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Do We Inherit or Create Our Personalities? A Review and Analysis of the Evidence

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ABSTRACT

There has been an ongoing debate about whether personality is inherited through genes or created through the environment. This article addressed the issue by analyzing three research articles about the heritability of a particular personality trait through research methods, limitations, and known information. Common patterns and trends seen in the three articles were then investigated and applications of the studies, as well as the relevance of those studies, were examined. The first study is a twin study that examined the heritability of the environmental sensitivity trait and examined its genetic overlap with traits in the big 5 personality traits. The second study is a molecular behavioral genetics study that examined how dopamine-related genes and environmental factors such as stressful life events and parental warmth contribute to the development of a highly sensitive personality. The third study is a longitudinal sibling study that examined how parenting behaviors can affect adolescent responsibility and young adult conscientiousness. From the three studies above, it is clear that in general, personality traits have relatively high heritability. However, genes are not the only thing that influences personality. Non-shared environmental factors also contributed significantly to the development of personality, especially to the variations of personality traits. Certain genes may be expressed only when an environmental condition is met. It is the interaction between genes and the environment that shapes the development of personality and makes individuals who they are.

Introduction

In the genes of human beings, almost 99.9% of the DNA is the same, and the remaining 1% is what makes each individual unique (Stangor and Walinga, 2014). The traits and behaviors that vary in humans create distinctive personalities. There has long been a debate about whether personality is inherited by genetic information or created by environmental factors. Psychologists have traditionally used twin/sibling studies, as well as longitudinal studies to examine the degree to which personality traits are heritable. By using behavioral genetics, researchers have found that certain genes are only displayed in some environments, and molecular genetics researchers have found numerous genes associated with certain personality traits. The current article analyzed three studies related to the nature vs nurture debate of personality traits, exploring patterns and trends, the application of the studies to future researches, and the relevance of those studies to everyday life.

Overview of Three Studies

Study 1 (Assary et al., 2020)

Research Methods

The study was conducted to examine the hereditary design of Environmental Sensitivity, by 1) assessing its heritability, 2) exploring the presence of multiple heritable components, and 3) studying its genetic overlap with current personality traits. The study used a sample of 2,868 adolescent twins with a mean age of 17 years. Within the sample, there were 1,011 Monozygotic twins, 901 same-sex Dizygotic twins, and 956 opposite-sex twins. Parental ratings of physical similarity were used to determine Twins' zygosity, and DNA testing was provided in instances where zygosity could not be determined by using physical similarity. Environmental Sensitivity was measured using the Highly Sensitive Child (HSC) Scale, in which the participant was given statements such as "I don't like watching TV programs that have a lot of violence in them" and then rated them on a Likert rating scale from 1 (not at all) to 7 (extremely) by how much they agree with the statement. The HSC scale measured behavioral sensitivity, which was defined as the threshold of the reactivity to stimulus.

To estimate the heritability of Environmental Sensitivity, the correlation of Monozygotic and Dizygotic twins was used to create an ACE model which estimated the contribution of genetic and environmental factors on phenotypes observed in a trait (partitioned into shared environmental and nonshared environmental). In addition to the ACE model, an ADE model that replaced the shared environmental effects with non-additive genetic effects was created in order to determine the model of best fit, and a sex-limitation model was also constructed to examine the extent of influence sex difference had on heritability. Lastly, a multivariate common pathway ACE Model was constructed to investigate the presence of multiple heritable components, and a multivariate independent pathway ACE model was constructed to examine the degree in which the genetic influences of Environmental Sensitivity had on common personality traits.

Limitations to Research

Due to the research being correlational, causal relationships cannot be determined between the variables. Although results showed that for genetic influences on variability in all traits, Monozygotic twins had a higher correlation than Dizygotic twins, the researchers couldnot be sure that the difference was purely genetic, due to the lack of variable manipulation and a control group in this study.

The use of the self-report questionnaires, such as the Highly Sensitive Child (HSC) Scale, can be unreliable because it is subjected to the participant's cognitive biases. The participant could manipulate the results of the questionnaires to the outcome they desire. For example, If a participant wants to be seen as someone who is amiable, they could rate the statement "I don't like watching TV programs that have a lot of violence in them" as 7 (extremely), whereas in reality, they watch a lot of violent TV programs. The use of parental ratings of physical similarity to determine a twin's zygosity could also make the study results inaccurate. For instance, a study conducted by Wenjing Gao and his colleagues found that the accuracy of only using physical features to determine zygosity was only 85.4% (Gao et al., 2012). The sample of the study are adolescents, which means that the findings of this research might vary in younger or older populations. Lastly, while the HSC scale is a promising measurement of Environmental Sensitivity, it is unlikely that one measurement could fully represent the heritable variance in Environmental Sensitivity. Therefore, further studies should seek to replicate the study using different age groups, different samples, and different measurements of Environmental Sensitivity.

Known Information

On average, females scored higher on sensitivity and personality measures of neuroticism, conscientiousness, and agreeableness than males, but there were no significant differences for measures of openness and extraversion. Age

also did not show a significant correlation with any of the traits. In both females and males, Monozygotic twins showed a larger correlation of genetic influence on the variability in the traits than Dizygotic twins. The heritability of Environmental Sensitivity was 0.47, with no evidence of shared environmental influences. The remaining 0.53 of the variation was due to non-shared environmental influences. Since genetic influences accounted for 47% of the variation (nearly half) in Environmental Sensitivity, it is reasonable to conclude that it is a heritable trait.

The multivariate independent pathway ACE model examined the variance of sensitivity and personality traits that were due to hereditary influences that are common to all traits versus those that are specific to each trait. The results showed that common genetic influences explained 0.36 of the heritability of Environmental Sensitivity, and specific genetic influences accounted for 0.09. Therefore, of the total 0.45 heritability estimated for Environmental Sensitivity in this model, 80% were due to genetic effects shared with personality traits, and the other 20% were due to genetic influences specific to sensitivity. Common genetic influences that explain individual differences in sensitivity are mainly shared with the personality traits of neuroticism and extraversion, and they did not make any notable contribution to the heritability of conscientiousness, openness, or agreeableness. Common non-shared environmental influences made a significant contribution to explaining the variance for all of the traits in the Big Five Personality Traits, but it did not explain the variance in Environmental Sensitivity. Instead, the variance in Environmental Sensitivity was almost entirely explained by specific non-shared environmental influences.

Study 2 (Chen et al., 2011)

Research Methods

The study approached personality traits on a neural system level, genotyping multiple genes in the dopamine system in an individual and associating it with their personality traits. 480 healthy Chinese college students enrolled in Beijing Normal University (208 males and 272 females) that averaged around 19.9 years of age were selected as the sample population of this study. 16 neurotransmitter genes within the dopamine system were selected and 98 polymorphic loci that had the most variance were tested. The participants were genotyped using the standard Illumina GoldenGate Genotyping protocol, and two of the participants were excluded due to having a greater than 10% null genotyping result. The study aimed to examine the contribution of the dopamine system and various environmental factors to a personality trait deeply rooted in the nervous system, the Highly Sensitive Personality. Stressful life events and parental warmth were selected as the external environmental factors.

The Highly Sensitive Personality trait was measured using the Highly Sensitive Person Scale (HSP), which characterizes sensitive personality as being easily aroused by external stimuli and having high levels of sensitivity to subtle stimuli. The scale contains 27 questions about sensitivity, such as ‘‘Do you tend to be very sensitive to pain?’’, and participants rate it using a Likert rating scale with 1 being ‘‘Not at all’’ and 7 being ‘‘Extremely’’. Stressful life events were measured using a scale adapted from a similar research used in Compas (Compas, 1987). The scale lists 24 possible stressful events, such as failing an exam, parents getting divorced, and the death of a relative. Participants had to indicate if they have experienced each of the events during early childhood, early adolescence, or their college years. Parental warmth was measured using the Parental Warmth and Acceptance Scale, which consists of 11 statements such as ‘‘My parents really understand me’’, and participants rate them using a 6 point scale, with1 being ‘‘Disagree strongly’’ and 6 being ‘‘Agree strongly’’. All scales were translated from English to Chinese by Chinese-English bilinguals and double-checked by native speakers.

Three major analyses were conducted in this study. First, the Analysis of variance test was conducted to detect the loci that should be included. Next, multiple regression analyses were conducted to examine the contributions of the genetic variations (SNPs) and the environmental factors to the Highly Sensitive Personality. Lastly, a series of permutation tests were run to assess the likelihood of false positives with the multiple regression analyses. The contributions of environmental factors were estimated by adding them into the regression models using the forward stepwise procedure.

Limitations to Research

There are several limitations to this research. The sample participants in the study are not representative of the entire population. The samples were young college students from a university, which means that they are likely well educated, and possibly have a better parent-to-child relationship than the average person. Therefore, the results of this study can only be applied to this particular group of students. To be able to generalize the study results to the entire population, researchers should replicate this study using participants that have different ages, different family backgrounds, different education, and different ethnicity, etc.

Second, the scales used in the study could be unreliable due to the wording effect, so it is possible that participants would choose one answer when reading the question, but choose another when the question is rephrased. The Highly Sensitive Person Scale may also not fully capture the definition of having a "sensitive personality", which also applies to the other two scales. Due to these reasons, further research should use different scales to measure the concept of "sensitive personality", "parental warmth", and "stressful life events".

Third, the study only selected 98 polymorphisms in the dopamine system, this means that some critical polymorphisms that might be significant to the research could have been missed. Lastly, the scales used in the study were translated from English to Chinese. Although it was translated by experts and double-checked, it is possible that translation errors can occur. If translation error does occur, the results from the scale may not be accurate and could be biased.

Known Information

The results of the study show that highly sensitive personality is significantly positively correlated with the number of stressful life events during secondary school and college years, but it was not correlated to parental warmth. Gender is not correlated with having a highly sensitive personality. The number of stressful events was negatively correlated to parental warmth, and the stressful life events experienced during early childhood, early adolescence, or college years were positively correlated with each other. Stressful events during college years, that is, recent stressful life events, made significant contributions to highly sensitive personality.

Of the 98 single nucleotide polymorphisms (SNPs) tested, 10 made statistically significant contributions to highly sensitive personality. Specifically, participants who were homozygous for the allele rs16894446, rs1611123, or rs7131056, or heterozygous for rs4929966 or rs3842748, reported higher sensitivity on the HSP scale, while participants who were homozygous for the allele rs7131056, rs895379, rs2975292, rs12612207 or rs2561196, or heterozygous for the allele rs6062460, reported less sensitivity. These results show that the dopamine system contributes substantially to highly sensitive personality.

Study 3 (Ramos et al., 2019)

Research Methods

The current research uses a longitudinal sibling study to explore environmental and genetic mechanisms that contribute to the association between parenting behaviors and virtuous character(specifically, responsibility and conscientiousness). This study examines whether parenting behaviors and virtuous characters of their child have common genetic or environmental influences and whether the child's virtuous characters shape the parents' behaviors.

The sample of this study consisted of same-sex twin and sibling pairs living in two-parent households. In addition, all parents of the participants were married for at least five years, and non-twin sibling pairs were no more than 4 years apart in age. The sample was assessed two times during the study, once during middle adolescence (Time 1), and once during early adulthood (Time 2). During Time 1, the sample consists of 93 pairs of identical twins, 99 pairs of fraternal twins, 277 pairs of full siblings, 109 half-sibling pairs, and 130 step-sibling pairs in stepfamilies. During Time 2, the sample included 55 pairs of identical twins, 49 pairs of fraternal twins, 89 pairs of full siblings, 35 half-sibling pairs, and 40 stepsibling pairs in stepfamilies. The participants that did not participate during Time 2 had

almost no difference compared to participants during Time 1, except that mothers participating at Time 2 were younger and family income was lower. Participants were primarily Caucasian and middle class with the parents' average years of education being 13.8.

During Time 1, parent reports of parenting behaviors were assessed using the Child Rearing Issues total conflict and punitive discipline subscales, Parent-Child Relationship closeness and conflict subscales, Expression of Affection expressive and instrumental affection subscales, and Conflict Tactics Scale conflict subscale. Parental negativity is defined as anger and conflict that the parent displays within the parent-child relationship, which is measured using questions such as "How often have you punished this child more severely than usual for misbehavior?". Parental positivity is defined as affection and closeness that the parent displays within the parent-child relationship, which is measured using questions such as "How often have you made a gift for another family member?".

At Time 1, adolescent responsibility, which is defined as "a youths' conscientiousness, dependability, and responsibility towards other"(Ramos et al., 2019), was assessed using a combination of adolescent self-report and parental ratings. Adolescents' self-rating of their responsibility was assessed using the responsibility subscale of the California Psychological Inventory, which includes true or false questions such as "There's no use in doing things for people; you only find that you get it in the neck in the long run." Parental report of responsibility was assessed using the Responsibility and Cognitive Agency subscales of the Child Competence Inventory. At Time 2, conscientiousness, defined as "the degree of persistence and motivation in goal-oriented behavior"(Ramoset al., 2019), was assessed by young adult self-report using the Conscientious subscale of the NEO Personality Inventory.

The study was analyzed using OpenMX 2.7.11, a modeling package in program "R". The package uses likelihood estimation to fill in incomplete data. Regressions for age, sex, age&sex, and age differences were applied to raw scores and residual scores were analyzed. Means and variances, and phenotypic correlations among traits were collected. Lastly, a multivariate Cholesky decomposition was modeled, which separates the variances into shared environmental, and nonshared environmental factors.

Limitations to Research

This study has several limitations. First, due to this study being a longitudinal study, the attrition of the sample from Time 1 to Time 2 could affect the study's ability to find environmental influences on virtuous character development. Second, because adolescent responsibility and parenting behaviors were assessed at the same time, it is difficult to determine which of these factors had the greatest influence on the development of virtuous character development. Lastly, because this was a child-sibling study, only genetic influences on the siblings could be examined, and the parents' genetic influences on parenting behaviors could not be examined.

Known Information

The phenotypic correlations showed several things. First, parental negativity is found to be negatively correlated with adolescent responsibility and young adult conscientiousness. Second, parental positivity is positively correlated with adolescent responsibility but only weakly correlated with young adult conscientiousness. Lastly, adolescent responsibility was also found to be weakly associated with young adult conscientiousness.

The Multivariate Cholesky decomposition found that there were shared hereditary variances among adolescent responsibility and parental positivity and that shared environmental influences contributed significantly to the correlation between adolescent responsibility and parental positivity. The decomposition analysis also found that genetic factors had great influences on adolescent responsibility and young adult conscientiousness and that nonshared environmental influences had a significant effect on parental behaviors, adolescent responsibility, and young adult conscientiousness.

Discussion

Patterns and Trends

There are several patterns and trends found in the three studies above. First, there is notable evidence that some traits of personality are heritable. In all three of the studies, genetic factors, whether it be genes inherited from parents or polymorphisms found in the dopamine system, all have shown significant contributions to the development of personality traits in the individual. Second, the studies mentioned above show that one single gene only has small effects on a personality trait, each personality trait is affected by many genes and each gene could affect multiple personality traits. Third, the results from the study show that personality traits do not exist independently, they interact with each other.

Despite the relatively high heritability of the personality, however, environmental factors also affected personality. Results in Study 1 and Study 3 both show that non-shared environmental influences contributed moderately to personality development. Although the studies show that environmental factors have only moderate contributions to the display of a personality trait, they have a significant influence on the unique variations of that trait. For example, if an individual has a genetic predisposition of having a highly sensitive personality trait, the environment that individual lives in could determine the "degree" that the trait is displayed (Chen et al., 2011). If the individual has experienced multiple stressful life events, their sensitivity might be higher than if they did not experience those events. Finally, all three studies show that parents, specifically parenting behaviors, have a significant impact on the personality development of adolescents.

Application

The study of the genetic and environmental contributions in personality has a variety of applications in everyday life. Studying the environmental effects on a particular trait, specifically parenting behaviors, on the development of adolescent personality could have a lasting impact on how parents will raise their children in the future. For example, if a parent knows that positive parenting behavior such as being responsive and affectionate could make their child develop a virtuous personality, they will be more likely to implement positive parenting behaviors with their child.

Furthermore, there are genes that influence personality that is triggered by environmental factors, so if parents can adjust their parenting behaviors accordingly, it is possible that they can increase the probability of the development of virtuous personality traits, and reduce the probability of the development of adverse traits.

In addition, studying how personality is influenced by genes may enhance our knowledge of neuropsychiatric disorders and therefore promote new treatment approaches (Sanchez-Roige et al., 2018). For example, by recognizing that neurotensin is associated with high sensitivity personality, which is related to schizophrenia(Cáceda, Kinkead, and Nemeroff, 2006), and that the 5-HTTLPR polymorphism of the serotonin transporter gene is found to be associated with traits related to neuroticism, such as anxiety, depression, hopelessness, and feelings of guilt, psychiatrists could prescribe medications that inhibit those genes to treat these disorders.

Relevance

The results from all three studies have several implications for future research. Study 1 provided assurance that, to some extent, Environmental Sensitivity is heritable. This will allow molecular genetic researchers to use it as a reliable phenotype in their research. Additionally, study 1 found that the genetic influences on Environmental Sensitivity also affect personality traits of extraversion and neuroticism, which assists future studies on the shared genetic influence of these traits. The use of a multi-polymorphism examination in study 2 opened up a new approach to gene-behavior studies. Unlike most of the previous studies which are only single-gene or single-polymorphism, the use of the new approach allows researchers to examine gene to gene interactions and assess the overall contribution of a neuronal

system to a personality trait. Study 3 shows that the relationship between adolescent responsibility and parental positivity is largely due to shared environmental influences. This finding is important to future studies regarding how parental behaviors can affect children's personalities. Past research has suggested that children who are raised in a positive environment and frequently receive praises from their parents often have virtuous personalities (Kasser et al., 1995). The findings in the current study suggest that the shared environment between parent and child might explain why parental positivity and adolescent responsibility covary with each other.

Conclusion

From the three studies above, it is clear that in general, personality traits have relatively high heritability. However, genes are not the only thing that influences personality. Non-shared environmental factors also contributed significantly to the development of personality, especially to the variations of personality traits. Certain genes may be expressed only when an environmental condition is met. It is the interaction between genes and the environment that shapes the development of personality and makes individuals who they are.

References

Assary, E., Zavos, H. M., Krapohl, E., Keers, R., & Pluess, M. (2020). Genetic Architecture of Environmental Sensitivity Reflects Multiple Heritable Components: A Twin Study with Adolescents. Molecular Psychiatry. https://doi.org/10.1038/s41380-020-0783-8

Cáceda, R., Kinkead, B., & Nemeroff, C. B. (2006). Neurotensin: Role in Psychiatric and Neurological Diseases. Peptides, 27(10), 2385–2404.https://doi.org/10.1016/j.peptides.2006.04.024

Chunhui Chen, Chuansheng Chen, Moyzis, R., Stern, H., Qinghua He, He Li, Jin Li, Bi Zhu, & Qi Dong. (2011). Contributions of Dopamine-Related Genes and Environmental Factors to Highly Sensitive Personality: A Multi-Step Neuronal System-Level Approach. PLoS ONE, 6(7), 1–9. https://doi.org/10.1371/journal.pone.0021636

Compas, B. E. (1987). Stress and Life Events During Childhood and Adolescence. Clinical Psychology Review, 7(3), 275–302. https://doi.org/10.1016/0272-7358(87)90037-7

Gao, W., Li, L., Cao, W., Zhan, S., Lv, J., Qin, Y., . . . Hu, Y. (2006). Determination of Zygosity by Questionnaire and Physical Features Comparison in Chinese Adult Twins. Twin Research and Human Genetics, 9(2), 266-271. https://doi:10.1375/twin.9.2.266

Kasser T, Ryan R, Zax M, Sameroff A (1995) The Relations of Maternal and Social Environments to Late Adolescents Materialistic and Prosocial Values. Dev Psychol 31(6):907–914. https://doi.org/10.1037/0012-1649.31.6.907

Ramos, A. M., Neiderhiser, J. M., Griffin, A. M., & Reiss, D. (2019). Did I Inherit My Moral Compass? Examining Socialization and Evocative Mechanisms for Virtuous Character Development. Behavior Genetics, 49(2), 175–186.
https://doi.org/10.1007/s10519-018-09945-4

Sanchez-Roige, S., Gray, J. C., MacKillop, J., Chen, C. H., & Palmer, A. A. (2018). The Genetics of Human Personality. Genes, Brain, and Behavior, 17(3), e12439. https://doi.org/10.1111/gbb.12439

Stangor, C., Walinga, J. (2014, October 16). 12.3 Is Personality More Nature or More Nurture? Behavioural and Molecular Genetics. Introduction to Psychology - 1st Canadian Edition. Retrieved November 7, 2022, from https://vle.pce.edu.bt/pluginfile.php/32283/mod_page/content/8/Introduction-to-Psychology-1st-Canadian-Edition-1479931225.pdf/