Overview

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On the publication of the 2025 Annual Review, I would like to outline the background and progress of this project to date.

1) Overview of the Study

This report presents the final-year (2025) results of the Grant-in-Aid for Scientific Research (B), titled *"Elucidating the Relationship Between Individual and Environmental Factors from the Fetal Period to Adulthood and Social Behavior in Adolescence Through a Longitudinal Study."*

The cohort study, which began in 2004, has followed participants for 21 years at the time of this report. The overarching research theme shared by the investigators in this project is as follows:

1. To clarify the developmental mechanisms underlying social behavior by examining relationships between social behavior in adolescence (the main outcome) and early developmental environmental and individual factors,

including observational data on mother–child interactions during infancy and early childhood as exposures.

2. To investigate how behavioral characteristics in early childhood influence the formation of values in adolescence, focusing on the development of abstract thinking—shaped through the transition from egocentrism in early childhood to decentration in middle childhood—and social behavior as mediating processes.
3. To examine the contribution of genetic and physiological factors to development by conducting retrospective analyses of gene expression, stress-related biomarkers, and physician-observed data.
4. To construct a developmental model by capturing the interrelationships among factors from early childhood through middle childhood as exposures, using a longitudinal and integrative approach, and analyzing their relationships through a dynamic systems approach that incorporates time-lag effects.
5. To clarify the continuity between adolescents' social behavior and the values and social behaviors of their caregivers.

6. To identify factors that enable researchers and collaborators to sustain longitudinal studies, thereby contributing to future longitudinal research.
7. To provide the accumulated longitudinal data, under certain conditions, as a shared developmental research database for researchers in Japan.

To address these research objectives, the project was organized into the following eight groups:

1. Tanaka Shigeki: Epigenetic analysis of stress and glucocorticoid receptors in early childhood.
2. Ogawa Masahiro: Analysis of the relationship between medical observations in early childhood and developmental outcomes in adolescence.
3. Obnanawa, Wright, Naoko: Analysis of childhood stress and social behavior in adolescence.
4. Tamai Kouta: Analysis of cohort developmental data using time-series methods.
5. Nakayama Rumiko: Developmental study of self-evaluation in childhood and adolescence and parental child-rearing attitudes.
6. Takeshima Katunori: Investigation of the relationship between depressive behaviors in childhood/adolescence and behaviors in early childhood.

7. Namba Kumiko: Examination of the relationship between social behavior in adolescence and self-regulation in early childhood.
8. Jikihara Yasumitu: Examination of open access to accumulated research data and its clinical applications.

Regarding open access, Professor Emeritus Ujiie Tatsuo of Nagoya University, former President of the Japanese Association of Developmental Psychology, has joined the project as a supervisor.

External evaluation is scheduled for 2026 by Professor Emeritus Savelsbergh of Vrije Universiteit Amsterdam and Professor Ujiie Tatsuo. In addition, a hearing by the Children and Families Agency was conducted in January 2026.

2) Background of the Study

This study is grounded in two fundamental questions inherent in developmental research itself. The first concerns describing the course of development—namely, clarifying how human development changes over time. Through this, developmental researchers are able to identify and evaluate the developmental stage of an individual. While age differences can also be demonstrated through cross-sectional methods, such approaches tend to abstract away individual differences. In

contrast, this study adopts a longitudinal approach to capture developmental trajectories that incorporate individual variability.

A second key issue concerns the mechanisms underlying developmental change—specifically, how the developmental transformations of various functions, as revealed through longitudinal research, are generated. The longstanding question in developmental theory—whether behavioral development arises from innately programmed mechanisms or is acquired through learning—remains unresolved. One reason for this is the complexity of contributing factors. For example, even in the mother–child relationships in early development reported in this cohort, numerous elements—such as language, emotion, motivation, sensorimotor function, and caregiving environments including maternal characteristics—interact with one another, often with temporal lags.

Another reason lies in the relationship between observable behavior and its underlying function. This can be conceptualized in terms of homology and analogy. For instance, pointing and vocalization both serve interpersonal communicative functions, yet the observable behaviors themselves are entirely different. Similarly, in mother–child relationships, the frequency and quality of conversations with the mother change their meaning as

indicators of relational dynamics depending on the developmental stage.

Such issues can only be elucidated by examining outcomes and exposures from a developmental perspective, informed by the concepts of homology and analogy. In this study, more than 7,000 variables have been tracked from birth. Beyond simply plotting these data, we aim to analyze their interrelationships across multiple factors and time points in a cross-lagged manner, and to propose underlying mechanisms that may explain these relationships.

Environmental factors treated as exposures include parental emotions toward the child during the fetal period, postnatal parental feelings toward the child, maternal behaviors in mother–child interactions at four months of age, parental beliefs about child-rearing, paternal involvement in childcare, socioeconomic status (SES), changes in the home environment such as job transitions, peer relationships at school, and classroom adjustment. Individual factors include physiological conditions after birth, as well as children's cognitive abilities, motor functions, language abilities, sensorimotor coordination, and resilience, as assessed through developmental testing.

Sociality as an outcome from infancy through childhood is measured through developmental assessments of social behavior

toward children and adults, self-regulation in interactive contexts, and classroom adjustment. In addition, from an ecological perspective, and with the consent of guardians and childcare providers, evaluations by classroom teachers of children's group behavior in nursery schools and kindergartens are also included.

3) Theoretical Background of the Study

With regard to explanatory models of developmental processes as described above, several approaches that go beyond the simple nature-versus-nurture framework have begun to emerge. One such approach is the dynamic systems approach proposed by researchers such as Thelen and Fogel. A representative example is the theory of multilayered interactions among functions based on dynamic systems theory, as articulated by Thelen and Smith (2002), building on the developmental model of Waddington (1957) (Figure 1).

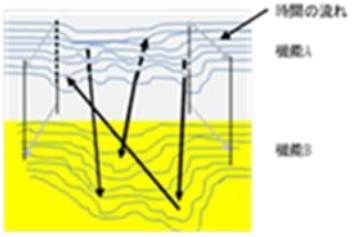

Figure 1. 多層モデル

This perspective posits that human behavior is not pre-programmed; rather, it emerges through interactions among underlying component elements. In this view, dynamic

relationships among elements give rise to new forms of behavior. Although empirical studies remain relatively limited, for example, Bertenthal and Campos (1984) demonstrated that when infants who had not yet developed independent locomotion were given experience with movement using walkers, cognitive functions that typically emerge later were subsequently observed. Such findings suggest that emergent phenomena in developmental change are produced through interactions among functions. This framework has been incorporated as one of the theoretical foundations of the present study.

Another perspective incorporated into this study is epigenetics, which seeks to explain developmental mechanisms through interactions between genetic and environmental factors (e.g., Sameroff, 1975; Ford & Lerner, 1992). A key point in this framework is that development is not only shaped by interactions between genetic and environmental factors, but also that whether genetic traits are expressed depends on these interactions with the environment.

In our study, which takes social behavior as the primary outcome, individual characteristics at birth interact with factors such as parental child-rearing attitudes, socioeconomic status, and childcare environments to produce behaviors with individual-specific characteristics. At the same time, these interactions may

induce methylation of specific genes, leading to modifications in gene expression that in turn influence subsequent behavior. In our project, pilot genetic analyses have been initiated since last year, focusing on gene methylation associated with exposure to strong stress.

4) Implementation Overview

Each research group is advancing investigations into the issues described above. At present, however, the data that have been cleaned are available only up to the third year of junior high school, and analyses remain at a partial stage. The progress of each group is shared at general meetings held twice a year.