A Feasibility Study: Application Of Brain-Computer Interface In Augmentative And Alternative Communication For Non-Speaking Autistic Population

Background

One of the important diagnostic criteria for autism diagnosis is communication problems [1]. Around 25% to 35% of the autistic population are not able to reveal spoken communication [2–4]. However, "Non-Speaking doesn't mean Non-Thinking," as mentioned in a poem by a non-speaking person [5]. All people have a basic human right to have the resources and supports necessary to communicate their desires, thoughts, & feelings [6]. Autistic individuals cannot effectively communicate their needs and desires. This can increase feeling isolated and trigger a variety of emotional problems (e.g., depression) and self-injury behaviors [7], especially in the non-speaking autistic population [8,9].

There are a variety of approaches (such as Didactic and naturalistic ABA, Pivot Response Treatment, Discrete Trial Training[10]) that benefit early childhood to elicit their speech[11]. However, the evidence indicates the difficulty of teaching verbal communication to children after the age of five [12–15]. Besides, there are few studies for teaching directly expressive verbal communication to the non-speaking autistic population based on a recent review though there is a substantial literature on teaching pre-verbal skills (e.g., joint attention, imitation) [12].

In this regard, technology-based Augmented and Alternative Communication (AAC) can be a better strategy for the non-speaking autistic population. AAC benefits the non-speaking autistic population to communicate their needs, thoughts, and desires[16–18]. A meta-analysis comparing different types of AAC applications (e.g., Picture Exchange [PE], Picture Exchange Communication Systems [PECS], Speech Generating Devices (SGD)), reported that Both SGD and PECS are rated as effective in helping autistic people to communicate basic needs, wants and desires [18]. It also reported that many in the non-speaking autistic population prefer using technology-based AAC for communicating[18]. Tech-based AAC compensates for some difficulties in speaking that older children and adolescents experience[16–18] although the use of AAC is "severely understudied" for autistic adolescents and adults[19–21], suggesting a burning need for developing high-tech AAC considering each autistic person's needs[19]. AACs have been less effective for older children and adults compared to preschoolers (5 and younger)[22,23]. AAC should be easy to use, with low cognitive demand, and address different needs of autistic adolescents [19,21]. Currently, AAC applications, however, are not equitably accessible in terms of availability in rural areas, affordability for people with diverse socioeconomic statuses, and learnability[24–26]. To use of AAC devices effectively requires training for autistic individuals and extensive theoretical and practical experiences for teachers [11,24,26].

There are inherent limitations in the use of AAC applications for those who have the most significant learning needs, multiple disabilities, and/or motor skills problems [17,18,27,28] as well as those who have the least functional speech [22]. Considering the potential of AAC, we aim to expand its modalities for the autistic population by adding brain-interface technology (BCI). BCI can translate brain signals into identifiable words, or/and audiovisual output. The AAC-BCI has been suggested as a beneficial approach for those with significant or multiple disabilities such as Rett syndrome [28] as it has short training times and a simple control task. Further, by direct translation of the brain signals to audio/visual output (or in other words—by direct, natural, neural control of assistive technologies [29]), the limitations of traditional AAC devices such as the misattribution of motor movement of participants [30], can be resolved [29].

There has been growing interest in using electroencephalogram (EEG)- based BCI for a variety of conditions, (e.g., autism, aging, and physical disabilities) [31] and a variety of outcomes including rehabilitation (e.g., therapies to regain physical abilities), diagnosis (e.g., coma), recreation (e.g., gaming, art), assistive technology (e.g., communication, mobility) [32]. Researchers [33] have found that EEG-based BCI with an accurate algorithm using machine learning (ML) could be influential in leading us to understand and help autistic people develop the capacity to effectively communicate their thoughts, feelings, and ideas. Further, BCI is easy to use and does not need training or using motor skills on part of the participants [25]. The evidence indicates using a steady-state visually evoked potentials (SSVEP) paradigm in BCI can contribute to efficient, accurate communication [34]. SSVEP can be applied to a variety of populations and conducted in a short time, without needing an overt response, with a high signal-to-noise ratio (SNR) and high information transfer rate (ITR) [34,35].

Based on our brief literature review (from 2015 to 2022), BCI studies in the autism field can be classified into two main categories - identification and training purposes. For example, BCI can be used to identify signal patterns related to sound/music preferences [36] and the music consistent with autistic children's moods for therapy purposes [37]. Further, the signal patterns related to mental stress [38,39], interest level in a task, and mental workload in autistic children can be detected using BCI [40–43]. Social joint attention of autistic children also can be detectable using the BCI technique [33]. Among autistic

children, training-purposed BCIs have been shown to improve attention using a BCI-based video game [44], social skills using neurofeedback training [45], social joint attention [46–50], and learning to interpret emotional facial expressions and social skills [51] and learning to drive for autistic adolescents [41].

Current studies indicate that using BCI can be useful and feasible in the autism population to improve social skills and teach specific tasks. However, there is no evidence of using BCI to expand AAC or improve communication for autistic people [52]. There is a variety of AAC-BCI used with other populations [25,53–59] and established literature on AAC for those with cognitive and literacy problems[58] that could be enlightening for our project by adapting their principles and knowledge [58] for us with the autistic population.

An EEG-based BCI is popular to use because it is a non-invasive, safe, and more affordable technique compared to other devices and can facilitate accurate communication [29]. *We aim to explore the use of an EEG-based BCI in AAC (12 pictures in this study) for the Non-Speaking Autistic population.* We will study the feasibility of BCI+AAC in autistic individuals who already use AAC successfully because they will not have difficulty with the motor responses and we can explore their comprehension across different modalities. Further, we can compare the results of using BCI with pictorial-AAC conditions and AAC without BCI conditions. If the results of this project are promising, the possibility of BCI-AAC will be considered for those with significant and multiple disabilities (e.g., autism with significant intellectual disabilities, neurodevelopmental disabilities, such as Rett syndrome).

Aim

The proposed study aims to explore the application of BCI-AAC to autistic youth and young adults. Brain signal patterns will be detected using an SSVEP-based BCI in response to visual stimuli (12 pictures) in the non-speaking autistic population. Recognized brain signal patterns from participants will subsequently be translated into audio output presented via a phone app or computer.

Method

Participants. We will recruit participants (N= 15, age = 12 -18) from autism communities and organizations. They may speak minimally or not be able to speak. For minimally speaking participants, word counts will be assessed based on the guideline to define the level of speech [12]. Inclusion criteria: participants should have a formal diagnosis of either autism or neurodevelopmental disability. Those with secondary conditions of mild intellectual disabilities (ID) as well as those without ID will be included. Participants should already have demonstrated an ability to use AAC as well as have normal vision or corrected normal vision (not less than 20/100 on a Snellen test). Photosensitivity assessment will be checked before enrolment in the study with visual light sensitivity questionnaire-8 (VLSQ-8). Exclusion criteria: participants who do not have the mentioned formal diagnoses, those with epilepsy history, those who have metallic cranial implants, and those with moderate or most significant ID will be excluded. Before starting recruitment, the IRB application will be submitted and once it is confirmed, the recruitment will be started. The consent (parent) and assent (youth with ASD) letters will be provided for those who declare their interest in the study voluntarily.

Measures. The Peabody Picture Vocabulary Test, 5th Edition (PPVT-5)[60,61]. This standardized norm-referenced instrument measures receptive language. Further, before each conduction, the comprehension of participants, or receptive attention, from each experiment picture will be checked by asking them to point out each picture by telling the name of the picture. The number of distinct words for minimally-speaking participants will be reported, which was recommended for a clear language phenotype of participants[12]. *Social Communication Questionnaire (SCQ)*[62], a parent questionnaire, will be administered for autism scores and has an excellent concurrent validity. *Early Reading Screening Instrument (ERSI)* [63] will assess knowledge of letters, the concept of words, and word recognition. This test gives information regarding participants' degree of literacy. Overall, we will be able to have a clear phenotype of participants regarding the current levels of reading, receptive language and autism scores.

Study Protocol. *Task design and BCI modality:* A total of 12 pictures (i.e., AAC) will be selected for the task. In each trial, 4 pictures will randomly be presented on an LCD monitor in front of the subject and 4 LEDs placed in the top left (1), top right (2), down left (3), and down right (4), of the monitor. LEDs flicker with 8, 10, 12, and 15 Hz respectively. Subjects will be requested to select the output command (i.e., one of 4 pictures on the monitor) by paying attention to a sound that defines the number of the picture along with a visual cue (i.e., an arrow pointing at the picture). Each session will include 120 trials and each picture will be presented 10 times. Each trial time is equal to 7 seconds including 5 seconds picture presentation followed by a 2-second rest black/white screen (the total duration of each session will be 14 minutes). Overall,

3 sessions will be presented by inserting about a 5-minute break between sessions. The schematic task design and presentation are shown in Figure 1.

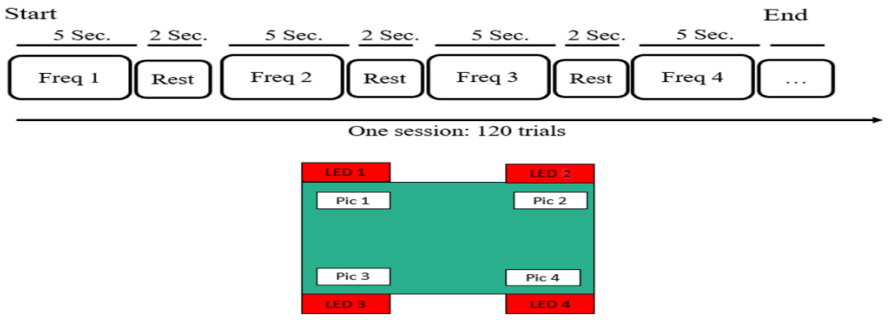

Figure 1: Schematic presentation of task.

Data acquisition: Eight channels of EEG signals will be acquired using a 10-20 standard system. Electrodes will be placed in occipital and parietal areas. The right ear and Fpz are dedicated to reference and ground electrodes respectively. Online notch (50 Hz) and bandpass filters (2-100 Hz) will be used. The frequency sampling frequency in this study is 512 Hz. The location of EEG electrodes is depicted in Figure 2. Synchronization pulses/trigger signals will be recorded simultaneously with EEG signals.

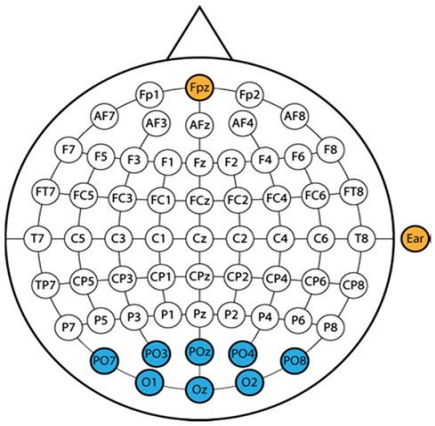

Figure 2: The location of EEG electrodes.

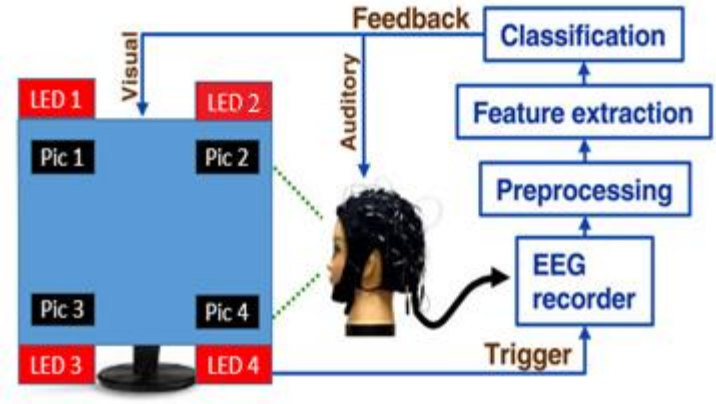

Figure 3: General block diagram of the experimental setup and data analysis.

Data analysis. Firstly, EEG data will be preprocessed with a baseline correction and offline appropriate bandpass filters. Then the data of each trial will be extracted using triggers/ synchronization pulses. After the preprocessing, extracted signals of each trial will be analyzed with time, frequency, and time-frequency analysis. Informative features for each analysis will be used in the input table of machine learning methods. Machine learning methods (e.g., SVM, Decision tree, etc.) classify the signals and determine the output command. A general block diagram of the experimental setup and data analysis is illustrated in Figure 3. Further, the data from the SCQ, PPVT-5, and ERSI will be reported and analyzed descriptively.

Performance analysis. Two well-known criteria will be measured for validation of the analysis. Accuracy (Acc) defines the fraction of corrected trials for all trials (Eq.1). Information transfer rate (ITR). A general evaluation metric devised for BCI systems determines the amount of information that is conveyed by a system's output. ITR is equal to information transferred in bits per trial, N= number of targets, and P is equal to the classification accuracy. It is calculated by dividing the number of correct command classifications by the total number of classified commands (Eq.2).

$$Acc = \frac{\#\ Correct\ selected\ trials}{\#\ All\ trials} \quad \text{(Eq.1)}$$

$$ITR = log_2 N + P\ log_2 P + (1-P)\ log_2\left(\frac{1-P}{N-1}\right) \quad \text{(Eq. 2)}$$

Other requirements for application

Which MIDB cores will be utilized to facilitate the research? (½ page)

Considering the interdisciplinary nature of the proposed project, we will collaborate across multiple departments/centers at MIDB as follows. Jessica Simacek, with extensive knowledge in autism and interdisciplinary research areas, the director of "*TeleOutreach Core (TOC)*" core, and Mark Fiecas with the interdisciplinary areas including EEG and time series, the director of "*The Measurement and Human Phenotyping Core (MHPC)*" contribute to this project. TOC and MHPC will facilitate this project by providing the related knowledge and skills on autism, brain science as well as equipment (e.g., EEG), data acquisition (EEG data), and testing rooms (to conduct surveys and experiments).

Applications should provide a statement of how the work fits the mission of the MIDB (½ page) and confirm whether the study will take place at MIDB.

The use of BCI requires interdisciplinary cooperation of researchers (with expertise in rehabilitation science, psychology, clinicians, machine learning, and signal processing) to improve its applicability and convenience as well as benefits for clients [37]. The proposed project will require the use of MIDB research facilities testing rooms and EEG facilities and assistance. For this reason, MIDB can be an appropriate place where the project can take place. The current project brings experts from different fields to improve life outcomes and quality of life by facilitating communication for autistic youth and young adults.

Updated CV

In the next page.

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EDUCATION

Allameh Tabataba'i University, Tehran, Iran
Department of Psychology, Ph.D. Psychology and Special Education 2017
Degree awarded with Highest Distinction in recognition of honors dissertation:
"Developing Comprehensive Emotion Regulation Program (CERP) and Evaluating its Effectiveness on Emotion Regulation, Executive Functions and Social Problem-Solving in Children with LD"

University of Tehran, Tehran, Iran
Department of Psychology and Education of Exceptional Children,
M.A. Psychology and Special Education 2012
Degree awarded with Highest Distinction in recognition of honors thesis:
"Designing an expert system to screen for autism"

University of Isfahan, Esfahan, Iran
Department of Psychology and children with special needs,
B.A. Psychology and Special Education 2009
Degree awarded with Highest Distinction in recognition of honors
"Emotional problems and brain lesions in children with stuttering in Shiraz"

RESEARCH EXPERIENCE

University of Minnesota, Minneapolis, MN
Institute on Community Integration
ARRT Postdoctoral Associate 2021-present
Literature Review, Analyzing Data, Writing Grant Proposal, Deigning Questionnaires, Designing Projects, Applying For Grants, Writing Budgets

Norwegian University of Science and Technology (NTNU), Norway
Department of ICT and Science 2019-2020
Social Robot Lab
ERCIM Postdoctoral fellow
Developing Projects, Conduction, IRB, Grant Writing, Presenting Paper Conferences, Exchange Program, Leaning and Working With Social Robots and Other Technologies

University of Shahid Beheshti, Iran
Department of Psychology and Education 2017-2018
Research Assistant, writing manuscripts, writing books, translation, and statistical analysis

University of Tehran, Iran
School of Electrical and Computer Engineering
Researcher 2011-2019
Collaborating with social robot projects, developing interventions, analyzing data, behavioral coding for videos, writing manuscripts

University of Tehran, Iran
Faculty of Psychology and Educational Science
Research Assistant 2009-2019
Collaborating with anger management project, social problem solving project, translating, analyzing data, writing manuscripts, Literature review, book revision

Tarbiat Modares University, Iran
Faculty of education
Research Assistant 2014-2016
Collaborating with Longitudinal project on educational acceleration and radical educational acceleration, writing manuscripts, literature review

Ministry of Education, Iran
Research Institute for EC
Research Assistant 2013-2015
Collaborating with early identification of children with learning disabilities project and developing program to identify adaptive problem in children, literature review, organizing material

PUBLICATIONS

Journal Articles (in English)

Mahmoudi, M., Hameed, A. I. (under review). Attractiveness, acceptability and likeability of socially assistive robots for the elderly: a literature review. International Journal of Social robotics.

Mahmoudi, M., Southam-Gerow, M.A., & Akbari-Zardkhaneh, S. (In review). Emotion Regulation in Children with Learning Disorders: A Preliminary Comparative Study.

Akbari Zardkhaneh, S., Zanganeh, A., Mahdavi, M., Mansour-Kiaee, N., Mahmoudi, M., Jallalat-e-Danesh, M., & Tahmasebi-Garmtani, S. (in review). Development and Psychometric Evaluation of the Nemad Electronic Mental-Health Assessment Devices for Children (NEMAD-C): Parent and Teacher Reports. Social Psychiatry and Psychiatric Epidemiology (SPPE).

Soleiman, Pegah, Hadi Moradi, Maryam Mahmoudi, Mohyeddin Teymouri, and Hamid Reza Pouretemad. (2021). "Teaching Turn-Taking Skills to Children with Autism Using a Parrot-Like Robot." ArXiv:2101.12273 [Cs], January 28, http://arxiv.org/abs/2101.12273.

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and Family Problem-Solving Skills, Int J Behav Sci, 6.

Mahmoudi M, Akbari-Zardkhaneh S, Zadeh AAB, Ghobari-Bonab B, Shokoohi-Yekta M, et al. (2018) An Autism Screening Expert System: Reliability, Validity and Factorial Structure. Autism Open Access 8: 230. doi:10.4172/2165- 7890.1000230

Shokoohi-Yekta, M., Alimohammadi Malayeri, S., Akbari Zardkhanhe, S., & Mahmoudi, M. (2015). Effectiveness of an Intervention Program to Improve Parent-Adolescent Relationships. Procedia - Social and Behavioral Sciences, 205, 43 – 47.

Soleimman-Dehkordi, P., Moradi, H. Mahmoudi, M., Pouretemad, HR. (2015). The Design, Development, and Deployment of RoboParrot for Screening Autistic Children. Int J of Soc Robotics. 7:513–522.

Shokoohi-Yekta, M., Mahmoudi, M., Ghobari- Bonab, B., Bagherzadeh, A. A., Moradi, H., Pouretemad, H., Akbari Zardkhaneh, S., & Lotfi, S. (2013). Developing Autism Screening Expert System (ASES). AWERProcedia Information Technology & Computer Science, 04, 1074-1078.

Shokoohi-Yekta, M., Mahmoudi, M., Ghobari- Bonab, B., Akbari Zardkhaneh, S., & Lotfi, S. (2013). Online expert system for screening autism: an item analysis. AWERProcedia Information Technology & Computer Science, 04, 1074-1078.

Soleimman-Dehkordi, P., Salehi, S., Mahmoudi, M., Ghavami, M. Moradi, H. Pouretemad, HR. (2014). RoboParrot: A robotic platform for human robot interaction, case of autistic children. IEEE, Proceeding of the 2nd RSI/ISM International Conference on Robotics and Mechatronic, October 15-17, 2014, Tehran, Iran

Shokoohi-Yekta, M., Mahmoudi, M., Ghobari- Bonab, B., Akbari Zardkhaneh, S., & Lotfi, S. (2013). Designing an expert system to screen for autism: Investigating psychometric properties. AWERProcedia Information Technology & Computer Science, 04, 1074-1078.

Soleimman-Dehkordi, P., Salehi, S., Mahmoudi, M., Teimouri, M., Moradi, H. Pouretemad, HR. (2011). The Use of RoboParrot in the Therapy of Children with Autism Children: In Case of Teaching the Turn-Taking Skills, Springer-Verlag Berlin Heidelberg.

Journal Articles (in Persian)

Shokoohi-Yekta, M., Akbari Zardkhaneh, S., & Mahmoudi, M. (In reviewing). Effectiveness of psycho-social training package on anger and aggression in urban bus drivers. Security and Social Order Strategic Studies Journal.

Mahmoudi, M., Borjali, A., Alizadeh, H., Ghobari-Bonab, B., Ekhtiar, H., & Akbari-Zardkhaneeh, S. (In reviewing). Emotion understanding in children with learning disorders and normal children. Journal of Clinical Psychology Andishe va Raftar.

Shokoohi-Yekta, M., Akbari Zardkhaneh, S., Mahmoudi, M., & Dashti, D. (2018). Efficacy of anger management training on hostility and well- being of parents. Knowledge & Research in Applied Psychology, 19. No. 2 (Continuous No. 72)- summer, PP: 44-53.

Shokoohi-Yekta, M., Akbari Zardkhaneh, S., & Mahmoudi, M. (2017). Effectiveness of Anger Management Training based on Cognitive-Behavioral Approach on Parents' Aggression and Mental Health. Psychological Research, 20, 1, 7-22.

Shokoohi-Yekta, M., Akbari Zardkhaneh, S., Mahmoudi, M., & Alavi, S. (2016). Effects of Teaching Advanced Parenting Programs on the Relationship Process in the Family. Quarterly Journal of Child Mental Health, 4(1), 35-46.

Mahmoudi, M., Borjali, A., Alizadeh, H., Ghobari-Bonab, B., Ekhtiar, H., & Akbari-Zardkhaneeh, S. (2016). Emotion regulation in children with learning disorders and normal children. Quarterly Journal of Research in school and virtual learning, 4, 13, 69-84.

Shokoohi-Yekta, M., Akbari Zardkhaneh, S., Parand, A., Mahmoudi, M., & mashrouti, P. (2016). Effect of Teaching Problem Solving to Mothers on Family Processes and Parenting Styles. Quarterly Journal of Child Mental Health, 3, 1, 3-29.

Shokoohi-Yekta, M., Akbari Zardkhaneh, S., & Mahmoudi, M. (2015). Effectiveness of psychosocial skills training on driver's aggression and anger. Journal of Psychological Models and Methods, 6(21), 21-38.

Taziki, T., Mahmoudi, M., Ghobari-Bonab, B., & Ghasem-Zadeh, S. (2015). Longitudinal study: effectiveness of self-monitoring program on reduction of behaviors inattentive behaviors in slow paced students. Quarterly Journal of Slow Paced children, 3 (5), 349-363 [in Persian]

Shokoohi-Yekta, M., Akbari Zardkhaneh, S., & Mahmoudi, M. (2015). Teaching interaction strategies based on problem solving and its effects on parenting style and problem solving in the family. The Quarterly journal of Psychological science, 14, 55, 373-387.

Beh-Pajooh, Ahmad., Mahmoudi, M. (2015). Need assessment for social support in mothers of children with autism. Rooyesh-e-ravanshenasi, 4(11): 3-22.

Akbari-Zardkhaneh, S., & Mahmoudi, M. (2015). The Efficacy of Adolescent Development Training Program to Parent on Parent-Child Relationship and Family Function. Quarterly Journal of Child Psychological Development, Vol. 2, 2, 55-66.

Shokoohi-Yekta, M., Zamani, N., Mahmoudi, M., Pourkarimi, J., & Akbari Zardkhaneh, S. (2014-2015). Efficacy of cognitive-behavioral interventions on anger control of high school students. Scientific-Research Journal of Shahed University, 21(11), 61-70.

Mahmoudi, M., Ghobari Bonab, B., Shokoohi-Yekta, M., Pouretemad, H., Akbari Zardkhane, A. (2014). Preliminary study of psychometric properties of autism screening expert system for children with autism 2-6 years old. Journal of Exceptional Children, 4, 11: 94-110.

Mahmoudi, M., Ghobari Bonab, B., Shokoohi-Yekta, M., Pouretemad, H., Akbari Zardkhane, A. (2014). Preliminary study of expert system development in diagnosis of autism in children aging 2 to 6 years old: adequacy evaluation of items. Journal of Psychology, 18, 1: 94-110.

Khodayari-fard, M., Paknejad, M., Akbari, S., & Mahmoudi, M. (2012). The status of social-political attitude and social adaptation of wounded wars children. Applied Psychological Research, 3(2): 13-24.

Poursharifi, H., Akbari Zardkhaneh, S., Yagubi, H., Peyravi, H., Hassan Abadi, H. R., Hamid Pour, H., Sobhi Gharamaleki, N., & Mahmoudi, M. (2012). Psychometric properties of Iranian Mental Health Scale for students. Applied Psychological Research, 3(3): 61-84.

Books

Arjmandnia, A. A. Mahmoudi, M. (2015). Strategies to improve working memory. Tehran: NashreFarhang. (In Persian)

Arjmandnia, A. A., Khanjani, M., & Mahmoudi, M. (2011). Strategies of rising hope in students and youth. Tehran: Office of Cultural Studies and Social Planning Ministry of Science, Research and Technology. (In Persian)

Conference Articles

Mahmoudi, M., Hameed, I.A. (2019). Cognitive rehabilitation for the elderly using social robots: a brief review. In Proceedings of ICERI2019, Spain.

Hameed, I.A., Mahmoudi, M. (2019). "ICPS-NAO": Nurturing thinking children using a social robot. In Proceedings of ICERI2019. Spain.

Shokoohi-Yekta, M., Akbari Zardkhaneh, S., & Mahmoodi, M. (2013). Impact of teaching problem solving program in the family. The 6th International Congress of Child and Adolescent Psychiatry, September, Tabriz-Iran.

Shokoohi-Yekta, M., Akbari Zardkhaneh, S., & Mahmoudi, M. (2012). The impact of cognitive-behavioral intervention on anger management of high school students. Advances in Child and Adolescent Psychiatry. Paper presented at The 5th International Congress of Child and Adolescent Psychiatry. October 8, 2012 – October 11, 2012.

Ghobari Bonab, B., Taziki, T., & Mahmoudi, M. (2012). Effectiveness of self-monitoring training on reduction of attention problems in children with intellectual disabilities and attention deficit hyperactivity disorder. Advances

in Child and Adolescent Psychiatry. Paper presented at The 5th International Congress of Child and Adolescent Psychiatry. October 8, 2012 – October 11, 2012.

Mahmoudi, M., Ghobari-Bonab, B., & Shokoohi Yekta, M. (2012). Application of Expert systems in Diagnosis and Rehabilitation of Children with Developmental Disabilities. Advances in Child and Adolescent Psychiatry. Paper presented at The 5th International Congress of Child and Adolescent Psychiatry. October 8, 2012 – October 11, 2012.

Baghezedeh, A. A., Mahmoudi, M., Moradi, H., Pouretemad, H., Ghobari, B., Shokoohi, M. (2012). An Online Expert System for Autism Screening. Advances in Child and Adolescent Psychiatry. Paper presented at The 5th International Congress of Child and Adolescent Psychiatry. October 8–11.

Beh-Pajooh, A., Mahmoudi, M., Ofoghi, H. (2012). Assessing need for social support in parent of children with autism disorder. Advances in Child and Adolescent Psychiatry. Paper presented at The 5th International Congress of Child and Adolescent Psychiatry. October 8–11.

Mahmoudi, M., Ghobari-Bonab, B., & Shokoohi Yekta, M. (2012). Symptoms prevalence in Iranian children with autism. Paper presented at The 3th National Congress of Iranian Psychological Association. February 25-27.

Mahmoudi, M., Afrooz, GH., Dousti, M. Motor therapy and Down syndrome. Paper presented at The 1th National congress of school and child with special needs. October 23-24, 2012.

Mahmoudi, M., Yarmohammadian, A., & Akrami, Nahid. Emotional problems and brain lesions in children with stuttering in Shiraz. Paper presented at The National congress of education and health in pre-school children. May 15, 2012.

RESEARCH INTERESTS

Neurodevelopmental Disabilities; Interdisciplinary Research; Socially Assistive Robots, Developmental Psychopathology; Emotion Regulation; Social Problem Solving; Neuroimaging Studies

CLINICAL EXPERIENCE

Zafar clinic, Tehran, Iran
Therapist, Evaluator 2015-2019
Cognitive training for children with Neurodevelopmental Disabilities
Testing, Developing intervention plans

Ostad Roozbeh clinic
Assistant Therapist 2014-2015
Developing intervention and measurement plans for children with IDD

Faranak clinic
Therapist 2013-2014
Assistance in Parent Child Mother Goose Program for children with hearing impairments,
Therapy for children with behavioral problems; parenting training

Center for treatment of autistic disorders (CTAD)
Beh-Ara autistic clinic
Assistant Therapist, Intern 2010-2013
Assistance in training and diagnostic interview for children with autism

Higher Institute of Oxin

Educational counselor 2008-2013
Individual Educational Planning, time management, reading strategies,
analyzing educational tests and progresses

Exceptional elementary schools
Alzahra Hospital
Intern 2006-2008
Observing, helping in producing educational material for children with IDD;
visual impairments, hearing impairments, intellectual disabilities; autism

SERVICE

University of Tehran
Department of psychology 2010-2012
Executive committee member
Conducting educational workshops in the psychology field

GRANTS

University of Minnesota
CEHD JumpStart grant 2021-2022
Role: Co-Principal Investigator & Project Coordinator
Project: "Enhancing physical activity among older adults using Nao, a socially assistive robot (SAR)"
Total amount: $50,000

HONORS/AWARDS

Honor for the best poster in The 5th International Congress of Child and Adolescent Psychiatry, Tehran, Iran 2012
Ranked 1th among more than 13000 participants in nationwide university entrance M.A. exam, Iran 2009

SKILLS

Software: SPSS; NVivo, Qualtrics; WebPlotDigitizer,
Overleaf; Covidence; Ryan; Zotero, basic Git
Languages: Farsi (native), English (fluent)

COURSES/WORKSHOP ATTENDED

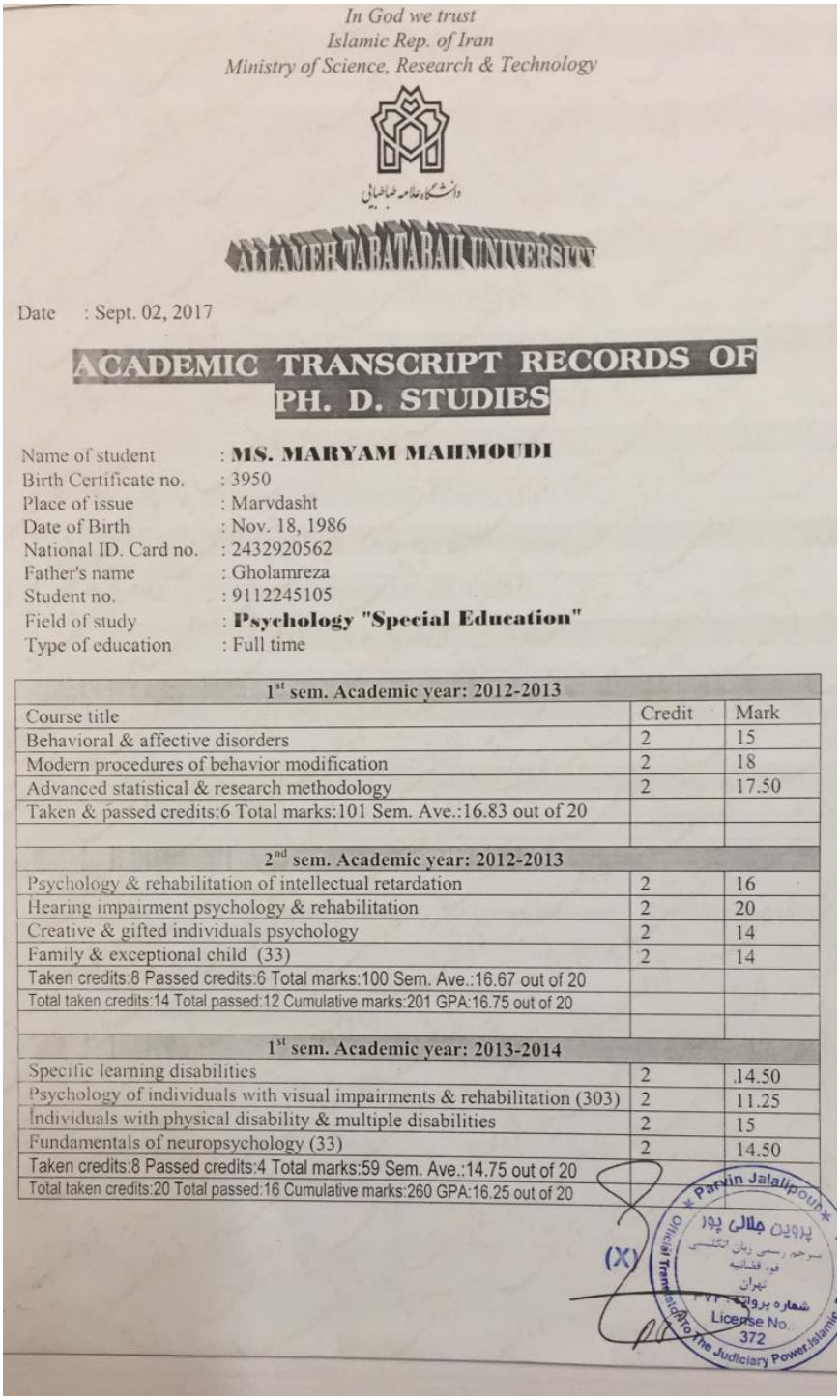
EPSY 5261 (001) Statistical Methods, Spring course, College of Education and Human Development, University of Minnesota, Spring semester. 2022
EPSY 5123 (001), Programming Workflows for Psychological Research, Spring course, College of Education and Human Development, University of Minnesota, Spring semester. 2022
Github For Researchers, Brock University 2022
Latex with Overleaf, Brock University 2022
Research Involving Human Subjects (RCR). University of Minnesota. 2021
Social / Behavioral or Humanist Research Investigators and Key Personnel. University of Minnesota. 2021
Social / Behavioral or Humanist Research Investigators and Key Personnel - Refresher Course 1 (HRP107), Section: 001. University of Minnesota. 2021

RCR-Human Subjects (RC4201) Section: 001. University of Minnesota.	2021
Preventing Sexual Misconduct, Discrimination and Retaliation (PIPSME), Section: 001. University of Minnesota.	2021
Assessing Capacity to Consent to Research (HRP103), Section: 001. University of Minnesota.	2021
Python Basics for Data Science with edX!	2021
Academic Writing Made Easy (on edX)	2021
Grant Writing and Crowdfunding for Public Libraries, held by University of Michigan (on edX)	2021
Introduction to Web Scraping - - held by Liberal Arts Technology & Innovation Services (LATIS), College of Liberal Arts, Department of Statistics, University of Minnesota (online)	2020
Introduction to Web APIs in Python, held by Liberal Arts Technology & Innovation Services (LATIS), College of Liberal Arts, Department of Statistics, University of Minnesota (online)	2020
Introduction to NVivo, held by Liberal Arts Technology & Innovation Services (LATIS), College of Liberal Arts, Department of Statistics, University of Minnesota (online)	2020
Introduction to Python for Social Science - held by Liberal Arts Technology & Innovation Services (LATIS), College of Liberal Arts, Department of Statistics, University of Minnesota (online)	2020
Webinar: ACRP Certification: Why, Who and How Should You Prepare, held by the association of clinical research professionals (online)	2020
Experimental Design in Qualtrics workshop, held by Liberal Arts Technology & Innovation Services (LATIS), College of Liberal Arts, Department of Statistics, University of Minnesota	2020
Machine Learning, by Stanford University (online)	2020
Introduction to R Workshop, held by Liberal Arts Technology & Innovation Services (LATIS), College of Liberal Arts, Department of Statistics, University of Minnesota (online)	2020
Torrance Tests of Creative Thinking, held by the Ministry of Petroleum. Tehran, Iran.	2017
Neuroimaging Workshop: functional MRI imaging and data analysis by FSL, presented by Neuro Imaging Analysis Group (NIAG) at Imam Khomeini Hospital.	2015
"Neuropsychological rehabilitation", presented by Professor Wilson and Dr. Winegardner, at Shefa Neuroscience Research Center	2015
"Kestenberg Movement Profile", presented by Prof. Kestenberg, at Allameh Tabataba'I University	2013
"ADHD software for attention", presented by Dr. Nokani, at University of Tehran	2011
“CBT course”, presented by Dr. Shafi-Fard, at University of Tehran	2011
"psychology and culture”, The international congress of psychology, religious and culture	2011
"the forgiveness protocol", presented by Dr. Ghobari-Bonab, in the University of Tehran	2011
"autism diagnosis and treatment", presented by Mrs. Azizi, in the University of Tehran	2011
"music therapy and autism spectrum disorder", Shahid Beheshti University	2009

MEMBERSHIPS/VOLUNTEERING

Autism Mentorship Program (AMP), Member of Community Advisory Board	2022-present
Minnesota Psychological Association, Member	2020-present
Quarterly Psychology of Exceptional Individuals, Reviewer	2019-2020
Journal of Autism and Developmental Disorders (JADD), Reviewer	2017-2019
“Educational Research Methodology” Iranian Curriculum Studies Association, Member	2013-2019
“Iranian Council for Exceptional Children”, Member	2009-2012
Invited talk on the success at education, Students Scientific Association of Psychology, Shahid Beheshti University	2009

Transcripts



In God we trust
Islamic Rep. of Iran
Ministry of Science, Research & Technology

دانشگاه علامه طباطبائی

ALLAMEH TABATABAII UNIVERSITY

Date : Sept. 02, 2017

ACADEMIC TRANSCRIPT RECORDS OF PH. D. STUDIES

Name of student : **MS. MARYAM MAHMOUDI**
Birth Certificate no. : 3950
Place of issue : Marvdasht
Date of Birth : Nov. 18, 1986
National ID. Card no. : 2432920562
Father's name : Gholamreza
Student no. : 9112245105
Field of study : **Psychology "Special Education"**
Type of education : Full time

1st sem. Academic year: 2012-2013		
Course title	Credit	Mark
Behavioral & affective disorders	2	15
Modern procedures of behavior modification	2	18
Advanced statistical & research methodology	2	17.50
Taken & passed credits:6 Total marks:101 Sem. Ave.:16.83 out of 20		
2nd sem. Academic year: 2012-2013		
Psychology & rehabilitation of intellectual retardation	2	16
Hearing impairment psychology & rehabilitation	2	20
Creative & gifted individuals psychology	2	14
Family & exceptional child (33)	2	14
Taken credits:8 Passed credits:6 Total marks:100 Sem. Ave.:16.67 out of 20		
Total taken credits:14 Total passed:12 Cumulative marks:201 GPA:16.75 out of 20		
1st sem. Academic year: 2013-2014		
Specific learning disabilities	2	14.50
Psychology of individuals with visual impairments & rehabilitation (303)	2	11.25
Individuals with physical disability & multiple disabilities	2	15
Fundamentals of neuropsychology (33)	2	14.50
Taken credits:8 Passed credits:4 Total marks:59 Sem. Ave.:14.75 out of 20		
Total taken credits:20 Total passed:16 Cumulative marks:260 GPA:16.25 out of 20		

(X)

Parvin Jalalipour
پروین جلالی پور
مترجم رسمی زبان انگلیسی
قوه قضائیه
تهران
شماره پروانه ۳۷۲
License No. 372
Official Translator To The Judiciary Power-Islamic

2nd sem. Academic year: 2013-2014		
She has withdrawn this semester		
1st sem. Academic year: 2014-2015		
Psychology of individuals with visual impairments & rehabilitation	2	18
Taken & passed credit:2 Total marks:36 Sem. Ave.:18 out of 20		
Total taken credits:22 Total passed:18 Cumulative marks:296 GPA:16.44 out of 20		
2nd sem. Academic year: 2014-2015		
Comprehensive examination (35)		15.01
Total taken credits:22 Total passed:18 Cumulative marks:296 GPA:16.44 out of 20		
1st sem. Academic year: 2015-2016		
Comprehensive examination (24)		16.36
Total taken credits:22 Total passed:18 Cumulative marks:296 GPA:16.44 out of 20		
2nd sem. Academic year: 2015-2016		
Dissertation (25)	18	
Total taken credits:22 Total passed:18 Cumulative marks:296 GPA:16.44 out of 20		
1st sem. Academic year: 2016-2017		
Dissertation (25)	18	
Total taken credits:22 Total passed:18 Cumulative marks:296 GPA:16.44 out of 20		
2nd sem. Academic year: 2016-2017		
Dissertation (30)	18	
Taken & passed credits:18		
Total taken credits:40 Total passed:36 Cumulative marks:296 GPA:16.44 out of 20		

Type of course	Basic courses	Thesis	Total
Number of credits	18	18	36
Average out of 20	16.4		16.44

Remarks

Explanation of the marks is as follows:

25= incomplete 33= Prerequisite courses 34= Comprehensive-pass 303= without effect on GPA

Date of admission : Sept. 10, 2012

Date of graduation : June 25, 2017

****

Signed & sealed by Allameh Tabatabaii University

Signature & stamp of the university is verified: Jamasb Nozari; Gen. Director of Students of Ministry of Sc. Re., & Tech., signature of Khadijeh Robatjazi; Head of Education Services Dept.

No.:92 Date: Sept. 15, 2018

Translation is accurate

Translator is competent to translate

Tehran, Sept. 23, 2018

(X)

Parvin Jalalipour * Official Translator To The Judiciary Power Islamic Rep. Of Iran

پروین جلالی پور

مترجم رسمی زبان انگلیسی

قوه قضائیه

تهران

شماره پروانه: ۳۷۲

License No. 372

Letter of endorsement from proposed mentor(s)

UNIVERSITY OF MINNESOTA

Twin Cities Campus

Masonic Institute for Developing Brain
Institute on Community Integration
University of Minnesota
2025 E River Pkwy,
Minneapolis, MN 55414

May 31, 2022
Masonic Institute for the Developing Brain (MIDB)
Delivered via email

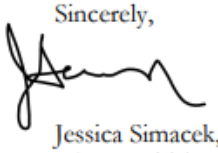
Dear Masonic Institute for the Developing Brain (MIDB) committee,

I am pleased to support the current grant proposal, titled "A Feasibility Study: Application Of Brain-Computer Interface In Augmentative And Alternative Communication For Non-Speaking Autistic Population" with the collaboration of Barkley Memorial Center, the University of Nebraska-Lincoln, and the University of Minnesota, Institute on Community Integration (ICI), TeleOutreach Core, and Biostatistics department, Analytic Cores, Masonic Institute for Developing Brain.

As the Director of the TeleOutreach Core, I have great experience in using technology for reaching and including children, youth, and adults with disabilities, particularly whom may have low incidence and high complexity needs. In my lab, we have developed telehealth-based interventions for early childhood and a variety of technology-based studies. I have studied specifically AAC for adults with Rett syndrome and related complex communication needs. I believe that findings from the current project could inform future research to improve communication opportunities for people with significant or multiple disabilities. Further, the proposed project plan could be a great opportunity to have a new interdisciplinary and interstate collaboration between AAC researchers at two institutions: the University of Minnesota and the University of Nebraska-Lincoln.

I confirm that the MIDB TeleOutreach Core can offer support for the protocol development and on-going consultation on AAC methodology. Please do not hesitate to contact me if I can be of further assistance.

Sincerely,



Jessica Simacek, PhD
Director, TeleOutreach Center and MIDB Research Core, Research Manager 2, Institute on Community Integration
Sima0034@umn.edu
2025 E River Pkwy, MIDB room 1-323, Minneapolis MN 55414

University of Minnesota

Analytics Core

SCHOOL OF PUBLIC HEALTH DIRECTORY

Masonic Institute for the Developing Brain
2025 East River Parkway
Minneapolis, MN 55414

June 1, 2022

Dear "Masonic Institute for The Developing Brain" (MIDB) committee,

I am pleased to support the current grant proposal, titled "*A Feasibility Study: Application Of Brain-Computer Interface In Augmentative And Alternative Communication For Non-Speaking Autistic Population*" with the collaboration of the University of Nebraska-Lincoln, Barkley Memorial Center and the University of Minnesota, Institute on Community Integration (ICI), TeleOutreach Core, and Biostatistics department, Analytics Cores, Masonic Institute for Developing Brain.
I have an extensive experience with neuroimaging research, including the connectivity of the human brain. My interdisciplinary research focuses on functional connectivity and imaging. From a methodological perspective, my primary interest is in time series analysis. My expertise in methods, EEG, time series could be related to how I could support the current proposed project. As the Director of Analytic Core, I can offer help with data analysis including data management, data cleaning, preprocessing and signal analysis for the data extracted from EEG.

Sincerely,

Mark Fiecas, Ph.D.,
Assistant Professor
Director of the Analytics Core
Masonic Institute for the Developing Brain
Division of Biostatistics
University of Minnesota

University of Nebraska-Lincoln

AAC Translation Lab

College of Education and Human Sciences

318I and 318L Barkley Memorial Center
Lincoln NE 68583-0738
Phone: (402)-472-3846

May 31, 2022

Dear "Masonic Institute for The Developing Brain" (MIDB) committee,

I am pleased to support the current grant proposal, titled "*A Feasibility Study: Application Of Brain-Computer Interface In Augmentative And Alternative Communication For Non-Speaking Autistic Population*" with the University of Minnesota, Institute on Community Integration (ICI), TeleOutreach Center, and Division of Biostatistics, Analytic Cores, Masonic Institute for Developing Brain.

As a speech-language pathologist certified in clinical competency (SLP-CCC), and director of the Augmentative and Alternative Communication Translation (AACT) Laboratory at the University of Nebraska-Lincoln (UNL), I have unique experience in brain-computer interface (BCI) research in relation to supporting access to augmentative and alternative communication devices (BCI-AAC). In more detail, my work has identified multiple areas crucial for the real-world implementation of BCI-AAC technology, including the importance of extending BCI-AAC to children and adolescents who may have minimal or emerging language and literacy skills and be currently left without an efficient or effective form of communication. Further, my research is informing the development of clinically focused and user-centered design frameworks aiming to elucidate how to best design and implement BCI-AAC devices, based upon individuals' unique cognitive-sensory-motor profile.

My research indicates a need to improve AAC access to children/adolescents with severe physical impairments who may also have a diagnosis of autism spectrum disorder (ASD), such as those diagnosed with Rett syndrome. The proposed project plan aims to bolster BCI-AAC development and implementation through a novel approach using a pictorial-based BCI-AAC controlled by noninvasive electroencephalography (EEG) over a one-year period. Individuals with Rett syndrome may present with a complex profile including ASD and physical impairment. Therefore, in addition to establishing BCI-AAC feasibility for those with ASD, this proposed project is especially exciting as it will lay a crucial foundation for future studies aiming to disambiguate the impacts of ASD and motor difficulties on brain-signals utilized for BCI-AAC access, helping understand how to best optimize and tailor BCI-AAC solutions to different individuals.

Considering my expertise in BCI-AAC for communication disorders, which includes 15 peer reviewed publications in BCI-AAC, I am excited to provide study consultation, as needed. In this regard, I am looking forward to providing input on user-centered considerations in BCI-AAC design and implementation, protocol development and setting, BCI-AAC task designs, and interpretation of study findings as they relate to the real-world implementation of BCI-AAC technology. I am confident in the abilities of our interdisciplinary team that is established based on people's interest and expertise. The team has a well-rounded focus in supporting individuals with ASD, as well as experience in providing technology for the population with disabilities. The proposed work will also strengthen connections between University of Minnesota and UNL, particularly to develop a long-term learning collaborative. If funded, I believe that this work will greatly benefit those with neurodevelopmental disabilities in high need of communication supports.

Sincerely,

Kevin Pitt, Ph.D., CCC-SLP
Assistant Professor, Director of the AAC Translation Lab
Department of Special Education and Communication Disorders, University of Nebraska-Lincoln

UNIVERSITY OF MINNESOTA

Duluth Campus

Department of Communication Sciences and Disorders
College of Education & Human Service Professions

174 Chester Park
31 West College Street
Duluth MN, 55812-1198

Office: 218-726-7974
Fax: 218-726-8693
http://www.d.umn.edu/csd
Email: cd@d.umn.edu

May 31, 2022

Maryam Mahmoudi, PhD, Post-Doctoral Associate
University of Minnesota Institute on Community Integration
2025 East River Parkway Minneapolis, MN 55414

Dear Dr. Mahmoudi:

Thank you for sharing information about your proposal ***A Feasibility Study: Application Of Brain-Computer Interface In Augmentative And Alternative Communication For Non-Speaking Autistic Populations*** that will explore the application of brain-computer interface augmentative and alternative communication for youth and young adults diagnosed with autism. I am glad to provide my support of your proposed project.

I have witnessed an urgent need to improve access to augmentative and alternative communication interventions for individuals diagnosed with autism whose speech does not meet their daily communication needs. Zisk and Dalton (2019) explained three types of speech disabilities experienced by individuals with autism including (a) intermittent speech in which the individual cannot always speak, (b) unreliable speech in which the spoken words may not match the intent, and (c) insufficient speech in which the individual cannot meet their daily communication needs. Each of these situations prevents an individual with autism from being able to communicate sufficiently to experience academic, social, and emotional development. The National Joint Committee for the Communication Needs of Persons with Severe Disabilities states that access to appropriate augmentative and alternative communication interventions and technologies to support communication is critical for individuals with autism.

I have over a decade of experience as a licensed speech-language pathologist who focuses on augmentative and alternative communication for individuals with severe communication disabilities, have earned a PhD in this area, hold a certificate of clinical competence from the American Speech-Language-Hearing Association, and serve in a leadership role in the Minnesota Speech-Language-Hearing Association's Augmentative and Alternative Communication Committee. I gladly accept your invitation to consult as-needed for your project and eagerly offer my support for this important endeavor.

Sincerely,

Jolene K Hyppa Martin

Jolene K Hyppa Martin, PhD, CCC-SLP
Speech-Language Pathologist & Associate Professor
University of Minnesota Duluth Department of Communication Sciences and Disorders
31 West College Street 195 Chester Park Hall
Duluth, MN 55812 218-726-7029 jhyppama@d.umn.edu

Detailed budget and budget justification with timeline

WorkPackages	Description	M 1	M 2	M 3	M 4	M 5	M 6	M 7	M 8	M 9	M 10	M 11	M 12
WP-1: Research Ethics	IRB application												
WP-2: Development	Purchaching Equipment												
	Developing study protocol												
WP-3: Conduction	Recruiting participants												
	Assessments												
	Experiment Conduction												
WP-4: Data analysis	Signal Processing												
	Machine Learning												
	Statistic analysis												
WP-5: Writing Reports	Manuscript												
	Conference Paper												

Budget and Budget Justification [next page]

University of Minnesota
A Feasibility Study: Using Brain Computer Interface For Communication In Non-Speaking Autistic (NSA) Population
BUDGET DETAIL

		Full FTE	FTE	ARRT Fellowship	MIDB COST	TOTAL (inkind) COST	Total Cost
PERSONNEL							
	Maryam, Mahmoudi.Ph.D, ARRT Postdoctoral Associate, Institute on Community Integration (ICI), [PI]	in-kind		20%		*$ 10,455*	
	Renata Ticha, Ph.D, Research Associate, Co-director of the Global Resource Center for Inclusive Education, Co-director of the Research and Training Center on Outcome Measures, Institute on Community Integration (ICI); [Project Mentor]	donated time (2hr/week)	0%			$ -	
	Brian Abery, Ph.D., Research Manager 3, Co-director Research and Training Center on HCBS Outcome Measurement, Co-director, Global Resource Center for Inclusive Education; Director ARRT Fellowship Program[Projec Mentor]	donated time (2hr/week)	0%			$ -	
	Vassilios, Morellas, Ph.D, Research Professor, Department of Electrical and Computer Engineering and Center Director of the Robots and Sensors for Human Well-Being (ROSE-HUB), [Co-PI]	in-kind	4%			*$ 7,528*	
	TBH 1-2 Undergraduate Research Assist. @ $15/hr. for 576 hours for 9 months.				$ 3,225		
	Subtotal				***$ 3,225***	**$ 17,982**	
Fringe							
	36.8%, Faculty and P & A - Abery				$ -		
	36.8%, Faculty and P & A - Ticha				$ -		
	36.8%, Faculty and P & A - Morellas					$ 2,770	
	25.7%, Postdoctoral Associate - Mahmoudi					$ 2,687	
	0% Undergrad Reseatch Asst.						
	Subtotal					**$ 5,457**	
Consultants							
	Ahmadreza Keihani, Ph.D, Tehran University of Medical Sciences	in-Kind					
	Kevin Pitt, PhD, CCC-SLP, Assistant Professor, Director of the AAC Translation Lab, Special Education & Communication Disorders, University of Nebraska–Lincoln	in-Kind					
	Jolene Hyppa Martin, Ph.D, CCC-SLP, Associate Professor Communication Sciences, Head of Augmentative and Alternative Communication (AAC) Clinic, University of Minnesota-Duluth	in-Kind					
	Subtotal						
Cores & Services							
	MIDB Analytics Core services, directed by Mark Fiecas, PhD, Assistant Professor, Division of Biostatistics				$ 6,000		
	MIDB Telehealth Core, directed by Jessica Simacek, Ph.D, [Co-PI]				$ 1,508		
	Participant inducements ($50/per each participant)				$ 1,000		
	EEG services (including using EEG, wearing and running EEG, extracting data), 20 persons, 44 hours, $70 per hour				$ 3,080		
	EEG technician assistant ($70 per hour), including fringe				$ 3,080		
	Subtotal				**$ 14,668**		
Equipment							
	Hardware board, plus software, experiment kit				$ 300		
	USB-6002 16-Bit 50 kS/s Multifunction I/O and NI-DAQmx				$ 515		
	4 Back light LED (2.5*2.5 cm)- Red color [C-E-Back-Light]				$ 25		
	Standard 12 pictures				$ 200		
	Subtotal				$ 1,040		
	MIDB FUNDING REQUEST				$ 19,973		
	ARRT FELLOWSHIP FUNDING			$ 13,141			
	Inkind contributions					$ 10,298	
	TOTAL COSTS						$ 43,412

Personels	
Renata Ticha	Renata Tichá, Ph.D., Co-Principal Investigator is a Research Associate at ICI with extensive experience in services to persons with disabilities as a program evaluator and researcher. She holds a doctorate in Special Education and has worked at the ICI for 13-years, coordinating and directing projects involving survey, assessment, and intervention research. Dr. Tichá has (co)authored publications on outcome assessment as well as directing research undertaken by the ICI's RTC on Community Living. Dr. Ticha's work on the National Core Indicators data set has led to significant enhancement in the manner in which we measure the outcomes of adults with IDD and our knowledge of the impact of Federal, State, and local policies on person's lives. Her recent work includes study of NCI data set, the development of improved personal and systems-level HCBS outcome measures, and the evaluation of a variety of interventions designed to enhance the stability of the direct service workforce who support adults with IDD. In addition to contributing to product development, Dr. Tichá will mentor all evaluation activities including data collection and assessment, and assume responsibility for overseeing data management. She will also work with Dr. Abery in overseeing budgetary and contract matters.
Maryam Mahmoudi	Maryam Mahmoudi, Ph.D., PI and Project Coordinator. Maryam Mahmoudi has a Ph.D. in psychology and is an ARRT postdoctoral associate at the ICI. Prior to this she was a postdoctoral fellow at the Social Robotics Lab at the NTNU, Norway. Dr. Mahmoudi currently works on a variety of projects including evaluation of the use of smart living technologies for people with disabilities and the use of robotics to support people with disabilities in ther employment. She has a decade of experience in interdisciplinary research. For her master degree, she developed an online expert system for screening autism for her country of origin, Iran. Subsequently she initiated a collaboration with the Advanced Robotics and Intelligent Systems Program on projects focused on using a robot to screen autism in children and teach basic social skills to those with this disability. During her fellowship, she gained experience of working with a Nao robot to teach advanced social problem solving skills to children with autism and provide cognitive stimulation interventions for ageing adults. For the current project, she will assume responsibility for recruiting participants, coordinating project activities, developing program and study protocol in a teamwork on a day to day basis.
Vassilis Morellas	Vassilis Morellas, Ph.D. - CS & E. Dr. Vassilios Morellas is a Research Professor in the Department of Electrical and Computer Engineering and Center Director of the Robots and Sensors for Human Well-Being (ROSE-HUB). His research interests are in the area of geometric image processing, machine learning, robotics and sensor integration to enhance automation of electromechanical systems. His past research experience also includes work on Intelligent Transformation Systems where he developed innovative technologies to reduce run off the road accidents. Dr. Morellas obtained his B.S. in Mechanical Engineering from the National Technical University of Athens, Greece, his MSME from Columbia University, NY and his PhD from the Department of Mechanical Engineering at the University of Minnesota. He publishes regularly in peer review conference proceedings and journals and has coauthored a book on camera programming. Dr. Morellas will provide expertise on Machine Learning techniques for analyzing the components of brain signal patterns. Also, he guides his students for BCI setup and assisting during experiments.
Brian Abery	Brian Abery, Ph.D., Principal Investigator, Project Director. Brian Abery is the Director of the Research and Training Center on HCBS Outcome Measurement (RTC/OM), and Co-Director of the National Center on College Students with Disabilities (NCCSD) and the Global Disabiity Rights and Inclusion Program (GDRIP) at the Institute on Community Integration (ICI). He has been Principal Investigator of numerous projects designed to enhance the self-determination, educational inclusion, transition, and employment of youth and adults with disabilities, better understand the impact of care coordination on the health outcomes of members of this population, and how to support them in the achievement of post-secondary goals and adult life. His most recent related projects have focused on how to effectively use robotics to support people with disabilities in customized and supported employment in collaboration colleagues from the University ot Tokyo and OryLabs in Japan, and understanding the impact of Smart Living Technology on the self-determination, social inclusion, and independence of adults with IDD. Dr. Abery holds a doctorate in educational psychology and has an extensive background in research, program development, and evaluation. He is currently or in the recent past has been the PI or Co-PI on NIDILRR (smart home technology, HCBS Outcome Measurement; Self-determination); U.S. Department of State (Self-Determination, Response to Intervention and Inclusive Education), Administration on Community Living (Transition, NCCSD), UNICEF, and UKAID projects. In addition to contributing heavily to the content development, Dr. Abery will mentor the overall project, evaluation/assessment activities taking place as part of the project data collection, and data analysis. In addition, he will work together with Dr. Ticha to mentor day-to-day efforts of project staff as well as serve as the liaison between collaborating University departments and community organizations.
TBD Undergraduae Research Assis	Student will help set up BCI, run BCI, connecting devices, trouble shooting, assist the experiments , every student could help with around 30 hours monthly and overall, 272 hours for 9 months.
Consultant	
Ahmadreza Keihani	Ahmadreza Keihani is a candidate at Tehran University of Medical Sciences (TUMS), Biomedical Engineering. His research interest fields are nonlinear dynamics and chaos, EEG and biological data science, Brain Computer Interface (BCI) and Neuroimaging. His Ph.D. thesis was focused on finding the nonlinear coupling between brain and muscles activities in ALS patients using nonlinear dynamics and chaos analysis (Joint EE-EMG, MRI study). During the current project, he will provide consultation on BCI task design and protocol.
Kevin Pitt	Kevin Pitt, Ph.D., CCC-SLP is the director of the Augmentative and Alternative Communication Translation (AACT) Lab atht e University of Nebraska-Lincoln. His research focuses on the development and implementation of AAC devices for adults and children with severe physical impairments. Kevin's long-term goal for the AACT Lab is to translate new AAC access technologies, with a primary focus on brain-computer interface (BCI) technologies, out of the laboratory setting and into clinical practice. These efforts hope to support the smooth incorporation of BCI into existing clinical practices alongside existing AAC techniques, and support fully inclusive access options across the lifespan. In addition to his research, Kevin teaches Anatomy & Physiology of Speech & Hearing, while co-teaching the Augmentative & Alternative Communication (AAC) course. Prior to arriving at Nebraska, Kevin spent five years as a graduate research assistant at the Speech and Applied Neuroscience Lab at the University of Kansas. He began his career as a Radiologic Technologist and a Magnetic Resonance Imaging (MRI) Technologist at St. Louis University Hospital, before transitioning to a career in speech-language pathology. For the current project, he will support the project with consultation regarding BCI-AAC design, methodology, EEG adaptation for adolescents with disabilities and guidlines for a standard BCI-AAC study.
Jolene Hyppa Martin	Jolene Hyppa Martin, Ph.D., CCC-SLP, Associate Professor Communication Sciences, Head of Augmentative and Alternative Communication (AAC) Clinic, University of Minnesota-Duluth. She has over a decade of experience as a licensed speech-language pathologist who focuses on augmentative and alternative communication for individuals with severe communication disabilities, has earned a PhD in this area, hold a certificate of clinical competence from the American Speech-Language-Hearing Association, and serve in a leadership role in the Minnesota Speech-Language-Hearing Association's Augmentative and Alternative Communication Committee. She will provide support regarding communication assessment, picture selections, task design and AAC and related areas.
Services & Cores	
Participant inducements ($50/per each participant)	To compensate partially participants' time and their transportation expenses.
EEG services	The total duration of the experiment for each participant (~130 min or 2:10 hour for each participant): Because of sensitivities of the participant, each person exposes half hour to EEG cap to see if they are comfortable with it. EEG: 30-min(familarity)+45-min (preparation and wearing cap) + 3(15-min recording sessions) + 2(5-min break). We write the budget for 20 participants if we consider to lose some participants or data. Overall for 20 persons, we need 44 hours of EEG access.

Please include information regarding the project's IRB/IACUC status.

The IRB application for the proposed project will be started once the proposal will be granted.

References

1. *Diagnostic and statistical manual of mental disorders: DSM-5™, 5th ed*. xliv, 947 (American Psychiatric Publishing, Inc., 2013). doi:10.1176/appi.books.9780890425596.
2. Baghdadli, A. *et al.* Adaptive trajectories and early risk factors in the autism spectrum: A 15-year prospective study. *Autism Res.* **11**, 1455–1467 (2018).
3. Rose, V., Trembath, D., Keen, D. & Paynter, J. The proportion of minimally verbal children with autism spectrum disorder in a community-based early intervention programme. *J. Intellect. Disabil. Res. JIDR* **60**, 464–477 (2016).
4. Wodka, E. L., Mathy, P. & Kalb, L. Predictors of Phrase and Fluent Speech in Children With Autism and Severe Language Delay. *Pediatrics* **131**, e1128–e1134 (2013).
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