# Scientists uncover new facts concerning working memory in children

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Researchers from the Higher School of Economics conducted a meta-analysis in which they compiled data across 17 neuroimaging studies on working memory in children. The data shows concordance in frontoparietal regions recognized for their role in working memory as well as regions not typically highlighted as part of the working memory network, such as the insula. The study, titled "N-back Working Memory Task: Meta-analysis of Normative fMRI Studies With Children," was published in the journal *Child Development*.

Working memory refers to the system that functions while performing complex tasks such as reasoning, comprehension and learning. For example, working memory can retain a shopping list or a telephone number, or calculate how long it will take to get somewhere. It is well known that working memory increases with age. For example, it is easier for an 11 year-old to learn more complex concepts, such as decimals and fractions in math class, than it is for a 7 year-old, as the working memory for an 11 year-old is greater.

Previous neuroimaging studies with adults have identified the areas of the brain that are activated when a person's working memory is implicated; however, data from children were unclear. In this particular project, scientists performed a meta-analysis of data from 17 different working memory neuroimaging studies carried out with children. Collectively, the studies examined brain responses of 260 children from 6 to 15 years.

Children were asked to play a cognitive game called the n-back task, which is likely, the most popular measure of working memory. Subjects identify whether the picture they are looking at is the same or different from the picture 'n' times back; as the number 'n' increases, difficulty increases. While the children are playing the game, scientists use functional magnetic resonance imaging (fMRI) to collect brain images. By looking at the images, scientists see where the blood was flowing at certain points in time, for example, as the child was playing an easy level or a difficult level of the game.

Zachary Yaple, a Ph.D. candidate, and Marie Arsalidou, an assistant professor at HSE, evaluated the data from the 17 studies using activation likelihood estimation. Upon averaging the results across the age groups, the researchers found that children implicate posterior parts of the brain similarly to adults. This is to be expected, as the posterior parietal cortex processes visual-spatial aspects of stimuli. On the other hand, problem solving and higher-order attention processes activate the prefrontal cortex, which is located at the front of the brain. Interestingly, across studies, no agreement whatsoever was observed in the prefrontal cortex. This result was unexpected due to the fact that each separate study had reported prefrontal cortex activity, though not always in exactly the same place. HSE scientists concluded that averaging the data across the wide age range, as is often done in developmental neuroscience, resulted in a loss of information.

"This is an important finding for future research," said Marie Arsalidou. "In order to capture the changes in working memory as children get older, scientists should examine narrower age groups. Averaging data erases vital information." She stressed the need to carry out meta-analyses like this one in order to better understand the mass of data that is now available to researchers around the world.

HSE scientists also identified activity in regions not typically highlighted as part of the working memory network, such as the insula. This part of the brain is usually linked to emotion or the regulation of the body's homeostasis. The insula is located deeper in the brain, between the frontal and temporal lobes of the brain, and this finding sheds a little more light on its complex role.

Above all, research in developmental cognitive neuroscience has the potential to change the way we think about how we learn. "It's important for education and, further down the road, to make positive steps in public policy," explained Marie Arsalidou. "Maybe one day, we'll take into consideration how the brain develops and how we can use this to make learning more powerful at these critical ages. By understanding basic brain development in children, we may be able to create interventions or programs that would improve their learning experience."

**More information:** Zachary Yaple et al, N -back Working Memory Task: Meta-analysis of Normative fMRI Studies With Children, *Child Development* (2018). DOI: 10.1111/cdev.13080

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