Title	球技競技者における運動視の特性・機能的役割・神経機構
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論 文 内 容 の 要 旨

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論文題名	球技競技者における運動視の特性・機能的役割・神経機構 （Characteristics, functional role, and neural mechanism of motion vision in fast ball game athletes）

論文内容の要旨

Introduction: Visual function is critical for fast ball game athletes as a determinant of the sport performance, and the visual system especially needs to process the information concerning the motion of a ball and opponents accurately and quickly in a temporal constraint, making the subsequent motor actions. The motion vision is based on a signal processing of a dorsal visual pathway in the brain, independently on a ventral pathway for object vision. Therefore, the ability of the motion vision is expected to contribute to the ball-game performance, however, it is still unclear 1) whether fast ball game athletes have superior motion vision comparing to nonathletes, 2) whether the motion vision contributes to the visuomotor performance, and 3) whether event-related potential (ERP) recorded from higher order visual area MT which is a center of visual motion analysis represents stimulus motion coherence and task performance. Therefore, I examined these points using the motion direction discrimination (MDD) task based on random-dot kinematogram.

Methods: College table tennis athletes and nonathletic college students (nonathlete) participated in this study. [MDD task] A fixation point (FP) was presented at the center of the LC display, and randomly moving dots were displayed in four circular apertures (diameter 8º) located diagonally from FP. One among them contained target dots which moved to the same direction at a certain percentage (motion coherence), and participants were asked to report the direction of target dots. The inverse of the minimum discriminable motion coherence was calculated as MCS. MCS measurements were conducted with/without background noise of randomly moving dots throughout the display and at three distance of apertures from the FP, 8º (Near), 12º (Middle), 16º (Far). [CVM task] Visuomotor performance was measured using the consecutive visuomotor (CVM) task, in which target (small Gabor patch) moved horizontally in a liner uniform motion from right to left of LC display one after another at a random Y-axis position. Participants were instructed to hit target by a cursor which moved in vertical axis along the left side of the display relying on the manual prehension force given to force-sensor. Seven speed conditions of target from slow to fast were tested and visuomotor performance was assessed as hit rate. [EEG] EEG was recorded from area hMT/MST during MDD task.

Results and discussions: Athletes showed a superiority in MCS only at middle target location (perifoveal region) comparing to nonathletes, and the difference was more remarkable in background noise condition. It suggests that table tennis athletes have superior ability to extract motion signal from noisy background in a dorsal-pathway-dominant peripheral visual field and daily practice of table tennis improves motion vision in a visual-field-dependent manner. Next, I examined the relationship between MCS and visuomotor performance using the intra-individual variability of the MCS. Both MDD and CVM tasks were conducted 10 times on different days, finding a strong correlation between MCS and CVM performance. Thus, MCS is suggested to contribute to visuomotor performance. Finally, N2 waves of ERP in hMT/MST was found in some participants to reflect not only motion coherence of moving dots but also success/failure of task.

　　　　In conclusion, motion vision is superior in fast ball game athletes, contributes to the visuomotor performance, and is underpinned on hMT/MST activity, suggesting importance of improvement of motion vision ability for fast ball game athletes.

論 文 審 査 の 結 果 の 要 旨 及 び 担 当 者

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論文審査の結果の要旨

　これまで、スポーツのパフォーマンスに関与する視覚機能に関する研究が多く行われてきた。しかし、脳の視覚情報処理の観点から明確に区別される2種類の視機能（形態視・運動視）のうち、球技スポーツで重要となる運動視の評価は行われてこなかった。そこで、本論文はサルの神経生理学的研究で用いられた動くドット刺激（Random dot kinematgram）を視覚刺激として採用し、ヒトの運動視能を定量評価する課題を構築し、球技競技者の運動視能の特性、役割、神経機序を調べることを目的とした。その結果、球技競技者は、特定の周辺視野において運動視能が優れており、運動視能は実際のスポーツパフォーマンス場面を模倣した視覚運動課題のパフォーマンスとも相関し、さらに、ドット刺激の動き出しによって誘発される脳波の特定成分が、課題成否（動きの知覚）と関係していることが明らかになった。これらの結果は、これまでのスポーツパフォーマンス研究ではアプローチできなかった視覚情報処理についての新たな知見であり、独自性や新規性も十分に高いと言える。

　以上のことから、呉屋良真に博士の学位を授与するに相応しいと判断された。