Development of a learning task for a process-oriented diagnostics of developmental speech sound disorders: a pilot study

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Introduction

Background

- Differential diagnosis and treatment planning of speech sound disorders (SSD) is one of the major bottlenecks in the field of pediatric speech-language pathology
- Intervention methods aim at specific parts of the speech production process, where diagnostic instruments consist of tests that measure knowledge and skills, and lack a direct relation with the underlying processes

Research goal

- An individualistic, process-oriented approach for the diagnosis and treatment of pediatric SSD
- Advantages
  - Direct leads for treatment - tailored to the individual speaker
  - Evaluate and adjust treatment during the evolution of the disorder

Aim of the present study

- Development and evaluation of a learning task as an instrument to assess the acquisition of sensori-motor representations of novel speech sound units

Methodology

Participants

- 6 normally developing children: 3 male, 3 female; aged 4.8-7.8 yrs
- 5 children with SSD: 2 male, 3 female; aged 4.3-7.5 yrs (Table 1)

TABLE 1: Diagnostic classification of the children with speech sound disorders.

ID	Classification	Age (y;m)	Sex	WBQ (PPVT [1])	Intelligibility (ICS [2])	Auditory discrimination (Palpa [3])		Diadochokinesis (DDK; pataka)		Oral-motor mov. assessment
						words (% correct)	nonwords (% correct)	score	judgment	iso – seq – seq fast (% correct)
CLI1	PD	5;9	m	127	4	94	100	1	2	85 – 83 – 60
CLI2	PD+PAD	7;6	v	106	4	94	86	1	1	92 – 94 – 50
CLI3	CAS/PD	4;11	v	115	3.86	94	86	0	4	77 – 78 – 60
CLI4	PD	6;7	v	84	3.42	64	44	1	1	77 – 67 – 40
CLI5	CAS/PD	4;8	m	85	4.29	56	47	1	3	58 – 33 – 30

ID	Classification	Picture naming (60 words CAI [4])				Word repetition (WR; 10 words CAI)				Non-word repetition (10 non-words similar to WR CAI)			
		PCCI	PCCCI	PSSC	atyp/typ. sub.proc.	PCCI	PCCCI	PSSC	atyp/typ. sub.proc.	PCCI	PCCCI	PSSC	atyp/typ. sub.proc.
CLI1	PD	0.94	0.70	.96	3/0	.98	.50	1.00	1/0	.88	.27	.94	4/1
CLI2	PD+PAD	1.00	0.96	.97	0/0	1.00	.95	1.00	0/0	.88	.95	.95	13/5
CLI3	CAS/PD	0.57	0.13	.80	28/9	.48	.23	.62	23/11	.71	.27	.80	26/10
CLI4	PD	0.81	0.39	.82	4/8	.69	.77	.82	5/7	.65	.50	.73	18/24
CLI5	CAS/PD	0.88	0.65	.92	5/4	.91	.77	.95	0/5	.73	.09	.67	4/4

DDK-score 0 = [pataka] could not be produced; 1 = [pataka] could be produced.
DDK-judgment 0 = perfect; 1 = [pataka] in sequence in normal rate, but no acceleration; 2 = [pataka] in sequence incorrect ([t] or [k] could not be pronounced), but speeding up on two different consonants ([pata], [taka]) was possible; 3 = no fluent [pataka], not in sequence; 4 = no [pataka] production either in isolation or in a sequence of two.

Procedure (Table 2)

- Learning paradigm: repetition task of nonwords from a soundboard presented via headphones
- Stimuli: 3 non-native speech sound(-cluster)s in 4 context conditions, each item repeated 3×

TABLE 2: Schematic overview of the learning task.

Stage	*Goal*	*Conditions*		*Example*
		Syllable /ga/ and /ʃa/	*Syllable-cluster /mla/*	
Introduction	Explain target representation	Auditory and visual input	Auditory and visual input	
Baseline measurement		10 x attempt to produce target syllable in isolation		/ga/
Training 1	Practice target stimuli in different conditions	-Sequencing -Prosody -Alternation following consonant -Embedding	-Sequencing -Prosody -Embedding	/gagaga/ /`gaga/, /ga`ga/ /gaka/, /gaxa/, /gaba/ /gapa/, /taga/, /tagapa/
Break		Five minutes of play time		
Training 2	Repeat training stage 1	-Sequencing -Prosody -Alternation following consonant -Embedding	-Sequencing -Prosody -Embedding	/gagaga/ /`gaga/, /ga`ga/ /gaka/, /gaxa/, /gaba/ /gapa/, /taga/, /tagapa/
Endpoint measurement		10 x attempt to produce target syllable in isolation		/ga/

Data analysis & Results

Data analysis

- Consensus transcription of all utterances by two experienced speech therapists
- Dependent variables
  - Percentage consonants correct (PCC)
  - Percentage word-stress correct (PWSC; Prosody condition)

Statistics

- Repeated measures analyses of variance
- Pearsons correlations
  - ΔPCC (Training 2 - Training 1) & auditory discrimination
  - PCC & PWSC
- Case-wise comparison with Control group

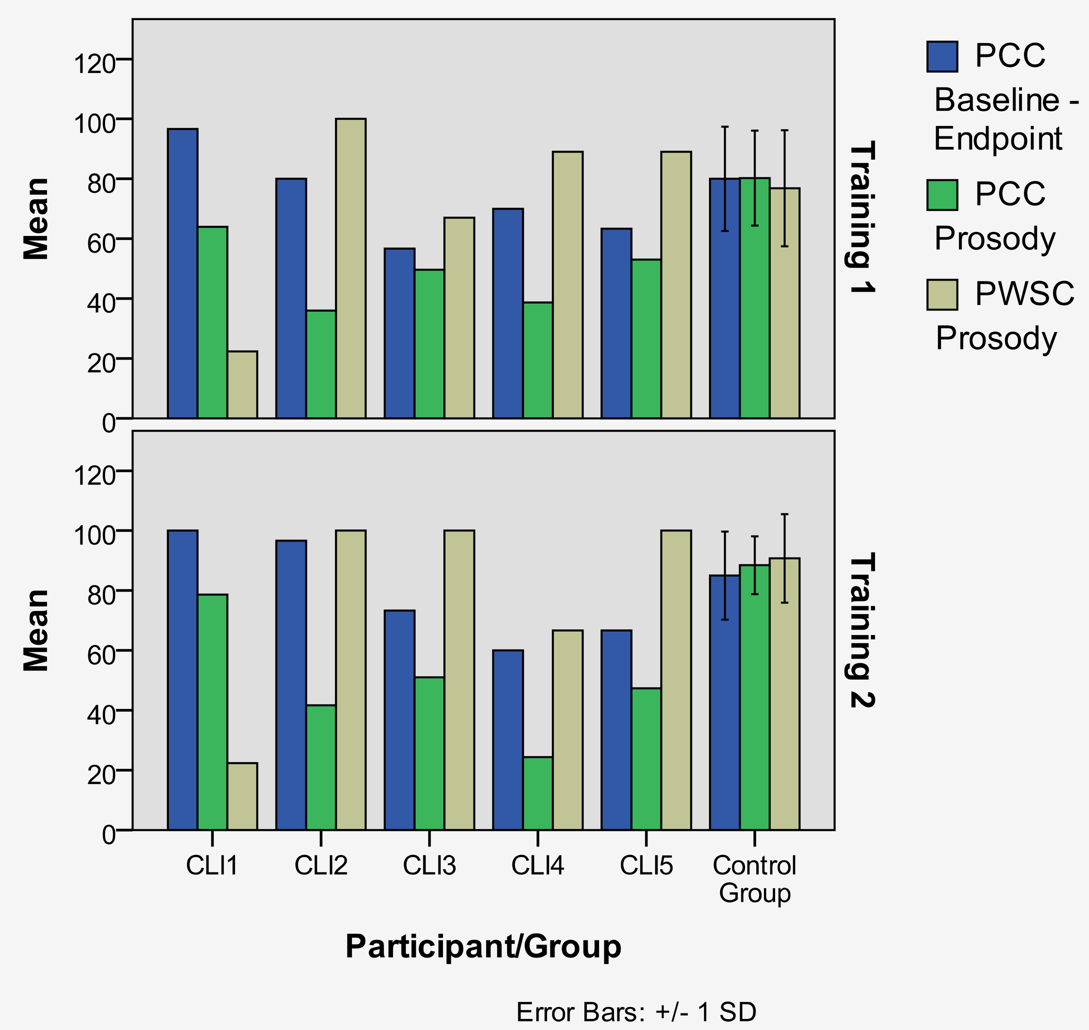


FIGURE 2: Prosody condition: mean percentage consonants correct (PCC) and percentage word-stress correct (PWSC).

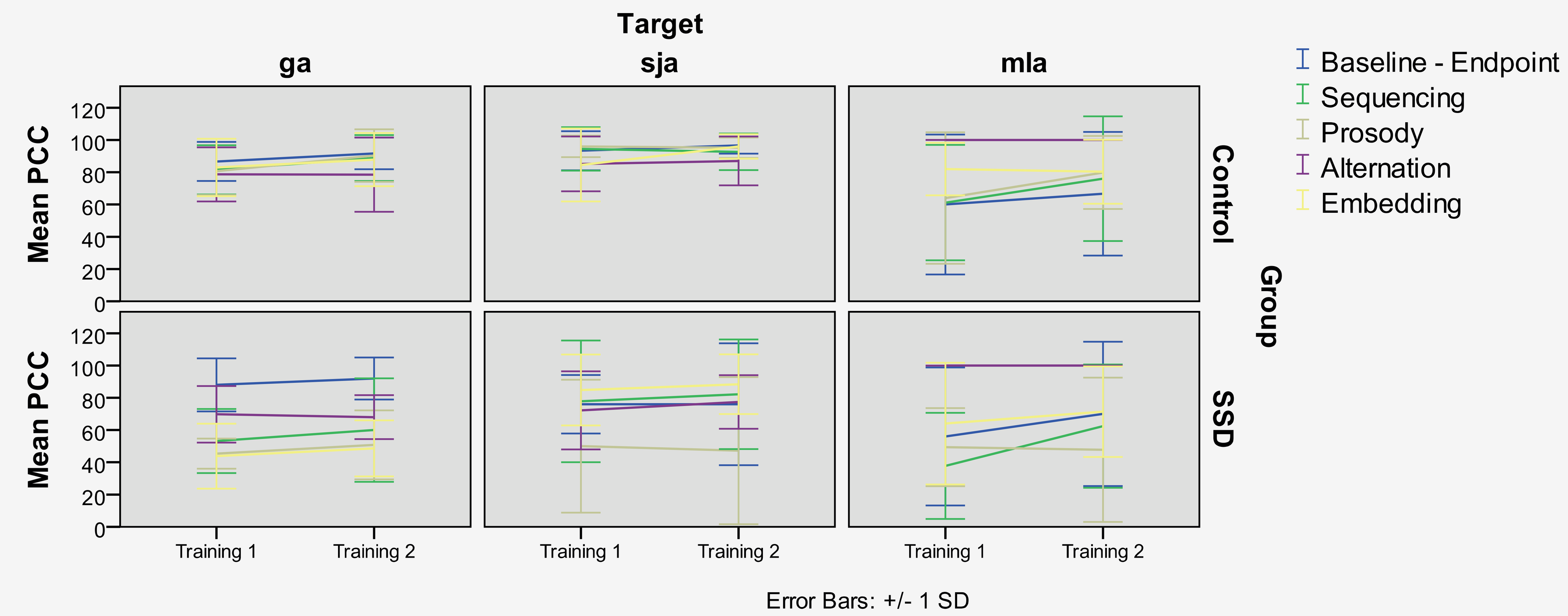


FIGURE 1: Group comparisons of mean percentage consonants correct (PCC) in the different training conditions.

Group effects

- PCC overall
  - Main effect for *ga* $[F(1,9) = 12.616, p < .01]$
  - Not for *mla* or *sja*
- PCC per condition
  - Prosody $[F(1,9) = 20.939, p < .001]$
  - Embedding $[F(1,9) = 4.158, p = .072]$

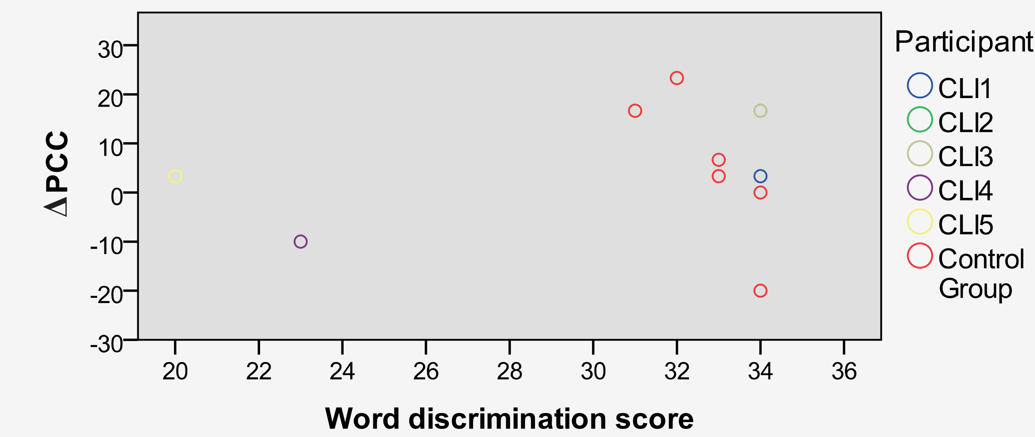
Correlations

- ΔPCC & auditory discrimination overall
  - Word discrimination & overall learning effect $[r = 0.690, p < .05]$
- ΔPCC & auditory discrimination per target
  - Non-word discrimination & learning effect for *ga* $[r = 0.649, p < .05]$
  - Word discrimination & learning effect for *ga* $[r = 0.601, p = .05]$
  - No significant correlations for *mla* or *sja*
- PCC & PWSC in Prosody condition
  - SSD Group $[r = -0.651, p < .05]$

Learning effects

- PCC overall
  - Main effect for *mla* $[F(1,9) = 5.417, p < .05]$
  - Not for *ga* or *sja*
- PCC per condition
  - Embedding $[F(1,9 = 5.648, p < .05]$
  - Sequencing $[F(1,9 = 4.959, p = .053]$
- PWSC: No significant effects
- No learning effect by group interactions

FIGURE 3: Overall ΔPCC vs. Word discrimination score.



Discussion

- Underlying profiles vary widely per child with SSD
- Results highlight important role of perception abilities
  - Strong correlation between non-word discrimination score and learning effect
- Results highlight important role of word-stress in SSD
  - Higher PCC in the prosody condition for *ga* and *sja* in SSD vs controls
  - Negative correlation between PCC and PWSC in the prosody condition
  - Detailed analysis of the individual data
    - ∗ 2 cases: trade-off between accuracy at the segmental and supra-segmental levels

Future directions

- More data needed!
- Promising results for the profiling of SSD, suggesting that a detailed assessment of the acquisition of novel sensori-motor representations could provide direct starting points for therapy planning
- Focus assessment on Embedding, Sequencing & Prosody

References

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