Recent developments in SLA studies of phonology
Evaluating the “Critical Period” Hypothesis: Perceptual Learning of Mandarin Tones in American Adults and American Children at 6, 10 and 14 Years of Age.

Yue Wang and Patricia K. Kuhl
abstract

examination of the perceptual learning of lexical tones in Mandarin Chinese by American young adults and children from 6 to 14 years old covering the age range surrounding the “critical period”
The participants received a two-week computerized Mandarin tone training program designed to be child-friendly for the trainees in each of the four age groups (but not the controls), percent correct identification increased significantly from the pre-training test to the post-training test.
comparing the pre-puberty and the post-puberty groups, no abrupt decrease in the degree of improvement was found, as would have been predicted by the Critical Period Hypothesis.

these results support the view that language learning is not a strictly timed developmental process with rigid cut-off periods.
predictions

- according to the Critical Period Hypothesis (CPH), language-learning ability is reduced at puberty
- resulting from the loss of neurological plasticity of the brain (Lenneberg 1967)
- puberty marks a closing of the window of opportunity for learning
an alternative theory:
future learning may be limited by prior learning
which itself alters the brain
producing a kind of interference effect that impacts later learning (Kuhl 2000)
thus, experience itself, rather than time, is the critical variable
recent studies have indicated that cortical representations may be continuously shaped throughout life (Van Turennout et al. 2000)
and that language-related cortical responses may differ as a function of linguistic experience (Perani et al.. 1998)
with sufficient experience and exposure, adult second language (L2) learners can authentically perceive or produce novel L2 sounds which have no native language (L1) phonemic counterparts (Flege 1995)
more explicitly, auditory training studies have successfully trained adult listeners to better distinguish non-native sounds (Logan et al. 1991)
these findings suggest that adult perceptual mechanisms have more plasticity than was previously recognized
few direct tests of second language speech learning comparing across the age range from childhood into adolescence, and into adulthood

wrt the Critical Period Hypothesis, direct comparison between children at different ages and adults is particularly interesting

if puberty marks the closing of the window of opportunity for learning, one would expect a discontinuity in speech learning abilities for pre-puberty and post-puberty children (and adults)
the experiment

the perceptual training procedure:

the learning of lexical tones in Mandarin Chinese by American adults and children

Mandarin phonemically distinguishes four tones differing in pitch height and contour shape
results

- significant improvement in the identification of Mandarin Chinese lexical tones
- after the 2-week perceptual training
- for American children at 6, 10, and 14 years old, as well as American adults
Figure 1: Mean percent correct identification of the four Mandarin tones for the trainees (upper panel) and controls (lower panel) of the four age groups. [*] indicates that the difference is significant at p<.05.
The Perception and Production of English /æ/ and /ə/ by Korean Children and Adults Living in North America

Kimiko Tsukada, David Birdsong, Ellen Bialystok, Molly Mack, Hyekyung Sung and James Flege
abstract

the production and categorial discrimination of English /æ/ and /aː/ by native Korean (NK) adults and children

a total of 108 participants (72 NK and 36 age-matched native English speakers) were tested twice

the NK participants were further subdivided according to length of residence (LOR) in North America
in Experiment 1 (perception), both the NK adults and NK children differed from age-matched native English (NE) participants in discriminating /æ/ from /ə/

but the NK children showed more accurate discrimination than the NK adults did

in Experiment 2 (production), the NK children’s production of the two target vowels closely resembled NE children’s

however, the NK adults failed to produce as large a contrast as NE adults

the differing pattern of results obtained for discrimination and production for the NK children but not the NK adults suggested that the relation between production and perception abilities in a second language (L2) might depend on the age of L2 learning
the experiments

- the performance of NK adults and children was compared to age-matched NE speakers
- both the NK and NE participants were tested on two occasions separated by about 1.2 years
- the two English vowels examined here – /\a/ and /\u/ – occur in a portion of vowel space occupied by a single Korean vowel, and are of known learning difficulty for Koreans
the questions addressed

1. Would the NK children perceive and produce the contrasts between English /ʰ/ and /ʰ/ better than NK adults with the same LOR in North America?

2. Would greater differences exist between NK and NE adults than between NK and NE children?

3. Would the NK children show greater evidence of speech learning from Time 1 to Time 2 than the NK adults?
results Exp.1

- Significantly higher scores were obtained for NE adults than NE children.
- Whereas the opposite held true for NK participants.
- Korean adults with an LOR of 5 years obtained lower scores than Korean children with an LOR of 5 years (Child-5).
Figure 1: Mean discrimination scores obtained for six groups. The brackets enclose ± one standard error. The scores are averaged over two times of testing.
results Exp.2

- the NK children produced much larger contrasts than the NK adults
- but there was little difference between NE adults and children
Figure 2: Mean acoustic distance between /ɛ/ and /æ/ by the six group of participants (in Bark). The brackets enclose ± one standard error. The scores are averaged over two times of testing.
general results

- NK children have learned to produce and, to a lesser extent, perceive the distinction between English /ɹ/ and /θ/ in a native-like fashion following 3 years of residence in North America.

- For the NK children, development of native-like production occurred before native-like perception.
Relationship between L2 production and perception

- Some studies suggested that native-like perception may precede native-like production (Borden et al. 1983, Flege 1993)
- But others suggested the opposite (Sheldon et al. 1982)
- It is generally agreed that the relationship between the production and perception is complex, and is affected by factors such as amount of L2 experience (Llisterri 1995)
the NK adults differed from NE adults both in perceiving and producing English /IPA sound/ and /IPA sound/

whereas the NK children differed from the NE children only in perception

this pattern might be taken to mean that L2 learners will come to produce L2 vowels accurately before developing the ability to perceive L2 vowels in a native-like fashion
Articulatory and perceptual influences on the production of non-native consonant clusters

Lisa Davidson
One hypothesis regarding speakers confronted with sequences phonotactically ill-formed for their language is that they will treat these structures as comparably “illegal”.

However, while English speakers given non-native fricative-initial onset clusters do not produce them with perfect accuracy, they are better when the first consonant (C1) of the cluster is /f/, followed by /z/, and lastly by /v/.

These findings can be interpreted in terms of a combination of perceptual and articulatory influences on phonotactic structures.
predictions

L2 speakers do not produce all non-native clusters with equal accuracy, even if all of the clusters in question are illegal in the speaker’s native language.

e.g., an investigation of the production of English /pr/, /br/, /fr/, initial clusters by Japanese and Korean speakers,

where neither language has /r/ as the second segment of a cluster,

showed that while the speakers had relatively little trouble with /pr/, they were less accurate on /br/, followed by /fr/
these results were explained using the phonological notion of markedness:

- as elements of the clusters became more marked (voiced stops are more marked than voiceless stops but less marked than fricatives)

- L2 learners were less likely to produce them correctly here:

- the markedness of certain place and voice features is based on specific phonetic characteristics that distinguish them from the optimal fricative /s/
English speakers were tested on their ability to produce clusters beginning with /s/, /f/, /z/, and /v/

Czech was used to record the auditory stimuli

since English has /s/-initial clusters, it is assumed that being fricative-initial per se is not disallowed by the English grammar

it is the place and/or voicing of /f/, /z/, and /v/ that are prohibited
the sibilants /s, z/
are significantly more perceptible than
non-sibilants /f, v/

1. because the sound source is filtered by a front-
cavity resonance for sibilants /s, z/, the
amplitude of the frication noise is much greater
than that for labiodental fricatives, which have
no cavity in front of the obstruction

2. this high-intensity noise and clear timbre
contribute to the salience and distinctiveness of
/s/, making its acoustic properties almost
vowel-like

3. alveolar fricatives have a long anterior cavity,
resulting in a well-defined, distinct spectral
shape
4. /f, v/ have significantly lower noise amplitude relative to /s, z/

5. discriminant analysis and perceptual confusion tests have shown that non-sibilant fricatives like /f/, /v/, /snowflake/, /thumbdown/, and /crescentstar/ are significantly more likely to be confused with one another than are sibilants such as /s/, /z/, /hart/, and /crescentstar/
voiced fricatives vs. voiceless fricatives

- Voiced fricatives are disadvantaged compared to voiceless ones on articulatory grounds:
  - The optimal situation for obstruent voicing occurs when oral pressure is maximally lower than glottal pressure
  - For the most favorable frication, however, oral pressure should be maximally higher than atmospheric pressure
  - Thus setting up conflicting articulatory requirements for the production of voiced fricatives
voiced obstruent clusters

- are further disadvantaged by the fact that they are longer in duration than single voiced obstruents
- which may require the conflicting air pressure requirements to be sustained for longer than the speech system can accommodate
- voiced fricative-stop clusters have articulatory shortcomings similar to those of fricative-fricative clusters
- just as frication requires high oral pressure, stops block the flow of air
- which likewise causes oral pressure to increase
- adversely affecting the pressure drop needed for voicing
the hypothesis

- English speakers fail to accurately produce non-native clusters with initial fricatives other than /s/ because
  - (i) the weak-intensity fricatives (like /f/ and /v/) contain poor perceptual cues, and
  - (ii) voiced obstruent sequences (like those beginning with /z/ or /v/) are articulatorily difficult to produce
Pseudo-Czech word-initial clusters

/s/  /sm/,  /sn/,  /sf/,  /sp/,  /st/,  /sk/
/f/  /fm/,  /fn/,  /fs/,  /fp/,  /ft/,  /fk/
/z/  /zm/,  /zn/,  /zv/,  /zb/,  /zd/,  /zg/
/v/  /vm/,  /vn/,  /vz/,  /vb/,  /vd/,  /vg/
### Possible Response Types

<table>
<thead>
<tr>
<th>RESPONSE</th>
<th>EXAMPLE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Correct</td>
<td>/zvabu/ → [zvabu]</td>
</tr>
<tr>
<td>Epenthesis</td>
<td>/zvabu/ → [zəvabu]</td>
</tr>
<tr>
<td>Deletion</td>
<td>/zvabu/ → [zabu], [vabu]</td>
</tr>
<tr>
<td>Prothesis</td>
<td>/zvabu/ → [əzvabu]</td>
</tr>
<tr>
<td>Seg. Chg.</td>
<td>/zvabu/ → [svabu]</td>
</tr>
<tr>
<td>Other</td>
<td>/zvabu/ → ∅, [vəvabu], [sfada]</td>
</tr>
</tbody>
</table>
results

/sC/ > /fC/ > /zC/ > /vC/

these findings suggest that weak-intensity non-sibilant fricatives are disadvantaged relative to /s/

but voice is even more detrimental to English speakers’ ability to produce the cluster

as evidenced by the decreased accuracy on /z/ relative to /f/

as expected, /v/-initial clusters induce the poorest performance of all the fricatives

since /v/ is both non-sibilant (weak intensity) and voiced
performance based on initial fricative
error types

[Bar chart showing error types for 'f', 'z', and 'v' sounds, with proportions for Epenthesis, Prothesis, Deletion, Seg Chg, and Other categories.]
discussion

- hidden markedness relationships among /s/, /f/, /z/, and /v/-initial clusters
- what is their origin?
- acc. to D., three possibilities:
  - they result from a universal hierarchy
  - they are a default relationship present in the initial state
  - they are language-specific
universal hierarchy?

if the relationships are universal, then all languages should respect the hierarchy found in the experimental results:

/sC/ > /fC/ > /zC/ > /vC/
however…

- while languages like Dutch or Norwegian allow some /f/-initial clusters but no /z/-initial ones
- languages like Italian and Serbo-Croatian have /z/-initial clusters but not /f/-initial ones
- still, if a language has /v/-initial clusters, like Tsou, Greek, or many Slavic languages, then they also have /f/ and /z/-initial ones (note that all of these languages have the phonemes /s/, /f/, /z/, and /v/)
initial state?

if the relationships are present in the initial state, but can be modified based on input from one’s native language

then speakers of all languages that do not have /f/, /z/, or /v/-initial clusters should perform like the English speakers on the production task tested in this experiment
language-specific relationships?

could perhaps result from differences in how the learning process occurs for distinct languages

in this case, significant cross-linguistic variation on the task examined here would be expected