USE OF CONTEXT IN WORKING MEMORY IN AUTISM

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Overview & Research Questions

Previous investigations have argued that subjects with autism:
- Have little access to generalization principles for words for recall (Hemmelin & O'Connor, 1978)
- Often have spared or heightened visual/spatial or concrete processing abilities (Frith, 1989)
- Show an executive function (EF) impairment for working memory (WM) tasks "across the board" (i.e., in visual and verbal domains) on operation span tasks involving storage and processing (Brannon, Pennington, & Rogers, 1996) and lack self (verbal) cuesing for EF tasks (Russell, Jarrold, & Hould 1999)
- Demonstrate less benefit from organization of visual targets than controls (Jarrold & Russell, 1997)

One goal was to compare working memory abilities in autism across:
1. Input modalities (visual, auditory)
2. Types of stimuli (object words, numbers, letters, patterns, icons)
3. Presentation modality (temporal, spatial)
4. Tasks requiring simple WM and those requiring processing and storage (EF component of WM), i.e., (operation span)

In addition:
- If subjects with autism lack verbal rehearsal in WM tasks, then recall for words may be improved by explicitly cuesting their semantic relation
- If subjects with autism are less able to use verbal rehearsal, then greater processing load at the end of a list when amount of retention is greatest may have less of an effect

Table 1: Receptive and Expressive Language

<table>
<thead>
<tr>
<th>Subject</th>
<th>Age Equiv</th>
<th>Gender</th>
<th>Language</th>
</tr>
</thead>
<tbody>
<tr>
<td>Subject 2</td>
<td>7 yrs</td>
<td>M</td>
<td>English</td>
</tr>
<tr>
<td>Subject 4</td>
<td>9 yrs</td>
<td>M</td>
<td>English</td>
</tr>
<tr>
<td>Subject 5</td>
<td>10 yrs</td>
<td>M</td>
<td>English</td>
</tr>
<tr>
<td>Subject 6</td>
<td>13 yrs</td>
<td>M</td>
<td>English</td>
</tr>
<tr>
<td>Controls-7yr</td>
<td>7 yrs</td>
<td>M</td>
<td>English</td>
</tr>
<tr>
<td>Controls-13yr</td>
<td>13 yrs</td>
<td>M</td>
<td>English</td>
</tr>
</tbody>
</table>

Subject 4

Count and addition abilities appeared to be better in autism across:
- Number processing abilities (Frith, 1989)
- Often have spared or heightened visual/spatial or concrete processing abilities (Frith, 1989)
- Demonstrate less benefit from organization of visual targets than controls (Jarrold & Russell, 1997)

Table 2: Operation-Span Tasks

<table>
<thead>
<tr>
<th>Task</th>
<th>Subjects</th>
<th>Simple Span</th>
<th>Complex Span</th>
</tr>
</thead>
<tbody>
<tr>
<td>Count-Span</td>
<td>Subject 2, 4, 6</td>
<td>2, 3, 4, 6</td>
<td>2, 3, 4, 6</td>
</tr>
<tr>
<td>Memory-Span</td>
<td>Controls-7yr</td>
<td>7yrs</td>
<td>13yrs</td>
</tr>
<tr>
<td>Letter-Digit</td>
<td>Subject 2, 4, 6</td>
<td>2, 3, 4, 6</td>
<td></td>
</tr>
<tr>
<td>Spatial-Temporal</td>
<td>Controls-7yr</td>
<td>7yrs</td>
<td>13yrs</td>
</tr>
</tbody>
</table>

Study 1: Are lexical and non-lexical stimuli recalled differently?

Word List Recall

Procedure:
- Subject recalled each word in a list immediately following auditory presentation of the list
- Length of list presented was dependent upon subject's digit span (DS) (4 items for lower DS, 6 items for higher DS group)
- Random list order
- Sentimental Related (SR): Same category (animals, plants, kitchen, vehicles, building, street, body parts)
- Unrelated (UR): Different category (same words as presented in SR)
- Semantic Cued (SC): SR lists presented in isolation with instructions regarding semantic relation after 3-week delay

General Procedure (Simple and Complex Span)

- Lists varied in length from 1 to 6 words, 3 to 6 items, presented for immediate recall with 3 trials per level
- List length was increased by 1 item if a participant achieved 3 of 5 trials correct; otherwise, the experiment was terminated at the maximum span score

Simple Span Tasks

- Simple digit, Backward digit, and Letter Span
- List was presented verbally by experimenter

Spatial Span

- Subjects presented with a filled grid on computer. After 10s delay, required to point to previously filled locations
- Example of let 5 stimulus:

Overall Complex Span

- Average of Noncanonical

Study 2 Results

Figure 4: Subjects with autism and older control subjects performed better on count span than sentence/sentence/letter span.

Study 2 Conclusions

- Complex span ability was not impaired equally across input modalities in autism
- Count and addition abilities appeared to be spared
- Letter and sentence span may have been too difficult. Require new norms

Study 3: Are spatial and/or temporal visual cues used for later recall?

Counts (CS)

- Subjects were instructed to count the blue squares as quickly as possible (Displays had twice as many distractors)
- Recalled based on maximum level passed in reaction time
- Conditions: Display Type (1) Canonical, (2) Noncanonical, or (3) Noncanonical but requiring Target Size (1) Small (3-5 target squares) or (2) Large (6-8 target squares)

Final Card Size: 1) Large or 2) Small

- Last card is large (6 squares) and first card is small (3-5 squares)
- Noncanonical: Subjects were required to recall the numbers (RT only measured)

Figure 5: Study 3 Results

Difference between RTs for large minus small target sizes

Study 4: Are all operation span tasks impaired equally?

Complex (Operation) Span Tasks

- Complex (Operation) Span Tasks
- Expected Response: row, white, nail

- Complex Span tasks impaired equally in autism compared to controls
- Performance on No memory control indicated that impairment on NC not due to increased verbal rehearsal with recall requirement

Study 3 Conclusions

- Subjects with autism were significantly better than 7yr controls in repeating and canonical conditions
- Performance on No memory control indicated that impairment on NC not due to increased verbal rehearsal with recall requirement
- Subjects with autism showed evidence for use of lexical organization in word and in canonical recall, but this was not the case with digits
- Ability with numbers and spatial patterns often exceeded abilities with words, letters and temporarily presented visual stimuli

Acknowledgments

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