Children with autism process visuospatial visual matching problems less linguistically and/or semantically than neurotypical children.

Fluid Reasoning in Children with Autism:

What if Brain Connectivity Varied According to Task Content and Complexity?

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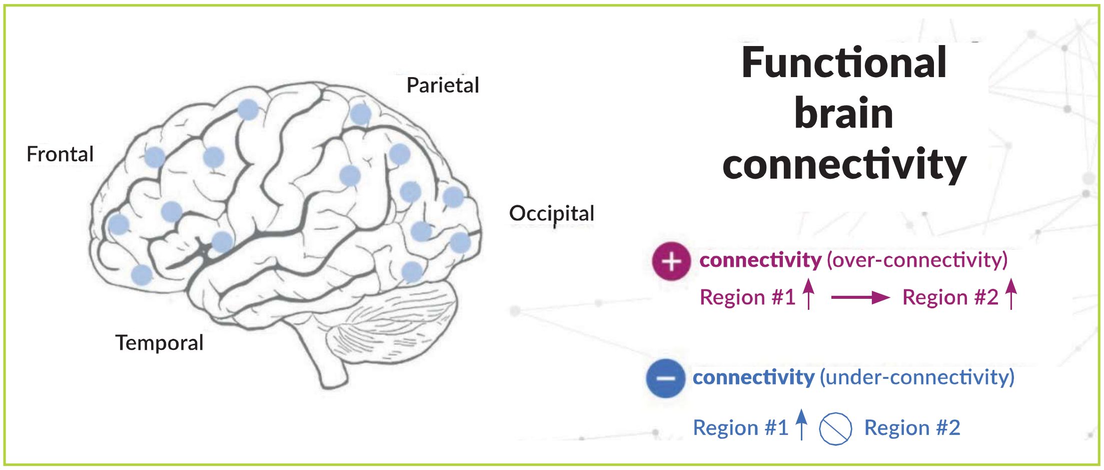
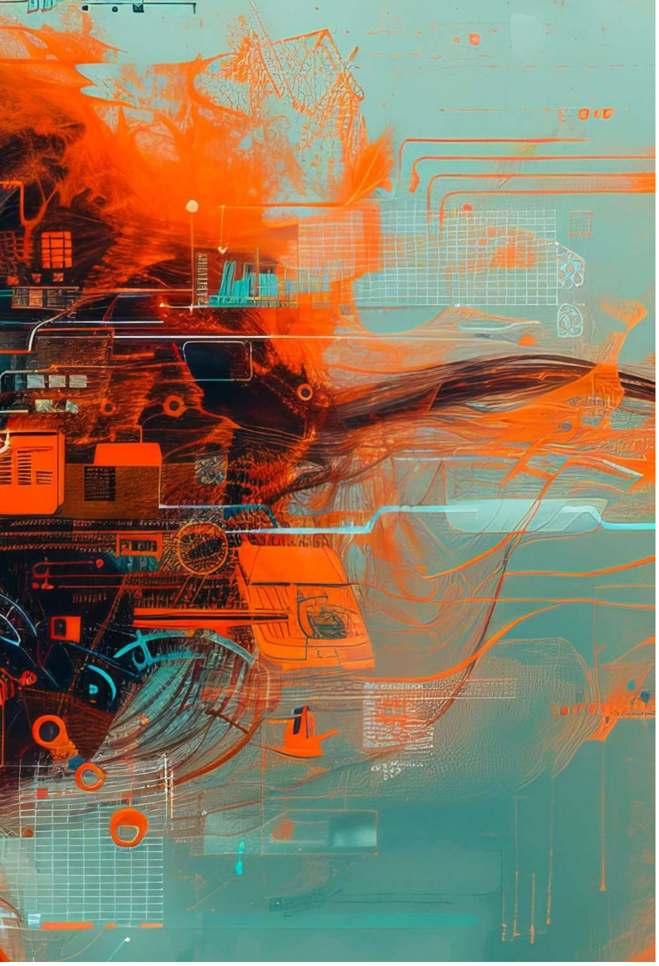
What is Brain Connectivity?

In neuroimaging, brain connectivity refers to the way in which brain regions communicate and interact with each other. Using a variety of tools, such as unctional magnetic resonance imaging, it is possible to determine how different brain regions activate and work together when performing an action or cognitive task.





In autism, a widely recognized model to explain brain function is one of **under-connectivity**[1-2]. This model proposes that, compared with neurotypical individuals, autistic people have less connectivity between brain regions that are far apart (i.e., between the frontal and parietal lobes and the occipital lobe), but more connectivity between regions that are close together, especially in regions at the back of the brain, such as the occipital lobe.

The presence of under-connectivity has often been found in autism studies, while very few results of **over-connectivity** have been reported. This could be explained by the fact that most studies used tasks that represent weaknesses in people with autism. On the other hand, for tasks recognized as strengths in autism, such as visual and spatial tasks, studies concluded that there is over-connectivity between perceptual regions in the back of the brain (e.g., occipital and parietal lobes) and regions in the front of the brain (i.e., frontal lobe) in adults with autism. This result has even been observed in tasks involving more complex abilities, such as reasoning, a skill that enables us to use logical thinking to solve new problems. To date, very few studies have been able to investigate how the brains of autistic children function during reasoning tasks.

This is what led Janie Degré-Pelletier and her colleagues to study connectivity patterns during reasoning in autistic children. More specifically, in their study published in the journal Cerebral Cortex, the researchers addressed the following question: how does the nature of the task and the complexity of the problems influence brain connectivity in children with autism?

Methodology

To answer their question, 23 children with autism and 23 typical children aged between 6 and 15 years old performed a reasoning task in a functional magnetic resonance imaging (fMRI) machine to collect the functional activity of their brains as they performed the task. The task in question varied in terms of content (visuospatial versus semantic) and complexity (visual matching versus reasoning). Children had to choose which of three images completed the pictorial matrix (Figure 1).

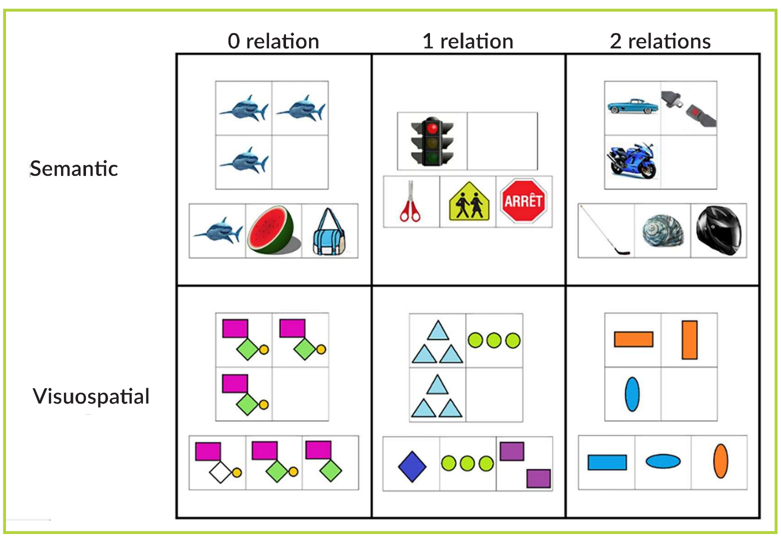


Fig. 1 Example of presented tasks. Top row: semantic tasks, Bottom row: visuospatial tasks. From left to right, items vary in complexity. For example, for the top-right item (2 semantic relations), we need to infer that a seatbelt offers protection in a car, and therefore, a helmet offers protection on a motorcycle.

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original article:

Degré-Pelletier, J., Danis, É., Thérien, V. D., Bernhardt, B., Barbeau, E. B., & Soulières, I. (2024). Differential neural correlates underlying visuospatial versus semantic reasoning in autistic children. *Cerebral Cortex*, *34*(13), 19-29. https://doi.org/10.1093/cercor/bhae093

Other References:

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Results

Visuospatial Task

For the **visuospatial** matching task, children with autism showed underconnectivity, compared to neurotypical children, between the perisylvian language regions and the left temporo-occipital region, which is associated with complex object recognition. This finding suggests **that children with autism process visuospatial visual matching problems less linguistically and/or semantically** than neurotypical children.

However, for the more complex visuospatial items, which require reasoning skills, the opposite pattern of connectivity was observed: autistic children showed over-connectivity between occipital regions and several temporal, occipital, and frontal regions, compared with neurotypical children. By way of background, these brain regions are known to play a role in visual perception, working memory, and selective attention. This is in line with the findings of previous studies, which support the fact that in autistic people, **visual processing via activation of perceptual regions in the occipital lobe is involved in cognitive processes that require more than just visual processing**, as was the case for reasoning.

Interestingly, the over-connectivity identified with increasing level of complexity in visuospatial problems in the present study contrasts with what has been observed previously in adults with autism. In fact, less variability in connectivity has been found in association with increasing task complexity during visuospatial reasoning problems in these adults[3]. Thus, the findings of over-connectivity observed in children seem to reverse with age in the autistic population. The study by Degré-Pelletier and colleagues, therefore, supports the need for longitudinal studies to explain this difference and the potential effect of puberty on connectivity patterns in people with autism.

Semantic Task

In contrast to the results obtained with the visuospatial items, the semantic, visual matching and complex reasoning items showed no difference in connectivity between autistic and typical children.

What can we learn from this study?

In summary, these results demonstrate that the nature of the task used can greatly vary brain connectivity patterns, thus challenging the under-connectivity model in autism[1-2]. It is becoming increasingly clear that connectivity patterns observed during cognitive tasks vary according to item content and the level of complexity, but also according to the age of the participants. Overall, this study has added to our understanding of autistic children's brain function, which was still largely unstudied, and also highlights the importance of considering the age and developmental period of autistic and neurotypical individuals in neuroimaging research. It is by taking these different elements into consideration that it will eventually be possible to better understand the autistic brain in all its complexity.