



Development of rhotic vowels in young children with and without speech sound disorders: transcription vs. acoustic analysis

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INTRODUCTION

- Rhotic vowels have not been investigated extensively even though they prove to be difficult for young children to master.
- Studies of rhotic vowel acquisition have primarily focused on rhotic monophthongs ([ɜː] or [əː]) produced by children over 6 years of age.
- Previous transcription-based studies (Pollock, 2013; Chung, Farr, & Pollock, 2013, 2014) focused on the accuracy and/or error patterns of rhotic monophthongs and diphthongs produced by children with and without speech sound disorders (SSDs). Accuracy of rhotic vowels was not strongly correlated with age – but showed a bimodal distribution.
- Most rhotic vowel errors can be described by patterns of Derhoticization (to a mid-central or back-rounded vowel) or Rhotic Diphthong Reduction or Coalescence (Pollock, 2013). Not many studies have examined the relationship between perceptual judgments of accuracy or error type and acoustic characteristics of rhotic vowels produced by young children.

PURPOSE

- The purpose of the present study was to investigate:
- Acoustic characteristics of rhotic monophthongs and diphthongs produced by young children with and without SSDs, and
 - The extent to which perceptual judgements of accuracy matched with acoustic patterns.

METHODS

a. Participants

- Three groups of children, learning Western Canadian English, a rhotic dialect (see Table 1):
 - 19 children (8 boys & 11 girls) with typically developing speech (TDS), 2 to 5 year-olds
 - 15 children (12 boys & 3 girls) with SSD, 3 to 6 year-olds
 - 2 children (one 4-year-old boy & one 5-year-old boy) with a history of SSD
- These groups were re-categorized based on each child's PVC-r & PCC-r (see Figure 1).
 - Group A: PVC-r \geq 70 & PCC-r $>$ 70
 - Group B: PVC-r \geq 70 & PCC-r $<$ 30
 - Group C: PVC-r $<$ 30 & PCC-r $<$ 30
 - Two children (SSD06 & TDS12) who did not fall into any of these groups

Diagnostic Group	Age	GroupA	GroupB	GroupC	SSD06	TDS12	Total
TDS	2	1	1	2	-	1	5
	3	1	3	1	-	-	5
	4	3	0	2	-	-	5
	5	4	0	0	-	-	4
		9	4	5	0	1	19
SSD	3	0	0	3	1	-	4
	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

Table 1. Description of participants for each diagnostic and age group

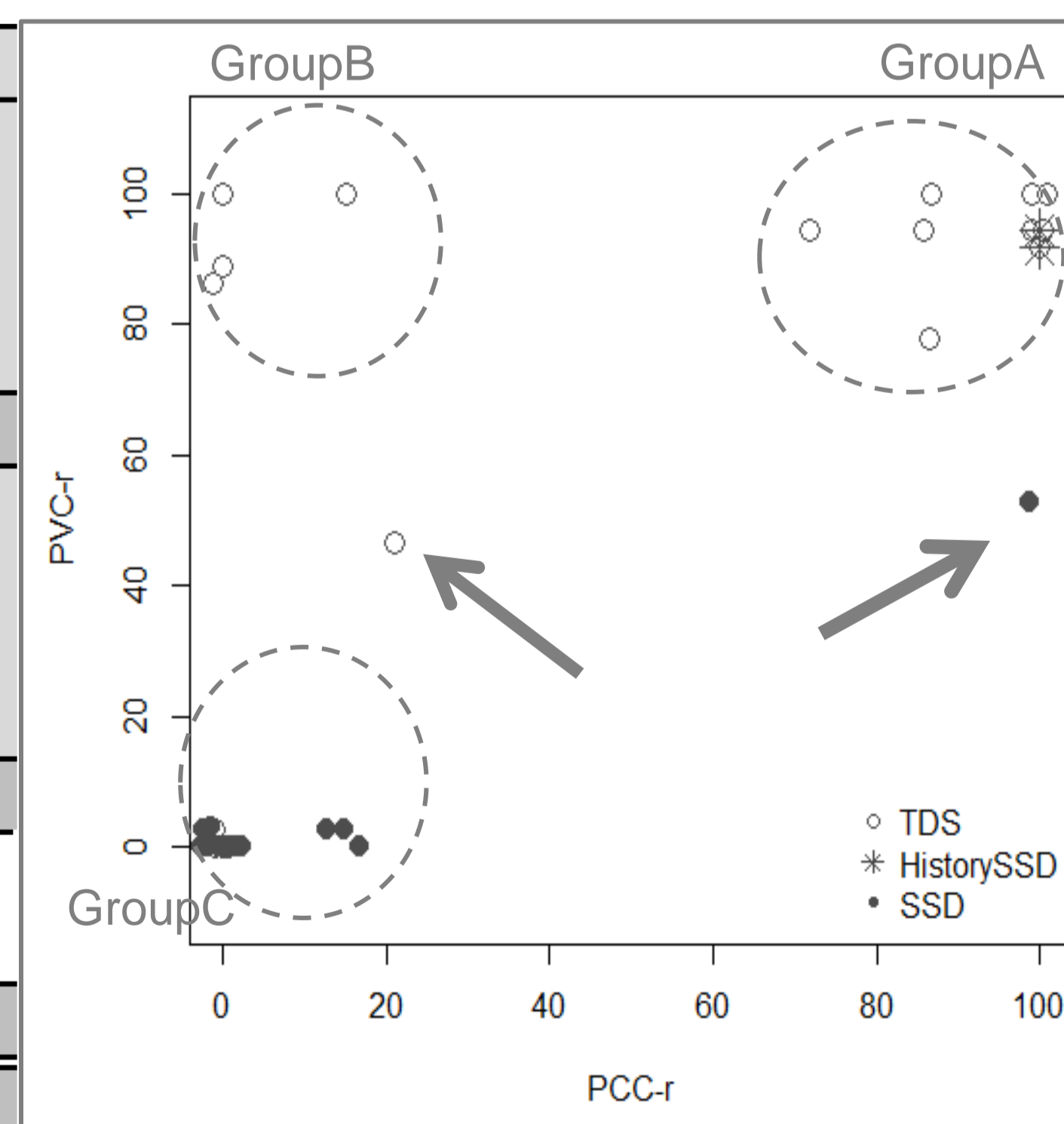


Figure 1. PVC-r by PCC-r. Each dot represents the mean accuracy of rhotic productions for each child.

b. Stimuli

	Open Syllable	Closed Syllable
rhotic monophthongs	/ɜː/ her, fur, stir	bird, purse, shirt
	/əː/ tiger, zipper, feather	scissors, crackers, whispered
rhotic diphthongs	/ɪəː/ ear, deer, hear	ears, beard, tears
	/ɛəː/ hair, chair, bear	stairs, scared, theirs
	/ɔəː/ four, door, store	horse, fork, short
	/ɑəː/ car, star, jar	heart, hard, shark

Table 2. List of target words.

c. Procedure

- Target words were elicited using a picture naming task
- Productions were transcribed using LIPP (*Logical International Phonetic Programs* software (Oller & Delgado, 2006))
- For acoustic analyses, F2, F3, and vowel duration were extracted using a custom speech analysis program created in MATLAB (Morrison & Nearey, 2011)

RESULTS & DISCUSSION

a. Acoustic characteristics

- F3 patterns:
 - Groups A & B: clear F3 downward movements, eventually getting closer to the average minimum adult F3 values
 - Group C: relatively stable and higher F3 values across the vowel duration as compared to those of Groups A & B
 - TDS12: some hints of F3 downward movements, but the patterns were not clear.
 - SSD06: rather clear F3 downward movements (F3 offset reaching closer to the mean minimum adult F3 values) – Note: SSD06 had an idiosyncratic error pattern involving rhotic vowels with /ɜː, əː, ɪəː/ produced as [eəː] and /ɔəː/ produced as [oəː]. His productions of these vowels were incorrect, but still rhotic.

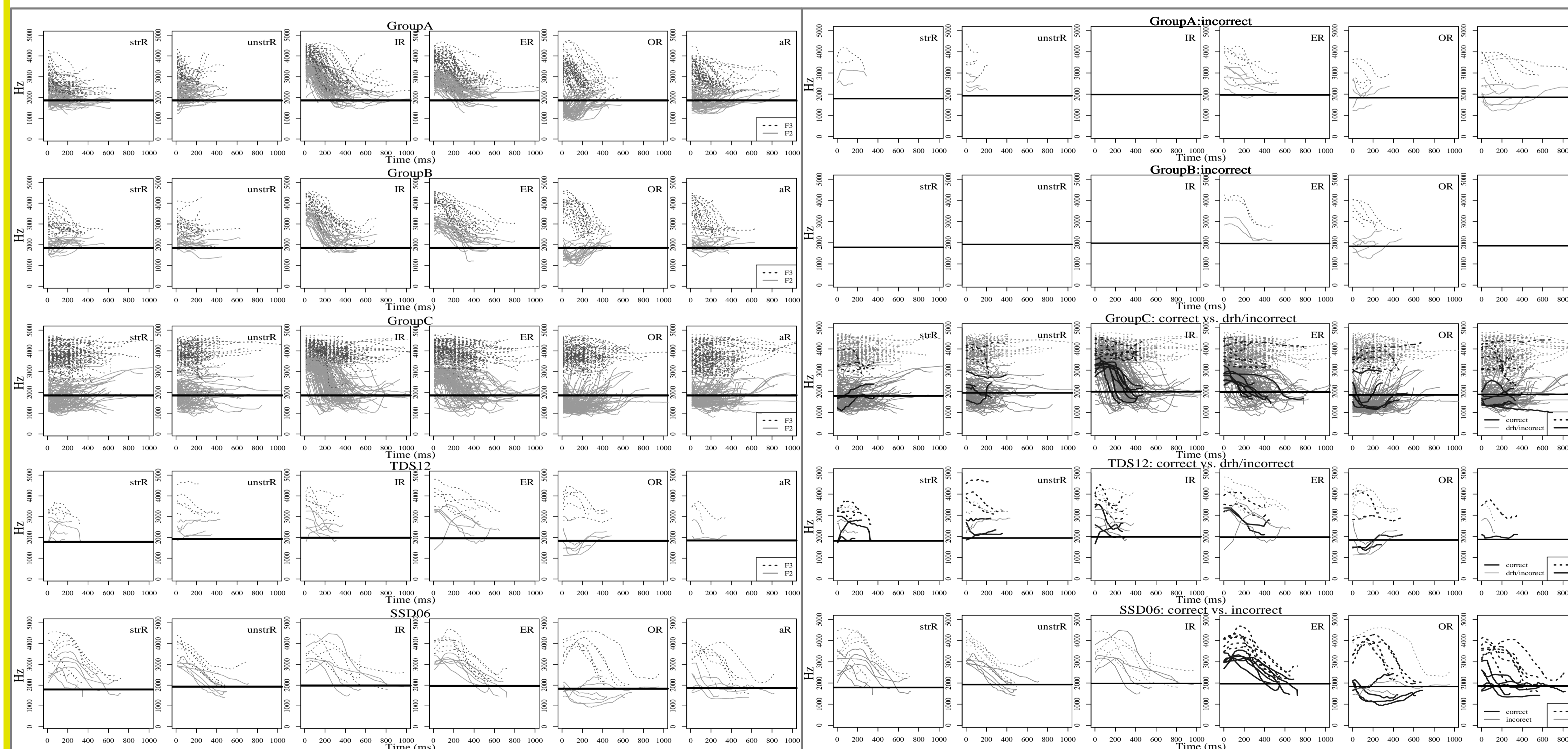


Figure 2. F2 and F3 (Hz) spectral movement patterns of six rhotic vowels (strR = /ɜː/, unstrR = /əː/, IR = /ɪəː/, ER = /ɛəː/, OR = /ɔəː/, aR = /ɑəː/) for each group of children and the two outliers. Black dotted line represents F3 (Hz) and grey solid line represents F2 (Hz). The thick solid black line indicates the average minimum F3 values of each target vowel produced by female adults, reported in Chung & Pollock (2014) (/ɜː/: 1787Hz, /əː/: 1925Hz, /ɪəː/: 1982Hz, /ɛəː/: 1832Hz, /ɔəː/: 1832Hz, /ɑəː/: 1856Hz).

Figure 3. F2 and F3 spectral movement patterns of “correct” and “incorrect” productions of each group of children. Only incorrect productions are shown for Group A and B (first two rows) and both correct (thick black line) and incorrect (grey lines) productions are shown for Group C, TDS12, and SSD06.

b. Relationship between perceptual judgment & acoustic patterns

- Groups A & B: showed traces of rhoticity even for productions that were transcribed as incorrect
- Group C: Even productions that were transcribed as “correct” showed no clear sign of F3 dropping (no clear difference between the F3 slope of correct and incorrect productions)
- TDS12: no clear difference between “correct” and “incorrect” productions
- SSD06: both “correct” and “incorrect” productions were perceived as rhotic and showed expected downward F3 patterns

c. Summary & Clinical Implications

- Mismatch observed between acoustic patterns and perceptual judgments of accuracy, despite relatively high level of transcription reliability for rhotic vowels (81% broad, 77% narrow)
- Highlights the importance of using both acoustic analysis and perceptual transcription clinically

d. Future plans

- Acoustic analysis by rhotic vowel error pattern type (categories based on phonetic transcriptions)
- Comparison of inexperienced listeners’ ratings of rhoticity to acoustic measurements and phonetic transcription by experienced listeners

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