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学位論文内容の要旨

博士の専攻分野の名称：博士（保健科学）　　氏名：Boasen, Jared Franklin

学位論文題名

Neural correlates of musical improvisation performance: a magnetoencephalographic investigation

（即興演奏に伴う神経活動：脳磁計による探究）

The ability to improvise, or execute free associative thinking, is a powerful and useful skill for all aspects of our lives in situations where creative ideation or spontaneous responses are required. One way of training this skill is through music. Basic musical ability is intrinsic to all people regardless of age, race, or physical ability. Thus musical improvisation training has wide applicability. Paired or ensemble musical improvisation is also considered conversational, and thus training it is akin to communication training via a non-verbal auditory medium. Correspondingly, musical improvisation is a popular therapeutic tool for non-verbal communication. Furthermore, long-term training of musical improvisation in both clinical and healthy populations has been reported to improve, or be significantly correlated with sociability and creativity.

To better understand these therapeutic and training-based effects, it is important to clarify the nature of brain activity associated with improvisational music performance. A fair amount of work regarding this has already been done in modalities such as magnetic resonance imaging (MRI), functional MRI, and electroencephalography (EEG). These modalities respectively offer insight into the structural, hemodynamic, and spectral neural correlates. However, how brain activity in different oscillatory frequency bands is modulated in different brain areas due to improvisational music performance has hitherto been largely unclarified. To this end, studies employing magnetoencephalography (MEG), which permits spectral-spatial analyses of brain activity, are well suited. Some MEG studies regarding music performance have been reported. However, aside from my own work, I have found no reports regarding improvisational music performance in MEG.

The primary goal of this thesis was to demonstrate the feasibility of musical improvisation performance experimentation in MEG, and produce results that would not only have practical relevance, but also drive future studies regarding musical improvisation training/therapy and contribute neurophysiological evidence supportive of their wider implementation. To accomplish this, I designed and constructed two unique, MEG-compatible musical instruments. I also established an experimental paradigm for musical improvisation performance modeled after conversational forms of music performance used in real live performance or therapy. I then used these instruments and the musical improvisation performance paradigm in two studies. The first study targeted predominantly non-musicians (N = 13). The second study targeted improvisationally experienced musicians (N = 13). Both studies investigated spontaneous source-level brain activity associated with improvisation performance in three different frequency bands: theta (5-7 Hz), alpha (8-12 Hz) and beta (15-29 Hz). The second study furthermore investigated correlations between improvisation-associated brain activity and creative ability (N = 14).

As a result of these studies, I was able to significantly differentiate spectral-spatial brain activity associated with improvisational cognition in non-musicians, improvisationally experienced musicians, and in improvisationally experienced musicians with high creative ability. The inexperience of the non-musicians was reflected by lower alpha band and beta band activity during mental imagery of musical improvisation performance compared to copied performance in parietal brain areas, a sign of inefficient associative processing during creative ideation. Improvisationally experienced musicians meanwhile demonstrated greater theta activity in left temporal rhythm production and communication areas, greater alpha activity in left sensorimotor and premotor areas, and less beta-activity in areas associated with inhibition control. These findings highlighted the communicative nature of the improvisational style used, and support the notion that production of novel auditory content may be facilitated by a more internally-directed, disinhibited cognitive state. Finally, improvisationally experienced musicians with high creative ability showed an inverse pattern of brain activity in frontal brain areas associated with inhibition compared to those with low creativity, suggesting that those with higher creative ability have a heightened ability at entering a disinhibited state.

In all, the present thesis has achieved my goal to build a foundation for neuromagnetic research regarding improvisational music cognition that not only corroborates findings from other modalities in this field, but through its established paradigm also permits further direct neuromagnetic investigation into the effects of improvisational music training and therapy that will hopefully support its wider implementation.