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Brain Imaging: Advancing Towards The Educated Brain

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Abstract: Recent research empowers the the usage of mind-imaging strategies withinside the technology-improved studying (TEL) context to recognize students' cognitive tactics at some stage in technology-assisted studying, with the remaining purpose to enhance students' effects in those environments. Given the significance of the promising effect of mind-imaging strategies withinside the technology-improved studying context, it's miles of extreme significance to examine and look into the angle associated with intersection of those studies areas. However, no matter the developing hobby on this promising studies field, there may be a loss of systematic literature overview investigating how mind-imaging strategies had been implemented in technology-improved studying environments. Brain imaging strategies offers facts to the researchers approximately the shape and the operation of the mind. With these studies, it changed into aimed to benefit educators a one-of-a-kind factor of view concerning to the brains imaging strategies' contribution to the training. The mind imaging strategies had been grouped into 3 classes as structural, functional and metabolic. Additionally, it has been assumed that mind imaging strategies may also be utilized in training and this may make contributions educators to recognize how studying happens and decide the studying difficulties.

Key Words: Neuroscience, Education, Brain imaging techniques, Brain Researches

BRAIN IMAGING: AN INSIGHT VIEW

Brain imaging allows scientists and doctors to view and monitor the areas of the brain. Brain images can be produced using structural imaging techniques, commonly MRI (Magnetic Resonance Imaging) and CAT (Computed Axial Tomography), or functional imaging strategies like PET (Positron Emission Tomography) and functional MRI (fMRI). Structural imaging is designed to identify abnormalities such as strokes, bleeding, and tumours, while functional imaging procedures evaluate how the brain is working. Functional imaging techniques can be used to study the brain at rest, or during an activity such as when a person is hearing, seeing, feeling, moving, talking and thinking. These measurements are based on the flow of blood in the brain, and changing levels of oxygen in specific brain regions depending on that flow.

WHAT IS BRAIN IMAGING TECHNOLOGY?

The year 1924Trusted Source marked the first human electroencephalography (EEG), recorded by German psychiatrist Hans Berger. This early EEG was able to detect electrical waves in the brain that would rise and fall as different brain cells communicated with each other. Since then, neuroimaging techniques have gotten increasingly more sophisticated, and are an important tool for neurology and mental health specialists. Commonly used brain imaging techniques are:

- functional magnetic resonance imaging (fMRI)
- computerized tomography (CT)
- positron emission tomography (PET)
- electroencephalography (EEG) and magnetoencephalography (MEG)
- functional near-infrared spectroscopy (fNIRS)

One of the benefits of brain imaging is how easily it can be performed. It doesn't require invasive steps and often simply involves laying down and being still while the scan takes place around you. These modern brain imaging techniques enable doctors to map out the regions and functions of your brain in a non-invasive way.

BRAIN IMAGING TECHNIQUES

According to Antonenko et al. (2014), the basic premise in neuroscience research is that some performed tasks generate specific demands on the brain and cause changes in chemical and electrical neural activity, resulting in a host of physiological responses. Although there are multiple technologies and methods to measure physiological responses, some are more relevant to the educational research community. These include electroencephalography, functional near- infrared spectroscopy, and functional magnetic resonance imaging (Antonenko et al., 2014).

- **Electroencephalography:** It assesses changes in the brain's electrical activity (Antonenko et al., 2014) by placing several electrodes on the scalp (Kalagi et al., 2018). Four distinct rhythms, at least, are generated by this electrical activity in the brain: delta, theta, alpha, and beta waves (Basar, 1999). Through these brainwave rhythms, it is possible to analyse the amplitude, frequency, and power of neural oscillations. These data are analysed to expand our understanding of human cognitive architecture and the interaction between its components during cognitive tasks (Antonenko et al., 2014). EEG offers some significant advantages, such as high temporal resolution (providing evidence on the time course of neural processing), portability, and low cost. However, some drawbacks limit its utility as low spatial resolution, sensitivity to environmental noise, the inverse problem of source localization, and time-consuming preparation (Antonenko et al., 2014; Soltanlou et al., 2018). However, new advances in electrode headset design (e.g., wireless EEG) and signal processing have expanded the EEG range of applications, including research in educational settings (Antonenko et al., 2014).
- **Functional near-infrared spectroscopy**: There signal reflects the dynamics of cerebral blood flow (Antonenko et al., 2014). Specifically, fNIRS is an optical imaging technique that utilizes near-infrared light to measure changes of oxygenated and deoxygenated haemoglobin in cortical brain structures (Soltanlou et al., 2018). fNIRS presents significant advantages as recording in natural body position, relatively high temporal resolution, low sensitivity to motion artifacts, portability, and low cost (Soltanlou et al., 2018). However, fNIRS also presents some disadvantages as low spatial resolution, only cortical brain coverage, the influence of extra-cerebral hemodynamic, the influence of hair and skull characteristics (Soltanlou et al., 2018). In educational neuroscience research, fNIRS can be considered one of the most satisfactory techniques to investigate brain activation changes due to its diversity of advantages (Soltanlou et al., 2018).
- **Functional magnetic resonance imaging**: It can register changes in haemoglobin's oxygenation state (Antonenko et al., 2014). This brain-imaging technique requires that the participant be inserted into a scanner with a large, tube-shaped magnet. Consequently, images of the magnetic resonance signal, generated by the protons of water molecules in brain cells, are created (Antonenko et al., 2014). fMRI presents various advantages as whole-brain coverage, very high spatial resolution, structural and functional data, good source localization (Antonenko et al., 2014). Nevertheless, its disadvantages, which are related to relatively low temporal resolution, sensitivity to motion artifacts, constraints on body position, contraindications (e.g., heart pacemaker), high cost ($500,000 and up), limit the application of fMRI in educational research (Antonenko et al., 2014; Soltanlou et al., 2018). Therefore, fNIRS is gaining popularity among researchers in the educational neuroscience research field because it is a lower-cost non-invasive alternative to fMRI (Antonenko et al., 2014).

- **PET**: Work by Gordon Brownell and his colleagues at Massachusetts General Hospital in the 1950s contributed significantly to the development of positron emission tomography (PET) technology. Tomographic imaging techniques were developed further by Michel Ter-Pogosyan and colleagues in 1975, and PET has now become a popular imaging device in the medical and psychological world. PET scans work by measuring the levels of sugar glucose in the brain to determine where neurons are firing from. This can work as neurons use glucose as their fuel. During a PET scan, a radioactive tracer substance is injected into the blood. When parts of the brain become active, the blood which contains the tracer is sent to deliver oxygen, creating visible spots which can then be detected and used to create a video image of the brain. Areas which become active will be using more glucose than inactive areas. Because this is visible on the PET scanner, functions of these areas can be highlighted and can help detect any abnormalities. PET scans, however, are costly and invasive, as well as only being able to locate generalized areas of brain activity, rather than specific locations.

TECHNOLOGY -ENHANCED LEARNING

Technology-enhanced learning is the use of technologies in the learning and teaching process to support new learning experiences and enhance existing learning contexts (Keppell et al., 2015; Law et al., 2016). Currently, different technologies are aiming to support learning, such as Intelligent Tutoring Systems (ITS), Massive Open Online Courses (MOOCs), Computer-Supported Collaborative Learning (CSCL), and so on (Kulik & Fletcher, 2016; Oliveira & Bittencourt, 2019; Sung et al., 2017; Tenório et al., 2016). The technology-enhanced learning field has brought many research problems to researchers, such as how to identify the students' experience while using these environments (Oliveira, 2019) and how to adapt the systems to provide better results for each student (Oliveira et al., 2020). Brain-imaging techniques can be a path to address some of these previously stated challenges in the TEL field. These techniques can be used in TEL environments to analyse/measure the effects of different approaches on students' brain activities (Bamatraf et al., 2016b; Çakır et al., 2015; Samah et al., 2018) as well as to offer students a personalized experience (AranaL lanes et al., 2018; Ghiani et al., 2015). Combining these two research fields (Brain-Imaging Techniques and Technology Enhanced Learning) can mean an important advance for the great area of education, helping to better identify students' experience in educational systems or modelling systems individualities for each student. However, to advance the field, it is essential to know what has already been done and the area's advances in recent years.

NEUROEDUCATION: A PACING ROAD TO EDUCATION OF ANINDIVIDUAL

MRI scans are non-invasive, with minimal risk, and relatively inexpensive (less than a psychological test battery). Suppose a person can have a 20-minute structural MRI scan to determine his or her pattern of Gray and white matter in the areas salient for intelligence, like those proposed in the P-FIT. Will this pattern predict either the best subjects for this person to focus on or the best educational strategies to help this person learn a specific subject? Research studies to test these ideas are possible today if there was sufficient funding to test large, diverse samples such as that described recently articulating developmental brain processes associated with intelligence (Shaw et al., 2006). On an even more speculative note, neuroscience research suggests that there may be neural factors that increase the growth of regional gray matter or white matter. If such factors exist, drugs can be developed to stimulate them. Whether such drugs would work best during childhood or perhaps even in the adult brain is an empirical question. Suppose they work better in men or women. Neuroscience is advancing inexorably, so sooner or later, educators must engage these issues with expertise that is not easy to obtain. There are some resources concerning basic neuroscience and education available, but for the most part, they either ignore intelligence as a topic (Blakemore & Frith, 2005) or assert that there is no scientific definition of intelligence (Organization for Economic Co- operation and Development, OECD, 2007). Someday, we believe that our educational system will be informed by neuroscience knowledge, especially concerning intelligence,but how we get from here to there remains unclear.

As recent as 1991, a variation of MRI was invented, known as functional magnetic resonance imaging (fMRI). fMRI is a brain-scanning technique which works by measuring the blood flow in the brain when a person is performing a task. The main idea behind fMRI is that there is more neuronal activity in the brain during a task and that viewing this activity will lead to a greater understanding of how brain structure's function. fMRIs are an extension of MRIs which just show the structure of the brain.

In fMRIs, any activity in the brain will 'light up' on the scanner due to blood flow being flooded in that area. fMRIs make it possible to show when exactly activity is occurring and how brains can change with different experiences.

fMRIs give psychologists a new perspective on phenomena such as what happens in the brain when we are dreaming, listening to music, and whether certain tasks produce different responses in the brain.

fMRI is a non-invasive technique which also has high spatial resolution, meaning it is able to pinpoint almost the exact location that activity is occurring in the brain.

fMRI is also able to record signals from all regions of the brain, unlike other methods such as EEG that are better at detecting activity on the surface of the cortex.

However, fMRI has poor temporal resolution, with responses peaking about 5 seconds after neuronal electrical activity occurring. This makes it difficult to distinguish stimuli to response and therefore interpretations of fMRI data need to be analysed carefully.

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