Retention of speech sequence learning in stuttering and Parkinson’s disease

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Multi-Site Study

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Introduction

“There are strong indications that the BG circuit…plays an important role in the pathophysiology of stuttering” (Alm, 2004; Giraud et al., 2008; Jones et al., 2002; Lim et al., 2005).
Behavioral Similarities for PPD and PWS

1. tremor (Denny & Smith, 1992),
2. reaction time slowing (Smits-Bandstra, De Nil, & Rochon, 2006),
3. slow movement durations (Max & Yudman, 2003),
4. unnatural breaks and pauses in fluent sequence production (hand movements) (Weiss, Stelmach, and Hefter, 1997; Webster 1986; 1989).

Why PPD?
Why PPD?

Neurological Similarities for PPD and PWS

1. Left Deactivation –

2. Left Hyperactivation –

3. Right Hyperactivation –
Narrowing the field
Implicit Sequence Learning

Implicit = *I learned how to do it but I can’t explain how/what I learned* (Siegert, Taylor, Weatherall, & Abernethy, 2006).
Literature Review: 
Sequence Learning

- PPD implicit sequence learning deficits (Doyon, 2008; Siegert et al., 2006).
  - Speech and nonspeech tasks

- PWS sequencing deficits (Smits-Bandstra, De Nil, & Rochon, 2006; Smits-Bandstra, De Nil, & Saint-Cyr, 2006; Smits-Bandstra & De Nil, 2009; Smits-Bandstra & De Nil, submitted).
  - Speech and nonspeech tasks
Research Question

Do PWS and PPD show similar deficits in implicit sequence learning and retention relative to control subjects?
Methods

Subjects
14 PWS (6♀)  14 CS (6♀)  14 PPD (6♀)

Age
65.1 (6.0)  65.5 (5.6)  64.5 (6.8)

- mental state (MMSE), depression (BECK)
- speech and language (SSI-3, dysarthria)
- digit span, hearing, vision, medications
Task

Sequence = PO PI PO PE PI PA PE PA

(PA)            (PE)

(PI)            (PO)

8 trials = 1 sequence
Task

Sequence = PO PI PO PE PI PA PE PA

PO … PI (50%) PE (50%) PA (0%)
Procedure

**Day One**
- Block 1 – 72 sequence trials (9 sequences)
- Block 2 – 72 sequence trials
- Block 3 – 72 sequence trials
- Block 4 – 72 sequence trials
- Block 5 – 72 random trials (no reps, eg PO PO)

**Retention Test**
- Block 1 – 72 sequence trials
- Block 2 – 72 sequence trials
- Block 3 – 72 random trials
Procedure

Task:
Random Block 5

- sequence trials (PO PI)

- violation trials (PO PA)

(Eimer et al., 1996)
Accuracy

Percentage Accuracy of Control Subjects, PWS and PPD for Session One and the Retention Session

- Control
- PWS
- PPD

First Session
- Block One: 95%
- Block Two: 95%
- Block Three: 95%
- Block Four: 95%

Retention Session
- Block One: 95%
Retention: Speech Skill Learning

Reaction Time of Control subjects, PWS and PPD for All Syllables

Seconds

Block 1 | Block 2 | Block 3 | Block 4 | Block 1 | Block 2
Day One | Day One | Day One | Day One | Day One | Day One
Retention Test | Retention Test | Retention Test | Retention Test | Retention Test | Retention Test

Control ALL | PWS ALL | PPD ALL
Implicit Sequence Learning

Sequence-Specific Reaction Time for Control Subjects, PWS and PPD on Session One and the Retention Session

- **Control**
- **PWS**
- **PPD**

The graph shows the sequence-specific reaction time in seconds for different pairs (random and sequence) across the first session.
### Explicit Knowledge Questionnaire Scores (out of 10)

<table>
<thead>
<tr>
<th></th>
<th>Controls</th>
<th>PWS</th>
<th>PPD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Day 1</td>
<td>3.1 (2.1)</td>
<td>3.4 (1.8)</td>
<td>3.2 (1.8)</td>
</tr>
<tr>
<td>Retention</td>
<td>4.3 (2.1)</td>
<td>5.0 (1.4)</td>
<td>5.2 (1.3)</td>
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<tr>
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<tr>
<td>chance</td>
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<td>50%</td>
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Controls’ better performance not attributable to explicit learning (Rose, 2001; Russel & Rosler, 2000).
Discussion - Similarities

- Both show delayed reaction time (blocks 1 and 2)
- Both show sequence-specific learning and general speech skill learning deficits
- Both “catch up”, not just slower
Discussion - *Dissimilarities*

- PPD poorer accuracy
- PWS poorer general skill retention RT
- PWS unexpected pattern of implicit sequence learning
Theoretical Implications
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References
upon request
References

References

References


Medication

- PPD on medication
  - Large body of existing data (Fattaposta, 2002; Carbon et al., 2006).
  - Minimize large bradykinesia effects while still observing sequence learning effects (Ghilardia et al., 2007).
  - Sequence learning more affected by BG-frontal communication deficit than by DA medication (Muslimovic et al., 2007).
- Ethics/Ease of recruitment
Explicit Knowledge Questionnaire

(Sequence = PO PI PO PE PI PA PE PA)

<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
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<tbody>
<tr>
<td></td>
<td>The syllables never appeared in this order</td>
<td>The syllables appeared in this order very rarely</td>
<td>The syllables sometimes appeared in this order</td>
<td>The syllables often appeared in this order</td>
<td>The syllables always appeared in this order</td>
</tr>
</tbody>
</table>

A) PI PE X
B) PO PE PI √
C) PO PE PI PA √
Why PPD?

Neurological Similarities for PPD and PWS

1. Left Deactivation - primary motor cortex, supplementary motor area (PWS also left Broca’s)
2. Right Hyperactivation - SMA, prefrontal cortex, anterior cingulate bilateral cerebellum (PWS also right Broca’s)
3. Left Hyperactivation - prefrontal cortex, insula (Alm, 2004; Smits-Bandstra & De Nil, 2007)