter.

Oller, D. Kimbrough. 1980. The emergence of the sounds of speech in infancy. In Grace H. Yeni-Komshian, James Francis Kavanagh & Charles Albert Ferguson (eds.), *Child Phonology 1: Production*. New York: Academic Press.

Stark, Rachel E. 1980. Stages of speech development in the first year of life. In Grace H. Yeni-Komshian, James Francis Kavanagh & Charles Albert Ferguson (eds.), *Child Phonology 1: Production*. New York: Academic Press.

Stoel-Gammon, Carol & Judith A. Cooper. 1984. Patterns of Early Lexical and Phonological Development. *Journal of Child Language* 11. 247–271.

Vihman, Marilyn May, Charles A. Ferguson & M. Elbert. 1986. Phonological Development from Babbling to Speech: Common Tendencies and Individual Differences. *Applied Psycholinguistics* 7. 3–40.

Authors

Al-Qattan, Shaima	Newcastle University	shaima.al-qattan@newcastle.ac.uk
Barlow, Jessica	San Diego State University	jbarlow@mail.sdsu.edu
Bedard, Janice	University of Alberta	jkbedard@ualberta.ca
Benham, Sara	Purdue University	sbenham@purdue.edu
Buchwald, Adam	New York University	buchwald@nyu.edu
Burkinshaw, Kelly	University of Calgary	kburkinshaw@mun.ca
Chung, Hyunju	KyungHee University	hyunjuchung7@gmail.com
Combiths, Philip	San Diego State University	philcombiths@gmail.com
Cummings, Alycia	University of North Dakota	alycia.cummings@und.edu
Dahl Jørgensen, Line	University of Copenhagen	kcj876@hum.ku.dk
Day, Kayla	University of Alberta	knday@ualberta.ca
Dunger, Jaslyn	University of Alberta	jdunger@ualberta.ca
Fabiano-Smith, Leah	University of Arizona	leahfabianosmith@email.arizona.edu
Fazekas, Judit	University of Edinburgh	fffjudit@gmail.com
Foulkes, Paul	University of York	paul.foulkes@york.ac.uk
Gafos, Adamantios	University of Potsdam	gafos@uni-potsdam.de
Goffman, Lisa	Purdue University	goffman@purdue.edu
Hoehle, Barbara	University of Potsdam	hoehle@uni-potsdam.de
Inkelas, Sharon	University of California, Berkeley	inkelas@berkeley.edu
Jeffries, Ella	University of York	erwj500@york.ac.uk
Johnson, Keith	University of California, Berkeley	keithjohnson@berkeley.edu
Kavitskaya, Darya	University of California, Berkeley	dkavitskaya@berkeley.edu
Keren-Portnoy, Tamar	University of York	tamar.keren-portnoy@york.ac.uk
Kern, Sophie	Laboratoire Dynamique Du Langage, CNRS-Université de Lyon	Sophie.KERN@cnrs.fr
Khattab, Ghada	Newcastle University	ghada.khattab@newcastle.ac.uk
Kleber, Felicitas	Ludwig-Maximilian-Universität München	kleber@phonetik.uni-muenchen.de
Krueger, Breanna	University of Kansas	bkrueger@ku.edu
Larson, Alexia	University of North Dakota	alexia.larson@my.und.edu
Lindop-Fisher, Robin	University College London	robinlindopfisher@gmail.com
Llamas, Carmen	University of York	carmen.llamas@york.ac.uk
McAllister Byun, Tara	New York University	tara.byun@nyu.edu
McCabe, Patricia	University of Sydney	tricia.mccabe@sydney.edu.au
McKean, Cristina	Newcastle University	cristina.mckean@newcastle.ac.uk
Morin-Lessard, Elizabeth	Concordia University	emorin07@gmail.com
Morry, Jeanie	Memorial University	jmm415@mun.ca
Munson, Benjamin	University of Minnesota	munso005@umn.edu
Neenan, Laura	University of Kansas	l593n289@ku.edu
Ota, Mits	University of Edinburgh	mits@ling.ed.ac.uk
Page, Mike	University of Hertfordshire	m.2.page@herts.ac.uk
Pollock, Karen	University of Alberta	karen.pollock@ualberta.ca
Preston, Jonathan	Syracuse University	jopresto@syr.edu
Pruitt-Lord, Sonja	San Diego State University	spruitt@mail.sdsu.edu
Sabri, Manal	University of Arizona	msabri@email.arizona.edu
Santos, Brooke	Northern Arizona University	bs732@nau.edu

Santos, Christophe dos	INSERM & Université François-Rabelais de Tours	christophe.dossantos@univ-tours.fr
Scheidnes, Maureen	Memorial University	mscheidnes@mun.ca
Skarabela, Barbora	University of Edinburgh	bskarabela@gmail.com
Sosa, Anna	Northern Arizona University	anna.sosa@nau.edu
Stoel-Gammon, Carol	University of Washington	csg@u.washington.edu
Storkel, Holly	University of Kansas	hstorkel@ku.edu
Strahm, Stephanie	University of Ottawa	5189164@gmail.com
Tamási, Katalin	University of Potsdam	tamasi@uni-potsdam.de
Tessier, Anne-Michelle	University of Alberta	annemich@ualberta.ca
Tiede, Mark	Haskins Laboratories	tiede@haskins.yale.edu
Vihman, Marilyn	University of York	mv509@york.ac.uk
Vorndran, Jacquelyn	University of Kansas	jrvorndran@ku.edu
Whalen, Douglas	Haskins Laboratories/CUNY Graduate School	whalen@haskins.yale.edu
Wihlborg, Lovisa	University of Edinburgh	lovisa@hjinello.se
Yamaguchi, Naomi	CNRS & Université Sorbonne Nouvelle Paris 3	naomi.yamaguchi@univ-paris3.fr
Zamuner, Tania	University of Ottawa	tzamuner@uottawa.ca

Fun Time in St. John's and Vicinity

Attractions — St. John's

- Signal Hill & Johnson Geo Centre
  Note: Cabot Tower is currently closed for restoration, but you can observe a family of bald eagles off the Cuckold's Cove trail (which leads all the way to Quidi Vidi on a spectacular ridge)
- Memorial University Botanical Garden
- The Rooms (Art Gallery & Museum) -- FREE Admission Wednesday Night
- Basilica Cathedral
- Anglican Cathedral
- Railway Coastal Museum
- Quidi Vidi Village
- Fort Amherst
- The Suncor Energy Fluvarium & Pippy Park

Attractions — just outside St. John's

- Bell Island Mines (Ferry from Portugal Cove)
- Cape Spear
- Petty Harbour & North Atlantic Ziplines
- Ocean Sciences Centre (Logy Bay)
- Middle Cove Beach

Tours

- Whale-watching and Icebergs
  - St. John's Harbour (Iceberg Quest Ocean Tours)
  - Bay Bulls
    (Companies: Gatherall's, O'Brien's, …)

- City Tours
  - Legend Tours: http://www.legendtours.ca/tour.html
  - St. John's Tours (Departing from Sheraton & Delta Hotels): 739-0006 or 699-6372

Main shopping areas

- Downtown: Water Street & Duckworth Street
- Avalon Mall: Kenmount Road & Thorburn Road
- The Village Shopping Centre ("The Village"): Topsail Road & Columbus Drive

Some local events

- Folk Night
  June 24, 2015; 9:00 - 11:30 PM
  The Ship Pub, Solomon's Lane (265 Duckworth Street)

- 15th Annual Nickel Independent Film Festival (http://nickelfestival.com/)
  June 23-27; Shows start at 7PM
  LSPU Hall, 3 Victoria Street

- The Rooms 10th Anniversary Open House
  June 28th, 2015; 12:00 - 5:00 PM
  Free Admission

City of St. John's visitor information centre: 348 Water Street

More tourist information is available at the following locations or by visiting:
http://www.stjohns.ca/visiting-our-city/st-johns-information/tourism-links