Moving Beyond 'One-size-fits-all' Brain Training Solutions

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Scientia

MOVING BEYOND 'ONE-SIZE-FITS-ALL' BRAIN TRAINING SOLUTIONS

Brain training allows us to improve our cognition in the same way that gym workouts improve our physical health. The ultimate goal is transferable learning, which improves performance in real-world activities beyond the original training tasks. **Dr Susanne M. Jaeggi**, **Dr Anja Pahor** and **Dr Aaron R. Seitz** from the University of California Irvine and Riverside, are collectively driving forward exciting advances in brain training, as well as addressing the controversy surrounding its effectiveness and limitations. Above all, they aim to understand the key ingredients for creating successful interventions.

What is Brain Training?

Brain training is regarded as the mental equivalent of going to the gym. Instead of improving our physical fitness, it aims to strengthen the brain systems that support cognitive performance. Just as we would spend time on the treadmill to maintain our cardiovascular health, brain training can enhance cognitive functions such as motor control, memory, and attention.

There are many different approaches to brain training, depending on what the learner wishes to accomplish. Some are educational, targeting reading or math; others may focus on a specific work-based skill. Dr Susanne M. Jaeggi, Dr Anja Pahor and Dr Aaron R. Seitz, all from the University of California Irvine and Riverside, agree that brain training programmes must be designed appropriately to improve cognition and that beneficial effects should be unlikely to arise by chance. To demonstrate this, they compare brain training to the act of going to the gym with the intent of improving fitness. This differs from playing a sport such as basketball, where the focus is typically entertainment and skill development, and any improvement to fitness is a secondary, albeit beneficial factor.

An important aim of brain training is 'transfer', which is an improvement in individuals' abilities beyond the trained task. The desired outcome is that transfer is evident across real-world activities, not just those that feature within the training. For example, the focus may be improving the storage of memories but the skills learnt could also help someone to undertake non-trained tasks such as understanding complex information or decision-making. There are two different levels of transfer. Near transfer is when learning enhances activities that are similar to the training tasks. Far transfer occurs when learning is utilised in different contexts beyond the training context. This is the ideal outcome as it brings more benefits to everyday life.

Everyone can potentially benefit from brain training, but it is often developed to help individuals overcome difficulties or to develop superior abilities. Brain training has proved useful amongst the ageing population to sustain declining

Courtesy of the UCI School of Education

cognitive function, particularly in those at risk for dementia. People with impaired cognitive abilities arising from brain injury, developmental issues and even addiction often utilise these techniques in their rehabilitation. A less well-known usage is the training of specialists. This can range from bolstering the learning of surgeons in complex medical tasks, to boosting academic performance, to enhancing expert performance in sports. For example, Dr Seitz has shown that vision training can improve on-field performance in baseball.

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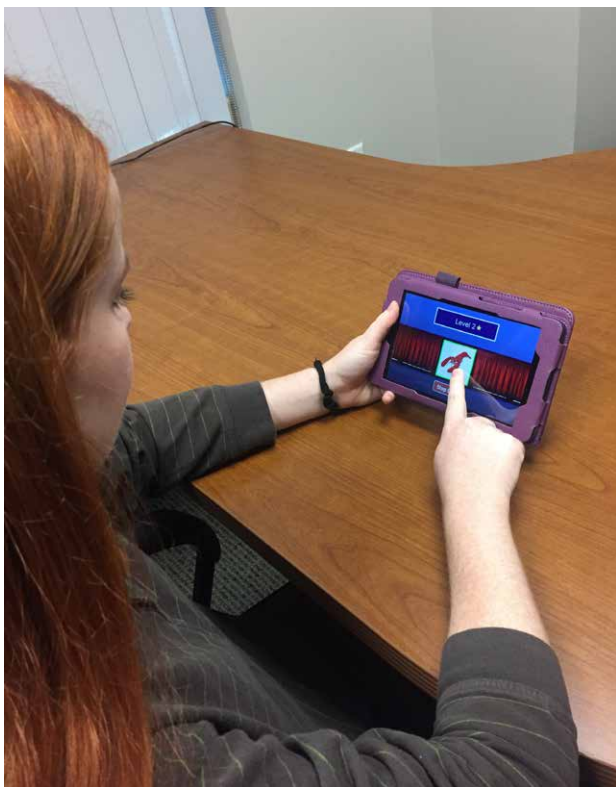
Courtesy of the UCI Working Memory & Plasticity Lab.

Addressing the Limited Evidence for Success

Brain training has become a billion-dollar business over the last decade. As Dr Pahor states 'The possibility of improving core cognitive functions is alluring, creating a high demand for brain training programs.' Despite the rapid growth in this sector, scientists remain cautious about the lack of evidence to support claims of success. One of the main controversies surrounds how the effectiveness of brain training programs are measured. Often participants are tested using very similar tasks to those used within the training. This makes it unclear whether learning can improve performance in different activities and real-world settings. Another limitation is the small groups of participants used in this research which makes it difficult to detect the individual differences that influence the key outcomes.

Nonetheless, the researchers believe that flawed methodologies do not mean we should rule out the positive effects of brain training. Instead, it is important to consider what these research studies were aiming to achieve. If the focus was the impact upon brain processes, then measures will not be set up to adequately assess the effectiveness of transfer to real-world settings. Drs Jaeggi, Pahor and Seitz emphasise that more research, using robust testing measures, is required to fully elucidate the benefits of specific brain training approaches, and critically, identify for whom these benefits can be seen.

The Effect of Multisensory Learning

The design principles that underpin brain training can have a significant impact on its effectiveness. Drs Jaeggi, Seitz and their research team have investigated the factors that may enhance program design. They theorised that features from the field of perceptual learning, in which learners use information from their experiences across multiple senses, could have a positive impact. Stimulating multiple senses throughout brain training could help to replicate real-life learning. When experiencing new situations, we can use vision, hearing, touch and even smell and taste to facilitate learning.

In 2020, Drs Jaeggi, Pahor, Seitz and their research team tested the impact of multisensory brain training. They demonstrated that combining auditory and visual learning enhanced abilities on untrained tasks. Participants trained using visuals alone, or alternating between audio and visual, did not perform as well as those completing the combined auditory and visual learning. This shows that using multiple senses helps to recreate realistic learning experiences and thus increasing the potential for broader transfer. Furthermore, these findings may be useful in designing brain training approaches for people who have specific sensory deficits.

Gamification of Training

Brain training programs often incorporate game-like features to enhance participant motivation. Much evidence already exists demonstrating that off-the-shelf videos games can improve players' perceptual and cognitive abilities. However, scientists are concerned that few of the successful principles found in regular video games are applied to commercially available brain training apps and products. The success of video games is not a random phenomenon – very carefully crafted levels, challenges and settings reduce player frustration and create a fun experience.

Clearly, adding simple graphics and sounds to regular cognitive tests does not have the same impact as utilising the more effective principles from video gaming. Without proper design, the introduction of gamification to brain training could reduce the effectiveness or even become a distraction. There is no doubt that gaming features can be a powerful motivator but when designing brain training there must be careful consideration given to which elements will enhance transferable learning. This is an important aim of ongoing work by Drs Jaeggi, Pahor and Seitz.
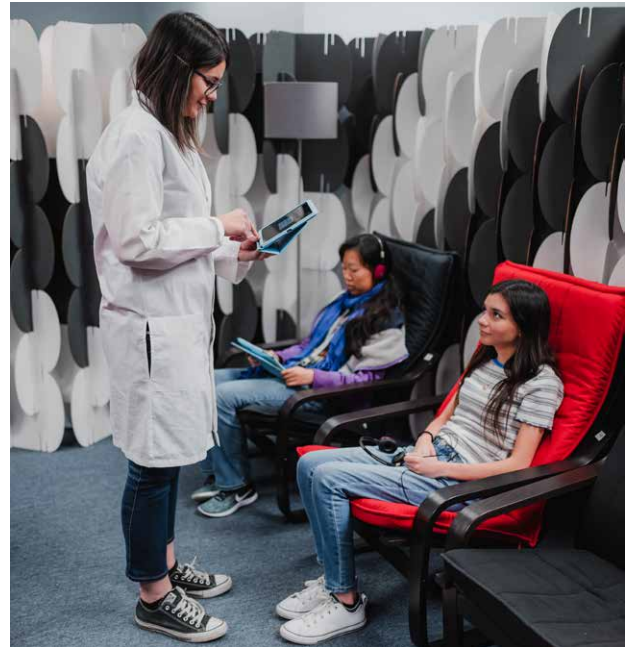
Courtesy of the UCR Brain Game Center.

The Impact of Individual Differences

Drs Jaeggi, Pahor and Seitz strongly believe that in order to enhance brain training we must acknowledge the many individual factors that come into play. Training can be impacted by age, general cognitive abilities and even attitudes. They argue that more adaptable programs are required to counteract or even capitalise on those individual differences.

Recently, Dr Jaeggi and her research team reviewed a number of scientific studies to highlight personal factors that impact brain training effectiveness. For example, it has been shown that those with room to improve show the most benefits. We know that cognition declines with age; hence, many brain training programs target older adults. The researchers noted that despite an emphasis on comparing the young and the old, there are very few studies capturing the effects across middle age. The research team also suggest that ceiling effects lead to doubt whether testing measures are sensitive enough to capture change, especially at high levels of performance.

Dr Jaeggi and her research colleagues have also uncovered attitudinal factors that may influence the effectiveness of brain training. An individual's belief that their own intelligence can be improved has been shown to positively impact their ability to apply learning from brain training. Placebo effects shown in a control group highlighted this discovery. Unsurprisingly, motivation also played a key role. People who perceived they had some weaknesses in their memory or cognition were more likely to engage with training and see positive results. Despite the belief that they needed brain training, these participants did not actually show poorer baseline performance than other participants. Furthermore, those who found the training

demanding were less likely to complete the intervention, and if they did, were less likely to benefit.

Not a 'One-Size-Fits-All' Approach

Individual differences highlight that there is no 'one-size-fits-all' approach in terms of brain training. People come from diverse backgrounds and have different experiences that may influence how they respond to training. There are varying needs and motivations for pursuing brain training, which dictate the kind of programs that are most suitable.

Drs Jaeggi, Pahor and Seitz are currently undertaking a large-scale citizen science study that aims to assess the impact of individual differences. They hope to provide robust evidence in order to argue against a 'one-size-fits-all' approach. The online study aims to recruit 30,000 participants and use a standard set of measures to assess multiple training approaches. By evaluating such large numbers and focusing on individual needs, the researchers will identify the individuals for whom brain training can provide the most benefits and the reasons why.

In line with the drive towards personalised medicine, it is clear that the important question now is not whether brain training works, but how to determine which type of training is right for the individual and their circumstances. Drs Jaeggi, Pahor and Seitz explain further that 'Our goal is to avoid a one-size-fits-all approach. Instead, we want to advance a new model based upon the premise that people are diverse in their cognitive strengths and needs, and therefore require the type of interventions that would serve them best.'

Meet the researchers

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Dr Susanne Jaeggi received PhDs in Cognitive Psychology and Neuroscience, as well as an advanced 'Habilitation' degree in Psychology from the University of Bern in Switzerland. She went on to become a Postdoctoral Fellow in Cognition and Cognitive Neuroscience at the University of Michigan. Currently, Dr Jaeggi is a Professor in Education and Cognitive Science at the University of California, Irvine. She studies working memory and related cognitive functions across the lifespan. Her major work focuses on the development of cognitive interventions and the investigation of how these may generalise to untrained non-cognitive abilities.

Dr Anja Pahor received her PhD in Behavioral and Cognitive Neuroscience from the University of Maribor in Slovenia and conducted postdoctoral work at the University of California, Riverside. She is a member of the UC Irvine Working Memory and Plasticity Lab, where she works as a Project Scientist, and the UC Riverside Brain Game Center for Mental Fitness and Well-being. Her research interests involve understanding the mechanisms underlying higher-level cognitive functions, particularly memory and reasoning. She is currently working on several multi-site research projects involving the assessment and training of executive functions in children and adults.

Dr Aaron R. Seitz received his PhD in Cognitive and Neural Systems from Boston University, and went on to conduct postdoctoral work in the Department of Neurobiology at Harvard Medical School in Neuroscience. He is now a Professor of Psychology and the Director of the UCR Brain Game Center for Mental Fitness and Well-being at the University of California, Riverside. Dr Seitz has a long-term interest in mechanisms of brain plasticity and transfer of learning. He uses psychophysical, physiological, brain imaging, psychopharmacological, genetic and computational approaches to understand mechanisms of human perception, attention, learning and memory.

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