Perspectives from Autism Research

Autism as a Difference in Complex Information Processing and Disrupted Neurofunctional Connectivity

PRESENTATION TO THE NATIONAL ACADEMIES' COMMITTEE CONDUCTING AN INDEPENDENT ANALYSIS OF DEPARTMENT OF DEFENSE'S COMPREHENSIVE AUTISM CARE DEMONSTRATION PROGRAM

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UNDERSTANDING OF AUTISM

- Neurodevelopmental difference
- Can become a disorder
- If the functional abilities of the individual cannot meet challenges from the environment
- Autistic individuals learn and act differently because their brains function differently
- They see the world differently

COMPLEX INFORMATION PROCESSING MODEL OF AUTISM

Journal of the International Neuropsychological Society (1997), **3**, 303–316.

Neuropsychologic functioning in autism: Profile of a complex information processing disorder

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NEUROPSYCHOLOGIC FUNCTIONING IN CHILDREN WITH AUTISM: FURTHER EVIDENCE FOR DISORDERED COMPLEX INFORMATION-PROCESSING

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COMPLEX INFORMATION PROCESSING MODEL OF AUTISM

In autistic adults and children (ages 8 – 15 years) with IQ > 70

Intact Abilities

- Attention
- *Sensory Perception*
- Elementary Motor
- Simple Memory
- **Formal Language**
- Rule-Learning
- Visuospatial Processing

Cognitive Weakness

- Complex Sensory
- Complex Motor
- Complex Memory
- **Complex Language**
- Concept formation
- Face recognition

Williams, Goldstein, & Minshew, 2015, 2006;Minshew, Goldstein, & Siegel, 1997

THE TERM "COMPLEXITY" AS USED IN THE MODEL

Various types of information can be complex:

- Large amounts of information without explicit structure
- Information of multiple types that must be integrated
- Time constraints
- Multiple simultaneous processing demands
- Under stress or anxiety

COMPLEX INFORMATION PROCESSING: UNDERLYING NEUROBIOLOGICAL DIFFERENCES

- Because of neurobiological differences, autism is **dynamically realized** as the autistic person processes information that the brain's mechanisms cannot accommodate
- Problems occur if there is a **mismatch** between available cognitive resources and the demands of the processing task

- Autistic individuals are challenged **at lower levels of complexity** than expected relative to age and general ability level
- Assumption: They accomplish tasks using different processing strategies than expected

FUNCTIONAL IMAGING STUDIES IN AUTISM

- Most consistent result is differences in coordination of relevant brain networks as revealed by measures of functional connectivity
- Both over and under connectivity of key brain regions (e.g., Guo et al., 2024; Kana et al., 2014; Minshew & Williams, 2007; Trapani et al., 2022; Uddin, Supekar, & Menon, 2013; Williams et al., 2013)
- Disrupted Connectivity Hypothesis of Autism (Kana et al., 2011)

FUNCTIONAL NEUROIMAGING IN AUTISM

- Differences in the distribution of the workload across the nodes of the brain network (Williams et al., 2013)
- Differences in the dynamic recruitment of neural resources in response to changes in contextual demand (Williams et al., 2013)
- Difficulty with neural synchronization during dyadic/conversational interactions (Quiñones-Camacho et al., 2021)
- Underlying problem with automatic conversion of information into a linguistic form (e.g. Carter et al., 2012; Koshino et al., 2005)
- Positive changes occur with maturation and experience in autism (Williams et al., 2013)

SUMMARY

- fMRI studies are consistent with the Complex Information Processing Model of autism
- Autism involves difficulty with
  - the allocation of cognitive resources when processing demands increase because of neurobiological constraints
  - Processing tasks that require integration of information because the brain regions are not working efficiently
- Similar behavioral performance may be achieved using different underlying cognitive processes that are sufficient under certain processing circumstances but may be insufficient when environmental demands change

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