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Role of Audiology in Brain by Using Near-Infrared Spectroscopy (NIRS) Technique

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DESCRIPTION

The Near-Infrared Spectroscopy (NIRS) technique makes use of the fact that hemoglobins absorb light at wavelengths between 650 nm and 1000 nm to identify variations in oxygenated haemoglobin (HbO2) and deoxygenated haemoglobin (Hbb) in biological tissue. Given that biological tissue is permeable to near-infrared light and that light photons traveling at these wavelengths can pass through tissue, haemoglobins can be found by counting the photons that escape absorption and reappear on the somatic surface. Furthermore, both HbO2 and Hbb can be detected using at least two different wavelengths because they both have absorption peaks at various infrared light spectrum levels (830 nm and 690 nm, respectively). The differences in the concentration of the two forms of hemoglobin associated with blood flow can then be inferred from the attenuation of the light signal re-emerging from the studied tissues. Evaluation of variations in HbO2 and Hbb concentrations that take place in certain areas of the cerebral cortex over a specified period of time is one of the main scientific and therapeutic applications of this technique. The fluctuation in HbO2 levels is thought to be a sign of cerebral blood flow and, consequently, of the functional activity of a particular cortical region. Instead, it is believed that the change in Hbb concentration is a sign of oxygen metabolism.

This technique is especially well suited for studying the physiology of the cerebral cortex in infants and very young children, who are not suitable for other functional neuroimaging techniques, such as functional Magnetic Resonance Imaging (fMRI) or Positron Emission Tomography (PET), due to obvious reasons. These methods, such as functional Magnetic Resonance Imaging (fMRI) or positron emission tomography, require either sedation or exposure to harmful radiation. Multichannel NIRS, despite having excellent temporal resolution, has just a few centimeters of spatial resolution and is now unable to match the accuracy of fMRI, which has a 1 mm discriminative capability. It's also important to keep in mind that NIRS can only image functional brain activity in the surface-level regions because it only penetrates to depths of around 3 cm. NIRS has been discovered to be particularly compatible with the existence of the CIs because it is a functional neuroimaging method unaffected by electrical artifacts. In recent years, it has been utilized to investigate the functional activation of the auditory cortex in both hearing-impaired adults and children with CIs, particularly the lateral temporal lobe and superior temporal sulcus. It was discovered that patients with CIs and good speech perception had temporal cortical activation similar to that of those with normal hearing, whereas patients with CIs who presented with a challenging perception of language stimulation had reduced activation of the same part of cortex. Recent research raises the notion that the brain reconfiguration that CI users undergo may actually improve speech perception and processing as a form of compensation. Using visual and vibro-tactile stimuli, multichannel brain NIRS has also been used to examine the neuroplastic remodelling of auditory cortices in profoundly deaf individuals without a CI. It was found that visual stimuli might activate the temporal cortex, but not tactile stimuli. These results support the recommendation that brain NIRS be used as a functional neuroimaging tool to direct post-implant rehabilitation intervention programming based on the improvement of the patient's auditory and linguistic outcomes. Additionally, evaluation of cortical remodeling following a protracted loss of auditory input in future CI recipients may aid in predicting the intervention's potential functional results.

However, the use of fNIRS to measure cognitive strain is very new. Research on the effects of attentional load on the frontal cortex in adults has demonstrated an inversely correlated relationship between HbO2 and the level of cognitive load, demonstrating that HbO2 is a reliable indicator of cognitive load during working memory and control tasks as well as visuomotor tasks. In older persons wearing hearing aids, HbO2 levels in the prefrontal cortex were likewise favorably correlated with listening effort. Adults with normal hearing demonstrate that listening effort depends on both hierarchical linguistic computation in the left hemisphere of the brain and higher cognitive auditory attention and working memory mechanisms in the frontal lobe. A unique pattern of functional rearrangement that is connected to successful hearing restoration with CIs has been identifiedusing fNIRS to assess functional connectivity. Higher

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cross-modal connectivity for auditory stimuli is associated with greater speech recognition abilities.

Although fNIRS has not yet been used to measure children's listening effort, it has been widely utilized in recent years to demonstrate infants' and kids' auditory attention, attention to speech, and speech processing. So, despite its limitations, brain NIRS can be suggested for the research of listening effort in the paediatric population with CIs. Similar to this, clinical protocols for the use of NIRS to assess speech processing in children with CIs have not yet been established, despite the fact that measures of speech processing with NIRS have been proposed for clinical practice, particularly in the area of language impairment and speech processing in schizophrenia.