Center for Lifespan Psychology

Max-Planck-Institut für Bildungsforschung
Max Planck Institute for Human Development

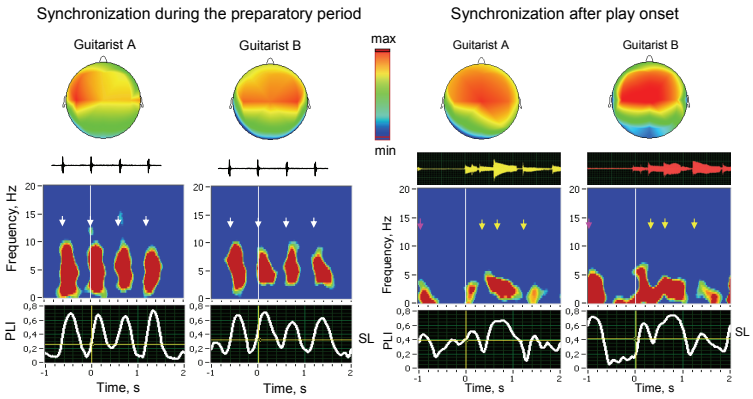
Interactive Brains, Social Minds: Interbrain Synchronization During Guitar Playing

Viktor Müller, Shu-Chen Li, Franziska Kopp, & Ulman Lindenberger

Introduction

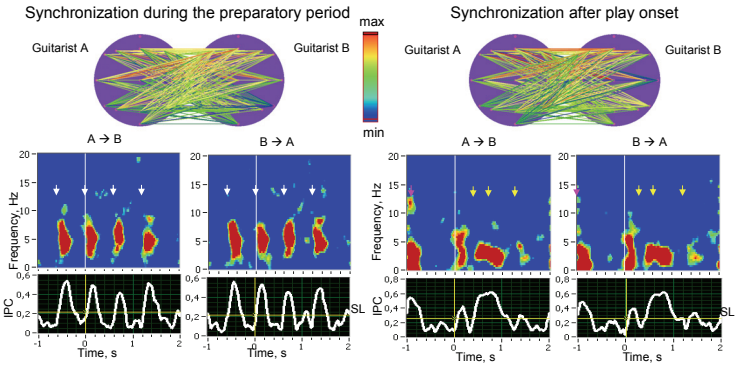
Considerable research indicates that synchronized neural activity in perception and action and oscillatory couplings between cortical and muscle activities during voluntary movement support brain–body–world interactions. However, little if anything is known about brain mechanisms implementing interpersonally coordinated behavior. We propose that oscillatory couplings between brains provide the neurophysiological basis for interpersonally coordinated voluntary actions, and may serve as a basic mechanism for the ontogeny of social interaction and social cognition. The aim of this study was to investigate and to explore the functional role of cortical activity synchronized between brains for interpersonal action coordination while playing guitar. We use musical performance (i.e. two professional guitarists playing in unison) as an experimental paradigm because it provides a well-defined behavioral measure of coordination accuracy (i.e. between-person differences in the timing of guitar strokes).

Synchronization within Brains



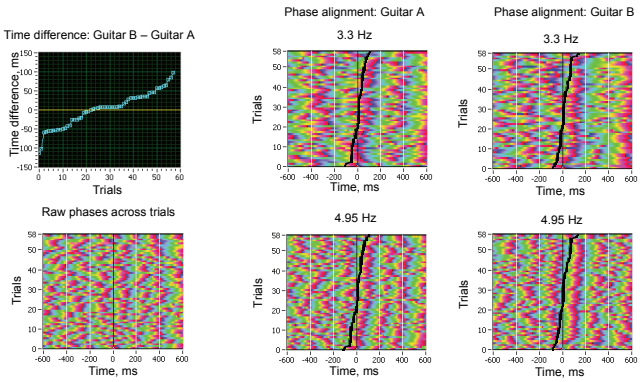
Phase synchronization within brains during the preparatory period of metronome tempo setting and guitar playing. Topological distribution and time-frequency diagrams of average PLI (Phase Locking Index) are shown for guitarist A and B separately. PLI was averaged across six fronto-central electrodes (F3, Fz, F4, C3, Cz, and C4). Only significant PLI-values ($p < 0.003$) are highlighted. All four metronome beats as well as play onset induced high phase synchronization in both guitarists (indicated by red colour). The time course of PLI values at the delta (3.3 Hz) and theta (4.95 Hz) frequency is depicted below the time-frequency diagram (SL = significance level).

Synchronization between Brains



Phase synchronization between brains during the preparatory period of metronome tempo setting and guitar playing. Topological distribution and time-frequency diagrams of average IPC (Interbrain Phase Coherence) are shown for guitarist A and B separately. IPC was averaged across six fronto-central electrode pairs. Only significant IPC-values ($p < 0.003$) are highlighted. All four metronome beats as well as play onset induced high phase synchronization between the brains (indicated by red colour). The time course of IPC values at the delta (3.3 Hz) and theta (4.95 Hz) frequency is depicted below the time-frequency diagram (SL = significance level).

Relation between Brain Synchronization and Behavior



Phase alignment of phase angles in single trials related to behavioral asynchrony of play onsets between the two guitarists. Asynchrony defined as the time difference (in ms) between play onsets of the two guitarists across 58 trials (also the black curve in the diagrams), and phase alignment of phase angles at the two frequency bins (3.3 and 4.95 Hz, the second and the third harmonic of the metronome frequency) sorted by behavioral onset asynchrony between the players are depicted.

Conclusion and Outlook

The degree of action coordination between two individuals is related to the degree of phase synchronization between their brains. Specifically, the brains of two individuals who are performing tightly coordinated actions show enhanced interbrain phase coherence.

Data acquisition and analysis methods for simultaneous EEG recordings from multiple persons are important for discovering interbrain oscillatory couplings during interpersonal interactions. Future research needs to explore the behavioral mechanisms that establish, sustain, and interrupt interbrain oscillatory couplings in communication, voluntary action coordination, and social cognitive development.

About the Project

In everyday life, people often coordinate their actions with each other. Examples include walking at a set pace, playing collective sports, dancing, playing music, and a wide range of social bonding behaviors such as eye-gaze coordination and joint attention between mother and infant, or between partners. Little is known about the mechanisms that implement interpersonally coordinated behavior.

The recently established **Interactive Brains, Social Minds** project investigates lifespan changes in behavioral and neuronal mechanisms that permit individuals to coordinate their behavior with each other in time and space (scientific investigators: **Viktor Müller**, **Shu-Chen Li**, **Michaela Riediger**, & **Ulman Lindenberger**; postdoctoral fellow: **Franziska Kopp;** predoctoral fellows: **Karen Bartling** & **Anna Kleinspehn)**.

The BabyLab

With Franziska Kopp's arrival in 2006, the project has established a laboratory for behavioral and electrophysiological assessments in infants and their mothers. Research topics include infants' action perception, long-term memory, and sensitivity to interpersonal timing, with special attention to the effects of social cues and maternal affect attunement.