

**Topic-Setting Program to Advance Cutting-Edge
Humanities and Social Sciences Research**
(Area Cultivation)

Progress Report
(Summary of Final Report)

[Understanding the genetic foundations of cultural variation in cooperation with evidence
from social psychology, neuroscience, and endocrinology]

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Institution: Tokai National Higher Education and Research System

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Academic Unit: Graduate School of Informatics

Position: Associate Professor

Research Period: FY2014 – FY2020

1. Basic information of research project

Research Area	New advances in humanities and social sciences using analytical methods incorporating praxeology, cognitive science, and neural science
Project Title	Understanding the genetic foundations of cultural variation in cooperation with evidence from social psychology, neuroscience, and endocrinology
Institution	Tokai National Higher Education and Research System Nagoya University
Core-Researcher (Name, Academic Unit & Position)	Keiko Ishii, Graduate School of Informatics, Associate Professor
Project Period	FY2014 - FY2020
Appropriations Plan (¥)	FY2014 2,000,000 JPY
	FY2015 3,450,000 JPY
	FY2016 3,200,000 JPY
	FY2017 4,700,000 JPY
	FY2018 4,300,000 JPY
	FY2019 3,600,000 JPY
	FY2020 1,350,000 JPY

2. Purpose of research

It is impossible for people to live without socio-cultural environments, and the socio-cultural environments cannot exist without the interaction of people. For this reason, it is no exaggeration to say that the various fields of the humanities and social sciences deal with cultural phenomena in a broad sense. However, the traditional humanities and social sciences do not provide sufficient answers to the fundamental questions of how cultural phenomena are created (i.e., how cultures are formed and maintained, and why different cultures have emerged). For example, cultural anthropological research has revealed shared meaning systems within a given culture through participant observation. Cultural psychological research has applied psychological experiments to the understanding of culture, and has shown that cultural norms and practices influence not only higher-order psychological processes such as self-construal and reasoning, but also lower-order psychological processes such as perception and attention. Recently, research based on cultural neuroscience, which incorporates neuroscientific methods into cultural psychology, has shown that such cultural influences can be found even at the brain and physiological levels. However, these findings cannot completely go beyond the description of culture, and do not answer the question of why culture exists in the first place.

In this study, one approach to this question is to focus on the possibility that genes and socio-cultural environments have coevolved (Cavalli-Sforza & Feldman, 1981; Durham, 1991; Richerson & Boyd, 2005). In other words, genetic and cultural traits interact to achieve adaptation to the ecological environment. This approach predicts that a culture exists as an adaptation to the environment and that its content corresponds to the environment. As a simple example, subsistence forms (culture) such as hunting and gathering, pastoralism, and agriculture are

adaptations to the environment. But not only that, genes can be influenced by the culture (it is well known that the trait of retaining the ability to digest raw milk after weaning evolved genetically among pastoralists). It is also possible that genetic adaptations to past environments may have predisposed us to our current culture. For example, there is a polymorphism in the dopamine D4 receptor gene (DRD4), and it is known that people with the 7R and 2R alleles have a higher propensity for novelty seeking than those with the 4R allele. There are regional variations in the allelic frequency of DRD4 polymorphism among populations. The most common allele is the 4R, which can be found across all regions of the world; the next most common is the 7R allele, which is quite common in Americans but rare in East and South Asians; the third most common is the 2R allele, which is quite common in East and South Asians but rare in Americans (Chang et al., 1996). Chen et al. (1999) demonstrated that these variations are related to migration history. The proportion of the 7R allele was positively associated with migratory distances. This regional difference in genotype may be a factor in defining cultural differences in the present day as people become more sedentary.

In this study, we attempt to explain the origins of a wide range of cultural differences, including Western and Eastern cultural differences, by applying the concept of gene and culture coevolution to the conventional social science approach that has examined the relationship between the nature of the human mind and the socio-cultural environment. Specifically, we will comprehensively examine how genetic polymorphisms related to neurotransmitters such as serotonin, oxytocin, and dopamine are associated with cultural differences, and based on empirical findings on the coevolution of genes and culture, we aim to clarify the genetic basis of cultural differences. In particular, by integrating the methods of social psychology experiments with those of natural science, such as genetic analysis and endocrinology, we aim to understand how cultural differences in self-construal, cognition, and emotional experience between East and West, which are difficult to explain only by conventional occupational patterns and ecological environments, have been created and maintained through coevolution. The purpose of this study is to understand how cultural differences in self-view, cognition, and emotional experience between the East and the West, which are difficult to explain only by ecological environments, have been created and maintained through coevolution.

3. Outline of research (Including study member)

In this study, we focused on the interaction between the nature of mind depending on the socio-cultural environment and genetic polymorphisms, using the coevolution model of genes and culture to understand the origin and maintenance of social and cultural differences. Specifically, we developed a comprehensive battery of behavioral tests on self, cognition, emotion, and distributive/cooperative behavior based on previous findings in social and cultural psychology, and conducted the tests in two rounds in Japan (Kobe University) and Canada (University of Alberta) (1st round: March 2015-April 2016, 2nd round: February 2018 - April 2019). Eventually, we collected data from approximately 800 participants. For this dataset, we first analyzed the 18 genetic polymorphisms of the participants and then examined which of the two possibilities was more plausible: 1) the possibility that the predominant cultural traits in each culture are more pronounced in those with certain genotypes (i.e., the possibility of culture-gene interaction), 2) the possibility that cultural differences are determined by the social and ecological environment of each society, and that these cultural differences are internalized by individuals independently of their genotype, resulting in higher adaptation of those individuals (i.e., the possibility of adaptation at the level of ontogeny).

Development of a comprehensive battery of behavioral tests

In December 2014, we held a meeting via Skype between Kobe University and the University of Tokyo to discuss the issues included in the battery of behavioral tests, and then created it. This included 24 questionnaires that consist of tasks and scales used in cultural and evolutionary psychology and scales measuring individual intelligence and personality such as IQ and Big Five (Behavioral Inhibition System and Behavioral Action System [Carver & White, 1984], Sense of Control [Lachman & Weaver, 1998], coping strategies [Carver, 1997], dialectical view of self [Spencer-Rodgers et al., 2010], independent and interdependent self-construals [Singelis, 1994], interpersonal influence and adjustment [Tsai et al., 2007], interpersonal reactivity index [Davis, 1983], moral values [Graham et al., 2008], psychopathic tendencies [Osumi et al., 2007], self-esteem [Rosenberg, 1965], forgiveness tendencies [Berry et al., 2005], holistic thinking [Ji et al., 2004], general trust and caution [Yamagishi & Yamagishi, 1994], loneliness [Russel et al., 1978], autism spectrum disorder tendencies [Wakabayashi et al., 2004], emotion expressivity [Gross & John, 1997], individualism/collectivism [Singelis et al., 1995], reading eyes task [Baron-Cohen et al., 2001], happiness questionnaire [Shimai et al., 2004], time discounting [Han & Takahashi, 2012], IQ [Raven's progressive matrices test], Big Five [NEO Five-Factor Inventory, Costa & McCrae, 1992], subjective socioeconomic status [Adler et al., 1994], a questionnaire asking about moving experience and early family environment) and four economic games (the dictator game, the ultimatum game, the trust game, and the prisoner's dilemma game). Many of these scales had already been developed in English and Japanese, but for those for which no corresponding translation was available, the principal investigator and co-authors (Ishii, Ohtsubo, Noguchi, Matsunaga, and Masuda) translated them and used them after discussing their validity. Since the preliminary results of the first analysis supported the adaptation hypothesis at the ontogenetic level, in the second round of data collection, we improved the battery test by selecting behavioral tendencies that seemed promising for comparison between cultures and increasing items related to mental health such as happiness and empathy. Moreover, we added a questionnaire about the family environment in childhood (Risky Families Questionnaire, Taylor et al., 2004).

Data collection and analysis of the battery of behavioral tests

In Japan (Kobe University), data was collected from 213 participants in the first session and 203 participants in the second session. In Canada (University of Alberta), data was collected from 181 participants in the first round and 200 participants in the second round. Nail samples were collected from all participants for analysis of genetic polymorphisms. In addition, saliva samples were also collected in the first round in Japan. In addition, data were collected from 207 participants in Japan (Nagoya University) using an abbreviated version of this behavioral battery test. The data collection at Nagoya was conducted from June to October 2019, and both nail and saliva samples were collected.

The Japanese and Canadian nail samples, as well as the Japanese saliva samples were sent to Aichi Medical University, where Matsunaga used the nail samples to identify genetic polymorphisms, and the saliva samples were used to measure salivary serotonin and salivary oxytocin levels in each person. Genetic polymorphisms were analyzed for 18 genes, including receptors for oxytocin, serotonin, dopamine, opioids, estrogens, cannabinoids, and orexin.

Toward a better understanding of culture-gene interactions: Asian immigrant study, oxytocin nasal spray

administration, and tryptophan supplementation experiment

This project planned to conduct a similar behavioral battery test in Asian immigrants to further understand the interaction between culture and genes. Based on the possible coevolution and interaction of culture and genes discussed above, Asian immigrants may exhibit a lower degree of internalization than the North American sample, regardless of their history of living in North American culture. On the other hand, based on the possibility of adaptation at the ontogenetic level, Asian immigrants may be thought to internalize North American culture according to their history of living in North America. In particular, the importance of living in North America at an early age may be important. Next, we focused on the fact that polymorphisms in the oxytocin receptor gene are associated with high and low levels of empathy and trust, and that the distribution of polymorphisms in the oxytocin receptor gene differs greatly between the West and the East. This research included genetic analysis and administration of oxytocin sprays to examine cultural differences in the effects of oxytocin administration. In addition, as a clue to overcome the current problem of the lack of correlational research and to consider biological mechanisms, we planned to focus on serotonin function and to explore the effects on psychological tendencies when serotonin function is increased by the intake of tryptophan supplements. However, these investigations were greatly influenced by recent research trends that make it difficult to publish research results on behavioral battery tests unless the sample size is increased. As a result, it took a considerable amount of time to collect and analyze the data. Additionally, the preliminary results showed that although the main effect of culture or genetic polymorphism could be confirmed, the interaction was not confirmed in most cases, as described below, these three studies were put on hold and three new studies were conducted to replace them as follows.

Analysis of salivary serotonin and oxytocin in Japanese participants

In order to confirm the assumptions of the oxytocin spray experiment and the tryptophan supplementation experiment, and to discover new findings in an exploratory manner, we measured the concentrations of serotonin, oxytocin, and cannabinoids in saliva samples collected only from the Japanese participants, and examined the relationship between these levels and the behavioral battery test.

Interaction between genetic and environmental factors: Influence of family environment in childhood

The results of the first round of data collection did not confirm the interaction between genes and culture on behavioral tendencies, indicated by the previous findings that the predominant values in the social and cultural environment were more pronounced in individuals with gene polymorphisms sensitive to environmental information (Kim et al., 2010; Kitayama et al., 2014). On the other hand, the preliminary results suggest that we have successfully replicated the previous findings regarding the interaction between genes and environmental factors, for example, that childhood adversity is a predictor of depression in adulthood only in individuals with an s allele in the serotonin transporter gene (Caspi et al., 2003). In the second round of data collection, thus, we also focused on the interaction between genetics and environmental factors, and examined whether the pattern of interaction appears regardless of cultures or whether cultural differences in behavioral tendencies can be observed reflecting differences in cultural characteristics included in environmental factors even if the interaction appears in the same way across cultures.

Genome-wide association analysis (GWAS)

The results of the first round of data collection were based on genetic polymorphisms (e.g., oxytocin receptor gene and dopamine D4 receptor gene) that existing studies on the interaction between culture and genes

have focused on. Since it was thought that findings may not have been found due to using such a limited set of polymorphisms, an exploratory genetic analysis service using Japonica array was used to examine the association between about 450,000 single nucleotide polymorphisms and psychological tendencies (especially happiness).

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4. Research results and outcomes produced

This study was initially planned to produce results based on the results of the first data collection, but research trends changed significantly in a short period of time, and it became difficult to publish the results without increasing the sample size, so the second round of data collection was additionally conducted. In addition, we needed to collect additional data on the relationship between saliva samples and psychological tendencies in Japanese subjects in order to increase the sample size. In such a situation, we proceeded with the analysis in parallel with the additional data collection and found the following results.

1) An association was found between the serotonin receptor gene (5HT2A) and the phenomenon of discounting future utility. Individuals with the G allele were less likely to discount future gain (i.e., less impulsive) than those with the A allele. Compared with individuals having the G allele, those having the A allele more emphasized the present gain and indicated a greater time discontinuity in the discount rate. Ishii wrote a paper based on these results, which was published in *Personality and Individual Differences*.

2) The higher the salivary serotonin concentration, the lower the ability to acquire perspective taking (one of the empathic abilities), which is important for reasoning about the feelings of others, and the lower the level of sharing happiness with others. It was also shown that the salivary serotonin concentration in adolescents was associated with childhood adversity. Matsunaga wrote a paper based on these results, which was published in *PLoS ONE*.

3) There was an association between the serotonin receptor gene (5HT2A) and the social sharing of happiness. Individuals with the G allele are more likely than those with the A allele to feel happy by the happiness of their friends. Matsunaga wrote a paper including brain imaging data, which was published in *Frontiers in Neuroscience*.

4) There was an interaction between cannabinoid receptor genes and culture on happiness. Positive attitudes toward life were generally higher in Canadian students than in Japanese students, but there was an effect of the cannabinoid receptor gene polymorphism (CNR1: rs806377), and individuals with the CC genotype, a

relatively rare genetic polymorphism in Japan, were found to be particularly positive about life, and were similar to Canadian students. In Canada, on the contrary, those with the TT genotype showed a higher positive attitude score. Matsunaga wrote a paper based on these results, which was published in *PLoS ONE*.

5) Prior research has shown that one of the genetic polymorphisms of the oxytocin receptor (rs53576) is sensitive to the cultural environment, particularly that individuals with the G allele are more likely to regulate emotions related to cultural norms than those with the A allele (Kim et al., 2011). While norms of emotion regulation are stronger in East Asia than in the West, norms of emotion expression are more dominant in the West than in East Asia. In this study, we focused on cultural differences in the norms of emotional expression and examined the possibility that genetic polymorphisms of oxytocin receptors may modulate them. Among the oxytocin receptor gene polymorphisms, rs2254298 was also analyzed and included in the analysis in addition to rs53576. The results showed that the degree of emotional expression, especially positive emotion, was significantly higher in Canada than in Japan. However, contrary to predictions based on previous studies, there was no effect of genetic polymorphisms. Ishii wrote a paper based on these results, which was published in *Culture and Brain*.

6) Prior research has shown that there is a qualitative difference between forgiveness in collectivistic cultures and forgiveness in individualistic cultures. Specifically, in collectivistic cultures, forgiveness is encouraged by cultural norms because social harmony is valued, and as a result, individual differences in personality are not associated with forgiveness. In contrast, the present study showed that agreeableness, extraversion, and neuroticism, which are among the five major factors of personality, were significantly correlated with the tendency to forgive in both Japan and Canada. Ohtsubo wrote a paper based on these results, which was published in *Canadian Journal of Behavioral Science*.

7) We focused on general trust and examined the interaction between environmental factors and an oxytocin receptor gene polymorphism (rs53576). The results showed that regardless of cultures, general trust tended to be lower in participants who reported growing up in a harsh environment. In addition, a genetic polymorphism of the oxytocin receptor (rs53576) affected the relationship, and the negative correlation between the early family environment and general trust was particularly pronounced for individuals with the AA genotype. Zheng (a graduate student supervised by Ishii) wrote a paper based on these results, which was published in *Psychoneuroendocrinology*.

8) Compared to North Americans, Japanese tend to pay more attention to interpersonal relationships, which extends to emotion recognition (e.g., Masuda et al., 2008). In this study, we explored cultural differences in the influence of information about the relationship between people in Japan and Canada. In this task, the facial expressions of the central figure and the surrounding figures were sometimes congruent and sometimes incongruent, and the relational cues that the figures were close friends, mere acquaintances, or strangers were manipulated. In Canada, a large amount of N400 was detected only when the perceiver was told that the person was a close friend, while in Japan, N400 was detected only when the perceiver was told that the person was a mere acquaintance. This finding elaborates on the cultural differences in attention in previous studies. Masuda and his graduate student wrote a paper based on these results, which was published in *Social Neuroscience*.

9) It has been pointed out that in East Asia, the tone of voice is more important than facial expression in understanding emotions than in North America. To investigate the possibility that tone is more important than facial expression in Japanese, we measured brain activity (EEG) in addition to behavioral indicators used in previous studies. The results showed that the interference effect of tone was greater than that of facial expression, and that the greater the interference effect of tone, the greater the amplitude of the positive potential P200, suggesting that

people are more likely to pay attention to tone spontaneously. Ishii and Noguchi wrote a paper, which was accepted for publication in *Culture and Brain*.

10) Previous research suggests that early family environments influence happiness and loneliness, and the associations are also influenced by the serotonin transporter gene. Specifically, childhood adversity lowers happiness (and increases loneliness), and this tendency is more pronounced in the s/s genotype of the serotonin transporter gene. On the other hand, many studies have reported inconsistent results, and some meta-analytic studies have been published in support of the inconsistent results. However, these studies were mainly conducted in the Western cultures, and it is unclear what kind of findings would be obtained in East Asia, where the proportion of people having the s/s genotype is much higher, if a sufficient sample size is used. In fact, when we examined the interaction between childhood adversity and serotonin transporter gene polymorphisms on happiness and loneliness in our Japanese sample, we found no significant interaction pattern. Ohtsubo wrote a paper about this, which was accepted (with minor revisions) for publication in *Japanese Psychological Research*.

11) Although previous studies have suggested that certain genetic polymorphisms of serotonin 2A receptors are associated with happiness, they have not been examined in the context of comparative cultural studies. Therefore, in addition to the Japanese sample in this project, we added a sample of Americans and examined the effect of the gene polymorphism as an indicator of how happy they feel when something good happens to their friends. As in the previous study, in the Japanese sample, individuals with the G allele were more likely than those with the AA genotype to feel happy when something good happened to their friends, and the same trend was observed in the American sample. Matsunaga wrote a paper based on the results, which was submitted to *Japanese Psychological Research*.

12) Cultural psychology research on social support has shown that the need to maintain mutually interdependent relationships makes East Asians less likely to seek social support against the backdrop of their concern that disclosing and discussing their problems with others will disrupt social networks. However, other explanatory factors for such cultural differences in social support have not been examined to date. Therefore, in this study, we focused on cultural differences in empathic concern. Consistent with our predictions, we found a mediation effect of empathic concern: Japanese people were less empathic than Canadians, and those with less empathic concern were less likely to seek social support. As a follow-up, an internet survey for non-student adults in Japan and the US confirmed the pattern. Zheng wrote a paper based on the results, which was submitted to *PLoS ONE*.

13) Previous studies have reported that cultural differences in independence and interdependence were emphasized among individuals with specific polymorphisms (alleles with 2 or 7 repeats) in the dopamine D4 receptor gene (DRD4) (Kitayama et al., 2014). Since the present study includes almost the same indices of independence and interdependence used in that previous study, we combined the first and second wave data sets and examined whether the findings could be replicated with a larger sample size than in the previous study. The results showed that the cultural differences in interdependence and interdependence were confirmed (i.e., Canadians were interdependent while Japanese were interdependent), but there was no interaction with DRD4. Ishii wrote a paper based on the results, which was accepted for publication in *Psychologia*.

14) In addition to the positive relationship between the early family environment and the ease of seeking social support, we examined the possibility of an interaction between a polymorphism of the opioid receptor and the early family environment on social support seeking. The more desirable the childhood environment, the more

likely one was to seek social support, a relationship that was observed in Japanese individuals with the GG genotype. Zheng is preparing for a paper based on the results.

15) We conducted a genome-wide association analysis, and instead of focusing on a limited number of gene polymorphisms and looking at their association with psychological tendencies, we comprehensively examined the association between about 450,000 single nucleotide polymorphisms and psychological tendencies (especially happiness and forgiveness), and proceeded to detect the association between unknown gene polymorphisms and psychological tendencies. Currently, we have narrowed down the candidates to four and are examining their validity.

The academic characteristic of this research is that it aims to integrate the humanities and sciences by using natural science methods to understand the element of "culture" that is common to various problems in the human and social sciences. In the traditional and standard social science model, culture is considered to be free from biological influences and is the exclusive subject of human and social sciences (Tooby & Cosmides, 1992). While the traditional standard social science model grants such a privileged status to culture, there has been a growing movement in the natural sciences to rethink culture in terms of adaptation (Cavalli-Sforza & Feldman, 1981; Durham, 1991; Richerson & Boyd, 2005). In psychology as well, culture has traditionally been treated as an exogenous factor that affects people's cognition, emotions, and behavior, but there has been a movement to clarify the dynamics of the mutual regulation of culture and the human mind, as represented by cultural psychology (Bruner, 1990; Markus & Kitayama, 1991; Shweder, 1990). This research can be positioned as an attempt to integrate the humanities and sciences, connecting these fields that share a fundamental interest. As an attempt to do so, we administered the behavioral battery test to approximately 800 individuals in Japan and Canada by targeting 18 genetic polymorphisms to see whether self-construal, cognitive characteristics, emotion regulation and expression, individual intelligence and personality, and individual environmental factors such as childhood family environment would differ across cultures, and whether the genetic variants influence the cultural differences. We were able to conduct such a large-scale comparative cultural study because of the collaboration between experts in cross-cultural studies focusing on social behavior and experts in endocrinology and psychiatry. The results suggest that the interaction between culture and genes is very limited, suggesting the possibility of adaptation at the individual developmental level of the hypotheses of this study. Conventional social and cultural psychology has developed theories that emphasize the process of individual internalization, assuming that through living in the relevant socio-cultural environment, people acquire an appropriate set of psychological and behavioral tendencies corresponding to the environment. On the other hand, while the interaction between culture and genes from a cross-cultural perspective was limited, the interactions between genes and environmental factors were found to be significant, for example, salivary serotonin concentration in adolescents differs depending on the family environment during childhood, and high and low salivary serotonin concentrations are related to empathy and the degree to which one can share happiness with others. The negative relationship between the early family environment and general trust was particularly pronounced for individuals with the AA genotype of the oxytocin receptor gene polymorphism (rs53576). Further analysis will deepen our natural scientific understanding of how social and cultural environments are related to the emotions and social skills of individuals living in them.

Compared to the stage in 2014 when this research project started, studies examining the interaction between genes and socio-cultural environmental factors have been criticized in various ways. Most of the previous studies have focused exclusively on a single gene, and have shown that individuals with polymorphisms in genes

that are particularly sensitive to environmental information are more susceptible to the effects of environmental factors surrounding them. For example, only in individuals having the s allele of the serotonin transporter gene, experiences such as childhood adversity (3-11 years old) are predictive of depression in adulthood (Caspi et al., 2003). Also, subsequent research has shown that individuals having the s/s genotype, in particular, are more likely to show signs of depression when their childhood home environment was dangerous or their current environment was very stressful, while they are less likely to show signs of depression when their childhood home environment was relatively safe or their current environment was not very stressful (Taylor et al., 2006). It has also been shown that behavioral tendencies in response to the dominant values in the social and cultural environment are more pronounced in individuals with genetic polymorphisms that are sensitive to environmental information (Kim et al., 2010; Kitayama et al., 2014). However, since Caspi et al. (2003), there have been many reports that the findings of the previous study on the interactions between genes and environmental factors are not replicated (e.g., Culverhouse et al., 2017). This is a very serious problem in the fields of psychology and neuroscience, where reproducibility has been loudly advocated in various fields. In particular, in the context of interactions between genes and socio-cultural environmental factors, the small sample size in each study and the assumption that the effect is due to a single gene is too simplistic and does not take into account the consequences of interactions between multiple genes, have been pointed out as reasons for the difficulty of replication. This study eventually collected data on about 800 individuals, meeting the standard sample size required in recent studies, and obtained comparative and cultural information on various behavioral tendencies, such as self-construal, cognitive styles, emotion regulation and expression, and individual environmental factors, such as individual intelligence, personality, and childhood family environments. The results of this analysis can be expected to have a significant impact on the discussion of reproducibility in the context of interactions between genes and socio-cultural environmental factors. We hope to make the current dataset public, which will allow other researchers to conduct secondary analyses in the future. This may lead to the emergence of new research based on the results of this analysis.

Furthermore, in order to overcome the criticisms and limitations of research related to the interaction of genes with socio-cultural environmental factors, it is desirable to accumulate findings based on clear hypotheses about the biological mechanisms by which the interaction occurs (Rutter, Moffitt, & Caspi, 2006). In fact, the findings of this study have problems beyond the scope of so-called correlation studies. Furthermore, the interaction between genetic polymorphisms is not assumed. In addition, the possibility that unknown genetic polymorphisms interact with socio-cultural environmental factors to influence psychological tendencies has not yet been examined. The exploratory genome-wide association analysis conducted in this study is an attempt to overcome these problems. Based on the findings of this study, it will be possible to develop research on the extent to which the association between unknown genetic polymorphisms and psychological tendencies is valid, and whether the association can be adjusted by socio-cultural environmental factors.