Here begins our new MIRAI
MOONSHOT RESEARCH & DEVELOPMENT PROGRAM

Protecting children's intellectual curiosity and individuality to realize a dynamic society

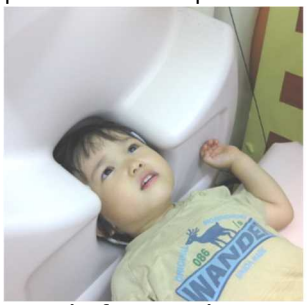
R&D Theme

Visualization of Children's Mental Well-being

Progress until FY2025

1. Outline of the project

The role of the research and development project "Assessment of Brain Individuality and Evaluation of Intervention Effects" is to explain the inherent characteristics of conditions such as Autism Spectrum Disorder (ASD) using both cognitive psychology and neuroscience (e.g., infant magnetoencephalography), enabling caregivers to view children in a more objective manner. The objective is to build scientific evidence to dispel misconceptions such as "developmental disorders caused by parenting" among families struggling with child-rearing and to prevent disharmony within the home (including parental maladaptation and abuse).



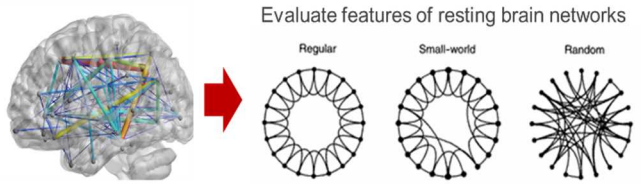
(Infant MEG)

(OPM sensor)

The role of the research and development project "Advanced Element Development of Brain-Measurement System Optimized for Children" is to explore the feasibility of applying optically pumped magnetometers (OPM) to infants in order to make the ASD diagnostic system more affordable and practical. It aims to verify whether OPM-MEG can replicate the results of previous studies conducted with SQUID-MEG.

2. Outcome so far

In "Evaluation of Brain Individuality and Intervention Effects," we have started recruiting participants and accumulating data. To facilitate smooth recruitment for this project, we have created a website and a dedicated site for participants. We have been analyzing brain network characteristics using graph theory to obtain brain indices reflecting the individuality of children.



Using this analytical method, we have reported a decrease in small-worldness in children with ASD tendencies compared to typically developing children (Shiota et al., 2022, Front Psychiatry). By applying similar analysis techniques, we conducted preliminary analysis of data from clinical trials of transcranial direct current stimulation (tDCS) in the past and demonstrated the potential to predict responders to working memory enhancement in adult males (Hirosawa et al., 2023, Front Psychiatry).

Regarding the "Advanced Element Development of Brain-Measurement System Optimized for Children," we have set up an OPM measurement environment within a magnetically shielded room and conducted tests to confirm the basic operation and stability of the sensor (Quspin QZFM Gen.2). We examined the possibilities and challenges of measuring brain magnetic fields on the order of several hundred femtotesla (100 fT = 10^-13 T). As a result, we found that the current measurement environment is within the range where brain magnetoencephalography (MEG) is possible. However, we also discovered that the spatial gradient of environmental magnetic fields remaining within the magnetic shielding, estimated to be around 0.1 nT/cm, can significantly affect the measurements.

3. Future plans

We will leverage the high temporal resolution of MEG data and characterize brain networks using metrics such as node degree, node efficiency, clustering coefficient, average path length, small-worldness, and network vulnerability to elucidate their relationship with individual traits, including children.

To achieve a lower cost for MEG measurements, we will continue optimizing OPM measurements. We will install 14 sensors of the 3D sensor type (Quspin QZFM Gen.3) and validate their potential for measuring brain activity in infants and exploring future applications. To accomplish this, we will develop techniques to eliminate various sources of noise, such as spatial distribution of magnetic fields in the measurement room, noise originating from peripheral devices, and electromyography signals. Utilizing spatial and temporal characteristics from the data collected by multiple sensor arrays, we will develop methods to remove noise and signal components unrelated to brain activity originating from magnetic field distributions.

(HIROSAWA Tetsu, MORISE Hirofumi: Kanazawa U)

国立研究開発法人 科学技術振興機構 Japan Science and Technology Agency

Protecting children's intellectual curiosity and individuality to realize a dynamic society

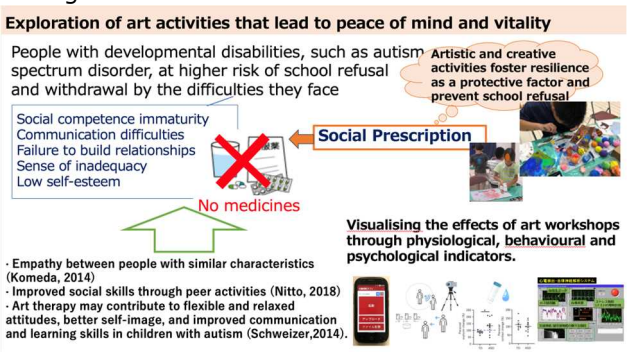
R&D Theme

Visualization of the Art Intervention Effects

Progress until FY2025

1. Outline of the project

The aim of this study is to establish objective endocrine and psychophysiological indicators that capture the improvement in mental well-being and social curiosity resulting from artistic activities, with the goal of providing art activities that allow children and adolescents with challenges in social skills and characteristics associated with Autism Spectrum Disorder (ASD) to enhance their sociability while feeling at ease.

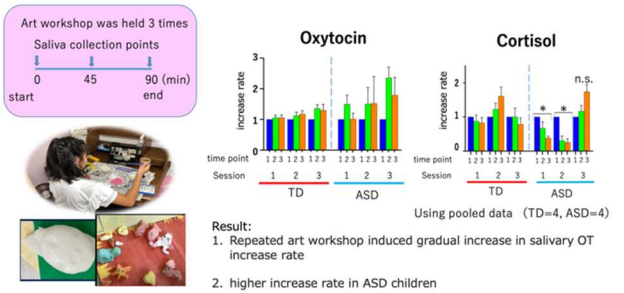


- Prepare the field for conducting face-to-face/remote Art Workshop Sessions (AWS) targeting children and begin collecting data on hormonal fluctuations in saliva.
- Develop a wearable small-scale electrocardiogram measurement system.
- Develop a face-to-face detection app and a motion visualization system.
- Initiate heart rate measurement in face-to-face AWS sessions targeting adults and accelerometer measurement using the face-to-face app, and evaluate the implementation protocol.
- Conduct a questionnaire survey on art activities and enhance the content.

2. Outcome so far

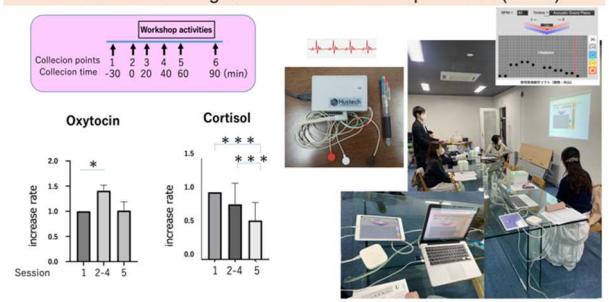
<Art Workshop> Due to the fluctuating impact of COVID-19, in the 2022 fiscal year, measurements were conducted on the changes in concentrations of hormones such as oxytocin and cortisol in saliva during remote AWS sessions. Psychological and behavioral data were obtained through video recordings, questionnaires, and interviews. The measurement points necessary to capture the fluctuations in oxytocin concentration in saliva were confirmed. Analyzing the changes in oxytocin concentration in saliva before the activity, 30 minutes after the activity started, and after the activity ended during children's participation in remote art activities, it was confirmed that children with ASD showed a higher increase in oxytocin concentration compared to typically developing (TD) children.

Changes in saliva OT concentration during remote art workshop activities (children)



<Electrocardiogram Measurement Device> A small wearable electrocardiogram measurement device was developed to remove noise, and a prototype software capable of real-time analysis and display of heart rate and autonomic nervous system indicators during daily life was completed. Measurements were taken for one week during both art activities and daily life to analyze individual fluctuations in autonomic nervous system activity."

Changes in saliva OT concentration and electrocardiographic measurements during face-to-face art workshop activities (adults)



<Face-to-face Detection App> Efforts are being made to continue development aiming to integrate face-to-face data with vital data.

<Motion Visualization System> Development was conducted for body orientation.

3. Future plans

Based on the research findings, we will organize face-to-face/remote Art Workshop Sessions (AWS) targeting adolescents with ASD characteristics, using optimized art activities. We will analyze the fluctuation values of hormones in saliva, measurement data from the face-to-face detection app and motion visualization system, as well as heart rate variability data, in relation to changes in participant characteristics and satisfaction. We will also examine the usefulness of these indicators in demonstrating the effects of art activities.

(TANANA Saori, GODA Norio: Kanazawa U
KOMAGOME Aiko: Tokyo U of Art
KANKI Teruo: Osaka U)

Here begins our new MIRAI
MOONSHOT RESEARCH & DEVELOPMENT PROGRAM

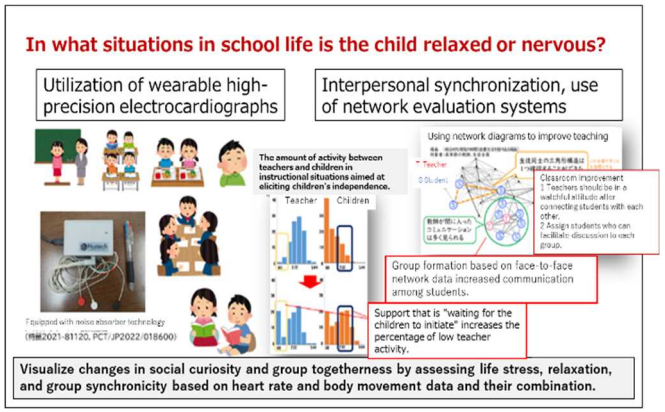
R&D Theme

Realization of schools that protect individuality

Progress until FY2025

1. Outline of the project

This project focuses on "schools," where diverse children live together, to promote learning based on inherent curiosity and to achieve a high level of mental well-being for children. Kanazawa University and Kaga City are collaborating on this research project with three main themes: "visualization of children's mental well-being and intellectual curiosity in schools," "examination of educational systems," and "ELSI for developmental disabilities.



○Target

Students enrolled in regular elementary school classes and special-needs classes

○Method

Students will be asked to wear a wearable high-precision electrocardiograph and face-to-face detection application while at school to acquire heart rate data and activity volume data.

2. Outcome so far

Device 1: Wearable high-precision ECG

A prototype device was created to improve the accuracy of heart rate and autonomic nerve measurement in daily life and to enable long-term measurement.

Device 2: Face-to-Face Inspection Synchronicity Detection Application

A system was introduced to evaluate the body movements during individual body activities and group synchronization by means of an acceleration sensor built into a small smartphone.

Research Implementation System

We regularly hold collaborative meetings composed of educators from the staff council, special education advisors, and researchers to share information regarding the adaptation and support status of students requiring assistance in schools.

Selection for Research Collaboration with Schools in Kaga City

For one school, with the cooperation of the Kaga City Board of Education and the target elementary school, a preliminary experiment was conducted using small smartphones to measure individual body movements during physical activities and group synchronization.

3. Future plans

We will continue to hold information sharing meetings between Kaga City and researcher's in university to grasp the current state of education in the community and share information about the adaptation and support situations for students requiring assistance, including those with developmental disabilities. We will conduct surveys on activities of strong interest and prepare for "Curiosity Exploration Time." Symposiums and other events will be organized to promote understanding of inclusive education among citizens and provide opportunities for comprehension.

(YOSHIMURA Yuko: Kanazawa University)

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