Noa Attali

Proposal for Cognitive Science Undergraduate Thesis

Effects of Age and Input for Cantonese Speakers’ Production of English Plosives

Primary Advisor: Karin Dr. Stromswold, Professor, Psychology

Secondary Advisor: Ana Rinzler, PhD student, Cognitive Psychology

**Abstract**

We are investigating the Critical Period Hypothesis (CPH) of second language (L2) acquisition. CPH posits that biological predispositions (e.g., neural plasticity) provide younger speakers with an advantage over older speakers, such that younger learners acquire L2 with greater ease. However, the role of an immersive L2 environment may affect the dependence of the critical period on the role of biology. In collaboration with Terry Au (ms), we hypothesize that amount of good L2 input influences the timing factor in L2 acquisition. We propose to test this hypothesis by assessing the effects of training on L2 phonology and whether these effects are age-related,. We will conduct acoustic analysis using PRAAT on data collected from a study by Terry Au (ms). In Au’s (ms) study, she examined the effect of intensive training on Cantonese speakers’ ability to produce and perceive notoriously difficult English contrasts. Our focus is on productions of English plosives /b, d, g/ and /p, t, k/ that occur in coda position of phonological minimal pair words (i.e., *bag* and *back*). We will analyze whether and in what ways the training factor and the age factor affect a speaker's ability to produce the contrast between these plosives. A future goal is to measure the ‘native-likeness’ of the Cantonese speakers’ productions through comparison with native English speakers’ productions.

*Keywords*: critical period; second language acquisition; phonology; perceptual training

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It seems to be a standard notion that younger speakers acquire a second language (L2) with greater ease than older speakers. Exemplifying the standard is anecdotal evidence that parents of immigrant families often have a stronger accent and a more effortful experience with producing speech that seems ‘nativelike’ than their children. This phenomenon may occur due to biological and maturational factors, environmental factors, or both. That is to say, the brain may lose flexibility with age such that late learners are biologically predisposed to attain lower levels of L2 proficiency than early learners. It may also be the case that the environment and linguistic input, the individual’s first language (L1), as well as the individual’s motivation and subjective fit to the environment, play a role in final L2 proficiency.

**Evidence for Maturational Factors Affecting Language Acquisition**

The biological possibility is referred to as the Critical Period Hypothesis (CPH). CPH makes various assumptions and predictions related to language acquisition, regarding both L1 and L2 acquisition (for a review, see Pallier, 2007). In the strict tradition, Lenneberg (1967) suggests there is a limited time period between birth and puberty in which language can be acquired and beyond which language acquisition and competency declines. Lenneberg (1967) utilizes indirect behavioral evidence to propose that, beyond puberty, the brain irreversibly loses neural plasticity necessary for language acquisition. A variation on Lenneberg’s (1967) idea is that a speaker’s L1 ‘fixes’ the functional neural connections in the cortex (Penfield, 1965; cited by Pallier, 2007).

There is much empirical support for the notion of a critical period. For instance, Curtiss (1977) studied children with severe linguistic deprivation and argued that their inability to attain linguistic competence, despite rehabilitation, is evidence in support of CPH. Further, Newport and Supalla (1987) studied congenitally deaf adults and argued that increasing age of exposure to ASL as L1 in childhood and puberty predicts a decline in ultimate language production and comprehension. However, their study showed a gradual decline in proficiency rather than a sharp drop, which suggests a sensitive rather than a critical period for language acquisition.

Later researchers have investigated the existence of a sensitive period for second language acquisition. When it comes to age effects on L2 rather than L1 proficiency, researchers must contend with the possible effects of L2 on L1 and with the correlation between age and non-maturational factors. As reviewed by Johnson and Newport (1989), the literature suggests that in studies of immigrants, age of arrival to a host country is the only predictor of L2 proficiency; and that late learners have an initial and short-lived advantage over early learners which is reversed when measured by ultimate attainment. The general observation is that older learners make more rapid strides towards L2 proficiency in the early stages of learning, but by the later stages – at which point ‘proficiency’ begins to be considered ‘ultimate attainment’ - have plateaued to a lower level, particularly in phonology.

In support of a sensitive period for L2 acquisition of a phonological system, Oyama (1976) studied Italian speakers that immigrated to America and argued that the heaviness of their accents in scripted and casual speech was predicted by their age of arrival. Judgments of accent along a scale by two native English speakers was the measure of phonological acquisition. Additionally, Johnson and Newport (1989) studied Chinese and Korean speakers that immigrated to America and argued that their performance on tests of grammaticality judgments for English morphology and syntax was also best predicted by their age of arrival. Age of arrival was the measure of immersion in L2 and it was found that immersion after the age of 7 predicted a gradual decline in performance from the nativelike standard. Within the lowered ranges of performance, there was a consistent decline and small variance in performance till puberty; after puberty there was no systematic association between age and performance and a heterogeneity of performance. These results were interpreted to follow from maturational factors. Moreover, attitudinal variables as measured by self-reports of American identification, motivation to learn, and self-consciousness in the L2 environment did not independently correlate as strongly as did age of arrival with performance.

The above studies in support of a sensitive period for L2 acquisition represents a more inclusive approach to CPH – in opposition to the exclusive approach which focuses on the effect of maturational factors on acquisition. In Johnson and Newport’s (1989) study, the measures of identification and self-consciousness together did have predictive power for ultimate performance, which suggests that even if attitudinal variables cannot form the sole basis of a model of L2 acquisition, they should not be excluded from the model. It is the aim of our study to investigate more closely these nonmaturational variables. Moreover, we aim to measure the dependent speech variable through acoustic analysis rather than through overt judgments, as was done by both Oyama (1976) and Johnson and Newport (1989).

**Evidence for Nonmaturational Factors Affecting Language Acquisition**

An immersive environment is important for L2 acquisition. In Terry Au’s (ms) review of the literature, there exist differences in affective and sociological learning conditions for early and late learners, especially for immigrant populations, such that late learners are adversely affected in L2 acquisition. Children in school settings are more likely to receive an immersive environment with good and constant input from native speakers, whereas late learners are more likely to be less assimilated into a social environment with enough good input.

Accents are in fact costly. Late learners can be hindered by consciousness of social stigmas associated with foreign accents, which creates a feedback loop because self-conscious or unmotivated speakers will speak less in the second language. A meta-analysis by Fuertes, Gottdiener, Martin, Gilbert, and Giles (2011) found evidence for these social stigmas; native speakers rated people with foreign accents much lower than people with standard accents on scales of apparent status (education, intelligence, success), dynamism (activity, liveliness), and solidarity (attractiveness, kindness, trustworthiness, and similarity to themselves). Derwing and Rossiter (2002) suggest therefore that adults may avoid conversations with native speakers; Gardner (1979) suggests adults may in fact avoid speaking in L2.

What are the results of manipulating the amount and quality of input across ages that learners receive? Terry Au (ms) studied child, adolescent, and adult Cantonese speakers who did and did not undergo a 6-week perceptual training program for English plosives /p, t, k/ and /b, d, g/, which was intended to provide the three different age groups with equal native L2 input. She found significant effects of training for all three age groups. She also found that the adult group benefited more than the younger groups (under certain conditions, not all), which contradicts the predictions of the sensitive period hypothesis for acquisition of a nonnative phonology.

**Study Goals, Hypothesis**

Our study continues analysis on the data collected by Terry Au (ms). As in Terry Au’s (ms) study, purely biological explanations for L2 proficiency can be distinguished from potential environmental factors by examining the effects of training speakers on L2 input. CPH is taken here to mean that a sensitive period for L2 phonological acquisition exists, but that non-maturational factors are negligible. Consequently, training late learners in phonological perception and production should be less effective than training early learners. If the quality and quantity of L2 input is an influential factor in L2 perception and production, then training late learners should be equally and potentially more effective than training early learners. Effective training is considered to result in statistically significant improvements in perception and production of L2, which here concern speakers’ abilities to produce the contrast between phonological minimal pair words. We hypothesize that training late learners should be equally and potentially more effective than training early learners. We are interested in the effects of training and age given the participants’ L1 and L2.

**Cantonese and English Plosives in Contrast**

The data collected by Terry Au (ms) are from native Hong Kong Cantonese Chinese speakers. English and Chinese are typologically distant; the former is a Germanic language and the latter, of which Cantonese is a dialect, belongs to the Sino-Tibetan language family (Chan & Li, 2000). Chan and Li (2000) argue that the typological distance causes considerable difficulties for Cantonese speakers in mastering standard English pronunciation. Like Chan and Li (2000) and Terry Au (ms), we assume that L1 phonological features transfer, interfere with, or influence L2 pronunciation in the L2 learning process. It is important to consider in what ways this influence may occur.

As Terry Au (ms) reviews, in English, the set of plosive stop consonants have a voicing contrast. Voicing is determined physiologically by vocal cord vibration during the closure of the stop and results acoustically in a periodic waveform. The voiced stops are /b, d, ɡ/ (e.g., bill, dill, gill) and the voiceless stops are /p, t, k/ (e.g., pill, till, kill). English orthography seems to regularize these particular distinctions. However, the reality is irregular. In utterance-initial and word-initial positions the distinction may be realized by aspiration rather than voicing. Aspiration is determined as a burst of air emitted between the stop onset release and the vowel onset. In such a case, all the plosives are voiceless, and the /b, d, g/ set are realized as unaspirated /p, t, k/ while the /p, t, k/ set are realized as aspirated /ph, th, kh/. That is to say, a native speaker may produce the initial consonant in “bill” as /p/ rather than /b/ and the initial consonant in “pill” as /ph/ rather than /p/. The result is that unaspirated voiceless /p, t, k/ may be the phonetic realization of either of the stop sets, depending on the context.

As Terry Au (ms) reviews, in Cantonese Chinese, the set of plosive stops only have the aspiration contrast. There is the voiceless unaspirated /p, t, k/ and the voiceless aspirated /ph, th, kh/. Orthography regularizes these distinctions such that the unaspirated set (/p, t, k/) are represented as “b”, “d”, and “g” and the aspirated sets (/ph, th, kh/) are represented as “p”, “t”, and “k”. Cantonese speakers can therefore be reasonably expected to always produce unaspirated voiceless stops like /p/ for an English “b”, though phonetically that “b” may need to be realized as /b/. The evidence is that Cantonese speakers do not generally master the voicing contrast. Additionally, English-as-L2 education may intensify this preferment for the aspiration contrast because it begins by teaching each letter of the alphabet in its word-initial position (e.g., “boy” for “b”), in which native speakers of English do use the aspiration contrast.

Indeed, Terry Au (ms) did not find training benefits for perceiving and producing the contrast in word-initial plosives, because participants used the aspiration contrast. But Terry Au (ms) found high benefits for perceiving and producing the contrast in word-final plosives, for which participants could learn to use the voicing contrast.

Numerous other differences regarding plosive production in Cantonese and English may affect phonological L2 acquisition. According to Chan and Li (2000), while English plosives may occur in word-initial, word-medial, and word-final positions, in Cantonese only /p, t, k/ plosives may occur in the word-final position. Also unlike in English, in word-final position plosives are unreleased and therefore unaspirated, which Chan and Li (2000) suggest “neutralizes the contrast” between aspirated and unaspirated plosives (p. 69) and may give the impression that Cantonese speakers “swallow” final plosives in English (p. 78). Finally, Cantonese has two coarticulated voiceless labiovelar stops, aspirated /kʷ/ and unaspirated /gʷ/, which do not exist in English.

**Methods**

**Participants**

In Terry Au’s (ms) study, the participants were in three age groups: young (9-10 years old), adolescent (11-13 years old), and young adult (18-22 years old). All were native speakers of Cantonese who had been learning English in a classroom setting since age 5 or 6 from teachers who were mostly L2 speakers of English. In each group the participants were randomly assigned to a perceptual training group for the English plosives or to a waitlist-control group. From the young group, 30 were in the training group and 32 in the waitlist control group (50% boys in each group). From the adolescent group, 23 were in the training group (48% boys) and 19 in the waitlist-control group (21% boys). From the university students, 18 were in the training group (33% men) and 18 in the waitlist-control group (28% men).

**Stimuli**

The stimuli in the perceptual training program run by Terry Au (ms) were a set of training phrases, recorded by multiple native speakers of American English, and presented on a computer with headphones. Each session contained 72 trials (in 2 blocks of 36 trials). In each trial, participants would hear a sentence such as “I say dog”, see “dog” and “dock” presented on the screen, and choose the word that they had heard. They received immediate feedback, earned rewards in the game on the basis of their percent correct for the session, and earned a final small compensation in the real-world at the end of the program.

*Assessment*. Participants took tests in perception and production at various times. The perception test resembled the training sessions except that it was longer with 150 test trials, recorded by a different native speaker, and 78 phrases were new to the participants in order to assess generalization of the training to untrained items. In the production test, participants were recorded reading aloud 42 of the “I say…” phrases from the perception test. See *Appendix A* for all stimuli.

**Experimental Procedure**

In Terry Au’s (ms) study, participants underwent 20 sessions of five minutes each over 4 to 6 weeks. In all three age groups, participants first took a pretest (i.e., the word perception task and word production task; Time 1). Each took an immediate posttest (Time 2) within a week of the program’s start, and then a 1-month follow-up posttest (Time 3). Waitlist-control participants took two baseline assessments to match the pretest (Time 1) and immediate posttest (Time 2) of the training group, after which they too received the training program.

**Planned Analysis**

**Acoustic Analysis**

We will perform acoustic analysis on the production data collected during the tests in Terry Au’s (ms) study, using PRAAT software. The aim of this analysis will be to measure aspects of low-level acoustic cues relevant to producing the contrast between plosives, which will allow us to develop a detailed picture of the effects of training and age on speaker productions. I will be responsible for analyzing data from the adolescent age group.

On data from word-initial phrases, we will mark voice onset time (VOT) duration as the length of time between the release of the onset stop consonant and the onset of periodicity marking the vowel. If there is aspiration, we will measure the mean aspiration intensity and mark aspiration duration in onset position. We will measure vowel duration using the .wav method to mark the start of the vowel and the F2 method to mark the end of the vowel. We will measure the F2 at the end of the vowel and the pitch (F0) of the vowel if there is a level pitch contour, or the change in pitch if there is not a level pitch contour. If there is a voicing bar, we will measure the duration.

On data from word-final phrases, we will mark vowel duration using the .wav method to mark the start of the vowel and F2 method to mark the end of the vowel. We will measure the F2 at the end of the vowel and the pitch (F0) of the vowel if there is a level pitch contour, or the change in pitch if there is not a level pitch contour. If there is a voicing bar, we will measure the duration. We will measure the duration of closure as the length of time between the end of the vowel and the onset of voicing for the consonant. We will mark whether there is a release burst at the onset of the consonant. See *Appendix A* for the word-initial and word-final phrases.

**Statistical Analysis**

We will conduct a series of ANOVAs to compare between pretest and posttest results within each age group in order to assess effects per age group, as well as between effects across age groups in order to assess the effects of age on proficiency. We also want to compare the predictive power of the acoustic cues we measure in acoustic analysis on proficiency within and across age groups.

**Start/End Dates**

Work on the project begins on May XX and will end August XX, 2018. Additional analysis of the data used in this study and further collection of data will continue throughout the 2018/2019 academic year.

**Student Advisor Meeting Schedule**

I will consult with my advisors at least once a week for the duration of the project.

**References**

Au, T. (2018). *Perceptual Training Program.* Unpublished manuscript.

Balusu, R. & Gafos, A. (2010). *Praat User’s Guide: Measuring Duration and Formants.* 1-9.

Bird, S., Wang, Q., Onosson, S., & Benner, A. (2015). *Acoustic Phonetics Lab Manual*. Department of Linguistics, University of Victoria. 1-82.

Chan, A. Y., & Li, D. C. (2000). English and Cantonese phonology in contrast: Explaining Cantonese ESL learners' English pronunciation problems. *Language Culture and Curriculum*, *13*(1), 67-85.

Chen, H., Chu, R., Wang, L., Chan Wong, P. M. J., Chan K. Y., Chee, E., & Wang, Q. (2012). Chapter 3: Acoustic Analysis of Consonants. *Praat Beginners’ Manual*. Retrieved from http://ec-concord.ied.edu.hk/phonetics\_and\_phonology/wordpress/learning\_website/chapter\_3\_consonants\_new.htm

Curtiss, S. (1977) *Genie: A psycholinguistic study of a modern day “wild child.”* New York: Academic Press.

Derwing, T. M., & Rossiter, M. J. (2002). ESL learners’ perceptions of their pronunciation needs and strategies. *System, 30,* 155-166.

Fuertes, J. N., Gottdiener, W. H., Martin, H., Gilbert, T. C., & Giles, H. (2012). A meta‐analysis of the effects of speakers' accents on interpersonal evaluations. *European Journal of Social Psychology*, *42*, 120-133.

Gardner, R. C. (1979). Social psychological aspects of second language acquisition. In H. Giles & R. St. Clair (Eds.), *Language and social psychology* (pp. 193-220). Oxford: Basil Blackwell.

Johnson, J. S., & Newport, E. L. (1989). Critical period effects in second language learning: The influence of maturational state on the acquisition of English as a second language. *Cognitive psychology*, *21*(1), 60-99.

Lenneberg, E. (1967). *Biological foundations of language*. New York: Wiley.

Newport, E., & Supalla, T. (1987). A critical period effect in the acquisition of a primary language.

Oyama, S. (1976). A sensitive period for the acquisition of a nonnative phonological system. *Journal of Psycholinguistic Research*, 5, 261-285.

Pallier, C. (2007). Critical periods in language acquisition and language attrition. *Language attrition: Theoretical perspectives*, *33*.

**Appendix A: Training and Testing Phrases** (adapted from Terry Au, ms)

**Pair: /p/ - /b/**

|  |  |  |  |
| --- | --- | --- | --- |
| **Word-initial** | | **Word-final** | |
| I say pack\*.  **I say pay\*.**  I say peak\*.  I say pet\*.  I say pill\*. | I say back\*.  **I say bay\***  I say beak\*.  I say bet\*.  I say bill\*. | **I say cap\*.**  I say lap\*.  I say nip\*.  I say rope\*.  I say cop.  **I say cup.**  I say mop.  I say nap.  I say rip.  **I say tap.** | **I say cab\*.**  I say lab\*.  I say nib\*.  I say robe\*.  I say cob.  **I say cub.**  I say mob.  I say nab.  I say rib.  **I say tab.** |

**Pair: /t/ - /d/**

|  |  |  |  |
| --- | --- | --- | --- |
| **Word-initial** | | **Word-final** | |
| I say teal\*.  I say tie\*.  **I say time\*.**  I say tone\*.  I say tuck\*. | I say deal\*.  I say die\*.  **I say dime\*.**  I say done\*.  I say duck\*. | I say bet\*.  I say bit\*.  **I say fat\*.**  I say fate\*.  **I say bat.**  I say coat.  **I say feet.**  I say got.  I say mat.  I say not. | I say bed\*.  I say bid\*.  **I say fad\*.**  I say fade\*.  **I say bad.**  I say code.  **I say feed.**  I say god.  I say mad.  I say nod. |

**Pair: /k/ - /ɡ/**

|  |  |  |  |
| --- | --- | --- | --- |
| **Word-initial** | | **Word-final** | |
| I say cane\*.  I say cap\*.  I say coat\*.  I say con\*.  **I say cot\*.** | I say gain\*.  I say gap\*.  I say goat\*.  I say gone\*.  **I say got\*.** | **I say dock\*.**  I say duck\*.  I say jock\*.  I say peck\*.  **I say back.**  I say lock.  I say muck.  **I say pick.**  I say rack.  I say tack. | **I say dog\*.**  I say dug\*.  I say jog\*.  I say peg\*.  **I say bag.**  I say log.  I say mug.  **I say pig.**  I say rag.  I say tag. |

\* = Untrained words. Boldfaced = Items used in assessing production as well as perception.