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Spontaneous eyeblinks are sensitive to sequential learning

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ABSTRACT

Although sequential learning and spontaneous eyeblink rate (EBR) have both been shown to be tightly related to cerebral dopaminergic activity, they have never been investigated at the same time. In the present study, EBR, taken as an indirect marker of dopaminergic activity, was investigated in two resting state conditions, both before and after visuomotor sequence learning in a serial reaction time task (SRT) and during task practice. Participants' abilities to produce and manipulate their knowledge about the sequential material were probed in a generation task. We hypothesized that the time course of spontaneous EBR might follow the progressive decrease of RTs during the SRT session. Additionally, we manipulated the structure of the transfer blocks as well as their respective order, assuming that (1) fully random trials might generate a larger psychophysiological response than an unlearned but structured material, and (2) a second (final) block of transfer might give rise to larger effects given that the sequential material was better consolidated after further practice. Finally, we tentatively hypothesized that, in addition to their online version, spontaneous EBR recorded during the pre- and post-learning resting sessions might be predictive of (1) the SRT learning curve, (2) the magnitude of the transfer effects, and (3) performance in the generation task. Results showed successful sequence learning with decreased accuracy and increased reaction times (RTs) in transfer blocks featuring a different material (random trials or a structured, novel sequence). In line with our hypothesis that EBR reflects dopaminergic activity associated with sequential learning, we observed increased EBR in random trials as well as when the second transfer block occurred at the end of the learning session. There was a positive relationship between the learning curve (RTs) and the slope of EBR during the SRT session. Additionally, inter-individual differences in resting and real-time EBR predicted the magnitude of accuracy and RTs transfer effects, respectively, but they were not related to participants' performances during the generation task. Notwithstanding, our results suggest that the degree of explicit sequential knowledge modulates the association between the magnitude of the transfer effect in EBR and SRT performance. Overall, the present study provides evidence that EBR may represent a valid indirect psychophysiological correlate of dopaminergic activity coupled to sequential learning.

1. Introduction

Sequencing actions and perceptions is one of the most fundamental skills in everyday cognitive processing (Clegg et al., 1998; Conway and Christiansen, 2001; Dehaene et al., 2015; Janata and Grafton, 2003). It is now well documented that dopaminergic activity is a robust mediator of sequential processing (Berns and Sejnowski, 1998; Jin and Costa, 2015; Schultz, 2016). Additionally, an extensive survey of the literature has shown that spontaneous eyeblinks might be an indirect and relevant marker of dopaminergic activity associated to a panel of cognitive functions such as attention, flexibility or inhibition (Jongkees and Colzato, 2016). However, to the best of our knowledge, no study investigated the potential relationship between sequential learning and spontaneous eyeblinks, which is quite surprising given their respective linkage with dopaminergic activity. The present study attempts to fill this gap.

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