**Using Brain Computer Interface To For Communication In Non-Speaking Autistic (NSA) Population**

**Background**

**Non-speaking autistic population**

“Non-speaking doesn't mean non-thinking,” mentioned by a non-speaking child (Grodin & McDonough, 2021). Around 25%to 35% of autistic population are not able to speak (Rose et al., 2016) while there is few studies for teaching verbal communication to non-speaking autistic population (Koegel et al., 2020). Autistic population need a sense of belonging to society and social inclusion, otherwise feeling isolated could affect their mental health and trigger suicidal ideas (Mitchell et al., 2021), which could be even more highlighted in those autistic who do not speak. Non speaking autistic population (NSAP) show a higher level of self-injury behaviors compared to speaking autistic population (Richards et al., 2012)

**Disadvantage of current AAC**

A meta-analysis compared AAC applications including Picture Exchange (PE), Picture Exchange Communication Systems (PECS), Speech Generating Devices (SGD) and found PECS and SGD are equally efficient, however, autistic participants preferred SGD applications (Aydin & Diken, 2020), indicating their preferences to use technology base methods. Further, their motor skills problems caused limited use of manual sign applications (Aydin & Diken, 2020).

Current AAC and related assistive technologies are not always equitably accessible in term of learnability, availability, affordability (Baxter et al., 2012; Elsahar et al., 2019; Moorcroft et al., 2019) and need training in theoretical and practical experiences for teachers (Baxter et al., 2012; Moorcroft et al., 2019)

**BCI and its application**

There have been growing interests in using brain-interface technology (BCI) based on electroencephalogram (EEG) for a variety of conditions such as autism, ageing, physical disabilities (Hossain & Doulah, 2020).

The classic applications of using BCI is to detect the pattern of task imagery. Researchers report that motor imagery signals can be detected using EEG signals to help people with disabilities including autism, physical disabilities, ageing adults (Hossain & Doulah, 2020) and a variety of outcomes, including rehabilitation (e.g., therapies to regain physical abilities), diagnosis (e.g., autism, coma), recreation (e.g., gaming, art), assistive technology (e.g., communication, mobility) (Zander et al., 2010).

**Benefit of BCI**

EEG based BCI can help interventional and diagnostic possibilities… BCI is easy to use and does not need physical or verbal respond…

**BCI application in autism**

BCI for autism population has been used to detect sound/music preferences for autistic children (Cibrian et al., 2018) and the music aligned with autistic child’s mood for using in therapy (Niu et al., 2022), to explore mental stress during arithmetic tasks (Sundaresan A et al., 2021), anxiety state (Penchina et al., 2020), emotional state (distress vs non-distress), engagement level in task, mental workload (Eldeeb et al., 2021; Fan et al., 2018; Val-Calvo et al., 2017), interest to tasks in autistic children by monitoring the level of attention (Ravindranathan et al., 2020), to classify joint attention (de Arancibia et al., 2020; M. G. Ezabadi & M. H. Moradi, 2021; Simoes et al., 2020), neurofeedback training to improve social skills (Teo et al., 2021), through a BCI video game to improve attention (Mercado et al., 2021), and to teach driving to autistic adolescents (Fan et al., 2018), improve joint social attention (Amaral et al., 2017; Bittencourt-Villalpando & Maurits, 2020; Castelo-Branco, 2019) and to teach interpreting emotional facial expressions and social skills (White et al., 2016). Overall, EEG-based BCI with an accurate algorithm using machine learning (ML) could be influential in leading us to understand and help autism (M. G. Ezabadi & M. H. Moradi, 2021). There is a variety of signal sources for using AAC including touch/breath activated, imaging, mechanical methods, and BCI methods for non-autistic population (Elsahar et al., 2019), however there is no evidence of using BCI for speech in NSAP or generally, to AAC devices for autism.

**Aim**

BCI can benefit autistic population including NSAP by facilitating communication between their internal world and external world, their peers, family members, friends, non-autistic population and via social media. It does not need training or using motor skills (Elsahar et al., 2019). Based on our literature review exploring autism and BCI keywords in multiple databases, we did not find any study working on verbal communication in NSAP. Only a recent review refers to the point of lack of BCI study for assisting speech in NSAP (Williams & Gilbert, 2020), however, there are studies have explored verbal communication in other population (J. van Kokswijk & M. Van Hulle, 2010; Khachatryan et al., 2015, 2016, 2018; Mora-Cortes et al., 2014; Wittevrongel et al., 2018) that could be enlightening for our journey by applying the principles for autism population. Therefore, our aim is to use BCI for NSAP to translate their brain signals to words and pictures, displayed on phone/computer monitor.

**Need for further research**

The use of BCI, which requires a interdisciplinary cooperation of researchers (with expertise in rehabilitation science, psychologist, clinicians, engineering, machine learning, signal processing) to improve its applicability and convenience as well as benefits for clients (Niu et al., 2022),

**Method**

We will use a mobile/portable EEG-based BCI to extract brain signals of non-speaking autistic participants when they are looking at pictures and hearing the name of the picture (multimodal approach). Then, the algorithm will be classified using ML techniques.

There are difficulties in training BCI for Autistic individuals (Kashihara, 2014). However, to control errors, there are a variety of approaches. For instance, a combination of Event Related Desynchronization (ERD)-based active BCI with gaze control, a hybrid BCI, may resolve the midas touch problem. And then, a passive BCI based on human error processing, bringing new forms of automated adaptation in BCI (Zander et al., 2010).

Further, using multimodal components (e.g., audio-visual) improves the accuracy in using BCI for speech compared to use one modal (Brumberg et al., 2018).

**BCI-P300 Paradigm**

“The stimulus presentation paradigm with the BCI-P300 is in many ways suitable for studies where the detection of EEG reaction characteristics for particular classes of stimuli and the predictive capacity of the EEG in terms of assigning one or another stimulus to particular classes are important.” (Ganin et al., 2018).

**Data analytic plan**

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