

INTRODUCTION

When participants listen to a rhythm produced by a human performer, they are able to “follow” the rhythm even though it can contain relatively large fluctuations in periodicity. This is due to the fact that autocorrelated temporal fluctuations contain relevant information for beat expectation: the occurrence of the upcoming beat is predicted by the occurrences of the preceding beats¹.

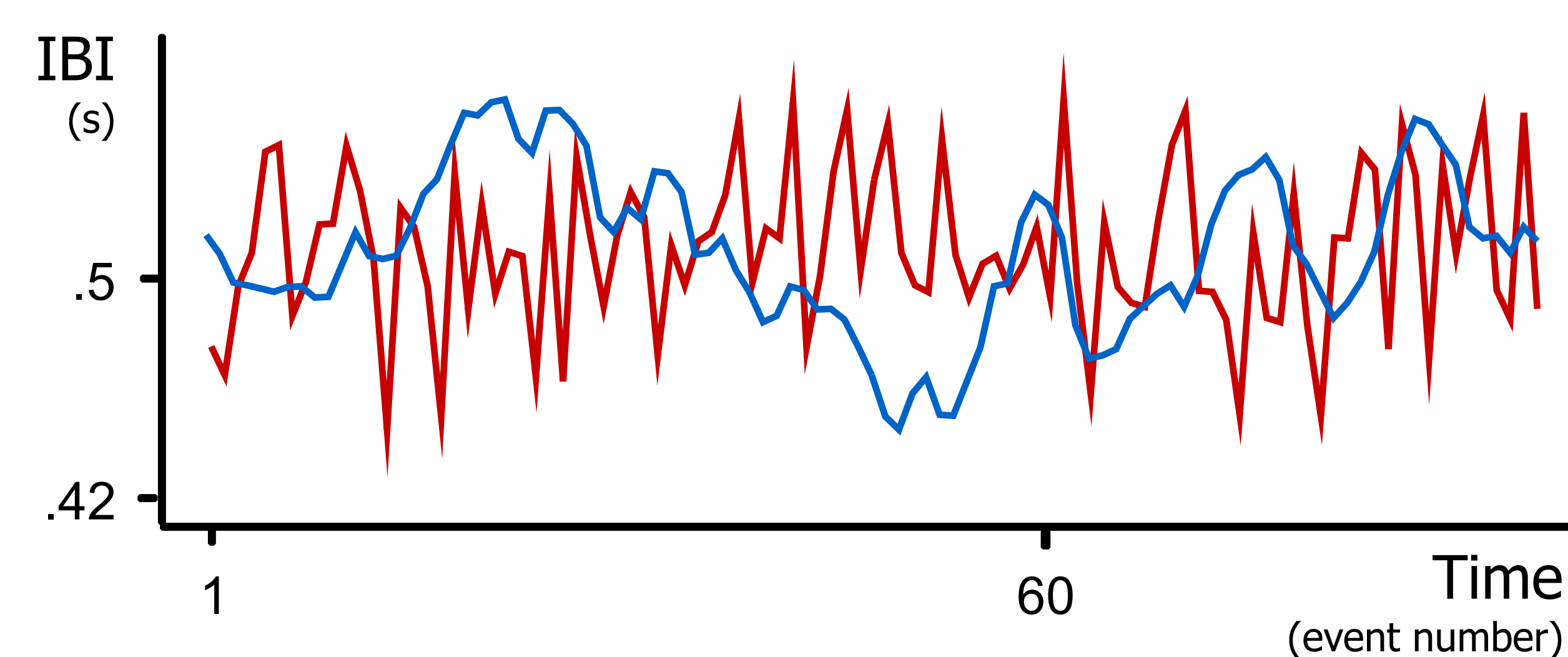
The Dynamic Attending Theory² proposes that the entrainment to nearly-periodic rhythms emerges from the dynamics of interaction between neural systems acting as “internal oscillators”. The internal oscillators are coupled by their anatomical connexions and, therefore, are able to mutually adjust their synchronization, even after the perturbation of one of the oscillators. Importantly, the internal oscillators generate a repetitive time window within which the system is expecting to receive a stimulation. The auditory events of an autocorrelated rhythm match those expectational windows better than those on a non-correlated, random, rhythm. Therefore, the autocorrelated rhythm would reinforce the neural oscillations, yielding a better neural entrainment than a randomly fluctuating rhythm.

In this study, we recorded the EEG activity elicited by auditory beats with autocorrelated fluctuations versus non-correlated fluctuations, in order to provide a direct electrophysiological measure of dynamic attending in healthy human participants.

METHODS

Acoustic Rhythmic Stimulation

Inter-Beat Intervals (IBI) temporal organization



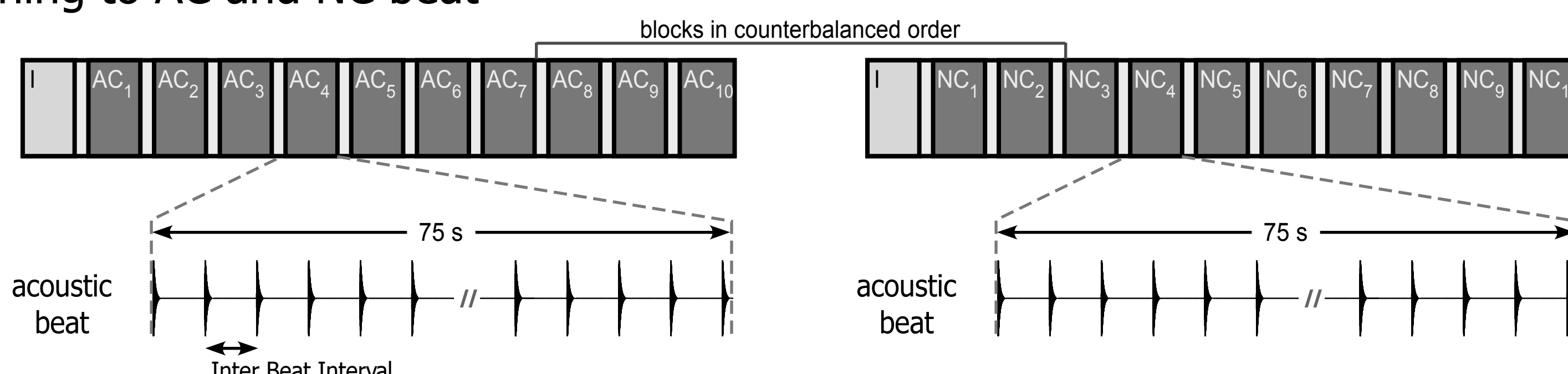
blue: Acoustic beat fluctuating around 2 Hz, with an auto-correlated (AC) jitter.

red: Acoustic beat fluctuating around 2 Hz, with a non auto-correlated (NC) jitter.

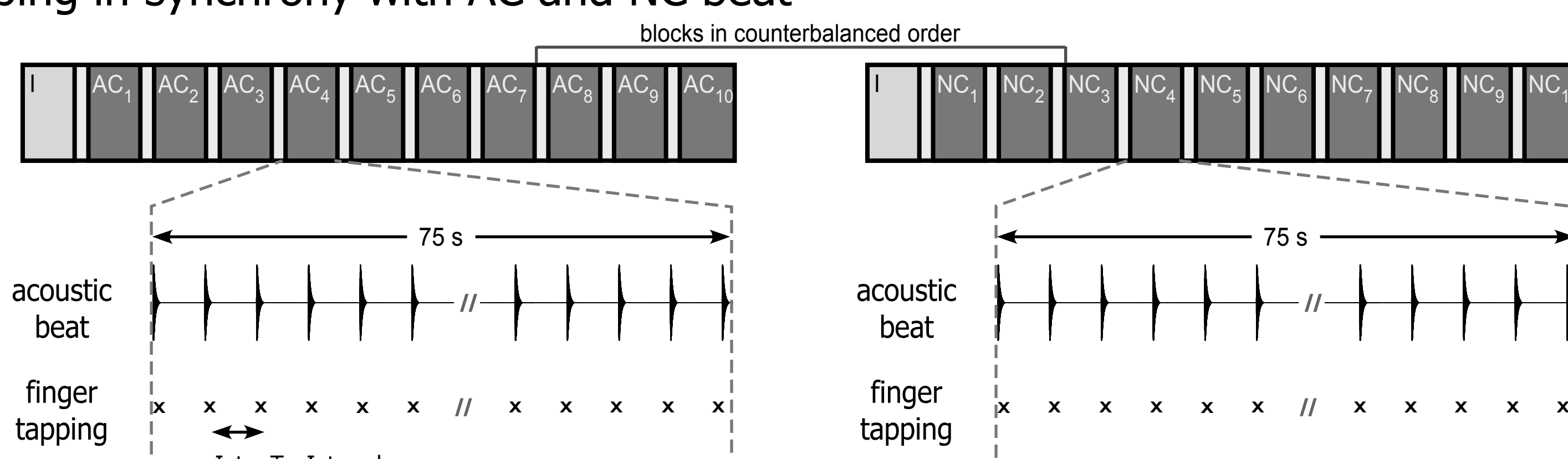
Both AC and NC beats have a jitter of max 8.6 % of the mean IBI, and 4% coef var.

Experimental Conditions

Part I: listening to AC and NC beat

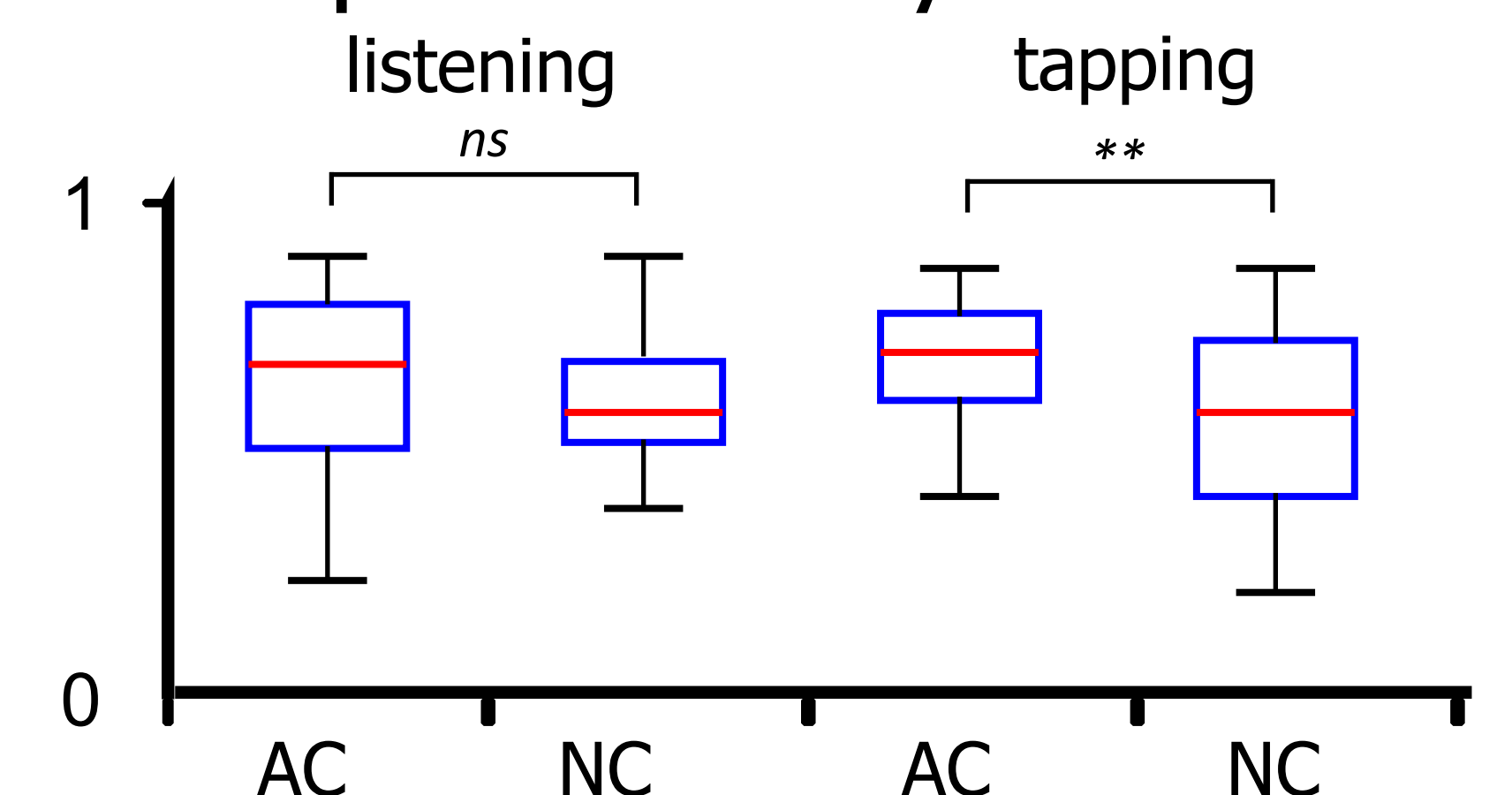


Part II: tapping in synchrony with AC and NC beat

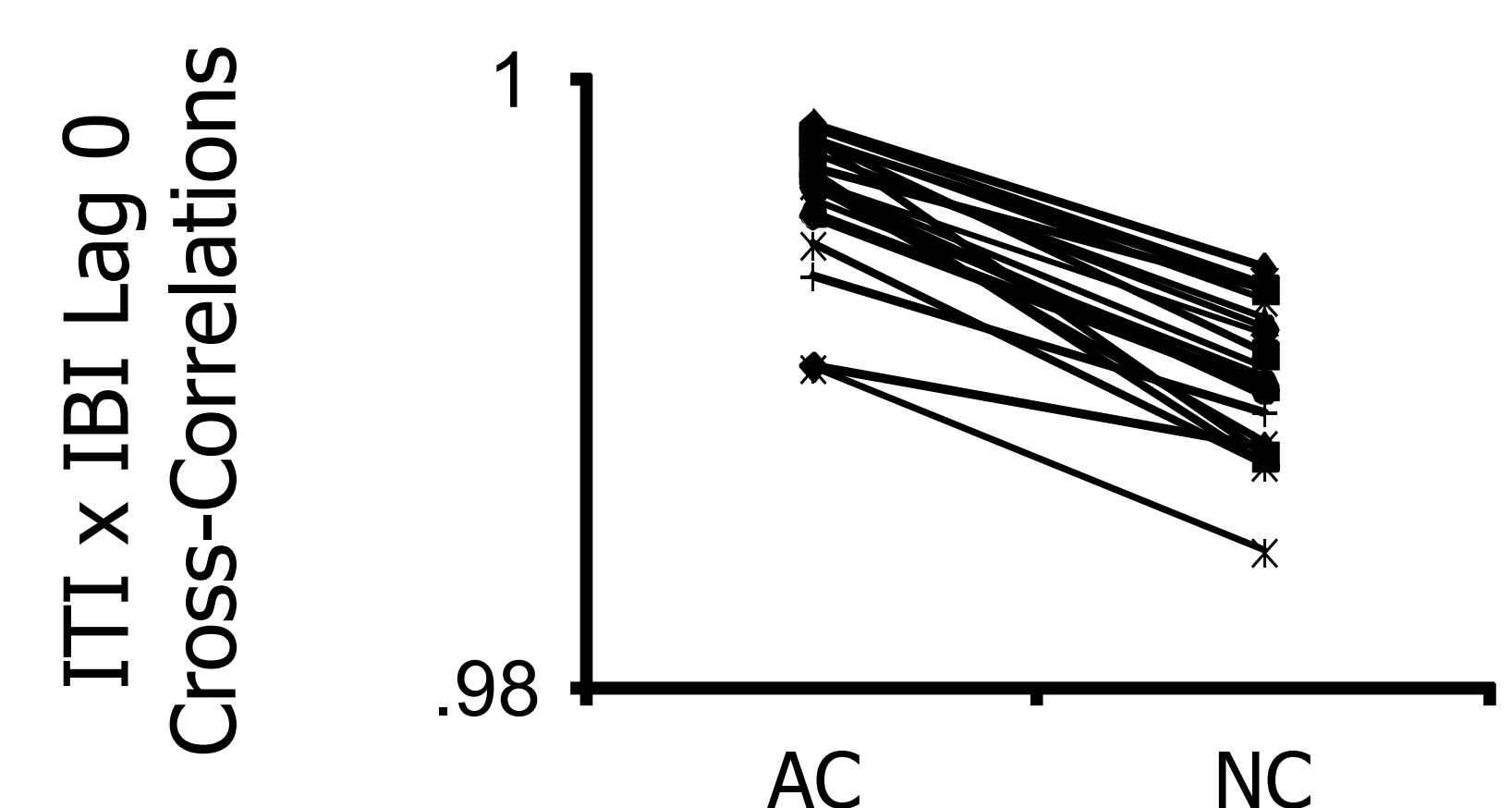


RESULTS

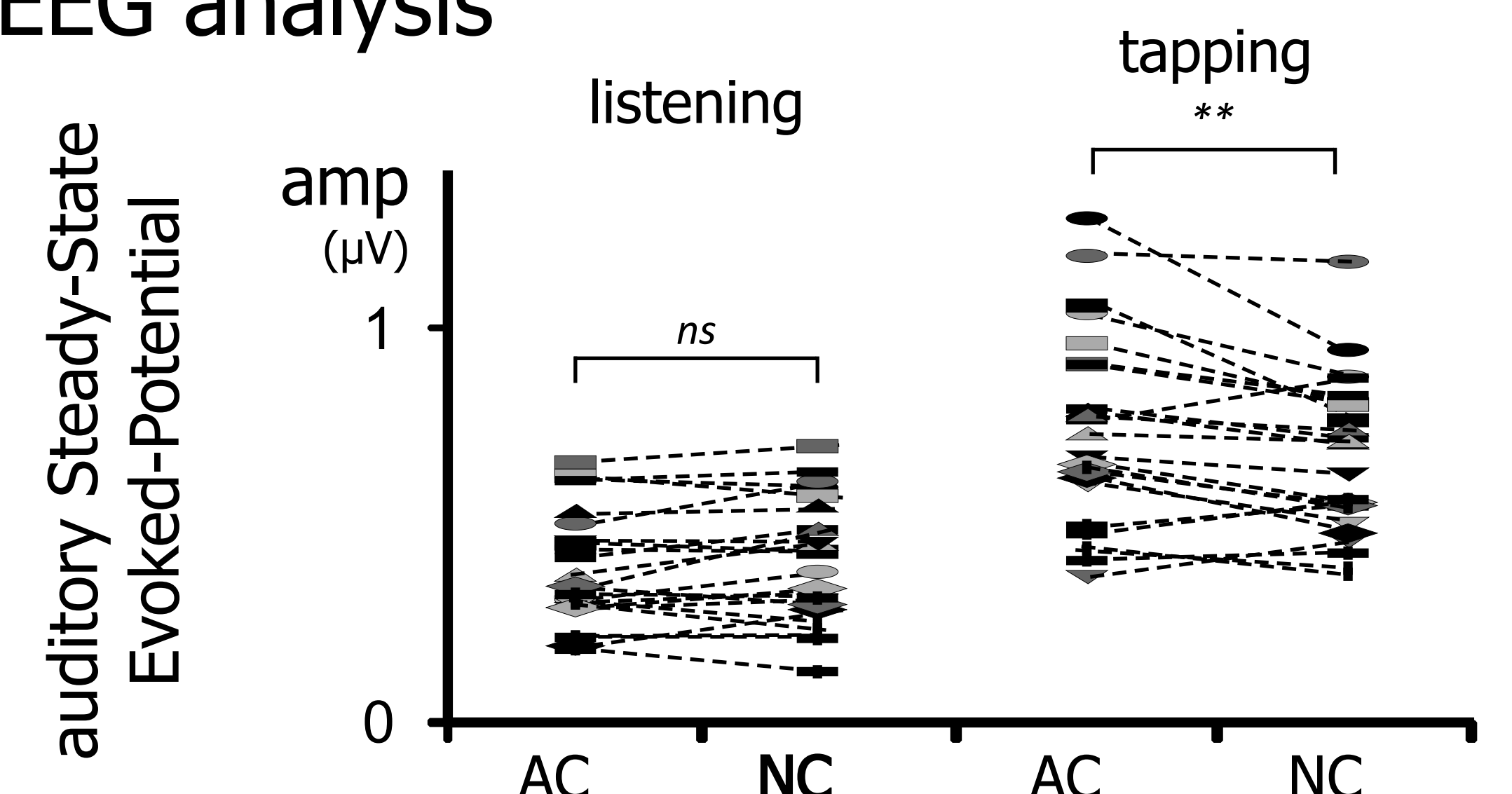
Rating of beat predictability



Tapping Analysis



EEG analysis



DISCUSSION

Participants rated the autocorrelated acoustic rhythms as more predictable than the non-autocorrelated rhythms, when they were actively tapping in synchrony with the acoustic rhythm. Their tapping showed a higher value of Lag-0 corss-correlation for the autocorrelated acoustic rhythm as compared to the non-autocorrelated acoustic rhythm, suggesting a better anticipation of the autocorrelated fluctuations of the acoustic rhythm.

The amplitudes of the nearly-periodic EEG signals related to the processing of the fluctuating acoustic beats were measured in the EEG spectra, according to the frequency-tagging approach³ and the time-warping method⁴. The response elicited by the AC rhythm showed a significantly greater amplitude than the response elicited by the NC rhythm when participants were actively tapping to the acoustic rhythms, but not when they were only listening to it.

These results confirm the hypothesis that beat-induced neural entrainment has the ability to tune itself to autocorrelated fluctuations in beat frequency, and suggest that overt movement is critical for dynamic attending.