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

**[3-page 0.5 inch margins]**

**Background**

*Non-speaking autistic population*

The main specifier for autism diagnosis is language problems (*Diagnostic and Statistical Manual of Mental Disorders*, 2013). Around 25% to 35% of autistic population are not able to speak (Baghdadli et al., 2018; Rose et al., 2016; Wodka et al., 2013), however “Non-Speaking doesn't mean Non-Thinking,” poem by a non-speaking poet (Grodin & McDonough, 2021). Autistic population should be supported to communicate their desires, thoughts and feelings. However, there is few studies for teaching verbal communication to non-speaking autistic population based on a recent review (Koegel et al., 2020). Autistic people need a sense of belonging to society and social inclusion, but feeling isolated could affect their mental health and trigger a variety of emotional problems such as suicidal ideas (Mitchell et al., 2021) and self-injury behaviors, especially in non-speaking autistic population (Richards et al., 2012).

*Disadvantage of current AAC*

Augmented and Alternative Communication (AAC) is another option for non-speaking population to communicate. A meta-analysis by comparing different types of AAC applications (e.g., Picture Exchange (PE), Picture Exchange Communication Systems (PECS), Speech Generating Devices (SGD)), reported that autistic population prefer using technology-based AAC for speaking and communicating (Aydin & Diken, 2020). However, current AAC devices for non-speaking autistic population are not always equitably accessible in terms of learnability, availability, affordability (Baxter et al., 2012; Elsahar et al., 2019; Moorcroft et al., 2019). The use of AAC devices needs training for autistic individuals and extensive theoretical and practical experiences for teachers (Baxter et al., 2012; Moorcroft et al., 2019). Further, motor skills problems in autistic population can limit the use of some AAC application, such as manual sign apps (Aydin & Diken, 2020).

*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*

BCI is easy to use and does not need physical or verbal respond…

*BCI application in autism*

Based on our brief literature review (from 2015 to 2022), BCI for autism population can be classified in two main class, i.e., identification and rehabilitation purposes. For example, BCI can identify sound/music preferences of autistic children (Cibrian et al., 2018) and the music aligned with autistic child’s mood for using in therapy (Niu et al., 2022), 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, and mental workload (Eldeeb et al., 2021; Fan et al., 2018; Val-Calvo et al., 2017), interest to tasks by monitoring the level of attention of autistic children (Ravindranathan et al., 2020), to classify joint attention (de Arancibia et al., 2020; M. G. Ezabadi & M. H. Moradi, 2021; Simoes et al., 2020).

Rehabilitation-purposed BCIs for autism include using a BCI-based video game to improve attention (Mercado et al., 2021), using neurofeedback training to improve social skills (Teo et al., 2021), improve joint social attention (Amaral et al., 2017; Bittencourt-Villalpando & Maurits, 2020; Castelo-Branco, 2019), to teach interpreting emotional facial expressions and social skills (White et al., 2016) and to teach driving to autistic adolescents (Fan et al., 2018).

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 [to explain multi-department team]*

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**

*Participants*. We will recruit participants (N= , age = ) from autism communities and organizations. They may speak minimally or not be able to speak. For minimally speaking participants, word counts will be reported based on the guideline in a systematic review paper (Koegel et al., 2020).

*Study Protocol*. Participants receive multimodal auditory and visual stimulus simultaneously including a picture and playing the name of the picture via a rhythmic-expressed/articulated/pronounced audio. The preferences of autistic population in terms of pictorial and musical/rhythmic features are considered... Also, in language processing features, evidence recently state rhythmic feature in communication underlies inference, generation and prediction of morphemes, words and phrases without prior knowledge (Meyer et al., 2020). The studies report “Rhythmic auditory cueing” can be effective for rehabilitation practices (Hardy & LaGasse, 2013), referring to neurologic music therapy (Thaut, 2007) that uses rhythmic activities to improve cognitive, sensory and motor functions (Fedotchev, Dvoryaninova, et al., 2019; Fedotchev et al., 2016; Fedotchev, Parin, et al., 2019; Hardy & LaGasse, 2013; Mayer-Benarous et al., 2021).

…. a rhythmic element in stimuli can improve the accuracy of pattern recognition of signals …...

*Stimulus Feedback*.

*EEG acquisition*. 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).

*Measures*

Vineland Adaptive Behavior Scales (VABS)-Third edition (Cicchetti et al., 2013; Sparrow, 2011). This standardized semi-structured interview measures personal and social skills, receptive and expressive communication utterance and motor skills for all ages.

**Data analytic plan**

We use Deep Neural Networks (DNNs) for BCI data classification was adapted for language modelling (Kostas et al., 2021) to generate automatic speech recognition. A study (Kostas et al., 2021) refers to a wav2vec 2.0 framework (Baevski et al., 2020), used for a self-supervised speech recognition through “encoding speech audio via a multi-layer convolutional neural network and then masking spans of the resulting latent speech representations, these then can be fed to a transformer network to build representations capturing information from the entire sequence” (Kostas et al., 2021).

*Performance analysis*.

*EEG analysis*.

*Offline and online preprocessing*.

*BCI Decoder*.

*Performance Analysis*.

**References**

Amaral, C. P., Simões, M. A., Mouga, S., Andrade, J., & Castelo-Branco, M. (2017). A novel Brain Computer Interface for classification of social joint attention in autism and comparison of 3 experimental setups: A feasibility study. *Journal of Neuroscience Methods*, *290*, 105–115.

Aydin, O., & Diken, I. H. (2020). Studies Comparing Augmentative and Alternative Communication Systems (AAC) Applications for Individuals with Autism Spectrum Disorder: A Systematic Review and Meta-Analysis. *Education and Training in Autism and Developmental Disabilities*, *55*(2), 119–141.

Baevski, A., Zhou, H., Mohamed, A., & Auli, M. (2020). wav2vec 2.0: A Framework for Self-Supervised Learning of Speech Representations. *ArXiv:2006.11477 [Cs, Eess]*. http://arxiv.org/abs/2006.11477

Baghdadli, A., Michelon, C., Pernon, E., Picot, M.-C., Miot, S., Sonié, S., Rattaz, C., & Mottron, L. (2018). Adaptive trajectories and early risk factors in the autism spectrum: A 15-year prospective study. *Autism Research*, *11*(11), 1455–1467. https://doi.org/10.1002/aur.2022

Baxter, S., Enderby, P., Evans, P., & Judge, S. (2012). Interventions using high-technology communication devices: A state of the art review. *Folia Phoniatrica et Logopaedica: Official Organ of the International Association of Logopedics and Phoniatrics (IALP)*, *64*(3), 137–144. https://doi.org/10.1159/000338250

Bittencourt-Villalpando, M., & Maurits, N. (2020). *Linear SVM Algorithm Optimization for an EEG-Based Brain-Computer Interface Used by High Functioning Autism Spectrum Disorder Participants* (rayyan-811178156). *76*, 1875–1884.

Brumberg, J. S., Pitt, K. M., & Burnison, J. D. (2018). A Noninvasive Brain-Computer Interface for Real-Time Speech Synthesis: The Importance of Multimodal Feedback. *IEEE Transactions on Neural Systems and Rehabilitation Engineering: A Publication of the IEEE Engineering in Medicine and Biology Society*, *26*(4), 874–881. https://doi.org/10.1109/TNSRE.2018.2808425

Castelo-Branco, M. (2019). *An Interventional Study to Improve Social Attention in Autistic Spectrum Disorder (ASD): A Brain Computer Interface (BCI) Approach* (Clinical Trial Registration study/NCT02445625). clinicaltrials.gov. https://clinicaltrials.gov/ct2/show/study/NCT02445625

Cibrian, F. L., Mercado, J., Escobedo, L., & Tentori, M. (2018). *A step towards identifying the sound preferences of children with autism* (rayyan-811179831). https://www.scopus.com/inward/record.uri?eid=2-s2.0-85116318882&doi=10.1145%2f3240925.3240958&partnerID=40&md5=73c035813215ef4dd52bbcc6b8d07f3b

Cicchetti, D. V., Carter, A. S., & Gray, S. A. O. (2013). Vineland Adaptive Behavior Scales. In F. R. Volkmar (Ed.), *Encyclopedia of Autism Spectrum Disorders* (pp. 3281–3284). Springer. https://doi.org/10.1007/978-1-4419-1698-3\_255

de Arancibia, L., Sánchez-González, P., Gómez, E. J., Hernando, M. E., & Oropesa, I. (2020). *Linear vs Nonlinear Classification of Social Joint Attention in Autism Using VR P300-Based Brain Computer Interfaces* (rayyan-810833417). *76*, 1869–1874. https://www.scopus.com/inward/record.uri?eid=2-s2.0-85075887000&doi=10.1007%2f978-3-030-31635-8\_227&partnerID=40&md5=92f92349d48d4b9af10a9f5d2c1c58af

*Diagnostic and statistical manual of mental disorders: DSM-5TM, 5th ed* (pp. xliv, 947). (2013). American Psychiatric Publishing, Inc. https://doi.org/10.1176/appi.books.9780890425596

Eldeeb, S., Susam, B., Akcakaya, M., Conner, C., White, S., & Mazefsky, C. (2021). Trial by trial EEG based BCI for distress versus non distress classification in individuals with ASD. *SCIENTIFIC REPORTS*, *11*(1).

Elsahar, Y., Hu, S., Bouazza-Marouf, K., Kerr, D., & Mansor, A. (2019). Augmentative and Alternative Communication (AAC) Advances: A Review of Configurations for Individuals with a Speech Disability. *Sensors (Basel, Switzerland)*, *19*(8), 1911. https://doi.org/10.3390/s19081911

Fan, J., Wade, J. W., Key, A. P., Warren, Z. E., & Sarkar, N. (2018). EEG-Based Affect and Workload Recognition in a Virtual Driving Environment for ASD Intervention. *IEEE Transactions on Bio-Medical Engineering*, *65*(1), 43–51.

Fedotchev, A. I., Bondar, A. T., Bakhchina, A. V., Parin, S. B., Polevaya, S. A., & Radchenko, G. S. (2016). [Music-Acoustic Signals Controlled by Subject’s Brain Potentials in the Correction of Unfavorable Functional States]. *Uspekhi Fiziologicheskikh Nauk*, *47*(1), 69–79.

Fedotchev, A. I., Dvoryaninova, V. V., Velikova, S. D., & Zemlyanaya, A. A. (2019). Modern technologies in studying the mechanisms, diagnostics, and treatment of autism spectrum disorders. *Sovremennye Tehnologii v Medicine*, *11*(1), 31–38.

Fedotchev, A. I., Parin, S. B., Polevaya, S. A., & Zemlianaia, A. A. (2019). Effects of Audio–Visual Stimulation Automatically Controlled by the Bioelectric Potentials from Human Brain and Heart. *Human Physiology*, *45*(5), 523–526. https://doi.org/10.1134/S0362119719050025

Ganin, I. P., Kosichenko, E. A., & Kaplan, A. Y. (2018). Properties of EEG Responses to Emotionally Significant Stimuli Using a P300 Wave-Based Brain–Computer Interface. *Neuroscience and Behavioral Physiology*, *48*(9), 1093–1099.

Grodin, E., & McDonough, Y. Z. (2021, Summer). Autism and Her Writing: “Non-speaking doesn’t mean non-thinking.” *Lilith*, *46*(2), 7.

Hardy, M. W., & LaGasse, A. B. (2013). Rhythm, movement, and autism: Using rhythmic rehabilitation research as a model for autism. *Frontiers in Integrative Neuroscience*, *7*, 19. https://doi.org/10.3389/fnint.2013.00019

Hossain, M. Y., & Doulah, A. B. M. S. U. (2020). *Detection of Motor Imagery (MI) Event in Electroencephalogram (EEG) Signals using Artificial Intelligence Technique* (rayyan-810833409). https://www.scopus.com/inward/record.uri?eid=2-s2.0-85096410661&doi=10.1109%2fEWDTS50664.2020.9224634&partnerID=40&md5=e81cab68d4bda73503d3a3c6fea2330a

J. van Kokswijk & M. Van Hulle. (2010). Self adaptive BCI as service-oriented information system for patients with communication disabilities. *4th International Conference on New Trends in Information Science and Service Science*, 264–269.

Kashihara, K. (2014). A brain-computer interface for potential non-verbal facial communication based on EEG signals related to specific emotions. *Frontiers in Neuroscience*, *8*. https://www.frontiersin.org/article/10.3389/fnins.2014.00244

Khachatryan, E., Van Hulle, M., & Manvelyan, H. (2015). Cognitive evoked potentials: A method for investigation of language processing in brain. *New Armenian Medical Journal*, *9*(4), 32–37.

Khachatryan, E., Vanhoof, G., Beyens, H., Goeleven, A., Thijs, V., & Van Hulle, M. M. (2016). Language processing in bilingual aphasia: A new insight into the problem. *WIREs Cognitive Science*, *7*(3), 180–196. https://doi.org/10.1002/wcs.1384

Khachatryan, E., Wittevrongel, B., De Keyser, K., De Letter, M., & Hulle, M. M. V. (2018). Event Related Potential Study of Language Interaction in Bilingual Aphasia Patients. *Frontiers in Human Neuroscience*, *12*. https://www.frontiersin.org/article/10.3389/fnhum.2018.00081

Koegel, L. K., Bryan, K. M., Su, P. L., Vaidya, M., & Camarata, S. (2020). Definitions of Nonverbal and Minimally Verbal in Research for Autism: A Systematic Review of the Literature. *Journal of Autism and Developmental Disorders*, *50*(8), 2957–2972. https://doi.org/10.1007/s10803-020-04402-w

Kostas, D., Aroca-Ouellette, S., & Rudzicz, F. (2021). BENDR: Using Transformers and a Contrastive Self-Supervised Learning Task to Learn From Massive Amounts of EEG Data. *Frontiers in Human Neuroscience*, *15*. https://www.frontiersin.org/article/10.3389/fnhum.2021.653659

M. G. Ezabadi & M. H. Moradi. (2021). A Novel Algorithm for Detection of Social Joint Attention from single-trial EEG signals of Autistic Spectrum Disorder (ASD). *2021 28th National and 6th International Iranian Conference on Biomedical Engineering (ICBME)*, 288–293.

Mayer-Benarous, H., Benarous, X., Vonthron, F., & Cohen, D. (2021). Music Therapy for Children With Autistic Spectrum Disorder and/or Other Neurodevelopmental Disorders: A Systematic Review. *Frontiers in Psychiatry*, *12*, 643234. https://doi.org/10.3389/fpsyt.2021.643234

Mercado, J., Escobedo, L., & Tentori, M. (2021). A BCI video game using neurofeedback improves the attention of children with autism. *Journal on Multimodal User Interfaces*, *15*(3), 273–281.

Meyer, L., Sun, Y., & Martin, A. E. (2020). “Entraining” to speech, generating language? *Language, Cognition and Neuroscience*, *35*(9), 1138–1148. https://doi.org/10.1080/23273798.2020.1827155

Mitchell, P., Sheppard, E., & Cassidy, S. (2021). Autism and the double empathy problem: Implications for development and mental health. *British Journal of Developmental Psychology*, *39*(1), 1–18. https://doi.org/10.1111/bjdp.12350

Moorcroft, A., Scarinci, N., & Meyer, C. (2019). A systematic review of the barriers and facilitators to the provision and use of low-tech and unaided AAC systems for people with complex communication needs and their families. *Disability and Rehabilitation: Assistive Technology*, *14*(7), 710–731. https://doi.org/10.1080/17483107.2018.1499135

Mora-Cortes, A., Manyakov, N. V., Chumerin, N., & Van Hulle, M. M. (2014). Language Model Applications to Spelling with Brain-Computer Interfaces. *Sensors*, *14*(4), 5967–5993. https://doi.org/10.3390/s140405967

Niu, X., Ji, S., Shen, T., Sun, M., Qiao, X., & Wang, T. (2022). *Invention and Application of Routine Treatment and New Intelligent Treatment Technology in Rehabilitation Training of Autistic Children* (rayyan-811179782; Vol. 799). https://www.scopus.com/inward/record.uri?eid=2-s2.0-85116475976&doi=10.1007%2f978-981-16-5912-6\_60&partnerID=40&md5=1128df18192077adf043272962464cd0

Penchina, B., Sundaresan, A., Cheong, S., & Martel, A. (2020). *Deep LSTM Recurrent Neural Network for Anxiety Classification from EEG in Adolescents with Autism* (rayyan-811179809; Vol. 12241). https://www.scopus.com/inward/record.uri?eid=2-s2.0-85092148309&doi=10.1007%2f978-3-030-59277-6\_21&partnerID=40&md5=3d52839b4b9b843f5c4cdb905d7c4c61

Ravindranathan, R., Tommy, R., & Athira Krishnan, R. (2020). *Experimental VALidation of findings using BCI in Autistic kids- (EVAL BCI)* (rayyan-811179799). *2020*, 658–661. https://www.scopus.com/inward/record.uri?eid=2-s2.0-85098932549&doi=10.1109%2fTENCON50793.2020.9293905&partnerID=40&md5=bffc5b62b7e2de2fd4cd1d5c752a2f53

Richards, C., Oliver, C., Nelson, L., & Moss, J. (2012). Self-injurious behaviour in individuals with autism spectrum disorder and intellectual disability. *Journal of Intellectual Disability Research: JIDR*, *56*(5), 476–489. https://doi.org/10.1111/j.1365-2788.2012.01537.x

Rose, V., Trembath, D., Keen, D., & Paynter, J. (2016). The proportion of minimally verbal children with autism spectrum disorder in a community-based early intervention programme. *Journal of Intellectual Disability Research: JIDR*, *60*(5), 464–477. https://doi.org/10.1111/jir.12284

Simoes, M., Borra, D., Santamaria-Vazquez, E., GBT-UPM, Bittencourt-Villalpando, M., Krzeminski, D., Miladinovic, A., Neural\_Engineering\_Group, Schmid, T., Zhao, H., Amaral, C., Direito, B., Henriques, J., Carvalho, P., & Castelo-Branco, M. (2020). BCIAUT-P300: A Multi-Session and Multi-Subject Benchmark Dataset on Autism for P300-Based Brain-Computer-Interfaces. *Frontiers in Neuroscience*, *14*(101478481), 568104.

Sparrow, S. S. (2011). Vineland Adaptive Behavior Scales. In J. S. Kreutzer, J. DeLuca, & B. Caplan (Eds.), *Encyclopedia of Clinical Neuropsychology* (pp. 2618–2621). Springer. https://doi.org/10.1007/978-0-387-79948-3\_1602

Sundaresan A, Penchina B, Cheong S, Grace V, Valero-Cabré A, & Martel A. (2021). Evaluating deep learning EEG-based mental stress classification in adolescents with autism for breathing entrainment BCI. *Brain Informatics*, *8*(1), 13.

Teo, S.-H. J., Poh, X. W. W., Lee, T. S., Guan, C., Cheung, Y. B., Fung, D. S. S., Zhang, H. H., Chin, Z. Y., Wang, C. C., Sung, M., Goh, T. J., Weng, S. J., Tng, X. J. J., & Lim, C. G. (2021). Brain-computer interface based attention and social cognition training programme for children with ASD and co-occurring ADHD: A feasibility trial. *Research in Autism Spectrum Disorders*, *89*. https://www.scopus.com/inward/record.uri?eid=2-s2.0-85119291464&doi=10.1016%2fj.rasd.2021.101882&partnerID=40&md5=4ecc58434964bc9320129a2b88f4edab

Thaut, M. (2007). *Rhythm, Music, and the Brain: Scientific Foundations and Clinical Applications*. Routledge. https://doi.org/10.4324/9780203958827

Val-Calvo, M., Grima-Murcia, M. D., Sorinas, J., Álvarez-Sánchez, J. R., de la Paz Lopez, F., Ferrández-Vicente, J. M., & Fernandez-Jover, E. (2017). *Exploring the physiological basis of emotional HRI using a BCI interface* (rayyan-810833448; Vol. 10337). https://www.scopus.com/inward/record.uri?eid=2-s2.0-85027040314&doi=10.1007%2f978-3-319-59740-9\_27&partnerID=40&md5=21596a983a1e827d770127cbb0a6ab41

White, S. W., Richey, J. A., Gracanin, D., Coffman, M., Elias, R., LaConte, S., & Ollendick, T. H. (2016). Psychosocial and Computer-Assisted Intervention for College Students with Autism Spectrum Disorder: Preliminary Support for Feasibility. *Education and Training in Autism and Developmental Disabilities*, *51*(3), 307–317.

Williams, R. M., & Gilbert, J. E. (2020). Perseverations of the academy: A survey of wearable technologies applied to autism intervention. *International Journal of Human Computer Studies*, *143*. https://www.scopus.com/inward/record.uri?eid=2-s2.0-85086141303&doi=10.1016%2fj.ijhcs.2020.102485&partnerID=40&md5=9556eba3ca3de0996c01ee6ceceab92e

Wittevrongel, B., Khachatryan, E., Fahimi Hnazaee, M., Carrette, E., Dauwe, I., Gadeyne, S., Meurs, A., Boon, P., Van Roost, D., & Van Hulle, M. (2018). Towards asynchronous speech decoding. *Frontiers in Neuroscience*, *12*. https://doi.org/10.3389/conf.fnins.2018.95.00085

Wodka, E. L., Mathy, P., & Kalb, L. (2013). Predictors of Phrase and Fluent Speech in Children With Autism and Severe Language Delay. *Pediatrics*, *131*(4), e1128–e1134. https://doi.org/10.1542/peds.2012-2221

Zander, T. O., Kothe, C., Jatzev, S., & Gaertner, M. (2010). Enhancing Human-Computer Interaction with Input from Active and Passive Brain-Computer Interfaces. In D. S. Tan & A. Nijholt (Eds.), *Brain-Computer Interfaces: Applying our Minds to Human-Computer Interaction* (pp. 181–199). Springer. https://doi.org/10.1007/978-1-84996-272-8\_11