EFFECTS OF PLEASANT AND UNPLEASANT AUDITORY MOOD INDUCTION ON THE PERFORMANCE AND IN BRAIN ACTIVITY IN COGNITIVE TASKS

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ABSTRACT

Our study focuses on mood induction with pleasant and unpleasant auditory stimuli during the break. Our test includes subjective evaluation (NASA-TLX, KSS, POMS), cognitive tests and brain responses (MEG and EEG). We aim studying the effect affective state has on work-like tasks. Hypothesis: pleasantness of auditory mood induction affects cognitive performance and brain responses.

1. INTRODUCTION

Cognitive performance results from multiple factors including arousal and physical fatigue. Affective state, major modulator for cognitive and physical performance, is often neglected. Here we investigate the effects of different dimensions in affective state on performance in cognitive tests and electrophysiology.

Music has the indeniable ability to convey strong emotions. In addition, lots of research under the topic of music is devoted to revealing the possible effects music claimed to have on cognitive performance. One of the famous cases is the controversial Mozart effect[1]. Not more than decade ago there was an intense debate about the reputed effect Mozart's music has on performance in certain spatially demanding cognitive tasks. The debate more or less concluded that music has an effect on affective state. This effect is called enjoyment arousal, i.e., arousing and positively valenced effect of musical experience[2]. However, the research around the discussion did not try to specify the dimensions of affective state influenced by the effect, in terms of the two dimensional model namely valence vs. arousal. A novel paradigm is designed for measuring the effect of mood on performance and related electrophysiology in cognitive tests. The tests are chosen to simulate a cognitively demanding tasks during a regular workday in office like work environment.

2. MOOD INDUCTION

There are a number of experimental techniques that have been developed to induce positive or negative mood in the participants. The effectiveness of these Mood induction procedures (MIP) has been investigated [3] and the MIPs using music have been shown to be effective. For example, the cardiovascular and respiratory patterns are changed according to the mood induced by music [4]. When studying the physiological features related to changes of mood, e.g., measures of heart rate or heart rate variability, blood pressure, etc., the acoustic and especially rhythmic content of the musical material plays a key role. One may expect effect related to temporal synchronization of the physiological functions and the musical material. Such synchronization, or entrainment of especially respiration to the temporal characteristics of the music used in the mood induction may completely override all physiological effects in the study [5].

Questionaires/Preparations	Personal Info + POMS	20 min
Testset 1	Cognitive tests	35 min
Questionaires	NASA-TLX, KSS, POMS	5 min
Mood induction	Pleasant/Unpleasant	12 min
Questionaires	POMS	5 min
Testset 2	Cognitive tests	25 min
Questionaires	NASA-TLX, KSS, POMS	5 min

Table 1: One visit testprotocol.

3. METHOD

3.1. Subjects and Procedure

We have currently measured 7 subjects. Five of them were female and two male. Their ages varied from 21 to 38, mean 27 standard deviation 6.6. In Table 1 is a protocol for one visit. Each visit starts with questionaires and preparations for the MEG and EEG measurements. The Profile of Mood States (POMS) are used to measure affective mood state of the subject.

We have three cognitive tests in our protocol: N-back, Task Switching and Image Memory. In Testset 1, each test includes training trials before the measurements. In Testset 2, tests are accomplished without training. The testsets are performed before and after a mood induction in two different days, i.e. tests are performed four times in total. Paradigm is counter balanced so that half of the subjects get negative induction first as the other half get positive treatment first.

After the cognitive tests the NASA-TLX, KSS and POMS questionaires are accomplished.

After the first round there is a break, which includes pleasant or unpleasant mood induction. In pleasant mood induction subjects are exposed to music of personal choice. We provide preselected playlists from different genres among pop, electro, classical, and rock. The playlists were created considering the effect on arousal. Mean tempo of each playlist is adjusted to match the mean tempo of the unpleasant sound sequence. It is mix of environmental noise created by superimposing negatively assosiable sounds, e.g. crying, alarms, and dental drills.

In the MEG we obtained a large number of brain responses from which we determined their amplitude and timing, especially

	KSS	Mental Demand	Frustration
Before Pleasant	6.2 (1.5)	2.0 (1.4)	3.0 (1.0)
Before Unpleasant	5.3 (1.7)	2.3 (1.6)	2.7 (1.8)
After Pleasant	5.7 (1.9)	2.5 (1.1)	2.5 (1.9)
After Unpleasant	5.5 (0.8)	2.3 (1.6)	2.3 (1.2)

Table 2: Mean and standard deviation for KSS (scale 1 (aroused) to 7 (sleepy)) and NASA-TLX (scale 1 to 5).

the onset and peak times. The responses are elicited by the presentations of the figures and sounds that occur in the cognitive experiments. In all test types the responses, reaction times, stimulus onsets and related electrophysiology are recorded with Neuromag data acquisition system.

N-back task: The participants will complete a visual n-back task after a practice trial. In each condition a total of 180 stimuli (numbers) will be presented one at a time on a computer screen. The participants will be instructed to give a response to whether the number is the predetermined "x" within a sequence of numbers (0-back), the same as the previous number (1-back), or the same as the number presented 2 numbers back (2-back), or not.

Task switching. When people have to switch between two tasks, they are slower on the task-switching than on the task-repeating trials [6]. We compared the time needed and mistakes made in unpredictable task-switching trials to those in task-repetition trials.

Image Memory. Tests for visual memory are prone to errors hence a good assessing technique for cognitive performance [7]. The test is alternation of The Cambridge Face Memory Test [8]. Instead of faces we use abstract images selected in collaboration with clinical psychologists. The difficulty of the task is adjusted by adding images to target train to achieve sufficient error frequency.

4. RESULTS

The questionnaire about the pleasantness of the break and its effects showed that the subjects found the break with self-chosen music to be clearly more pleasant than the break with noise. The perceived pleasantness of the break in scale 1 to 5 was 3.6 (0.24) for pleasant and 1.3 (1.2) for unpleasant break. The KSS questionnaire showed that the break changed the arousal level: the pleasant break increased it and the unpleasant break decreased it. In the NASA-TLX, the mental demands and the frustration changed differently according to break type, see Table 2. In POMS, the effect of the break type was most clearly seen in the arousal dimension. In the MEG and EEG, all three test types produced clear responses. For example, the presentation of the task image in the task switching experiment gave rise to clear P300 responses. The response magnitudes and latencies in the four conditions were compared. Simultaneously, the performance data from the experiments were obtained. The intra-subject variability was large compared to the effects of the break type.

5. DISCUSSION

Inducing mood changes by listening to music or sounds has been demonstrated in many experimental set-ups. Our aim was to induce mood changes by music or sounds during a short break between cognitively demanding tasks. We succeeded in creating a pleasant and an unpleasant break with measurable effects. When changes in the mood states, sleepiness and task-related effects were compared after the pleasant and unpleasant break, the results were individually quite variable and dependent on the individual situation prior to the break. The task performance of the participants became better during the experiment - the reaction times got faster and the hit rates became generally better. Such a learning effect has been shown also in previous studies. The effect of the short break in the midst of the task performance was surprisingly small and was largely masked by the learning effect. This may be due to the fact that the tasks themselves also induced changes in the mood. The tasks are demanding and frustating and may thus override the effects of the pleasant break. The EEG and MEG methods are clearly capable of capturing the brain activity related to the three tasks since clear brain responses were observed. The participants' response patterns were affected by the breaks, but the effects were not clearly consistent across subjects. This may be due to the differential effects of the tasks on individual subjects' mood. In sum, mood induction with music or sounds was found to be possible even during short breaks and it may affect the cognitive task performance.

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7. REFERENCES

[1] F. H. Rauscher, G. L. Shaw, and K. N. Ky, "Music and spatial task performance," *Nature*, vol. 365, p. 611, Oct 1993.

[2] E. G. Schellenberg and S. Hallam, "Music listening and cognitive abilities in 10- and 11-year-olds: the Blur effect," *Ann. N. Y. Acad. Sci.*, vol. 1060, pp. 202–209, Dec 2005.

[3] R. Westermann, K. Spies, G. Stahl, and F. Hesse, "Relative effectiveness and validity of mood induction procedures: a meta-analysis," *European Journal of Social Psychology.*, vol. 34, pp. 557–580, 1992.

[4] J. Etzel, E. Johnsen, J. Dickerson, D. Tranel, and R. Adolphs, "Cardiovascular and respiratory responses during musical mood induction," *International Journal of Psychophysiology*, vol. 61, pp. 57–69, 2006.

[5] C. Wientjes, "Respiration in psychophysiology: methods and applications," *Biological Psychology.*, vol. 34, no. 2–3, pp. 179–203, 1992.

[6] R. Rogers and S. Monsell, "The costs of a predictable switch between simple cognitive tasks," *J. Exp. Psychol. Gen.*, vol. 124, pp. 207–231, 1995.

[7] B. J. Sahakian, R. G. Morris, J. L. Evenden, A. Heald, R. Levy, M. Philpot, and T. W. Robbins, "A comparative study of visuospatial memory and learning in Alzheimer-type dementia and Parkinson's disease," *Brain*, vol. 111 (Pt 3), pp. 695–718, Jun 1988.

[8] B. Duchaine and K. Nakayama, "The Cambridge Face Memory Test: results for neurologically intact individuals and an investigation of its validity using inverted face stimuli and prosopagnosic participants," *Neuropsychologia*, vol. 44, pp. 576–585, 2006.