Intervening to alleviate lexical retrieval difficulties in children

Challenges of research within an educational neuroscience framework

Michael Thomas
• Study of typical development of productive vocabulary
• Study of atypical development
• Intervention – which technique works best
• Computational modelling of above to understand mechanisms
Word finding difficulties

• Developmental problems in productive vocabulary
• Characteristic behaviours:
  – the use of filler words (e. g., um), empty words (thing) or general verbs (doing) instead of more specific words
  – the use of a similar sounding word (canister for camera)
  – the use of a word with a similar meaning or in the same category (tiger for lion)
  – hesitation
  – repetition of words or phrases
  – rephrasing what they are saying
  – the use of gesture (miming cleaning teeth for toothbrush)
  – talking about their difficulty (“I know it, but I can’t think of it”)

Affects educational achievement, self-esteem

Primary but not necessary sole language deficit
Interventions for WFD

Semantic therapy

Phonological therapy
Two case studies

**Amy Naming**

![Graph showing number correct over different assessments](image)

- **Pre-therapy 1, 2, 3**
- **Post Phon, Wash out, Post Sem, Maintenance**

Legend:
- **Naming controls**
- **Unseen controls**
- **Semantic set**
- **Phonological Set**
Two case studies

Magda naming

Number correct

Assessment
Challenges

• What is the link between mechanism and intervention?

Challenges

• Therapy is a discovery process that is specific to the child – no general principles?

• Unclear whether best to work on areas of weakness or use areas of strength – depends on child? changes over time?

<table>
<thead>
<tr>
<th>Table 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Links between the nature of the children’s problems and the type of intervention used</td>
</tr>
<tr>
<td>□ It is important to find out why the WFD may be occurring and which storage is happening accurately –fuzzy storage needs working on!</td>
</tr>
<tr>
<td>□ Visualisation for semantic difficulties</td>
</tr>
<tr>
<td>□ Work on semantics gives them the tools to describe attributes of the sought after word</td>
</tr>
<tr>
<td>□ Sorting tasks - less expressive children, Descriptive tasks - verbally confident</td>
</tr>
<tr>
<td>□ Phonological awareness – when targeting literacy</td>
</tr>
<tr>
<td>□ Use strategies to access words in semantic system –triggers words stored in lexicon</td>
</tr>
<tr>
<td>□ Younger –gesture/description rather than initial sounds/other phonological</td>
</tr>
<tr>
<td>□ When knows spelling use letter-to-sound</td>
</tr>
<tr>
<td>□ When vocabulary deficit –use lots of contexts, LSA support appropriate</td>
</tr>
<tr>
<td>□ It is important to take account of dysfluency</td>
</tr>
</tbody>
</table>

Challenges

• Ask the child: what worked for you?

<table>
<thead>
<tr>
<th></th>
<th>Amy</th>
<th>Magda</th>
</tr>
</thead>
<tbody>
<tr>
<td>How much did you enjoy taking part in WORD?</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>How helpful was it to think about the MEANING of words?</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td></td>
<td><em>(Semantic worked best)</em></td>
</tr>
<tr>
<td>How helpful was it to think about the SOUNDS in words?</td>
<td>3</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td><em>(Phonological worked best)</em></td>
<td></td>
</tr>
<tr>
<td>What helps you most when you are stuck?</td>
<td>Chunking out; doing the actions; sometimes spelling.</td>
<td>I show someone the action... Tell a teacher or friend.</td>
</tr>
<tr>
<td>Do you think finding words is easier now?</td>
<td>At the beginning 1 and now it is 3.</td>
<td>A little bit easier</td>
</tr>
</tbody>
</table>
CLINICIANS

MECHANISMS

Attempt to close the gap from both directions:

1. Talk to clinicians about implicit causal theory
2. Build formal models of atypical neuro-computational systems and simulate effects of intervention
Computational modelling as a way to investigate mechanism

Real neural networks

Artificial neural networks
Harm, McCandliss & Seidenberg (2003)

- Does it matter when phonological problem resolves?
- Compare with training on orthographic-phonology relationships

Figure 4. Sample stimuli from the McCandliss et al. (in press) Word Building intervention. Consecutive items in the sequence were created by changing or moving only one grapheme.
Harm, McCandliss & Seidenberg (2003)

- Does it matter when phonological problem resolves?
- Compare with training on orthographic-phonology relationships

Word Building Intervention

A good model but the ONLY model of intervention!
Model for investigating the principles of intervention

- Simple network
- Easy to visualize behaviour
- Esp. formation of internal representations
Input space

Range: -0.5, 0.5
10 000 items
Simple learning problems

**Diagonal**
- Regular

**Islands**
- Irregular
Developmental deficits

Low connectivity ($C = 0.3$)

Low temperature ($T = 0.5$)
### Intervention patterns

<table>
<thead>
<tr>
<th>Target pattern</th>
<th>Training pattern</th>
<th>Intervention 1</th>
<th>Intervention 2</th>
<th>Intervention 3</th>
<th>Intervention 4</th>
<th>Intervention 5</th>
<th>Intervention 6</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image1" alt="Target pattern" /></td>
<td><img src="image2" alt="Training pattern" /></td>
<td><img src="image3" alt="Intervention 1" /></td>
<td><img src="image4" alt="Intervention 2" /></td>
<td><img src="image5" alt="Intervention 3" /></td>
<td><img src="image6" alt="Intervention 4" /></td>
<td><img src="image7" alt="Intervention 5" /></td>
<td><img src="image8" alt="Intervention 6" /></td>
</tr>
</tbody>
</table>
Trajectories
Sample animations...

- https://www.youtube.com/watch?v=_RCSFhoFg6s
- https://www.youtube.com/watch?v=Wlrr0Jr6kfo
- https://www.youtube.com/watch?v=Wlrr0Jr6kfo
Principles

• Importance of timing of intervention
• Specificity to deficit type?
• Specificity to problem domain?
Back to word-finding difficulties

• Aim:
  – Model individual profiles of developmental deficits in naming
  – Model interventions – which is most effective?
  – Test predictions against real data

• Key data: compare performance on four tasks, child vs. model
  – Picture naming
  – Picture comprehension
  – Semantic associations
  – Phonological ability
Picture naming task

Target: Triangle  
“Square”

Target: Coconut  
“Cocoon...some beach thing”

Target: Llama  
“Ghost” (via goat)
Picture comprehension

Time 1: Is it pineapple?  YES

Time 2: Is it melon?  NO

Combined accuracy score: 1
Picture comprehension

Time 1: Is it butterfly?  YES

Time 2: Is it wasp?  YES

Combined accuracy score: 0
Semantic associations
Semantic associations
Phonological ability (nonword repetition)

pennel
commeecitate
perplisteronk
skiticult
ballop
woogalamic
Two case studies

Comparison to controls (SDs from mean)

<table>
<thead>
<tr>
<th>Category</th>
<th>Amy</th>
<th>Magda</th>
</tr>
</thead>
<tbody>
<tr>
<td>Semantics</td>
<td>-1.8</td>
<td>-1.8</td>
</tr>
<tr>
<td>Phonology</td>
<td>-3.4</td>
<td>-3.2</td>
</tr>
<tr>
<td>Naming</td>
<td>-3.1</td>
<td>-4.2</td>
</tr>
<tr>
<td>Comprehension</td>
<td>-1.3</td>
<td>-2.5</td>
</tr>
</tbody>
</table>

AMY: More a phonological problem

MAGDA: ... and a semantic problem
Model of naming development
Simulate the intervention

Amy

Magda
Simulate the intervention

Amy

Magda

Data: Phonological works best

Semantic works best
Conclusions

• Link intervention with underlying mechanism
• Use computational models to advance theory / generate predictions
• Work with clinicians to understand (a) their implicit causal theories (b) what kinds the interventions they use
• Intervention studies = lots of challenges!
Acknowledgements

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• Project website: https://sites.google.com/site/wordfinding/home