【助成 40‑10】

ウェブゲームと計算論的モデリングを通して、人の汎化及び弁別能力を測定し、統合失調症との
関係を評価する

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〔研究の概要〕

この研究では、強化学習における一般化と識別プロセスを測定できる新しい実験パラダイムを開発しました。私たちは、3 歳から 50 歳以上までの広範な年齢層の人々が課題を実行した際の行動を説明するための計算モデルを開発することで、これらの二つのプロセスがどのように発展し、それに対する年齢の影響を見つけました。また、観察された変化の基になるさまざまな認知プロセスの変化するパラメーターを特定しました。さらに、この課題の変種をオンラインで大規模な参加者グループに実施することで、これら二つのプロセスのバランスと統合失調症に関連する症状との潜在的な関連性を見つけました。

〔研究経過および成果〕

Schizophrenia（統合失調症）is a mental disorder that creates a huge burden to the society. Although with intensive research, its cause remains unclear. The major medicines to treat schizophrenia target a type of receptors for the neurotransmitter dopamine, named D2 receptors（ドーパミン D2 受容体）. Recently, my colleagues found that this receptor is critical for animals to learn to discriminate the difference between similar situations in their predictability of future outcome（Iino, et al., Nature 2020）. In other words, when there is deficit in D2 receptors, animals over-generalize（過度の汎化）what they have learned. Arguably, over-generalizing in a similar but different situation from past experiences can lead to wrong prediction, and cause people to misattribute the surprising outcome to the wrong cause. It is possible that frequent confusion caused by over-generalization and misattributing causes may eventually lead people to have a disorganized view of the world, developing into delusion（妄想）. However, this hypothesis has not been tested. Importantly, to eventually transform biological findings into the understanding of schizophrenia, behavioral experiments on human participants have to be conducted to confirm that people who have tendency to develop schizophrenia indeed over-generalize or under-discriminate different situations. Towards this goal, my lab has designed a web-based game to measure the degree by which people can generalize and discriminate when they learn to gain rewards.

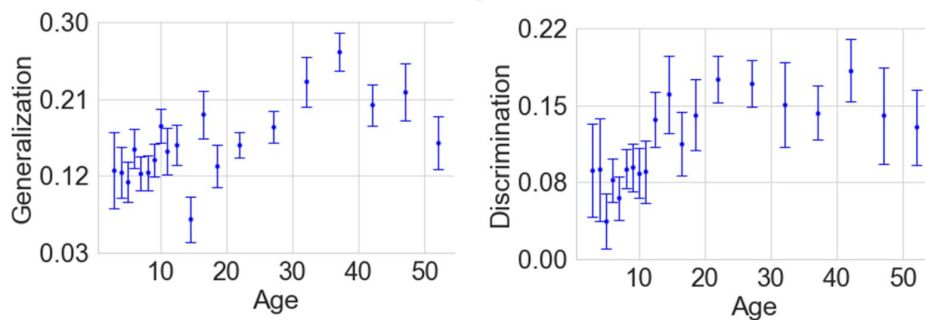**Developmental change of generalization and discrimination**

We have previously collected data of 1007 participants with ages starting from 3 years old to higher than 50 years old, playing the game we developed. In this game,

participants need to learn which of the 18 different objects lead to more reward and which lead to more punishment, and to choose only those leading to reward. The expected amounts of reward or
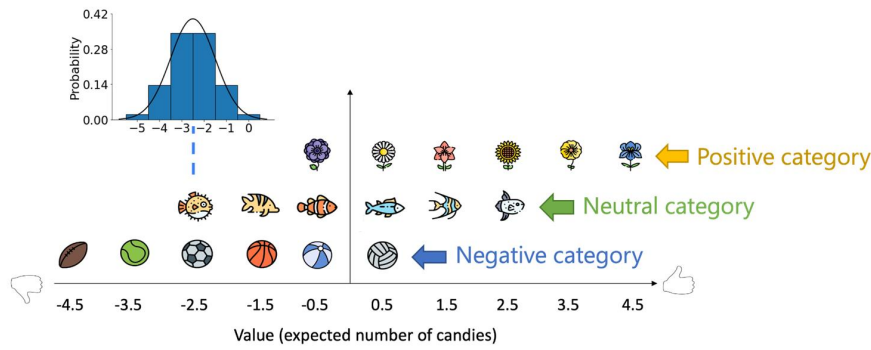
punishment by choosing each stimulus is organized in a hierarchical way according to the semantic categories (as in the figure above).

We quantified generalization by the difference in the frequencies of choosing stimuli of the same values but belong to different categories, and discrimination by the difference in the frequencies of choosing stimuli in the same categories but with higher or lower values. We found that performance of generalization increases with age and peaks at 30~34 years old and declines afterwards, while the discrimination peaks at 14~15 years old and remains stable afterwards.

variables underlie the observed performance change in the graph above.

Furthermore, we have examined the relationship between generalization/discrimination in our task and the degree of severity of psychotic symptoms from a group of participants recruited online. Contrary to our original hypothesis, we found a positive correlation between performance of discrimination of the severity of psychotic symptoms (r=0.31, p=0.004, N=89), indicating that people with higher risk of schizophrenia may rely less on prior knowledge of semantical categories when learning values of stimuli.

〔発表論文〕

We are in the process of completing the manuscripts summarizing the findings and will submit the papers soon.

By modeling the behavior in more details, we found that age-related change of multiple learning-related