

Patterns of Heritage Speakers' Perception of Arabic Consonants

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What are Heritage Speakers?

Definitions vary. For the purposes of this study, heritage listeners were characterized thus:

- People who grew up in the US, but were exposed to Arabic since birth because their parents speak it natively
- However, their dominant language (the language which they primarily use) is English, which they have also been exposed to since birth, because their parents speak it as a fluent second language

Some other relevant aspects of heritage speakers' unusual linguistic background:

- Exposure to a limited number of speakers
- Most extensive exposure at a young age, potentially producing effects of limited lexicon as well as attrition over time
- Lack of formal education in the heritage language

Hypotheses

- H1: Heritage listeners will be more accurate than L2 listeners and less accurate than native listeners, suggesting that at least under adverse listening conditions, heritage listeners' ability to extract phonological information is weaker than native listeners', due to incomplete acquisition or attrition, but early exposure makes them better than L2 listeners
- H2: OR, heritage listeners may pattern like native listeners, suggesting that early exposure is sufficient to establish phonological knowledge and maintain it even without extensive usage (Cf. Oh et al. 2003)
- H3: OR, heritage listeners may pattern like L2 listeners, suggesting that the combination of adverse listening conditions and lack of lexical information is sufficient to completely negate any benefits of early exposure

Sub-Hypotheses

If there are perception differences between heritage listeners and native listeners and L2 listeners, are the differences consistent?

- HA1: Heritage listeners exhibit no more variation than native listeners or L2 listeners; this would suggest that at least when age of acquisition of each language is consistent within the group, heritage listeners form a unified group
- HA2: Heritage listeners differ from each other much more than members of the other groups; this variation could be attributed to differences in learning experience (parents' fluency in English, frequency of Arabic usage, contexts of Arabic usage, language attitudes, etc.), and might indicate that they could be sorted into native-like heritage speakers and L2-like heritage speakers

Sub-Hypotheses

- HB1: Heritage listeners' differences from other groups are gradient, intermediate between native and L2 listeners (e.g. in accuracy, response times, and influences of masking noise, phonological environment, and practice)
- HB2: Heritage listeners' differences from other groups are not consistent; heritage speakers' perceptual behavior cannot be predicted from knowing the patterns of native and non-native listeners, which would suggest particular aspects of language acquisition that are inhibited or altered by the linguistic experience of heritage speakers

Stimuli

Stimuli were produced in by two male native speakers of Arabic (Iraqi and Palestinian); pronunciations largely reflected Modern Standard Arabic features.

Stimulus Shape

Stimulus shapes were CV and ?VC

Lexical Status

- Most combinations of sounds resulted in nonce words (e.g. ر /ra:/)
- About 25% of the stimuli were real lexical items (e.g. لا /la:/ 'not')

Participants

Heritage Speakers of Arabic

Born and raised in the US; speak English as a native language. Both parents are native speakers of Arabic and L2 speakers of English. $n = 5$

Native Speakers of Arabic

Born and raised in Arabic-speaking regions. Fluent L2 speakers of English. $n = 9$

L2 Speakers of Arabic (L1 English)

Studied Arabic as a college course; varied levels of experience. $n = 16$

Procedure

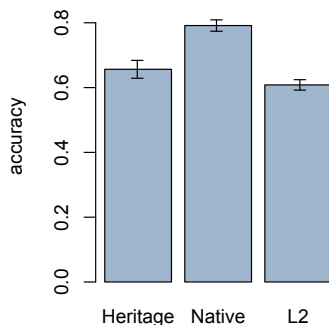
Blocking

6 blocks: each block had a different combination of structure (onsets and codas) and vowel (/ɑ:/, /u:/, /i:/)

- Button array with words written in the Arabic script, in consistent alphabetical order
- Listeners heard the stimuli (their order randomized within blocks of the same vowel), then selected a button
- Masking noise was played simultaneously with the stimuli (cf. Miller and Nicely 1955; Phatak, Lovitt, and Allen 2008; Wang and Bilger 1973)

Effects of Native Language

- Heritage listeners' mean accuracy of identifying segments was 62% (vs. native listeners' 74% and L2 listeners' 56%)

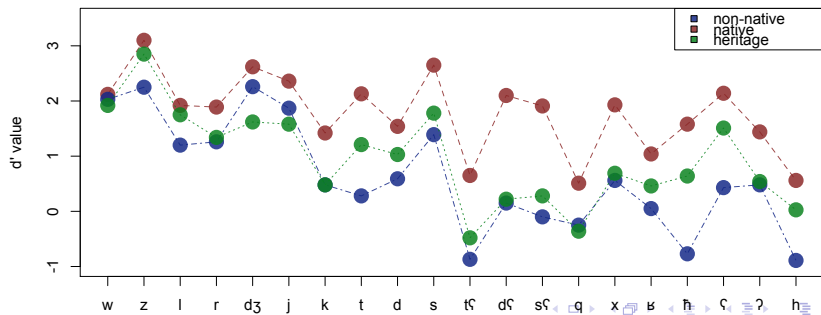


- Lower accuracy of even highly fluent non-native listeners under adverse listening conditions is also found in other studies (e.g. Cutler et al. 2004)

Differences by Segment

Overall, there was a high correlation between d' values for each segment between the listener groups:

- Heritage~L2: $R = 0.87$ ($p < 0.0001$)
- Heritage~Native: $R = 0.80$ ($p < 0.0001$)
- Native~L2: $R = 0.86$ ($p < 0.0001$)



Differences by Segment

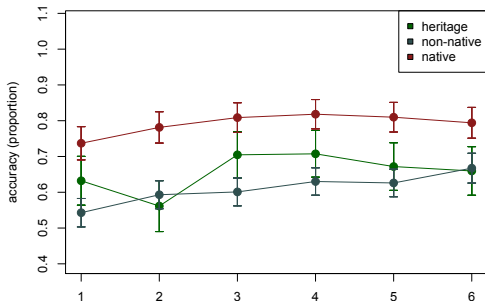
- Higher accuracy than L2 listeners for pharyngeals (74% vs. 45%, $p < 0.001$)
- Lower accuracy than native listeners for uvularized consonants (37% vs. 72%, $p < 0.001$) and glottals (51% vs. 69%, $p = 0.021$)
- More accurate identification of sounds with English analogs than without (73% vs. 56% accuracy, $p = 0.011$), like L2 listeners (70% vs. 50% accuracy, $p < 0.001$); weak trend among native listeners (82% vs. 76%, $p = 0.16$)

Table: Heritage Listeners' Segment Identifications

	w	t	t ^ʃ	d	d ^ʃ	s	s ^ʃ	z	l	r	dʒ	j	k	q	χ	ʁ	h	ʔ	h
w	91	-	-	-	-	-	-	2	-	-	-	7	-	-	-	-	-	-	-
t	-	83	2	3	-	2	-	-	-	-	-	-	7	2	2	-	-	-	-
t ^ʃ	2	8	39	-	-	2	-	-	-	3	2	-	10	14	10	3	-	2	5
d	-	2	2	75	2	-	-	3	2	-	7	2	-	-	2	-	-	-	5
d ^ʃ	3	2	24	19	37	-	-	2	-	-	-	-	-	2	-	10	-	-	2
s	-	3	-	-	-	90	3	-	-	-	-	-	2	-	2	-	-	-	-
s ^ʃ	-	3	3	-	-	50	37	-	-	-	-	-	3	-	3	-	-	-	-
z	-	-	2	2	-	2	-	93	-	2	-	-	-	-	-	-	-	-	-
l	3	2	2	10	7	2	-	-	47	2	2	8	-	2	-	13	2	-	-
r	-	2	3	-	-	-	2	-	-	69	2	-	-	-	-	9	-	10	2
dʒ	-	2	2	5	3	-	-	-	-	-	85	-	-	-	3	-	-	-	-
j	5	-	-	-	-	-	-	-	-	-	3	81	-	-	-	-	-	-	3
k	2	10	5	-	-	-	-	-	-	-	2	-	63	10	5	-	-	-	3
q	-	-	7	2	-	2	-	-	-	-	-	-	20	38	5	12	3	-	12
χ	-	8	-	2	-	2	2	-	-	-	5	-	-	3	64	3	2	-	7
ʁ	7	-	-	-	3	-	-	-	-	8	7	-	-	-	2	65	-	7	-
h	2	3	2	-	-	3	-	2	-	-	-	-	2	3	2	2	64	5	7
ʔ	-	2	-	-	-	-	-	-	-	2	2	3	2	3	-	-	-	83	3
ʔ	2	7	3	-	-	2	-	-	-	-	-	2	3	3	-	-	3	7	66
h	2	5	-	-	-	-	-	-	-	-	2	5	3	-	3	5	30	3	7

Effect of Time

- Heritage listeners' mean accuracy did not increase across the task, in contrast to both other groups



Variation by Listener

Responses varied by listener more than they did in the native listener group, similar to L2 listeners

- Mean correlation in pattern of responses among individual heritage listeners 0.87, which is significantly different from the correlation among native listeners 0.94 ($p < 0.0001$), but not among L2 listeners 0.85 ($p = 0.29$)
- High correlation between accuracy for different segments across listeners; mean correlation = 0.26. (0.19 among native listeners, 0.27 among L2 listeners); none of these differences were significant

Phoneme Frequency Effects: Within Arabic

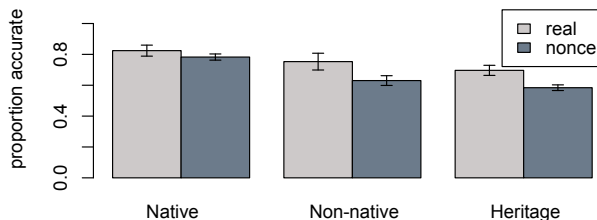
- Correlation between accuracy and Arabic type frequency (via Greenberg 1950):
 - Heritage listeners: $R = 0.14$, $p = 0.55$
 - L2 listeners: $R = 0.37$, $p = 0.086$
 - Native listeners: $R = 0.1$, $p = 0.67$
- No significant correlation between the production accuracy of Arabic-speaking children for these consonants (from Dyson and Amayreh 2000) and the accuracy of identifications in my results from any of the listener groups.

Phoneme Frequency Effects: Comparisons from Other Languages

- Correlation between token frequency in English and accuracy (omitting consonants with a frequency of 0)
 - Heritage listeners: ($R = 0.43$, $p = 0.13$)
 - L2 listeners: $R = 0.045$ ($p = 0.89$)
 - Native listeners: ($R = 0.35$, $p = 0.24$)
- Including consonants with a frequency of 0 in English, the correlations are much larger
- Correlation between cross-linguistic frequency of phonemes (in the UPSID database) and accuracy of their identifications:
 - Heritage listeners: $R = 0.37$, $p = 0.11$
 - L2 listeners: $R = 0.40$, $p = 0.08$
 - Native listeners: $R = 0.15$, $p = 0.54$

Influence of Lexical Knowledge/Experience

- Significantly higher accuracy for stimuli which were real Arabic words than other stimuli; also among L2 listeners; weaker trend among native listeners.



- However, heritage listeners did not select real word options as responses significantly more frequently than other stimuli ($p = 0.86$); L2 listeners did ($p = 0.038$).

Orthographic Influences

Many heritage speakers lack of formal education in Arabic, which may either directly influence their phonological perception, or influence their patterns of responses.

In another experiment with the same participants, familiarity with Arabic orthography was tested using an identification task with varied structures; in Arabic, short vowels and the absence of vowels are marked by diacritics, e.g.:

أَلت [ʔalət]

أُت [ʔalt]

High correlation between phoneme identification accuracy and structure identification accuracy

- Heritage speakers: $R = 0.91$, $p = 0.033$
- L2 speakers: $R = 0.73$, $p = 0.0014$
- Not significant for native speakers ($R = 0.51$, $p = 0.16$)

There was also a correlation between response time in the structural task and accuracy in the phoneme identification task, among heritage listeners ($R = 0.94$, $p = 0.02$) and L2 listeners ($R = 0.68$, $p = 0.0041$).

Conclusions

- Overall, heritage listeners' accuracy is intermediate between native listeners and L2 listeners, supporting Hypothesis 1.
- However, their accuracy across individual segments is variable
- Heritage speakers form a unified group, consistent with hypothesis A1; their variation is comparable to L2 listeners'
- They did not consistently exhibit the same influences as either native listeners nor L2 listeners, against hypothesis B1
- They seem to be sensitive to their history of practice:
 - They have higher accuracy for real words than nonce words (no effect among native listeners; among L2 listeners, the effect is due to different response frequencies)
 - Their lack of learning across the task and their low accuracy for some particular phonemes (e.g. /r/ and /dʒ/) may be due to their limited experience with new speakers

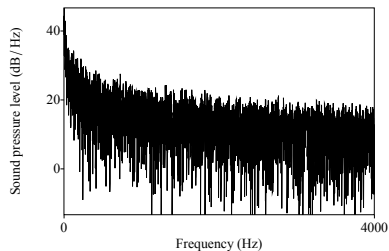
THANK YOU!

References

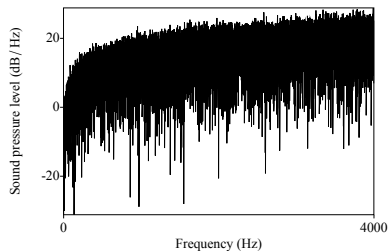
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Masking Noise

Pink Noise



Blue Noise



Button Array

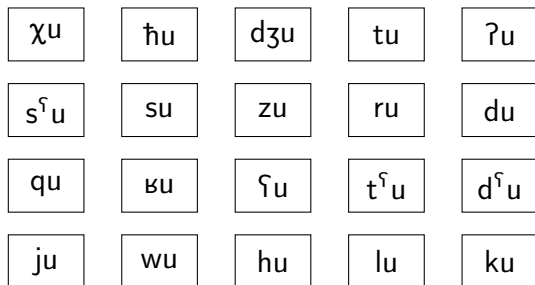


Figure: Diagram of Selection Button Array (In Transliteration)

Generalized Linear Mixed Model

Table: Factors and Significance

Source	F	df1	df2	Sig.
Corrected Model	11.8	175	1144	<0.0001***
native language (lang)	0.0	2	13494	1
segment heard (segment)	30.6	17	13494	<0.0001***
structure heard (structure)	66.4	3	811	<0.0001***
noise	0.0	1	13494	1
vowel	12.5	2	2034	<0.0001***
speaker	12.8	1	13494	<0.0001***
listener dialect (dialect)	0.35	1	21	0.56
lang*segment	3.8	34	13494	<0.0001***
lang*noise	0.0	2	13494	1
lang*structure	3.7	8	868	<0.0001***
segment*structure	13.6	35	13494	<0.0001***
vowel*structure	20.7	8	602	<0.0001***
lang*speaker*dialect	0.74	7	85	0.64

Response Frequencies

- Among heritage listeners, the response frequency of each segment had a very high correlation with accuracy ($R = 0.81$, $p < 0.0001$). This is much higher than the correlation among native listeners ($R = 0.61$, $p = 0.0037$) or L2 listeners ($R = 0.60$, $p = 0.0055$).
- Correlations between response frequencies across groups:
 - Heritage~L2: $R = 0.66$ ($p = 0.0014$)
 - Heritage~Native: $R = 0.73$, ($p = 0.00028$)
 - Native~L2: $R = 0.80$ ($p < 0.0001$)