The Place of Functional Near Infrared Spectroscopy in Psychiatry

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Brunswik (1956) who introduced the probabilistic functioning theory in psychology suggested that similar to representativeness of samples included in studies, conditions of a research experiment also have representative power. Laboratory settings generally provide sterile conditions that are far from daily life, and information derived in these conditions may not be translated to real world settings. Representative design refers to designating study conditions in such a way that they represent the behavioral settings (e.g., the real world) to which the study results are intended to apply (1). Although criticized by some authors (2) 'ecological validity' is another term introduced by Brunswik to describe a different concept, and had been used by many authors to imply representative design of studies (3). Low representativeness of study conditions –similar to the samples– reduce external validity, and lead to restricted conclusions. But perhaps more importantly, this may also interfere with internal validity. In case the research setting inherently leads to an effect **(i)** that is unevenly distributed among the study groups, and **(ii)** is associated with the outcome, then this inevitably would lead to a differential observational bias.

Functional magnetic resonance imaging (fMRI) has been used in psychiatry research for more than 30 years. The method relying on detecting blood oxygen level dependent signal marked a new epoch in neuro-imaging. Findings such as low prefrontal activity in schizophrenia during executive functioning (4) or hypersensitivity of amygdala to threatening stimuli in anxiety disorders (5) are now proposed as main pathophysiology of these disorders in psychiatry textbooks. However, fMRI study results particularly among psychiatric samples must be interpreted cautiously. First and the foremost is that the fMRI environment leads to stress. FMRI is a physically restricted environment that may lead to hyperventilation and tachycardia, and may end up with panic attacks and phobic avoidance in sensitive individuals (6). Even in healthy participants, fMRI leads to elevation in serum cortisol levels which suggest stimulation of the hypothalamo-pituitary-adrenal (HPA) axis (7). Obviously, participants with anxiety disorders will be more influenced from this stimulation than healthy control subjects. Besides, stimulation of HPA axis is also expected to interfere with amygdala response. Therefore, in this condition these would give rise to a differential observational bias that is difficult to control.

Another issue is the high noise in fMRI settings. Against wearing noise cancelling ear phones, participants are exposed to a considerable amount of noise in an fMRI scanner. In a cognitive task, attention and cognitive control resources must be excessively employed to overcome the noise and complete the task. In a behavioral study (8), compared with the silent environment, participants scored higher in cognitive inhibition and set shifting when they were exposed to 70 dB sound which resembles echo-planar fMRI noise. In an fMRI study (9), artificially increased scanner noise was associated with higher activity in frontal cortex, cerebellum, fusiform, and lingual gyri. Increased activity may represent over involvement of attentional resources to overcome noise effect. Neuro-imaging in attention deficit hyperactivity disorder (ADHD) suggested diffuse abnormal activity in attention, cognitive control, and working memory tasks in many areas including left and right and dorsal and ventral fronto-cingulo-strio-thalamic and fronto-parieto-cerebellar regions (10). FMRI noise may plausibly influence subjects with ADHD more than healthy control subjects. Besides, it has been shown that this noise would interfere with the outcome, activity in the aforementioned brain areas. Thus, similar to anxiety disorders, fMRI studies in ADHD may possess an inherent bias.

Functional near infrared spectroscopy (fNIRS) is a non-invasive imaging technology that allows in-vivo measurement of cortical activity. The method relies on different absorption characteristics of infrared light by oxygenated (Oxy-Hb) and deoxygenated (Hb) hemoglobin (11). The measured values correspond to blood oxygen level dependent signal in fMRI and reflect cortical activity 3–4 cm beneath the scalp (12). When compared with the fMRI, fNIRS allows measurement of cortical activity in a naturalistic sitting position, is relatively less sensitive

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to head movements, is easy to use and noise free. fNIRS environment compared with the fMRI is much more natural, and resembles to real world settings. This advantage allows monitoring cortical activity during complicated tasks in vulnerable participants. In fNIRS laboratory located at Ankara University Brain Research Center which began to operate in 2013, fNIRS has been used in complicated cognitive and social cognitive tasks such as social defeat (13), probabilistic reasoning (14), creativity (15), reading the mind from the eyes (16), bargaining/reciprocity (17), or response to painful stimuli (18) particularly in psychiatric samples. With the development of wireless fNIRS technology motor movement is no more a restriction (19).

The area of execution of psychiatry has been limited to the interpersonal space between the individual patient and the psychiatrist, partly as a consequence of the medical model and industrial effects, and partly related to the views of psychoanalysis and cognitive-behavioralism. The importance of the relationship of the patient with other humans was neglected by some schools. For example, Kleinian school rejected Bowlby's views on the importance of real relationship between the child and the mother in development of child bereavement, and stressed the role of child's unconscious fantasies instead. According to object relations terminology, the 'mother' is not even a mother but an 'object'. Indeed, there have been theories emphasizing the importance of interpersonal relationships such as the interpersonal model of Sullivan. However, these models generally stayed collateral to mainstream psychiatry. Cognitive and experimental psychology shared a similar destiny, and most sophisticated methodology served in the space between the psychologist and the experimental subject. Nevertheless, the recovery model in psychiatry and social cognitive psychology began to challenge this tradition in last decades. Parallel to these developments, neuro-science definitely must improve to examine social phenomena, and collect information from in the interpersonal area. Social-cognitive neuro-science is a new field developing to meet this need. fNIRS is capable of collecting activity data from more than one individual in a single session, has high temporal resolution, provides a representative experimental setting and may definitely contribute to social cognitive neuro-science particularly in the field of neuro-imaging.

Keywords: fNIRS; validity; psychiatry

References

1. Brunswik E. Perception and the representative design of psychological experiments, 2nd ed. Berkeley, CA, US: University of California Press; 1956.
2. Dawson DR, Marcotte TD. Special issue on ecological validity and cognitive assessment. *Neuropsychol Rehabil* 2017;27:599–602. [\[CrossRef\]](#)
3. Araújo D, Davids K, Passos P. Ecological Validity, Representative Design, and Correspondence Between Experimental Task Constraints and Behavioral Setting: Comment on Rogers, Kadar, and Costall (2005). *Ecological Psychology* 2007;19:69–78. [\[CrossRef\]](#)
4. Ragland JD, Yoon J, Minzenberg MJ, Carter CS. Neuroimaging of cognitive disability in schizophrenia: search for a pathophysiological mechanism. *Int Rev Psychiatry* 2007;19:417–427. [\[CrossRef\]](#)
5. Adhikari A. Distributed circuits underlying anxiety. *Front Behav Neurosci* 2014;8:112. [\[CrossRef\]](#)
6. Meléndez J, McCrank E. Anxiety-related reactions associated with magnetic resonance imaging examinations. *JAMA* 1993;270:745–747.
7. Tessner KD, Walker EF, Hochman K, Hamann S. Cortisol responses of healthy volunteers undergoing magnetic resonance imaging. *Hum Brain Mapp* 2006;27:889–895. [\[CrossRef\]](#)
8. Hommel B, Fischer R, Colzato LS, van den Wildenberg WP, Cellini C. The effect of fMRI (noise) on cognitive control. *J Exp Psychol Hum Percept Perform* 2012;38:290–301. [\[CrossRef\]](#)
9. Tomasi D, Caparelli EC, Chang L, Ernst T. fMRI-acoustic noise alters brain activation during working memory tasks. *Neuroimage* 2005;27:377–386. [\[CrossRef\]](#)
10. Rubia K. Cognitive Neuroscience of Attention Deficit Hyperactivity Disorder (ADHD) and Its Clinical Translation. *Front Hum Neurosci* 2018;12:100. [\[CrossRef\]](#)
11. Franceschini MA, Boas DA. Noninvasive measurement of neuronal activity with near-infrared optical imaging. *Neuroimage* 2004;21:372–386.
12. Toronov V, Webb A, Choi JH, Wolf M, Michalos A, Gratton E, Hueber D. Investigation of human brain hemodynamics by simultaneous near-infrared spectroscopy and functional magnetic resonance imaging. *Med Phys* 2001;28:521–527. [\[CrossRef\]](#)
13. Baskak B, Baran Z, Devrimci-Özgüven H, Münir K, Öner Ö, Özel-Kızıl T. Effect of a social defeat experience on prefrontal activity in schizophrenia. *Psychiatry Res* 2015;233:443–450. [\[CrossRef\]](#)
14. Baskak B, Baran Z, Ozguven HD, Karaboga I, Oner O, Ozel Kizil ET, Hosgoren Y. Prefrontal activity measured by functional near infrared spectroscopy during probabilistic inference in subjects with persecutory delusions. *Schizophr Res* 2015;161:237–243. [\[CrossRef\]](#)
15. Devrimci Ozguven H, Hosgoren Alici Y, Kale E, Yenihayat I, Baskak B. Inefficient cortical processing in creativity tasks in bipolar disorder: an fNIRS study. *Eur Neuropsychopharmacol* 2017;27(Suppl 4):S699. [\[CrossRef\]](#)
16. Duman B, Kale E, Yenihayat I, Baskak B, Devrimci-Özgüven H. Investigation of cerebral cortex hemodynamic activations using fNIRS during mind reading task in subjects with autism spectrum disorder. *Eur Neuropsychopharmacol* 2017;27:710–711. [\[CrossRef\]](#)
17. Ones U, Baskak B. Gender-Based differences in Risk-Taking Behaviour: A Neuro Economics Approach. In: Rasim Y, Löschnigg G, Arslan H, Icbay MI, editors. *Current Approach in Social Sciences*. Frankfurt: Peter Lang GmbH; 2015. pp.429–439.
18. Eken A, Kara M, Baskak B, Baltacı A, Gökçay D. Differential efficiency of transcutaneous electrical nerve stimulation in dominant versus nondominant hands in fibromyalgia: placebo-controlled functional near-infrared spectroscopy study. *Neurophotonics* 2018;5:011005. [\[CrossRef\]](#)
19. Hawkins KA, Fox EJ, Daly JJ, Rose DK, Christou EA, McGuirk TE, Otzel DM, Butera KA, Chatterjee SA, Clark DJ. Prefrontal over-activation during walking in people with mobility deficits: Interpretation and functional implications. *Hum Mov Sci* 2018;28:46–55. [\[CrossRef\]](#)