Chapter 15

Effect of a Motivational Song on the Autonomic Nervous System and the Heart of Indian Male Volunteers

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ABSTRACT

This chapter investigates the effect of a motivational song (stimulus) on the physiology of the autonomic nervous system and the electrical activity of the heart. Five min electrocardiogram (ECG) signals were acquired from 19 volunteers during the resting and the post-stimulus conditions. The RR intervals (RRIs) were extracted. Recurrence analysis of the RRI time series indicated a higher alteration (acceleration or deceleration) in the heart rate along with the reduction of the causality and patterned behavior of the RRIs. The exact alteration in the ANS physiology was examined using heart rate variability (HRV) analysis. The results of the HRV analysis suggested an increase in the parasympathetic activity in the post-stimulus condition. The alteration in the cardiac activity was analyzed using time domain and joint time-frequency domain analyses of ECG signals. The results suggested an alteration in the cardiac electrical activity of the heart in the post-stimulus condition.

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INTRODUCTION

Music has been reported to evoke the emotion of the persons (Pannese, Rappaz, & Grandjean, 2016). In fact, it acts as a stimulus, which can initiate emotional memories in the person (Becker, 2004; Schulkind, Hennis, & Rubin, 1999). Recent studies have suggested that the alteration in the emotions while listening to music is also associated with a change in the physical state of the person (Schneck & Berger, 2005). Briefly, we can say that while listening to music, there is a temporary change in the physiological and psychological state of the person (Kemp & Quintana, 2013). Listening to music has been reported to alter the physiological processes like promoting sleep, reduce anxiety, increase positive post-task attitude towards exercise and/or increase brain activities (Elliott, Carr, & Orme, 2005; Lin et al., 2008). The afore-mentioned day-to-day activities are being controlled by the functioning of the Autonomic Nervous System. The analysis of the ANS can be achieved in a non-invasive manner by studying HRV (Dodds, Miller, Kyle, Marshall, & Gordon, 2017). HRV analysis deals with the study of the beat-to-beat interval variation of the heart (Kleiger, Stein, & Bigger, 2005). The beat-to-beat interval variation mainly occurs due to the intervention of the ANS on the cardiac activity (Tavernier & Jeanne, 2014). HRV is studied by recording ECG signals from the human volunteers and computing the RRIs. Recurrence analysis provides information about the temporal variation in a time series (H Sabelli et al., 2005). Numerous studies have revealed that recurrence analysis of the RRIs can also be used to identify changes in the cardiovascular activity due to any stimulus or pathological condition (Chen, Chou, & Tseng, 2014). Taking the motivation from the facts mentioned above, this study attempts to understand the effect of listening to a motivational song on the ANS and the cardiac electrophysiology. In this study, we have selected a new generation motivational song from the Bollywood movie “Marry Kom”. This was intentionally done as the volunteers participating in our group are of the current generation, having age in the range of 21 and 23 years. The parameters of recurrence analysis were analysed to identify the variations in the RRIs of the pre- and the post-stimulus conditions. The HRV and the ECG (either original or wavelet processed) signal statistical parameters were used to classify the pre- and the post-stimulus conditions. In our study, we found that there are significant differences in both the ANS activity and cardiac physiology.

BACKGROUND

In the last few decades, the effect of music on the different human physiological systems has been extensively studied. Elliot et al. (2005) have reported that the exercise intensity, in-task effect and positive attitude towards exercise can be improved if the volunteers are made to listen to motivational music (Elliot, 2005). Recurrence analysis has evolved as an important non-linear tool for the analysis of different time series including the cardiovascular signals like the RRI series and the ECG signals (H Sabelli et al., 2005). Sun et al. (2008) have used recurrence analysis of RRIs for predicting the termination of atrial fibrillation, which can be useful to understand the mechanisms of arrhythmia (Sun & Wang, 2008). Sabelli et al. (2011) reported recurrence analysis-based estimation of distinct creative patterns in RRIs of depressed and psychotic persons (H Sabelli, Messer, Kovacevic, & Walthall, 2011). Chen et al. (2014) have proposed the use of recurrence analysis of HRV signals for quantifying the variation in the cardiovascular activity when exposed to low-frequency noise of a range of intensities (Chen et al., 2014). HRV analysis is an important non-invasive method to understand the ANS activity. Xue et al.