'Are we there yet?'—explaining ADHD science to children

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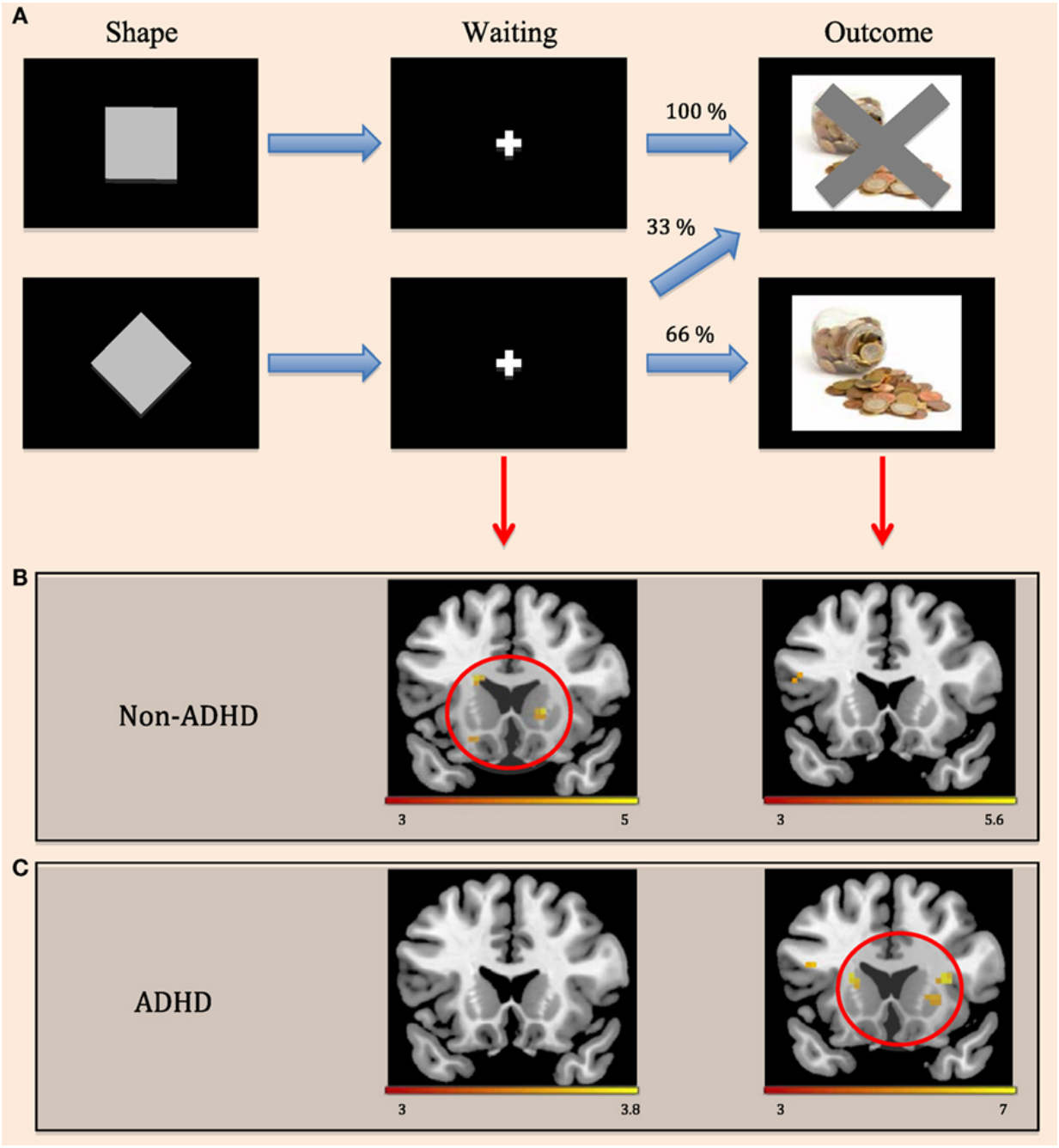

A. Students saw a series of images on the computer screen in the MRI machine. The square shape was never followed by a reward outcome (the jar of coins). The diamond shape was followed by a reward outcome 66% of the time. B. For students who didn't have ADHD, you see places in the striatum (where the red circle is) lighting up (in bright colors) during the period of waiting, but not during reward. C. For students who had ADHD, you see places in the striatum

(where the red circle is) lighting up when they actually saw the jar of coins, but not while they were waiting for it. In both panels (B,C), the lighter yellow color shows greater activation. Credit: OIST

Science is often complex, but it does not mean that only a select few should be able to grasp scientific concepts. Many recent efforts have been directed toward involving the public in the scientific process and broadening access to scientific data. Consistent with this approach, scientists at the Okinawa Institute of Science and Technology Graduate University (OIST) published their research on ADHD in a most unusual academic journal: *Frontiers for Young Minds* is an electronic science journal whose primary audience comprises children from elementary and junior high schools. Children are also involved in the fact-checking process necessary for any respected scientific journal, including the thorough peer review of submitted articles.

In this case, the 'Champions of Science' at the Chabot Space and Science Center, California, aged 12 to 15 years, performed the peer review of the collaborative research. Supported by trained scientists, the kids checked the robustness of the science and the quality and clarity of the language in the scientific article "Focusing is hard! Brain responses to reward in attention deficit hyperactivity disorder." The young reviewers then provided their feedback to the authors.

The topic at hand is the influence of ADHD on children's behavior. More precisely, the scientists' long-term plan is not only to understand the nature of ADHD, but to understand how ADHD affects brain processes and how this translates into everyday behavior.

"Kids with ADHD are often misunderstood and thought of as 'problem kids' in school and by parents," said Dr. Emi Furukawa of OIST. "They

tend to have more difficulties in everyday activities, sometimes remaining through adulthood, and we want to find out why that might be."

Even if pharmacological treatment is already available, its efficiency is limited due to our lack of understanding of the neurobiology of ADHD.

"We do have some behavioral and pharmaceutical interventions reducing the symptoms of ADHD, but we do not know exactly why they sometimes work and sometimes don't, along with the potential side effects as well," added Dr. Furukawa. "So we want to know exactly what might be happening in the brains of children with ADHD to better refine the interventions for them."

The scientists looked at the part of the brain called the striatum—pronounced "strai-ay-tuhm" as the article explains to the young audience—which is represented as the reward/pleasure center of the brain.

In short, a group of college students with or without ADHD completed a simple task in an fMRI scanner that measured activity in the striatum when waiting for a reward and when the reward was delivered. Through the fMRI brain scans, the study revealed the striatum of students without ADHD to be much more active in anticipation of the reward, potentially helping to focus onto the task at hand knowing reward was likely to follow. Students with ADHD, however, displayed the opposite pattern—receiving the reward triggered higher activity in the striatum compared to the anticipation the prize. This may negatively impact the ability of children with ADHD to stay focused if there is no reward immediately at hand.

"As psychologists, we have known we have to reward children with ADHD more frequently," added Dr. Furukawa. "But parents and

teachers have a hard time doing so because they wonder 'why do I have to more often reward children who misbehave?'"

As counterintuitive as these rewards might seem, Dr. Furukawa thinks that providing neurobiologically based explanations about ADHD might make more sense to caregivers or parents and encourage them to implement a behavior management strategy that benefits children with ADHD.

In any case, Dr. Furukawa acknowledged having children "peer reviewing" the research paper was very beneficial. "They came up with questions that none of the scientific reviewers thought to ask, asking about another part of the brain that lit up in both the ADHD and control groups and wondering about its function. Children have a different way at looking at the world, which as a scientist sometimes makes you re-think the way you explain your research," she concluded. "This system also facilitates fostering the next generation of scientists."

More information: Emi Furukawa, Focusing Is Hard! Brain Responses to Reward in Attention Deficit Hyperactivity Disorder, *Frontiers for Young Minds* (2017). DOI: 10.3389/frym.2017.00018

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