乳幼児期の腸内細菌叢および脳と認知機能の発達的関連

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1999年　　京都大学大学院教育学研究科博士後期課程修了　博士（教育学）
2002年　　京都大学霊長類研究所研修員
2008年　　京都大学大学院教育学研究科准教授
2014年～現在　京都大学大学院教育学研究科教授
2021年～現在　文部科学省 科学技術・学術審議会委員
2023年～現在　こども家庭庁こども家庭審議会臨時委員
2023年～現在　国立大学法人広島大学客員教授
2023年～現在　日本学術会議会員

主な研究テーマ

生物学や霊長類学、脳神経科学、心理学、情報工学、ロボティクスなどとの学際的アプローチにより、ヒト特有の脳とこころの働きが創発・発達するプロセス、およびその進化・生物学的基盤の解明を目指す「比較認知発達科学」を世界にさきがけて開拓した。現在は「腸内細菌叢―腸管―脳」軸に着目し、定型―非定型を問わず、ヒトの精神・認知機能が多様な軌跡をたどりながら創発・発達する動的プロセスの可視化およびその機序解明を目指している。

主な著書（直近３年間で公表されたヒトの腸 - 脳軸と表現型の発達的関連についての研究成果）

1. Matsunaga, M., Takeuchi, M., Watanabe, S., Takeda, A., Hagihara, K., & Myowa, M. (2025, in press) Association of short-chain fatty acid-producing gut microbiota and dietary habits with maternal depression in a subclinical population, *PNAS Nexus*.
2. Takeuchi, M.,（他 7名）, Myowa, M., & Hagihara, K. et al. (2025) The validity of a new resilience scale: the Japan Resilience Scale (J-RS) for mothers with a focus on cultural aspects. *BMC Public Health* 25, 1569.
3. Tanaka, Y.. Diaz-Rojas, F., & Myowa, M. (2025) Multimodal measurement of music engagement in a natural setting for infants, young children and parents, *MethodsX* 14, 103105
4. Matsunaga, M., Takeuchi, M., Watanabe, S., Takeda, A.K., Kikusui, T., Mogi, K., Nagasawa, M., Hagihara, K., & Myowa, M. (2024) Intestinal microbiome and maternal mental health: preventing parental stress and enhancing resilience in mothers. *Communications Biology* 7, 235.
5. Ueda, E.,（他 6名）& Myowa, M., (2024) Temperament in early childhood is associated with gut microbiota composition and diversity, *Developmental Psychobiology*, 66:e22542.
6. Diaz-Rojas, F., & Myowa, M. (2024) Estimation of Human Body 3D Pose for Parent-Infant Interaction Settings Using Azure Kinect and OpenPose, *MethodsX*, 13, 102861
7. Fujihara, H.,（他 7名）& Myowa, M. (2023) Altered gut microbiota composition is associated

with difficulty in explicit emotion regulation in young children. *Microorganisms* 11:9, 2245.

受賞

2004年　中山科学財団　中山賞奨励賞
2005年　日本霊長類学会　高島賞
2012年　日本心理学会　国際賞奨励賞
2013年　日本学術振興会ワシントン研究連絡センター・米国国立科学財団
　　日米女性研究者代表
2014年　NPO 法人 ニューロクリアティブ研究会 創造性研究奨励賞
2018年　Winner of the 2018 Ursula Gielen Global Psychology Book Award, Keller. H. and Bard, K.A. (Eds.) The Cultural Nature of Attachment: Contextualizing Relationship and Development, Cambridge, MA: MIT Press, 2018
2024年　日本文藝家協会「ベスト・エッセイ 2024」入選「脳科学者が犬を飼ったら」

要旨

腸内細菌叢は、生後の環境要因に大きく影響を受けながら変化し、３～４歳頃にかけて安定化する。腸内細菌叢は、免疫系や自律神経系、とくに迷走神経系などの経路を介して脳機能や精神状態に影響を及ぼすことが知られている。つまり、乳幼児期は腸の発達における「感受性期」にあたり、この時期の食生活習慣はその後の脳機能の基盤を形成する可能性が高い。

実際、乳幼児期の腸内細菌叢の組成変化や組成が、気質や認知・言語発達リスクと密接に関連することが欧米圏を中心に報告されてきた。しかし、腸内細菌叢は民族によって異なり、とくに日本人がもつ菌叢の組成は欧米人のそれとはかなり異なっている。そこで、私たちの研究グループは、日本人乳幼児とその母親 2800超ペアを対象とした腸内細菌叢データベース（睡眠や排便、アトピーなどの身体特性、認知発達や気質、育児ストレスなどの精神機能、食生活習慣との関連）を構築してきた。現時点で、①母子の菌叢のα多様性には強い関連がみられる、②子どもの自律神経系、とくに睡眠時の迷走神経活動は、幼児の菌叢および認知・精神機能の両方と関連する、③母親の育児ストレスの高さは、幼児の認知発達リスク・迷走神経活動の低さ・腸内細菌叢の組成と関連する、ことなどが明らかになっている。

精神疾患や発達障害を含むヒトの精神･認知機能の多様性が創発していく機序の解明は、個体のみを対象とし、かつ、実験室という制約された時空間で行われる研究手法では限界がある。私たちは、日常生活下でのヒト母子の心身状態を可視化し、それぞれの食生活習慣を活かした個別化された支援法の開発を進めている。科学的エビデンスに基づく生後早期からの介入、支援法の開発は、将来の心身の不全を未然に予防、緩和しうる有効な医療アプローチ創出へとつながる。現在、食生活習慣の改善や腸内細菌叢の操作（e.g., プロバイオティクスやプレバイオティクス）などの介入によりリスク改善が実際に認められるかなど、それらの因果性を長期にわたり検証する基礎研究を継続している。

The relationship between gut microbiota and brain and cognitive development in early childhood

Masako Myowa
Graduate School of Education, Kyoto University

Brief Curriculum Vitae

1994-1999	Graduate School of Education, Kyoto University (Ph.D., Kyoto University, 1999)
1999-2002	Research Fellow of the Japan Society for the Promotion of Science
2002-2003	Postdoctoral Research Fellow, Primate Research Institute, Kyoto University
2003-2008	Senior Lecturer, School of Human Cultures, The University of Shiga Prefecture
2008-2014	Associate Professor, Graduate School of Education, Kyoto University
2014-present	Professor, Graduate School of Education, Kyoto University
2015-present	Member of the Science Council of Japan (SCJ)
2020-present	Member of the Council for Science, Technology and Academic Affairs, Ministry of Education, Culture, Sports, Science and Technology (MEXT)
2021-present	Member of the Council for Children's and Family Agency
2022-present	Visiting Professor, Hiroshima University
2024-present	Member of the Council for the Ministry of Economy, Trade and Industry (METI)

Research Interests

My research explores the uniquely human brain and mind, as well as their evolutionary and biological foundations. I pioneered the field of comparative cognitive developmental science by integrating perspectives from biology, primatology, neuroscience, psychology, informatics, and robotics. This interdisciplinary approach has significantly advanced our understanding of the mechanisms and biological bases underlying human brain and cognitive development. Currently, our research focuses on the gut microbiota–gut–brain axis. We aim to visualize the dynamic developmental processes through which human brain and cognitive functions follow diverse trajectories, and to elucidate the mechanisms driving both typical and atypical patterns of development.

References (Publications in the past three years on the development of the human gut-brain axis and the diversity of phenotypic expressions)

1. Matsunaga, M., Takeuchi, M., Watanabe, S., Takeda, A., Hagihara, K., & Myowa, M. (2025, in press) Association of short-chain fatty acid-producing gut microbiota and dietary habits with maternal depression in a subclinical population, *PNAS Nexus*.

2. Takeuchi, M., (other 7 authors) , Myowa, M., & Hagihara, K. et al. (2025) The validity of a new resilience scale: the Japan Resilience Scale (J-RS) for mothers with a focus on cultural aspects. *BMC Public Health* 25, 1569.
3. Tanaka, Y., Diaz-Rojas, F., & Myowa, M. (2025) Multimodal measurement of music engagement in a natural setting for infants, young children and parents, *MethodsX* 14, 103105.
4. Matsunaga, M., Takeuchi, M., Watanabe, S., Takeda, A.K., Kikusui, T., Mogi, K., Nagasawa, M., Hagihara, K., & Myowa, M. (2024) Intestinal microbiome and maternal mental health: preventing parental stress and enhancing resilience in mothers. *Communications Biology* 7, 235.
5. Ueda, E., (other 6 authors) & Myowa, M. (2024) Temperament in early childhood is associated with gut microbiota composition and diversity, *Developmental Psychobiology* 66, e22542.
6. Diaz-Rojas, F., & Myowa, M. (2024) Estimation of human body 3D pose for parent-infant interaction settings using azure Kinect and OpenPose, *MethodsX* 13, 102861.
7. Fujihara, H., (other 7 authors) & Myowa, M. (2023) Altered gut microbiota composition is associated with difficulty in explicit emotion regulation in young children. *Microorganisms* 11:9, 2245.

Honors and Awards

2004 Incentive Award of the Nakayama Science Foundation, Nakayama Shoten Co., Ltd.

2005 Takashima Award, The Primate Society of Japan

2012 International Prize for Young Psychologist,
The Japanese Psychological Association

2013 Selected member of US-Japan Connections Symposium for Women Leaders in Science, Technology and Engineering and Mathematics, "Crossing Boundaries with Informatics" from Basic Science to Social Infrastructure, The National Science Foundation (NSF) and the Japan Society for the Promotion of Science (JSPS)

2014 Neuro Creative Award, The Neuro Creative Lab (NPO)

2018 Winner of the 2018 Ursula Gielen Global Psychology Book Award, The Cultural Nature of Attachment: Contextualizing Relationships and Development, Keller. H. and Bard, K.A. (Eds.) The Cultural Nature of Attachment: Contextualizing Relationship and Development, Cambridge, MA: MIT Press, 2018

2023 Served as the chief supervisor for the children's variety show "IRORIRO" on Yomiuri TV. The show won the Excellence Award in the Special Commendation Category (Youth Programming) at the 2023 Japan Commercial Broadcasters Association Awards. https://www.ytv.co.jp/irororiro/about/.

2024 "Best Essay 2024" by the Japan Writers' Association for the essay
"If a neuroscientist kept a dog" (published in "Tosho," March 2023 issue)

Abstract

The gut microbiota undergoes substantial changes in response to environmental factors and typically stabilizes around the age of three to four. It is well established that the gut microbiota influences brain function and mental states through multiple pathways, including the immune system and the autonomic nervous system—particularly via the vagus nerve. Accordingly, dietary habits during early life, often referred to as a "sensitive period," may play a critical role in shaping brain development.

Recent studies, especially in Western populations, have reported close associations between the composition and developmental trajectory of the infant gut microbiota and individual differences in temperament, as well as risks related to cognitive and language development. However, the composition of the gut microbiota varies significantly across ethnic groups. Notably, the gut microbiota of the Japanese population differs markedly from that of Western populations. In response, our research group established a large-scale gut microbiota database comprising data from over 2,800 Japanese mother–infant pairs. This database includes detailed information on physiological traits (e.g., sleep, bowel movements, and atopic symptoms), psychological characteristics (e.g., cognitive development, temperament, and parenting stress), and dietary patterns.

To date, we have identified several notable findings: 1) a strong correlation between maternal and child gut microbiota alpha diversity; 2) an association between children's autonomic nervous system activity—particularly vagal tone during sleep—and gut microbiota composition, as well as cognitive and psychological functioning; 3) links between maternal autonomic function and mental health and the child's autonomic regulation and risk of delayed cognitive development; and 4) elevated maternal parenting stress correlates with reduced vagal activity, increased risk of cognitive delays, and distinct gut microbiota profiles in children.

Studying individuals in isolation under experimental conditions is insufficient for understanding the mechanisms underlying diversity in human mental and cognitive functioning, including psychiatric and developmental disorders. Our current research aims to visualize the real-life physiological and psychological states of mothers and children, as well as to develop personalized support strategies that incorporate dietary habits. By establishing scientifically grounded early-life interventions, we aim to contribute to effective medical approaches for preventing or mitigating future mental and physical health dysfunctions. To this end, we are conducting long-term foundational research examining the causal effects of interventions, such as dietary improvements and gut microbiota modulation (e.g., through probiotics and prebiotics), on reducing developmental risk.