Insights from Comparisons of Children & Adults with ASD: What’s Changeable?

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Disclosures

- Some of the research to be discussed was conducted by me using grant funding from the National Institutes of Health. Duration: 2001 to 2012.

Learner Objectives

- Discuss recent findings from behavioral and neuroimaging research comparing cognitive and linguistic processing in children and adults with autism.
- Describe the developmental implications of these findings especially with respect to what is changeable in cognitive and linguistic processing in autism.
- Apply these findings to the design of language intervention for children with autism.

Brain Development

- Brain development is a genetically controlled process with respect to the formation of structure and physiological processes.
- **BUT**
  - This development occurs in response to environmental input.

Impact of a Neurodevelopmental Disorder

- Not a one time insult with typical progression after that point.
- Can affect neurodevelopment across the lifespan.

- This is true whether your genetic code for brain development is within the range of neurotypicality, or
- Whether your genetic code for brain development is outside of this range.
**How to Measure Neurodevelopmental Change**

- Longitudinal studies
- Cross-sectional studies
  - Samples of children at different ages
  - Comparisons of children and adults

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**Profile of Cognitive Strengths/Weaknesses**

(Williams, Goldstein, & Minshew, 2006)
(Minshew, Goldstein, & Siegel, 1997)

<table>
<thead>
<tr>
<th>Intact Abilities</th>
<th>Cognitive Weakness</th>
</tr>
</thead>
<tbody>
<tr>
<td>Attention</td>
<td>Complex Sensory</td>
</tr>
<tr>
<td>Sensory Perception</td>
<td>Complex Motor</td>
</tr>
<tr>
<td>Elementary Motor</td>
<td>Complex Memory</td>
</tr>
<tr>
<td>Simple Memory</td>
<td>Complex Language</td>
</tr>
<tr>
<td>Formal Language</td>
<td>Concept formation</td>
</tr>
<tr>
<td>Rule-Learning</td>
<td>Face recognition</td>
</tr>
<tr>
<td>Visuospatial Processing</td>
<td></td>
</tr>
</tbody>
</table>

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**Modality Shift Effect (MSE)**

(Williams, Goldstein, & Minshew, 2013)

- For measuring low level attention processing
- Requires minimal motoric response
- Requires no decision making or mapping of the stimulus to a particular button

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**Stimuli:**

- Sound:
  - High tone
  - Low tone
- Light:
  - Green light
  - Red light

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**Two presentation modes:**

- Sound and light stimuli:
  - Ipsi-modal (sound-sound or light-light)
  - Cross-modal (sound-light or light-sound)
Participants:
- 33 Children with autism compared to 33 age- and ability-matched controls with typical development (ages 8 to 15 years)
- 42 Adults with autism compared to 42 age- and ability-matched controls with typical development (ages 16 to 55 years)
- IQs ≥ 80

Results:
- Exaggerated “modality shift effect” occurred for children with autism when shifting from sound to light.
- No exaggerated “modality shift effect” occurred for the adults with autism.
- Responses of adults with autism were characterized by a generalized slowness relative to the adults with TD.

Conclusion:
- Results suggest a lag in maturational development in autism in basic information processing mechanisms.

fMRI Studies of Language Processing in Autism: Adults & Children with ASD

Subjects see the stimuli on a screen (which is behind them) via a small mirror above their eyes.

Photograph of Magnetic Resonance Imaging scanner set up for functional imaging

N-back Working Memory Task
(Koshino et al., NeuroImage, 2005)

500 ms

H G A A

1 back

1000 ms

H G A G

2 back
Individuals with autism used a right hemisphere working memory network while controls used the expected left hemisphere working memory network.

N-back Working Memory Task with 2-Letter Words  
(Carter, Williams et al., IMFAR, 2012)

- Stimuli: AT, IS, etc.
- Children with autism relied more on visual strategies to perform the working memory tasks for 2-letter words, especially in 0-back condition.
- Children with autism demonstrated some use of Broca’s area in 1-back condition, possibly in response to increasing task demands.

Social & Physical Judgment Tasks  
(Carter, Williams et al. 2012, PLOS One)

Social

Physical

Comparison of performance when making judgments

- TD Social > Physical
- AD Social > Physical
- TD-AD Social > Physical

- Even though language was unnecessary, the children with TD recruited language areas during the social judgment task.
- This suggested automatic encoding of their knowledge into language.
- However, this was not the case for the children with autism.

(Carter, Williams et al. 2012, PLOS One)
Children with autism may not have a left hemisphere language “interpreter”.

- Gazzaniga (2000) proposed that the LH language regions (“the interpreter”) are automatically engaged to interpret stimuli and assimilate them into comprehensible events.
- This automatic story-telling allows for elaboration and generalization of information such that the LH creates “order from chaos”.

Taken together, the results of these three fMRI studies suggest that:

- Individuals with autism may not automatically recode information linguistically.
- This lack of automatic recoding may underlie the slower development of spoken language in children with ASD.

Persistence of lack of automaticity may explain why adults with ASD who have acquired spoken language continue to be challenged in language comprehension and expression.

Direct Comparison of Linguistic Processing in Children & Adults with ASD

Participants:

- 15 children with autism (M age = 13.0 years)
- 14 children with TD (M age = 12.5 years)
- 13 adults with autism (M age = 24.9 years)
- 12 adults with TD (M age = 21.0 years)
- Mean VIQ for all groups ≥102.9

Examples of Literal and Ironic Stimuli:

**Literal:**
Johnny went on a hike with his brother. Suddenly he saw a huge snake next to his foot.
He said, "I am so scared."
Was Johnny afraid?

**Irony:**
Tommy was raking leaves into large mounds. His brother ran through the piles.
Tommy said, “You are a big help.”
Does Tommy think his brother helped him?

(Williams et al., 2013, *Autism Research*)
Behavioral Performance for the 4 groups on both text conditions

<table>
<thead>
<tr>
<th></th>
<th>Error Rates</th>
<th>Reaction Times</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Children</td>
<td>Adults</td>
</tr>
<tr>
<td></td>
<td>Autism</td>
<td>Control</td>
</tr>
<tr>
<td>Literal</td>
<td>11.7% ± 4.2</td>
<td>7.1% ± 2.7</td>
</tr>
<tr>
<td>Irony</td>
<td>28.0% ± 3.6</td>
<td>21.2% ± 3.5</td>
</tr>
<tr>
<td>Adults</td>
<td>1 (df)</td>
<td>p</td>
</tr>
<tr>
<td>Literal</td>
<td>5.9% ± 2.4</td>
<td>5.7% ± 2.1</td>
</tr>
<tr>
<td>Irony</td>
<td>21.2% ± 5.6</td>
<td>5.5% ± 2.9</td>
</tr>
</tbody>
</table>

Values are mean ± standard error

Reading Literal Sentences

- All four groups used the same basic language processing areas.
- Adults with autism had an activation pattern that was in some respects like that of the child controls and in other respects like that of the adult controls.

Irony Comprehension

- However, as the tasks demands increased, the adults with autism could not perform as well as the age and ability-matched adults with typical development.

(Williams et al., 2013)

An increase in skill and learning on semantic tasks and an increase in elaboration of semantic representations have been associated with greater activation in LMT region (Blumenfeld et al., 2006; Sandak et al, 2004)

LPT has been associated with semantic processing (Friederici et al., 2000) including a greater search for semantic associations (Chou et al., 2006) or the selection between competing representations (Hirshorn & Thompson-Schill, 2006).

Left medial frontal ROI may serve an integrative role in discourse processing (Mason & Just, 2011)
Prior research suggests that the right temporal region is related to context processing (Vigneau et al., 2011).

Both children and adults with autism had lower functional connectivity than controls when comprehending irony.

Overall, the adults & children with autism differed from the TD controls in:

1) Degree of network coordination.

2) Distribution of the workload among the parts of the network.

3) Active recruitment of key brain regions in response to differences in context.

Differences between the Adults & Children with ASD Suggested:

- Positive effects in language functioning with age and experience.
- Adults may have had increased semantic knowledge (LMT activation).
- Adults may have had increased contextual knowledge (RMT activation).
- Adults may have had increased coherence processing (LMedFG activation).

BUT Functional Connectivity Measures:

- Indicated that, regardless of age, participants with autism had less adaptability or responsiveness to the differing tasks demands than the child and adult controls.

- Behavioral cost of this difference only seen when comparing the performance between the adult groups.

Images of Autism and Control Cortical Networks

Summary of Findings:

- Children with autism have maturational lags in development of information processing.
- Processing of information can improve with maturation but continues to be slow.
- Basic problem with processing language appears to be lack of automatic recoding into language.
- Individuals with ASD can learn to recode linguistically but not as automatic as for TD.

Experience makes a difference!

- Neurofunctional changes in the processing of language do occur in response to environmental input.
- Most changeable are **Word Knowledge** and **World Knowledge**.
- These can be used to compensate for the underlying persistent linguistic processing problems.

Clinical Implications:

- What we do as SLPs matters!
- Gains can be made in **semantic** knowledge.
- Gains can be made in **contextual** knowledge.
- Need to consider these aspects during program planning.

We’ve been doing a lot of things right

- Strategies traditionally recommended for individuals with ASD such as:
  - making implicit information explicit
  - providing an organizational structure
  - providing visual methods to help hold information ‘on-line’ rather than in working memory, and
  - breaking the task down into discrete steps
- are all consistent with a reduction in processing resources that both children and adults need.

We can incorporate what we know from LLD:

For example, to increase reading fluency and comprehension, you could

- Use text for which the child/adult with autism has **experiential** knowledge (either through personal experience or video viewing).
- Ascertain pre-knowledge of **semantic** content or pre-teach unfamiliar semantic content.

Also consider that

- Problems with **social interactions** may be related to problems with **linguistic processing** not just pragmatics.
- “Scripts” may be a response to problems with linguistic coding of information.
- Familiarity of content may reduce the language processing load so free up resources for processing of pragmatic elements.
Lack of Cognitive Flexibility

- May occur because of a neurobiologically based difficulty with automatic shifting of processing resources in response to a change in the demands of the task.

- To facilitate task switching, may require a clear break between tasks with explicit cues about what the elements of the new task are---what types of thinking will be required to accomplish the task and/or how it differs from the previous task.

Language Mediator

- Because information may not be automatically encoded into language, both children and adults with ASD may need you to help them bridge the gap.

- Ex: Verbalizing steps of a procedural task

- Ex: Verbalizing emotional reactions

References


References (cont’d)


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Thank You

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