Developing Neuro-feedback Music (NFM) Software For Academic Stress Management and Well-being

This research develops software that reinforces healthy brainwave patterns by giving auditory feedback for better control of central nervous system activity. It will impact people's life by employing the therapeutic benefits of neuro-feedback (NF) and music therapy(MT) for treating academic stress, for example students' anxiety during examination periods. Its effectiveness will be investigated in training programmes and demonstrated in concerts using brainwaves to generate computer-aided compositions with traditional instruments.

While the use of biofeedback has been well documented in the arts (Miranda, 2014, Väljamäe, 2013), it is a promising interdisciplinary area to probe for therapeutic purposes located within music. Investigation is necessary as firstly, effective stress management has been demonstrated in numerous MT (Hanser, 1985, Leferbvre, 1991, Miller, 2011, Wigram *et al*., 2002) as well as NF studies (Baehr et al., 2001, Outsem, 2011), yet there has been little investigation in their combined therapeutic use. Secondly, existing NF software mainly focus on giving visual feedback and when there is sound, it is usually repetitious and un-stimulating, i.e. it neglects the wide-ranging capabilities of music (Miller, 2011) which could promote well-being.

To form a picture of a person's state of mind, a frequency spectrum is generated by analysing the raw electroencephalographic (EEG) signal, the electrical activity of the brain. Bandwidths in this frequency spectrum are separated and averaged into a set of brainwave rhythms: delta (0-4Hz), theta (4-8Hz), low alpha (8-12Hz), high alpha (12-16Hz), low beta (16-20Hz), etc. In training the user needs to keep the amplitude of certain brainwave rhythms above or below a preset thresholds in order to receive positive feedback from the software. The proposed NFM software uses generative music composition that changes when thresholds are reached, in order to reward the user with positive feedback. I aim to further develop this system with volunteering music students, whose brainwaves will generate music notation for themselves to play on traditional instruments.

To harness the strength of both MT and NF, in my MA I developed an NFM software prototype compatible with affordable single-channel EEG hardware. While monitoring EEG, the software instructs users to focus on certain sounds in order to induce an intended change in the EEG, adjusting and maintaining alpha waves over the threshold indicated. The software then rewards them with changing certain parts of the music which encourages the intended change in the brainwaves. This way the system creates a virtuous cycle where brainwaves and music are both an input and an output of each other. Similar to games, in order to be rewarded with new musical features, e.g. melody change or additional instruments, the user has to meet certain criteria to complete tasks, e.g. reaching threshold with the amplitude of the alpha brainwave rhythm or keeping its amplitude above threshold for 10 seconds.

NF will strengthen MT in many aspects. Firstly, NF makes MT more engaging and interactive as users can actually see and hear how their state of mind is effected by listening to music. Secondly, NF appeals to prospect users that not only value the intangible experience of MT but also trust scientific data of NF. In addition, NF is a technology that is able to help MT produce precise results.

Research questions

1. What repertoire of compositional techniques and musical elements can be utilised in NF with multi-channel EEG?
2. Can a resulting repertoire be used as a creative tool for composition with brainwaves?
3. How can the proposed NFM system be utilised in developing self-awareness about brain states and effective in order to cope with academic stress?

The aim of this project is to further develop my NF prototype with multi-channel EEG systems and to develop a broader musical repertoire to provide a music related tool for stress management and well-being. It is divided into 4 objectives:

1. to develop software for multi-channel EEG hardware with NF training protocols;
2. to employ the most effective musical repertoire in the training;
3. to implement an extensive trial period with (music) students, where the effectiveness is tested in real time computer-aided compositions;
4. to implement an extensive trial period with students experiencing academic stress.

I will research relevant literature on the impact of sound on the mind in order to identify effective sound

organisation techniques for the training. After building a variety of potential musical expressions in SuperCollider, an extensive trial period with volunteers will be conducted in order to receive feedback on the software's effectiveness. Subsequently, in line with the university's ethics policies and procedures, I will cooperate with Anglia Ruskin University student services to identify suitable persons for case studies regarding their stress reduction. In order to generate useful statistics, well-established psychological questionnaires such as the Bisht Battery of Stress Scale assessment will be adopted (Bisht, 1987), structured observations and diaries of participants collected and analysed. Data from quantitative methods e.g. digital surveys and EEG recordings will be analysed by the proposed software.

References

Baehr, E., Rosenfeld, J. P. and Baehr, R., 2001. Clinical use of an alpha asymmetry neurofeedback protocol in the treatment of mood disorders. *Journal of Neurotherapy*, 4 (4), pp. 11—18

Bisht, R. A., 1987. *Bisht Battery of Stress Scale*. National Psychological Corporation, Agra, UP, India.

Hanser, Suzanne B. 1985. Music therapy and stress reduction research. *Journal of Music Therapy,* 22.4: 193-206.

Health and Safety Executive Study, [pdf] Available at: <http://www.hse.gov.uk/stress/pdfs/eurostress.pdf > [Accessed 1 Mach 2015].

Miller, E. B., 2011. *Bio-guided music therapy*. London: Jessica Kingsley Publishers.

Miranda, E. R., 2014. *Guide to Brain-Computer Music Interfacing.* Springer.

Van Outsem, R., 2011. The applicability of neurofeedback in forensic psychotherapy: a literature review. *Journal of Forensic Psychiatry & Psychology.* 22 (2), pp. 223--242.

Wigram, T., Pedersen, I. N. and Bonde, L. O., 2002. *A comprehensive guide to music therapy*. London: Jessica Kingsley Publishers.