

Social Cognition is the process by which social information, especially its encoding, storage, retrieval, and application to social situations occur or the group of function related to adequately perceiving and processing social signals (consciously or unconsciously). The outcome of this process depends upon the interpretation of social signals emitted during the encounter, including not only language but also facial expression and body gestures. Humans are living in social environment and to fit in this world they need to adapt that environment. And it starts from very early stages of life just after birth. When someone fails in doing so it is considered as social impairment for example it is found in autism spectrum disorder mainly autism. According to the concept of broader autism phenotype autism-like symptom exists on a continuum stretching from typically developed (TD) normal population to deficient diverse clinical population. The normal population showed social cognition at threshold with no problem in living their everyday life. Studies report that close family members of children with ASD show autism like trait, similarly, individuals in STEM academic areas shows subclinical autism-like symptoms. Though Social cognition deficit occurs in a continuum, the present work aim to study whole BAP continuum (TD, Subclinical and clinical) to check whether Neurofeedback Training (NFT) can help in improving social cognition.

Objective: The present work aims to fill this research gap by exploring: social cognition deficit in clinical, subclinical, and healthy population by answering mainly three questions. Firstly, through this study we wanted to check the expressions of social cognition dysfunction in clinical, TD and subclinical population; secondly, we wanted to explore the effect of Neurofeedback Training on increasing EEG Mu rhythm suppression to enhance social cognition and thirdly, we wanted to see the association of Mu rhythm suppression with the theory of mind, emotional processing, and social cognition processes.

Methods: A between subjects, pre- post, and single-blind design was followed in the study. A total of 50 participants were recruited for this intervention study. After the recruitment of participants the pre-assessment was done for dependent measures (EEG Baseline, Social Deficit: Communication in a social environment, Theory of mind: Emotional processing, Theory of mind: Attribution). On the basis of pre-assessment data from Autism Spectrum Questionnaire, the sample was divided into subclinical and TD group. Similarly, the clinical group was also assessed on dependent measures. Here we want to see the effect of independent variable: Mu suppression (NFT training) on all the dependent variables of social cognition. After the grouping of the participant, all three groups underwent NFT intervention for mu suppression on C3 and C4 location. Total of 20 sessions were given per day. After the completion of 20 sessions, all dependent measures were reassessed as post-assessment and a follow-up was conducted after one month.

Analysis: All social cognitive measures were scored as per the standard procedure and coded. Data was analyzed using SPSS version 21. The data for present study was not normally distributed so non parametric statistics methods were used to analyze the data. Correlation, linear regression, Mann Whitney U test, Wilcoxon Sign Rank test and Kruskal Wallis H test were performed for present study data set.

Results and Conclusion: Results showed significant difference in the level of social cognitive performance in three subgroups. Neurofeedback Training showed a significant EEG Mu rhythm suppression in few cases across all three subsamples. Same pattern of result were observed for social cognition performance enhancement. The mu suppression result were

mixed up, with few cases where significant results were seen this sustained significantly till last session but this suppression was not reported in follow-up. There is a significant change in Beta rhythm was also reported along with mu suppression. No effect of Neurofeedback training was seen for other rhythms in all three populations. Here we found a new insight with change Beta rhythm, which needs to be studied in future. To best of our knowledge, so far no studies are conducted for mu suppression for enhancing social cognition in the whole population continuum. So the present work is new contribution in this research area.

As researchers, we admit that covering the heterogeneous population: TD-subclinical-clinical, is a challenging task, and this work suffers some significant limitations.

1. The sample size was too small to carry out prediction analysis. Therefore, results from regression analysis here can be taken as indicative only. A study with participants is required for statistical power and better understanding.
2. The study went on for 20 intervention sessions only. We have supporting evidence for the spectral and associate behavioral change in a few participants. A study design with variable intervention sessions is needed for getting a clear picture of results.
3. The process and methodology used here to target mu suppression were possibly not successful. Therefore, there is a need to conduct a study with different treatment group designs with different intervention and recording locations to ensure the targeted approach.
4. Behavioral data for clinical participants is suspected as the rater's observation may not be accurate. Therefore, other methods (e.g., video recording, experimenter's report multiple raters) should capture the participants' experiences and changes more accurately.
5. Though it is out of the current study score but considering the promising value of NFT intervention for many conditions, the method of data collection (temporal and spatial brain activity) data with behavioral data will be much more useful, wherever possible.

...