論文 / 著書情報
Article / Book Information

題目(和文)	
Title(English)	Group Effective Connectivity Model of Episodic Memory-related Cognitive Functions
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出典(和文)	学位:博士(学術), 学位授与機関:東京工業大学, 報告番号:甲第12006号, 授与年月日:2021年3月26日, 学位の種別:課程博士, 審査員:小池 康晴,金子 寛彦,杉野 暢彦,吉村 奈津江,永井 岳大
Citation(English)	Degree:Doctor (Academic), Conferring organization: Tokyo Institute of Technology, Report number:甲第12006号, Conferred date:2021/3/26, Degree Type:Course doctor, Examiner:,,,,
学位種別(和文)	博士論文
Category(English)	Doctoral Thesis
種別(和文)	論文要旨
Type(English)	Summary

（博士課程）
Doctoral Program

論 文 要 旨

THESIS SUMMARY

専攻： Department of	物理情報システム　専攻	申請学位（専攻分野）： Academic Degree Requested	博士　（　学術　） Doctor of
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要旨（英文 800 語程度）
Thesis Summary（approx.800 English Words ）

Animals is capable to interact with the environment in meaningful manner due to the function of central nervous system. This system enable animals to take information from the environment, process the information, then react accordingly to benefit the animals in certain way. Brain is at the center of the nervous system, act as a central information processing unit for the living being. In the relatively complex being, such as human, brain is capable of many complex capabilities. One of the important cognitive function for human is memory, it enables us to store information for later use for benefit of our life. Memory can be categorized into several groups based on their function. Episodic memory is a type of long-term declarative memory, it is a memory about one's own experience including action, place, time, emotion, and other related contextual experience. This episodic memory is hypothesized to be the basis for higher cognitive function such as self awareness or consciousness. It is important to understand how the episodic memory work if we want to understand how human mind function.

Brain can be divided into several regions based on several criteria such as cellular structure, anatomical structure, or functional structure. These regions are responsible to specific form of information processing or cognitive function. They work in tandem with each other to create higher cognitive function. To study how a cognitive function such as memory work, we need to understand the interaction between those brain regions.

Brain activity cannot be observe visually, however, the technology such as functional magnetic resonance imaging (fMRI) enables us to observe brain activity non-invasively. The fMRI observe brain activity by detecting the change in blood flow on assumption that the active brain area requires energy thus relatively larger volume of blood flow can be observed. Using the fMRI, we can identified active brain regions during the task of interest. There are two main mode of fMRI data acquisition, task-based and resting-state protocols. In task-based protocol, the subject is asked to perform a task during the scan, while in the resting-state protocol, the subject is asked to refrain from performing any task, both physically and mentally. These different mode of acquisition increase the analytic option brain activity study. However, only identifying active region of the brain does not give the full understanding of its interaction with each other.

Connectivity model is a model that illustrates the interaction between brain regions. There are several type of connectivity models. There are two prominent types of connectivity model used in the field of neuroscience, functional and effective connectivity models. Functional connectivity is a model that show the correlation between brain regions while effective connectivity shows causal interaction between the regions. These model can be derived using several mathematical framework.

In this study, we derived an effective connectivity model of resting-state fMRI related to memory recollection function using Tigramite causal discovery framework. This framework utilizes the concept of transfer entropy to estimate causal effect between each brain activity across time axis. It mitigates the curse of dimensionality by trying to eliminate irrelevant causal link using graph-based Peter Clark algorithm before transfer entropy estimation. We compare and discuss the result with the functional connectivity model of the same dataset derive from CONN-toolbox which determine correlation using Fisher-transform. In summary, the effective connectivity provides more information that improve interpretability of the model, however, the problem of curse of dimensionality which affects the practical computation time effective connectivity cannot be fully avoided.

The model that could be apply across group of population is needed for generalized interpretation of the connectivity model. Here, we propose the group connectivity analysis framework using connectivity model from Tigramite and utilizing Levenshtein distance to quantify each individual model so that the group representative model could be validate and verify with individual models across population. We show the proposed framework using task-based subsequent memory fMRI dataset, and discuss how the resulting group connectivity model agree with the prior clinical and function study.

In conclusion, in this work we focused on constructing brain connectivity model to describe how human memory work. We tried to improve the interpretability of the model by proposed the use of unconventional Tigramite framework on fMRI dataset, and also proposed the method to derive the group representative model within this framework.

備考 ： 論文要旨は、和文 2000 字と英文 300 語を 1 部ずつ提出するか、もしくは英文 800 語を 1 部提出してください。
Note : Thesis Summary should be submitted in either a copy of 2000 Japanese Characters and 300 Words (English) or 1copy of 800 Words (English).

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