Acquisition of consonant clusters by Greek-speaking children: The case of initial /s/-stop and stop-/s/ sequences

ICGL-8 Ioannina

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Introduction

- What is a consonant cluster?
  - δρόμος ['ðromos] 'road', ψάχνω ['psaxno] 'look for'.
  - Most clusters (e.g. [ðr], [st], [xθ]) are represented with two letters.
  - [ps] and [ks] are represented with one letter in spelling *ψ* and *ξ*.
  - The affricate [ts] is represented with two letters *τσ*.
- Why are they interesting?
  - Common in many languages.
  - Their acquisition is protracted.
  - Problematic for children with disorders, second language learners.

Overview of Talk

- Literature review
- Research questions
- Methodology
- Results:
  - Accuracy analysis
  - Error analysis
  - Duration analysis
- Summary and conclusions

Trends of typical consonant cluster development in English

1. Singletons produced before clusters.
2. Word-final consonant clusters generally appear in inventories earlier than word-initial clusters.
3. Two-element consonant clusters are generally produced and mastered earlier than three-element clusters.

Trends (continued)

6. Young children typically delete one element of a consonant cluster.
7. Other error patterns include:
   - substitution
   - coalescence
   - metathesis
   - epenthesis

Consonant clusters in Greek

- Greek has a rich system of consonant clusters in word-initial and word-medial position.
  - ['xθes] 'yesterday'
  - ['skjaxtɾo] 'scarecrow'
  - ['psaɾi] 'fish'

Αυτό είναι η πιο εύκολη λέξη που έχω μάθει
'This is the easiest word I've learned'

Focus of the study

/s/ +stop sequences	Example	stop +/s/ sequences	Example
/sp/	['spiti]	/ps/	['psaɾi]
/st/	['stasi]	/ts/	['tsada]
/sk/	['skilos]	/ks/	['ksilo]

Stop +/s/ clusters versus affricate /ts/

- /ts/ is traditionally analyzed as an affricate in Greek.
- /ps/ and /ks/ are traditionally analyzed as clusters.
- There is also acoustic evidence to support this interpretation for adults (Fourakis et al. 2003).

Acquisition of consonant clusters in Greek

- There is very little work on the acquisition of consonant clusters in Greek.
- Pan-Hellenic Association of Logopedics (1995) found that:
  - /s/ + stop clusters are acquired before stop + /s/ clusters.
  - stop + /s/ clusters are acquired before /ts/.
- However, that study did not control for stress, position in the word and vowel context.
- There is no information on error patterns.

Research Questions

- What is the time course of acquisition of /s/-stop and stop-/s/ sequences?
- What errors are typical in Greek children's acquisition of these sequences?
- Do children treat /ts/ differently from /ps/ and /ks/?

Participants

- 100 typically developing Greek-acquiring children between the ages of 2;0 and 6;0 and 20 adults.
- From Northern Greece (Thessaloniki).
- Passed a hearing screening.
- Children had age-appropriate speech and language development, based on parent and teacher report.

Child Participant Information

Age groups	N	Mean Age (in months)	Age Range	Non-verbal IQ
2-year-olds	15	29,784	24,3-35,3	NA
3-year-olds	15	42,913	38,56-47,83	116,7143*
4-year-olds	15	55,624	48,8-59,63	107,0667
5-year-olds	15	66,108	60,93-71,93	106,2667

* Calculated only using the 7 children over age 3;6.

Stimuli

- Target C or CC placed in word-initial position in:
  - Two or three-syllable words with word-initial stress
  - Familiar to the children
  - Pictureable
- Each target C or CC paired with all possible vowel combinations of /i, e, a, o, u/.

Example of stimuli

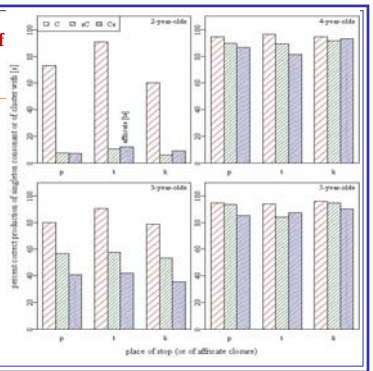
/sk/

Methods: Accuracy and error analyses

- Native-speaker transcription using Praat waveform editor
- Initial consonant and cluster were labeled
  - Correct
  - Incorrect
- If incorrect, phonetic transcription of perceived error
  - Substitution (e.g.['tava] for /'savɾa/)
  - Deletion (e.g. ['piti] for /'spiti)
  - Distortion (e.g. distorted /s/ in /'stoma/)

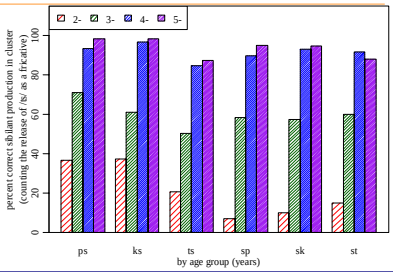
Results: Accuracy of singleton or cluster

- Accuracy increases with age.
- Singletons before clusters.
- Trend for /s/-stop clusters before stop-/s/ clusters.



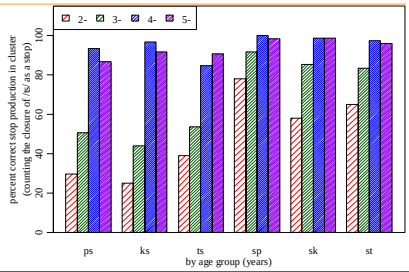
Results: Accuracy of /s/ in clusters and affricate

- /s/ in clusters more accurate in stop-/s/ than in /s/-stop clusters (2-year-olds only).
- /s/ more accurate in /ps/ and /ks/ compared to /ts/.
- /ts/ patterns differently than /ps/ and /ks/.



Results: Accuracy of stop in clusters and affricate

- stop more accurate in /s/-stop than in stop-s/ clusters and /ts/ (2- and 3-year-olds).



Methods: Error analysis for stop-/s/ clusters and /ts/

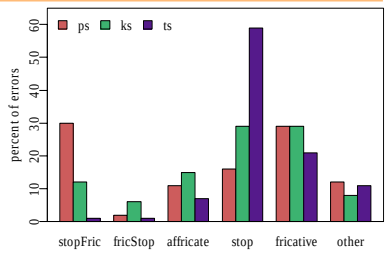
- We grouped the errors into different categories by manner.
  - StopFric substitution (e.g. ['kselni] for /'pselni/)
  - FricStop substitution (e.g. ['skjazefos] for /'ksaðerfos/)
  - Affricate substitution (e.g. ['tsaðelfos] for /'ksaðerfos/)
  - Stop substitution (e.g. ['tepi] for /'tsepi/)
  - Fricative substitution (e.g. ['sɑri] for /'psɑri/)
  - Other (e.g. [tsleni] for /pselni/)

Correct Error

/ 'ksaðerfos/ 'cousin'

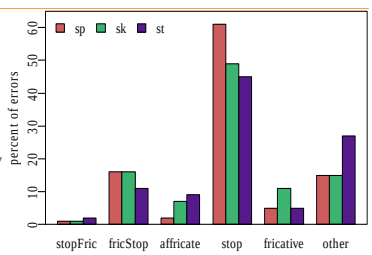
Results: Error analysis by manner

- Most frequent substitution for /ts/ is a stop.
- Most frequent substitution for /ps/ and /ks/ is a fricative or other stop-fricative sequence.



Results: Error analysis by manner

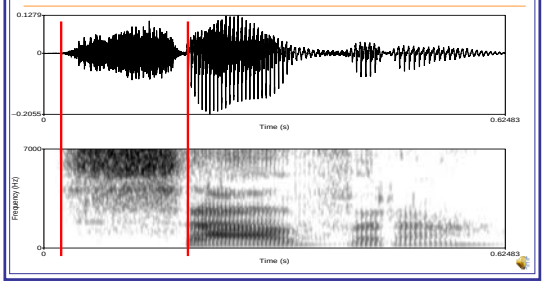
- Most frequent substitution for /s/-stop clusters is a stop.
- Errors on /sp/, /sk/, /st/ pattern like each other and differently from /ps/, /ks/ and /ts/.



Methods: Duration analysis

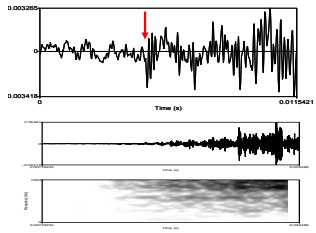
- /s/ duration was measured in word-initial position in /s/, stop-/s/, and /ts/ tokens that were transcribed as correct.
- Durations were measured for productions of 10 of the 3-year-olds, 10 5-year-olds, and 10 adults.

Methods: Duration analysis



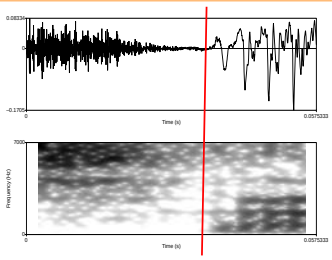
Methods: Measuring the onset of /s/

- Onset of frication was determined on the basis of the waveform and the spectrogram.



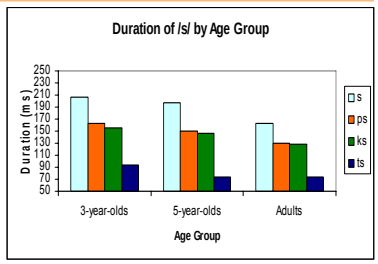
Methods: Aligning the end of /s/

- The end of /s/ was marked at the voicing onset for the following vowel.
- This was evidenced by the appearance of the voicing bar in the spectrogram and the onset of periodicity.



Results: Duration analysis

- Children tend to have longer /s/ durations than adults.
- /s/ is longer in singleton contexts in all age groups.
- /s/ is shorter in /ts/ than in /ps/ and /ks/ in all age groups.



Summary and conclusions

- Error patterns differ for stop-/s/ and /s/-stop clusters.
  - Children tend to delete the first member of the cluster.
  - Children delete the /s/ more often in /s/-stop clusters.
  - Children delete the stop more often in stop-/s/ clusters.

Summary (continued)

- Evidence from child speech suggests that /ts/ is analyzed as an affricate and differently from /ps/ and /ks/.
  - Error analysis: errors for /ts/ pattern differently than the errors for /ps/ and /ks/.
  - Duration analysis: /ts/ has consistently shorter /s/ duration in all age groups examined relative to /ps/ and /ks/.

Conclusions

- Results show the importance of cross-linguistic work on acquisition.
  - Cluster reduction in English and Greek.
- Results from acquisition can be useful to our understanding of the adult phonological system.
  - Status of /ts/ versus /ps/ and /ks/ in Greek.