Oral motor control and speech/language development in children with Down syndrome: what we know and what we don’t.

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Outline of talk

• Recap of findings from a longitudinal study on oral motor control and speech/language development

• Possible accounts of motor-language relationships and implications for Down syndrome

• Future research directions
Longitudinal study

- **Participants:**
  - Children with Down syndrome (n=33)
  - TD children matched on NVIQ and receptive language (n=33)

<table>
<thead>
<tr>
<th></th>
<th>Down syndrome</th>
<th>TD language matches</th>
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</thead>
<tbody>
<tr>
<td>Mean age (at time 1)</td>
<td>8;1</td>
<td>3;8</td>
</tr>
<tr>
<td>Age Range</td>
<td>5;11 – 10;8</td>
<td>2;3 – 5;10</td>
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</tbody>
</table>
Longitudinal analysis

Testing intervals
(months)

Group

DS

TD (CA matches)

TD (LA matches)

0 -------------------------- 12 -------------------------- 24

T1 → T2 → T3

T1 → T2 → T3

T1 → T2 → T3
## Methodology

<table>
<thead>
<tr>
<th>Oral motor measure</th>
<th>Example items</th>
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<tr>
<td>Single movements</td>
<td>Opening mouth, lip rounding, tongue protrusion</td>
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<tr>
<td>Performed to imitation</td>
<td></td>
</tr>
<tr>
<td>Single movements</td>
<td>Opening mouth, lip rounding, tongue protrusion</td>
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<tr>
<td>Performed to command</td>
<td></td>
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<tr>
<td>Rapid movements</td>
<td>Repeated mouth opening, tongue protrusion, vocalisation</td>
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<td></td>
<td>No. of repetitions in 10 seconds</td>
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</tbody>
</table>

(Alcock, 1995)
## Methodology

<table>
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<th>Oral motor measure</th>
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<td>Multiple (simultaneous) movements</td>
<td>Lip stretch + tongue protrusion</td>
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<tr>
<td>Performed to imitation</td>
<td></td>
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<tr>
<td>Multiple (sequential) movements</td>
<td>Lip stretch THEN tongue protrusion</td>
</tr>
<tr>
<td>Performed to imitation</td>
<td></td>
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</table>

2 movement and 3 movement combinations

(Alcock, 1995)
Methodology

- Speech: Percentage phonemes correct (using single word production from the DEAP phonology assessment).

- Expressive & Receptive language subtest scores (CELF/CELF Preschool)
  - Receptive: Sentence structure
  - Expressive vocabulary: Expressive vocabulary
  - Expressive grammar: Word structure

- Non verbal IQ: Block design (WPPSI/WISC)

- Phonological STM (Digit span)
Receptive language development

- TD language matched
- Down syndrome

Graph showing receptive language development over time for TD language matched and Down syndrome groups.
Expressive vocabulary development

Expressive vocabulary development over time, comparing TD language matched children and those with Down syndrome. The graph shows an increase in expressive vocabulary range (0-40) from Time 1 to Time 3.
Expressive grammar development

Expressive grammar (range 0 - 24)

- TD language matched
- Down syndrome
Oral motor associations with speech and language

- Is there an association between oral motor skills, speech, and expressive language development?

- Do these associations differ between children with DS and TD children?

- Cross sectional associations (T1 and T2)

- Effect of T1 oral motor skills on developmental trajectory of expressive language ability
  - Multilevel modelling
Cross sectional data: DS group

Time 1

- Age
- NVIQ
- STM

- Oral motor single command
- Oral motor rapid repeated
- Oral motor single imitation

Speech accuracy
Expressive vocabulary
Expressive grammar

Oral motor single command associated with speech accuracy
BUT not expressive language

(TD group, similar profile with addition of association between OM single command & expressive grammar)
Cross sectional data: DS group

Time 1
- Age
- NVIQ
- STM
- Speech accuracy
- Expressive vocabulary
- Expressive grammar
- Oral motor single command
- Oral motor single imitation
- Oral motor rapid repeated

Time 2
- Age
- NVIQ
- STM
- Expressive vocabulary
- Expressive grammar
- Time 2 OM (Sequential)
- Time 2 OM (Simultaneous)

Complex OM measures associated with expressive grammar

Also for TD group
Longitudinal analysis: DS group

Time 1 → Time 2

- Age
- NVIQ
- STM

**Speech accuracy**

- Expressive vocabulary
- Expressive grammar

- Oral motor single command
- Oral motor single imitation
- Oral motor rapid repeated

Speech accuracy

Expressive vocabulary

Expressive grammar
Longitudinal analysis: DS group

OM rapid repeated – speech accuracy
NS main effect, significant interaction effect
DS only: $\beta = 0.28$, $p = 0.03$
Longitudinal analysis: DS group

- Time 1 ➔ Time 2 ➔ Time 3

- Age
- NVIQ
- STM

- Speech accuracy
- Expressive vocabulary
- Expressive grammar

- Oral motor single command
- Oral motor single imitation
- Oral motor rapid repeated

OM single imitation — expressive grammar
NS main effect, significant interaction effect
DS only: Beta = .16, p = .01
• Oral motor skills associated with speech at time 1 (for both groups) and from time 1 – time 2 for children with DS

• Oral motor skills associated with expressive grammar at time 1 for TD children, and longitudinally for children with DS

• No association between oral motor skills and expressive vocabulary

• Caveat: not clear cut, different measures predict different skills at different times
Oral motor control & speech

- Not surprising that oral motor control & speech accuracy are associated.

- Lack of consistent longitudinal relationship suggests oral motor control and speech develop (or possibly, fail to develop) in tandem.

- Implications for therapy
  - Unclear: boost oral motor skills to improve speech, or focus on improving speech which may also boost oral motor control?
  - May be largely dependent on individual differences in speech.
Oral motor skills and grammar development, what is driving the association?
Oral movements to imitation

![Graph showing oral motor score over time for TD language matched and Down syndrome groups.]

Plus at time 1, significantly correlated with age for TD children (.40) but not children with DS (.22)
Conclusions

• Why would this affect grammar development?

• A possibility: motor impairments and telegraphic speech
  • Telegraphic speech = Dropping function words at the preservation of content words

  • E.g. The DEAP connected speech test:
    • Children make a story from objects in a picture
    • E.g: “The monkey is standing on the ball, and he has a snake around his neck”
    • E.g. children with DS: “Monkey, ball, snake, neck”

• Noted in previous studies on DS (but limited research)
Chapman (1998)

- Investigated everyday use of Expressive language using conversational samples

- Children with DS were impaired on mean length of utterance (MLU), total words produced, and the number of different words produced

- Elicited production led to an increase in all measures, but also led to a decrease in speech intelligibility
Oral motor control, speech perception and phonological development?

• Recent evidence for close knit relationship between speech production and perception, and possible role of motor control:

  • Adult experimental data
  • Child observational data (mainly TD)
Recent findings (1)

• UCL research group, working on typically developing adults

• TMS used to elicit motor evoked potentials (MEPs)

• Increased activation for lip (but not hand) MEPs during conditions of distorted speech

• Increased activation aided in the accuracy of speech perception

• Implications for Down syndrome?

Recent findings (2)

• Close knit developmental association between production & perception in early stages of language acquisition?
  • Vocal motor schemes (Vihman)

• Emergentist model of phonological development, incorporating motor constraints
  • McAllister-Byun, in press

• Suggest role of motor preferences/constraints in contributing to a ‘chain effect’ of subsequent development of phonological representations.
Oral motor-language associations - next steps

- Oral motor skills and early speech development
  - Working memory
  - Speech perception
  - Phonological development

- Utilise technology (& parents!)

- Informed by theoretical models of motor – cognitive – language interactions in typical and atypical development
  - DIVA model

- Potential for piloting different forms of intervention
Thank you!

• Thanks to:

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