

Neuro Future Design: Prospecting a New Transdisciplinary Science for a Sustainable Society

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Introduction: The Intersect of Future Design & Neuroscience

The aim of Future Design (FD) is to solve the problems that affect the sustainability of future generations by designing social systems from the ground up and putting them to work in the real world (“Future Design” by Tatsuyoshi Saijo, *TRENDS IN THE SCIENCES*, 2018, Vol. 23, Issue 2). In order to tackle global environmental challenges, inequality and poverty, and other issues of global and historical proportions, it is necessary for researchers from a wide range of academic disciplines to bring together completely new ideas and cooperate while utilizing their respective expertise.

Meanwhile, neuroscience seeks to “uncover the relationship between mind and matter”. It has drawn the interest of many people from natural science and the humanities alike because of this core feature. The development of neuroimaging technology, which enables the measurement of the brain activities of live human beings, in particular has enabled it to make progress as a transdisciplinary field of research while connecting with a wide range of disciplines including sociology, economics, and philosophy (“Searching for a New Science of Humanity” by Hideaki Koizumi, *TRENDS IN THE SCIENCES*, 2004, Vol. 9, Issue 2).

It is natural, then, for FD and neuroscience, having a transdisciplinary aspect in common, to intersect. In this article, I offer my expectations on how neuroscience may contribute in going forward with FD research. The term “neuro future design” that is used here includes all research that undertakes issues in FD utilizing the knowledge and expertise in neuroscience.

What Does Neuroimaging Tell Us Regarding FD?

One of the greatest advantages of neuroimaging research is that it can illuminate the “hidden” process going on inside the human skull. Human behavior is the manifestation of the neurological process that occurs inside the brain. Therefore, it may be possible by analyzing the pattern of brain activities to uncover the truth that cannot be detected by the mere observation of the behavior itself.

For example, applied research in FD to date indicates that gaining experience in thinking as an “imaginary future generation” enhances consideration for future generations and promotes creativity. Why does acting as an “imaginary future person” have this effect?

Peering into the brain raises the possibility of identifying the neurobiological substrates of concepts that can only be inferred from behavioral data as latent variables. This is particularly useful when multiple explanations concerning the motive behind certain behavior are possible from the analysis of behavioral observations and verbal reports. Brain activity data may help to ascertain which of the competing explanations is the most plausible.

Neuroimaging also helps to clarify the common neural mechanism that underlies a wide variety of expressive behavior. Empirical research in recent years in Bangladesh, Nepal and elsewhere verifies the possibility that FD may be a method whose effectiveness transcends language and culture. By analyzing the function of the brain, it may be possible to clarify the neural process through which the deliberation methods used by FD that are invariant *vis-à-vis* language and culture transform people’s behavior and thinking. Furthermore, the FD method has the potential to be effective on issues ranging from the sustainability of local infrastructure to environmental and other global issues, from which it can be inferred that it has the characteristics of fractals such as scale invariance (Saijo, keynote speech at the 22nd Experimental Social Science Conference, 2018). Interestingly, scale invariance is one of the fundamental characteristics of the brain. One of the core issues in neuro FD should be to illuminate the common neural mechanism of the brain that explains “why the FD approach is effective” across languages, cultures, and the issues subject to debate.

What Are the Neurobiological Substrates of “Futurability”?

One important concept in FD is “futurability”. Futurability, as Saijo states, means “the capacity of human beings to feel happiness by making decisions and engaging in behavior that make future generations wealthy even if they reduce current benefits or furthermore by merely thinking that way” (“Future Design”, *TRENDS IN THE SCIENCES*, 2018, Vol. 23, Issue 2). *Homo economicus* that classical economics assumes cannot have futurability. Therefore, the human beings that FD presents are completely different from those in the economics of old.

If futurability is part of human nature, what are its biological substrates? The knowledge accumulated through neuroscience gives us some useful hints. First, human beings have the capacity for

episodic future thinking, the ability to imagine a future event as if you are experiencing it now (“Remembering the Past to Imagine the Future: The Prospective Brain” by Daniel L. Schacter, Donna Rose Addis and Randy L. Buckner, *Nature Reviews Neuroscience*, 2007, 8(9)). This ability is one of the necessary conditions of futurability, since it is essential to imagining what the circumstances and environment will be for future generations and how decisions by the current generation will impact future generations. Interestingly, episodic future thinking is an ability unique to human beings. It is believed that it is difficult even for chimpanzees, who are the closest relatives of humankind (“Prospection and Natural Selection” by Thomas Suddendorf, Adam Bulley and Beyon Miloyan, *Current Opinion in Behavioral Sciences*, 2018, Vol. 24). There is anatomical research showing that the frontal pole, one of the brain’s regions responsible for episodic future thinking, is most prominently developed in human beings among primates. Episodic future thinking is also closely associated with the cognitive function called “prospection” in psychology. Martin Seligman, the prominent psychologist, emphasizes that prospection is the feature that defines human beings and argues that the current version of human beings should be called *Homo prospectus*, not *Homo sapiens*.

Second, it is recognized that human beings have the ability of vicarious reward processing, the ability to process rewards to others as if they were rewards to themselves. This also should be essential in order to be able to feel happiness through behavior that benefits future generations. It was reported recently that a gene expression pattern that does not exist in other primates such as monkeys and chimpanzees can be observed in the striatum, one of the regions in the human brain responsible for processing rewards (“Molecular and Cellular Reorganization of Neural Circuits in the Human Lineage” by Andre M. Sousa, Ying Zhu *et al.*, *Science*, 2017, Vol. 358, Issue 6366). Some researchers are beginning to think that the histological characteristics of this reward system are related to the social capabilities of human beings such as empathy and altruism.

Based on these findings, futurability can be interpreted as an ability unique to human beings that is expressed through the combination of episodic future thinking and vicarious reward processing. To be sure, the two elements here are merely necessary conditions. Other cognitive functions must be interactively involved to actually generate futurability. That said, the analyses there should constitute a foothold for future research to clarify the actual workings

of futurability. For example, in a laboratory experiment using an intergenerational sustainability game (“Negotiating with the Future: Incorporating Imaginary Future Generations into Negotiations” by Yoshio Kamijo, Asuka Komiya, Nobuhiro Mifune and Tatsuyoshi Saijo, *Sustainability Science*, 2017, Vol. 12, Issue 3), a stronger functional connection may have been generated between brain regions that are responsible for episodic future thinking (e.g. the frontal pole) and brain regions that are responsible for various rewards (e.g. the striatum) in the brains of the participants who chose sustainable options even when it required personal sacrifices compared to the brains of those who did not. Practical studies on “citizens discussions” (discussions among citizens randomly selected by governments or NPOs in Japan on any social or political issue) indicate that there are some people who are exceptionally skilled at thinking as imaginary future generations and coming up with innovative ideas (“Future Design – Evidence and Insights from Participatory Deliberations” by Keishiro Hara and Tatsuyoshi Saijo, *Journal of Japan Society on Water Environment*, 2017, Vol. 40, Issue 4). These people may have some common features in their striata and frontal poles. These are merely working hypotheses for now, but it is possible to verify them by analyzing the functions and structure of the brain through neuroimaging.

Can Changes in Social Systems Change Human Nature?

Even if futurability is part of human nature, it appears that it is not effective enough, at least for now, to solve the challenges related to sustainability. FD proposes to change the fundamental nature and mindset of human beings by not accepting the market, democracy, and other existing social systems as given and instead designing them anew. This proposal seems ambitious. Is it really possible to change human nature by changing social systems?

The latest research on neuroimaging is revealing that the human brain demonstrates incredible malleability in response to social and environmental factors. One example is a study with more than 1,000 participants that indicates that the socioeconomic status of parents has a wide-ranging impact on the structure of their children’s brains, which in turn affects reading, writing, and other cognitive functions (“Family Income, Parental Education and Brain Structure in Children and Adolescents” by Kimberley G. Noble, Suzanne M. Houston, *et al.*,

Nature Neuroscience, 2015, Vol. 18, Issue 5). There is also a report that indicates that the experience of urban life affects the structure of the brain (“Environmental Influence in the Brain, Human Welfare and Mental Health” by Heike Tost, Frances A. Champagne and Andreas Meyer-Lindenberg, *Nature Neuroscience*, 2015, Vol. 18, Issue 10). This may be related to the finding that the proportion of people who perform sustainable decision-making differs greatly between urban and rural areas. There is also a report to the effect that the structure of the brain changes in women after childbirth and that the change is related to their attachment to their children (“Pregnancy Leads to Long-lasting Changes in Human Brain Structure” by Eline Hoeksma, Erika Barba-Muller *et al.*, *Nature Neuroscience*, 2017, Vol. 20, Issue 2). As these examples illustrate, it is becoming increasingly evident that environmental factors and life experiences have a global impact on the structure of the human brain and that this in turn alters cognitive and social functions.

There is no evidence yet directly showing that social systems such as the market mechanism and democracy affect the structure of the brain. However, the possibility cannot be denied that current social systems affect the structure of the human brain and thereby define the nature of the people who live in contemporary society. To put it another way, it may be possible to promote change in the structure of the brain regions that are responsible for episodic future thinking and vicarious rewards and unlock the potential in human beings by constructing new social systems using FD. It will be difficult to verify this hypothesis by actually changing social systems. However, a starting point for research on this point could be having a few dozen participants undergo training to think as imaginary future generations through discussions and other means and studying how the effect appears as long-term changes in the structure of the brain. One recent report says that the structure of the brain does change after several months of training to nurture empathy and mercy for others (“Structural Plasticity of the Social Brain: Differential Change after Socio-affective and Cognitive Mental Training” by Sophie Louise Valk, Boris C. Bernhardt *et al.*, *Science Advances*, 2017, Vol. 3, Issue 10). Although the replication of this finding with independent groups is required to determine how definitive it is, it should be possible to introduce a similar research method to neuro FD.

Conclusion: Towards a Sustainable Species

From an evolutionary psychology perspective, it may be natural to think that futurability was never exposed to selection pressure since intergenerational sustainability never had a significant impact on adaptability in the environment in which human beings evolved. However, if social systems artfully combine episodic future thinking, vicarious reward processing, and other capabilities that have evolved separately, an evolutionary timespan may not be necessary for human beings to demonstrate futurability and share it broadly throughout society (“Cultural Recycling of Cortical Maps” by Stanislas Dehaene and Laurent Cohen, *Neuron*, 2007, Vol. 56, Issue 2). To borrow the term from Seligman, it must have been useful for human beings to have acquired the capability for prospection as it evolved in order to survive the global environments of the past. However, in order for human beings to continue to prosper as a sustainable species, it may be necessary to acquire futurability and transform itself into “*Homo futurabilis*”. This change should be distinguished from biological evolution. Instead, it appears to be a matter that should be achieved through the transformation of social systems.

Neuroscience can be viewed as a discipline that has sought to discover “where human beings have come from and where they are headed” and “how human beings may be able to change” by studying the uniqueness and malleability of the human brain. Meanwhile, FD is a discipline that asks “where human beings should be headed and how it should change for that purpose”. Thus, neuro FD as the composite of the two fields can be characterized as a discipline that brings together all contemporary knowledge and asks anew the philosophical question concerning the essence of what it means to be human that humanity has asked itself over the millennia: “Where have human beings come from, where are they now, and where are they going?”

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