AOS: A poorly understood speech disorder

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Background

• Patients suffering from AOS = patients with deficits in motor planning
Model of speech production

- mental lexicon
  - phonological representation
  - mental syllabary
    - motor planning system
  - motor representation
  - neuromuscular system
    - vocal tract
    - articulator movements
    - acoustic speech signal
Model of speech production

mental lexicon

phonological representation

mental syllabary
motor planning system

motor representation

neuromuscular system
vocal tract

articulator movements
acoustic speech signal

phonemes??

higher level motor representations??
Model of speech production

- mental lexicon
  - phonological representation
    - phonemes??
    - speech action units: SAUs
  - mental syllabary
    - motor planning system
      - motor representation
      - higher level motor representations??
  - motor representation
    - neuromuscular system
      - vocal tract
        - articulator movements
        - acoustic speech signal
Hypothesis

• Patients suffering from AOS = patients with deficits in motor planning

• Basic units of motor planning are speech action units (SAUs) (gestures, vocal tract units) (Evidence: Goldstein et al. 2007, Cognition)
A syllable is a score of speech action units. Example: “palm” [pʰam]

Motor planning

- comprise movement (blue) and target phase (white) -> goal-directed movements (cp. manual reaching movements)
A syllable is a score of **speech action units**. Example: “palm” [pʰam]

- Comprise movement (blue) and target phase (white) -> goal-directed movements (cp. manual reaching movements)
Motor planning

A syllable is a score of speech action units. Example: “palm” [pʰam]

- ... comprise movement (blue) and target phase (white) -> goal-directed movements (cp. manual reaching movements)
Motor planning

A syllable is a score of **speech action units**. Example: “palm” [pʰəm]

- ... comprise **movement** (blue) and **target phase** (white) -> goal-directed movements (cp. manual reaching movements)
- Complex **temporal arrangement**! (temporal overlap of movement actions) ... there is a need for motor planning!
Note: Speech is Movement!

• Speech is NOT a transformation of cognitive units (phonemes, letters) into an acoustic signal; **SPEECH is MOVEMENT** (production and perception of lip, tongue, ... movements)

• Basis for production: **syllable** = basic unit of temporal coordination
Note: Action units from the auditory viewpoint

- Formant trajectories directly encode articulator movements perceptually
- Formants = resonances of vocal tract
Understand AOS from viewpoint of motor planning

• A lot of speech errors, occurring in AOS can be explained easily from the viewpoint of motor planning, if speech action units are seen as basic units of speech production

• Major point: Temporal coordination (TC) of these units over time: only TC of SAUs changes, but not the basic set of SAUs

• Examples (German):
Understand AOS from viewpoint of motor planning

- Examples (German): only timing-problems:
  - schwa-epenthesis in consonant clusters:
    z.B. „Glasdose“ $\leftrightarrow$ „Ge\text{el}asdose“ [gla:s]
  - nasal-epenthesis between nasal and obstruent (plosive):
    z.B. „Lokomotive“ $\leftrightarrow$ „Lokomotiv\text{e}“ [mo:ti:]
  - [h]-epenthesis preceding (difficult) voiceless consonant:
    z.B. „Giraffe“ (r als stimmloser Frikativ) $\leftrightarrow$ „Gih\text{r}affe“ [gi:Xa]
  - voiced-voiceless-alternation in plosives:
    z.B. „\textbf{b}ellen“ $\leftrightarrow$ „\textbf{p}ellen“ [bE]

- All these processes can be phonological OR motor level processes!
- Here the motor level explanation for these processes:
[g(@)la:s] epenthesis
[g(@)la:s] epenthesis
[g(@)la:s] epenthesis

- Lips: {@}
- Tongue: {clo}, {a:}
- Tongue tip: {neut}, {l_clos}, {neut}, {n_clos}
- Velum: {-nas}, {obs}, {-nas}, {obs}
- Glottis: {-pho}, {+pho}
- Pulmon: {-pr}, {pr}

Time progression from left to right.
[mo(n)ti:] epenthesis

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[mo(n)ti:] epenthesis
[mo(n)ti:'] epenthesis

- Velum
- Time
- Phonation
- Pulmon
[gi(h)Ra] epenthesis
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[bE]/[pE] alteration
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[bE]/[pE] alteration

- lips
- tongue
- ton-tip
- velum
- glottis
- pulmon

time

velum: {neut}