Keio Twin Project and behavioral genetics of personality

Keio Twin Project (KTP) was established in 1998 to study the genetic and environmental etiology of various cognitive and behavioral characteristics, such as personality, psychopathology, social attitudes, and general and specific cognitive ability. The twin method can decompose observed individual differences into genetic and environmental sources by comparing the similarity of identical (monozygotic; MZ) with fraternal (dizygotic; DZ) twins. The rationale for this method is that the greater similarity of MZ to DZ twins reflects the influence of genetic factors because it is only attributable to the two-fold greater genetic similarity of MZ to DZ twins. Using this technique, the vast body of behavioral genetic research has shown that a substantial portion (about 30% to 50%) of the variance in various measures of personality is attributable to genetic factors (Bouchard & Loehlin, 2001).

KTP, using as many as 1,000 pairs of adolescent and young adult twins from the general population in the Tokyo area, has published several papers in international journals. Personality is one of main research areas. For example, Ando et al. (2002) examined the validity of Cloninger's seven dimensional model of temperament and character (Cloninger, Svrakic, & Przybeck, 1993) from behavioral genetic perspective, and revealed that character traits are as heritable as (or even more heritable than) temperamental traits, which was not originally predicted by the theory. Also, Ando et al. (2004), using multivariate genetic analysis that decomposes observed covariance between the multiple traits into genetic and environmental sources, revealed that two of the temperamental traits (novelty seeking and harm avoidance) are not genetically independent and requires reorganization of subscales. Yamagata et al. (2006) examined the validity of another major model of personality: the Five Factor Model (FFM) of personality (McCrae & Costa, 1999). They found that 1) the phenotypic structure of the FFM reflects underlying genetic structure, and 2) the genetic structure is universal across diverse cultural samples, supporting the genetic validity of the FFM (see also Jang et al., 2001; 2006). The Japanese Journal of Personality, a journal published by Japan Society of Personality Psychology, also includes our behavioral genetic work on personality; Takahashi, Yamagata, Kijima, Shigemasu, Ono, and Ando (2007) demonstrated that individual differences in Behavioral Activation System (BAS) and Behavioral Inhibition System (BIS) are genetically independent, supporting the validity of the Gray's model of temperament (Gray, 1987).

Currently, cross-cultural comparison of heritability of FFM traits (e.g., Yamagata et al., 2006) and of genetic structure of the Cloninger's model (e.g., Takahashi, Gillespie, Martin, Stallings, & Ando, 2005) is underway. Also, rather than just testing existing theories, KTP has been trying to develop a new theory that explains why personality traits are heritable from an evolutionary perspective (Hiraishi, Yamagata, Shikishima, & Ando, in press).

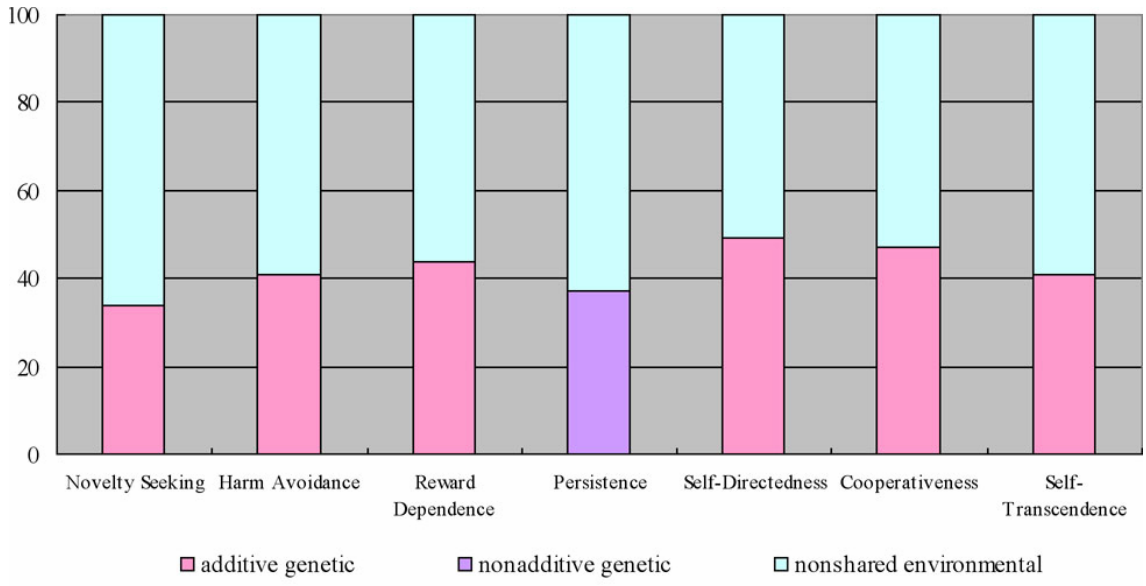

Figure 1. Heritability of Cloninger's Temperament and Character.

KTP has also examined the roles of genes and environment in development of personality. Using longitudinal data sets of adolescent twins, Takahashi, Yamagata, Kijima, Shigemasu, Ono, and Ando (in press) revealed that continuity in BAS and BIS is largely due to genetic influences, whereas change in the two systems is largely due to environmental factors. A similar pattern was also observed for the analysis on self-esteem (Kamakura, Ando, & Ono, 2007). Another focus of KTP is on the association between personality and psychopathology. Ono et al. (2002) examined the genetic and environmental etiology underlying the association between Cloninger's temperamental traits and depression, and found that genetic factors on the temperaments fully explain genetic influences on depression, suggesting that there are no genes for depression per se.

KTP has also been collecting data on cognitive ability. Ando, Ono, and Wright (2001) examined the genetic and environmental etiology of the commonality among four working memory functions (executive/storage, verbal/spatial) and general cognitive ability. They found that the commonality among the tests was due largely to a common genetic factor, and environmental influences are only weakly correlated across tests. Shikishima, Ando, Grialou, Takemura, and Okada (2005) examined the association between performances in syllogism test and general cognitive ability, and found that the two are genetically correlated to a substantial degree.

Future directions

Recently, more and more gene × environment interactions (i.e., differential effects of gene across environment) have been reported in both molecular genetic (Caspi et al., 2002) and behavioral genetic (Turkheimer, Haley, Waldron, D'Onofrio, & Gottesman, 2003) research, and KTP has also begun to focus on these phenomena. As initial findings, we reported that genetic influences on anxiety are smaller for those who experienced more stressful life events (Yamagata, Takahashi, Kijima, Ono, & Ando, 2006), and

genetic influences on social attitudes are smaller for those who were raised in families with high cohesion (Shikishima & Ando, 2004). Also, behavioral genetic research has been rapidly changing to include more biological and molecular genetic methods. KTP is now conducting a brain-imaging survey using Near Infrared Spectroscopy (NIRS) and event related potentials to find biological markers of cognitive ability. A study on epigenetic effects on MZ twin pairs who are discordant for cognitive ability is also underway.

Although whole human genome has been coded, we are still far away from understanding how genes and environment interact to create who we are. Combined with molecular biological approach, behavioral genetics will continue to play an important role in the study of personality psychology in the 21st century. So please keep your close attention to behavioral genetic research, especially from Japan!

References

Ando, J., Ono, Y., & Wright, M. J. (2001). Genetic structure of spatial and verbal working memory. *Behavior Genetics*, **31**, 615-624.

Ando, J., Ono, Y., Yoshimura, K., Onoda, N., Shinohara, M., Kanba, S., & Asai, M. (2002). The genetic structure of Cloninger's seven-factor model of temperament and character in a Japanese sample. *Journal of Personality*, **70**, 583-609.

Ando, J., Suzuki, A., Yamagata, S., Kijima, N., Maekawa, H., Ono, Y., & Jang, K. L. (2004). Genetic and environmental structure of Cloninger's temperament and character dimensions. *Journal of Personality Disorders*, **18**, 379-393.

Bouchard, T. J., Jr., & Loehlin, J. C. (2001). Genes, evolution, and personality. *Behavior Genetics*, **31**, 243-273.

Caspi, A., McClay, J., Moffitt, T. E., Mill, J., Martin, J., Craig, I. W., Taylor, A., & Poulton, R. (2002). Role of genotype in the cycle of violence in maltreated children. *Science*, **297**, 851-854.

Cloninger, C. R., Svrakic, D. M., & Przybeck, T. R. (1993). A Psychobiological Model of Temperament and Character. *Archives of General Psychiatry*, **50**, 975-990.

Gray, J. A. (1987). *The psychology of fear and stress* (2nd edition). Cambridge: Cambridge University Press.

Hiraishi, K., Yamagata, S., Shikishima, C., & Ando, J. (*in press*). Maintenance of genetic variation in personality through control of mental mechanisms: A test of trust, extraversion, and agreeableness. *Evolution and Human Behavior*.

Jang, K. L., Hu, S., Livesley, W. J., Angleitner, A., Riemann, R., Ando, J., Ono, Y., Vernon, P. A., & Hamer, D. H. (2001). Covariance structure of neuroticism and agreeableness: A twin and molecular genetic analysis of the role of the serotonin transporter gene. *Journal of Personality and Social Psychology*, **81**, 295-304.

Jang, K. L., Livesley, W. J., Ando, J., Yamagata, S., Suzuki, A., Angleitner, A., Ostendorf, F., Riemann, R., & Spinath, F. (2006). Behavioral genetics of the higher-order factors of the Big Five. *Personality and Individual Differences*, **41**, 261-272.

Kamakura, T., Ando, J., & Ono, Y. (2007). Genetic and environmental effects of stability and change in self-esteem during adolescence. *Personality and Individual Differences*, **42**, 181-190.

McCrae, R. R., & Costa, P. T. (1999). A five-factor theory of personality. In L. A. Pervin & O. P. John (Eds.), *Handbook of personality: Theory and research* (2nd ed., pp. 139-153). New York: Guilford Press.

Ono, Y., Ando, J., Onoda, N., Yoshimura, K., & Asai, M. (2000). Genetic structure of the five factor model among Japanese population. *Keio Journal of Medicine*, **49**, 152-158.

Shikishima, C., & Ando, J. (2004). Genetic and environmental influences on social attitudes: Evidence for increased shared environmental effects in families with high cohesion. *Behavior Genetics*, **34**, 660-660.

Shikishima, C., Ando, J., Ono, Y., Todo, T., & Yoshimura, K. (2006). Registry of adolescent and young adult twins in the Tokyo area. *Twin Research and Human Genetics*, **9**, 811-816.

Shikishima, C., Ando, J., Grialou, P., Takemura, R., & Okada, M. (2005). A behavioural genetic study of syllogism solving using longitudinal and graphical representations: A preliminary report. In P. Grialou, G. Longo, & M. Okada (Eds.), *Images and reasoning* (pp. 69-85). Tokyo: Keio University Press.

Takahashi, Y., Gillespie, N. A., Martin, N. G., Stallings, M. C., & Ando, J. (2005). Are the genetic and environmental factor structures of Cloninger's temperament dimensions common cross-culturally? International comparison among Australia, USA, and Japan. *Behavior Genetics*, **35**, 828-828.

Takahashi, Y., Yamagata, S., Kijima, N., Shigemasu. K., Ono, Y., & Ando, J. (2007). Gray's temperament model: Development of Japanese version of BIS/BAS scales and a behavior genetic investigation using the twin method. *The Japanese Journal of Personality*, **15**, 276–289.

Takahashi, Y., Yamagata, S., Kijima, N., Shigemasu. K., Ono, Y., & Ando, J. (*in press*). Continuity and change in behavioral inhibition and activation systems: A longitudinal behavioral genetic study. *Personality and Individual Differences*.

Turkheimer, E., Haley, A., Waldron, M., D'Onofrio, B., & Gottesman, II. (2003). Socioeconomic status modifies heritability of IQ in young children. *Psychological Science*, **14**, 623-628.

Yamagata, S., Suzuki, A., Ando, J., Ono, Y., Kijima, N., Yoshimura, K., Ostendorf, F., Angleitner, A., Riemann, R., Spinath, F. M., Livesley, W. J., & Jang, K. L. (2006). Is the genetic structure of human personality universal? A cross-cultural twin study from North America, Europe, and Asia. *Journal of Personality and Social Psychology*, **90**, 987-998.

Yamagata, S., Takahashi, Y., Kijima, N., Ono, Y., & Ando, J. (2006). Experience of stressful life events rather obscures genetic vulnerability of depression and anxiety in normal population: a study of gene-environment interaction. *Behavior Genetics*, **36**, 989-989.