RESEARCH ARTICLE



Self-selected versus imposed running intensity and the acute effects on mood, cognition, and (a)periodic brain activity

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Abstract

The beneficial psychological effects of exercise might be explained by self-determination theory and autonomy. However, the underlying neurophysiological mechanisms are even less clucidated. Previously neglected, aperiodic (Lff) brain activity is suggested to indicate enhanced cortical inhibition when the slope is steeper. This is thought to be associated with an increased cognitive performance. Therefore, we hypothesize that running with a self-selected intensity and thus given autonomy leads to stronger neural inhibition accompanied by psychological improvements. Twenty-nine runners performed two 30-min runs. First, they chose their individual feel-good intensity (self-selected run: SR). After a 4-weeks washout, the same speed was blindly prescribed (imposed run; IR). Acute effects on mood (Feeling Scale, Felt Arousal Scale, MoodMeter®), cognition (d2-R, digit span test) and electrocortical activity (slope, offset, Lff-corrected alpha and low beta band) were analyzed before and after the runs. Both runs had an equal physical workload and improved mood in the Felt Arousal Scale, but not in the Feeling Scale or MoodMeter®. Cognitive performance improved after both runs in the d2-R, while it remained stable in the digit span test after SR, but decreased after IR. After running, the aperiodic slope was steeper, and the offset was reduced. Alpha activity increased after SR only, while low beta activity decreased after both conditions. The aperiodic features partially correlated with mood and cognition. SR was not clearly superior regarding psychological effects. Reduced aperiodic brain activity indicates enhanced neural inhibition after both runs. The Lff-corrected alpha band may emphasize a different neural processing between both runs.

Keywords Physical exercise - Autonomy - Self-determination - EEG - Neural noise - Mental health

Introduction

It is well-established that physical exercise has a positive impact on mental health, manifested, for instance, by acute improvements in affective and mood states (Berger and Motl 2000; Penedo and Dahn 2005; Reed and Ones 2006; Liao et al. 2015) and in cognitive performance (Lambourne and Tomporowski 2010; Chang et al. 2012; Basso and Suzuki 2017). The self-determination theory (SDT; Deci and Ryan 1985a, b) with its three basic psychological needs (i.e., competence, relatedness, and autonomy) provides one theoretical explanation for the effects on self-determination

and the associated psychological improvements. In particular, perceived autonomy is considered as a key factor. Exercising driven by self-regulation and a more internal locus of control induces stronger improvements on affect (i.e., affective valence and activation) and mood compared to externally controlled and regulated behavior (Ekkekakis 2009). Importantly, psychological responses and cognition can influence each other, such that a positive affect is linked to an increase of attention (Kleinstäuber 2013; Niven 2013). Latter was found to be improved after physical activity as well (Hillman et al. 2003; Soudder et al. 2012). Moreover, other cognitive domains can be enhanced after exercising, such as executive function or memory performance (Chang et al. 2012). While there is still debate and inconsistency in the literature about the positive effects of exercise on affect, mood, and cognition, and the SDT has to be proven, shining light on the underlying mechanisms by investigating objective physiological responses might support the clarification of the SDT

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