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AI-based Analysis on Relationship between Genes and Personality: Evaluation Results with the ABO Blood Type

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ABSTRACT

AI can be applied in various ways to the measurement of personality in psychology. Measuring the impact of a single gene on personality can be handled by AI technologies, at least technically, i.e., using supervised learning models of machine learning. The ABO blood type is a relatively easy biological marker to examine; therefore, people in many countries know their type, and its impact on the relationship with personality has been the subject of a large amount of research. In this study, we selected the ABO blood type as the target gene, examined its association with personality, and cross-checked the results with previous works. Two scales were used to measure personality: a) blood type personality traits extracted from previous studies, and b) the TIPI-J, a simplified version of the Big Five personality test. In the former, the AI was able to predict the respondents' blood types with a higher probability than chance, while in the latter, the accuracy was within the range of chance. These obtained results were also discussed.

Keywords: ABO; Blood Type; Gene; Big Five; Personality.

INTRODUCTION

Aims of This Study

The use of artificial intelligence (AI) for personality measurement has a variety of possible applications in psychology. Many of them are conceptual, but some studies have yielded concrete results [1-2].

One possible application of AI is to investigate the relationship between genes and personality. In general, traditional studies examined the similarity of twins' personalities [3], or the relationship between personality tests and genes [4]. However, no clear consensus has been reached on the relationship between a single gene and personality so far. The most typical method for these studies is ANOVA, and traditional ANOVA can only handle linear relationships, not non-linear ones. Meanwhile, these issues are typical examples of supervised learning in AI, and since the models are relatively simple, they can be tested on currently available "ready-made" platforms, i.e., AWS or Microsoft Azure, at least technically. The aim of this study is to provide a practical and pioneering application of using AI to check these non-linear relationships.

Naturally, the most important issue is which gene to select. To examine multiple genes, DNA testing is necessary, but this can be time-consuming and expensive. Since blood type is a biological marker that is relatively easy to test, many people in many countries, especially in East Asian countries like Japan, know their own ABO blood type. More than 90% of Japanese

people know their types, and a lot of research has been conducted on its relationship with personality, not only in Japan but all over the world. As mentioned above, DNA testing is necessary to accurately determine genes, which requires considerable time and cost. However, in the case of the ABO blood type, self-reporting is not a problem as long as the sample is Japanese, making it suitable for a pioneering study like this one. Furthermore, it is easy to compare and cross-check the results with those of many previous studies. Therefore, in this study, we selected ABO blood type as the target gene, examined its association with personality, and compared it with studies that are representative of the previous research in this field.

Big Five Personality Test

The "Big Five" personality test is the most commonly used personality test in current psychology. As the name suggests, the Big Five test is a comprehensive description of personality by five factors called the Big Five [5-6]. These five factors are usually referred to as Neuroticism, Extraversion, Openness, Agreeableness, and Conscientiousness. In this model, question items are collected from dictionaries and traditional personality tests. Personality scales are re-analyzed, and the five factors are extracted through factor analysis. In this way, the Big Five are characterized by a bottom-up process without assuming any background theory, and personality is comprehensively captured by the five factors [7].

As mentioned earlier, the Big Five is a questionnaire-based personality assessment that consists of answering a series of questions about multiple self-reported personality traits. These traits are then integrated into five personality factors through statistical processing. Theoretically, the self-reported answers will appear directly or indirectly in the results.

Recently, a variety of efforts have been made to measure psychological factors with a small number of question items. Typical examples are subjective well-being [8] and self-esteem [9], which have been used in many studies. In 2003, for the Big Five personality tests, Gosling, Rentfrow and Swann developed a 10-item inventory with a seven-point scale, the Ten-Item Personality Inventory (TIPI) [10]. A Japanese version of this personality test was developed by Oshio, Abe and Cutrone in 2012 [11]. The test-retest reliabilities of these were 0.62-0.77 and 0.64-0.84, and Cronbach's alphas were 0.40-0.73 and 0.72-0.91 [10-11], which largely supported the validity of these two tests.

Blood Type Personality Theory

In 1927, Furukawa, a Japanese educational psychologist, published the world's first academic study of blood type and personality based on statistics [12-13]. Later, Nomi, an independent Japanese researcher, further developed Furukawa's study and published his work in 1971 [14], which has had the greatest impact on current research [15-16]. Nomi utilized various methods, including questionnaires, observations and statistical analyses of human behaviors, and surveys of the distribution of blood types among various occupations and special groups (Table 1). He claimed that the sample size of his studies was tens of thousands in total.

In Japan, South Korea, and Taiwan, half or more of the population believed in the relationship between blood type and personality [15, 17-20].

Sato, Miyazaki, and Watanabe, a group of Japanese psychologists, conducted a free-response survey of 197 college students [21]. Another Japanese group, led by Sakamoto and Yamazaki,

has surveyed 177 college students on 24 personality traits in annual opinion polls conducted by company affiliated with one of Japan's major television stations [22]. These results are shown in Table 2, and in general, these personality traits studied by Japanese academic researchers matched with those studied by Nomi (Table 1).

Table 1. Blood Type, Personality, and High Distribution Rate

Blood Type	Personality	High Distribution Rate
A	Have a sense of duty for "someone." Suppress emotions and desires. Value gentle compassion and perceptions. Observe rules, custom and order; avoid extremes. On the other hand, a bit conventional. Very consistent, drawing a clear line. Most stubborn and short-tempered inside.	Education minister High-ranking sumo wrestler
B	Self-paced behavior. Reluctant to be argued with or restrained. Cognitively flexible, highly innovative and accepting of new people. Least influenced by their surroundings, unconcerned; most careless. In general, not particular about things.	Baseball hitter
O	Strong desire to live and full of vitality. Strongly purpose-oriented. Once target is set, go straight ahead without hesitation. Physical intimacy for friends, family-oriented. Naked openness and parental love for best friends. On the other hand, very wary of "outsiders" or the unknown.	Prime minister Foreign minister Baseball hitter
AB	Rational, businesslike. Duality with a calm, cool stable side and an easily disturbed side with sentimental fragility. Very friendly and tidy; treat others with kindness when asked; smiling. Keep a certain distance from others.	Foreign minister Education minister

Many academic studies have used multi-item personality tests, i.e., the Big Five test, but the results have been considered as inconsistent [23-35]. Thus, there remains an endless academic controversy on whether the relationship has been scientifically confirmed or not. Furthermore, there was little statistical difference among respondents who knew little about blood type personality traits [36]. A 2014 study re-analyzed data from 10,000 respondents to a survey on consumer life in Japan and the United States, but no meaningful differences were found [37].

Table 2. Blood Type and Its Associated Stereotypes (#1: [21]; #2: [22])

Blood Type	#	Personality
A	1	Meticulous, Nervous, Serious
	2	I am careful when doing something. I am serious when I should be so. I am often worried about things. I make an effort toward my goal.
B	1	Self-paced, Individual, Lukewarm, Egoistic, Self-centered, Optimistic, Pleasant
	2	I often change my mind. I am not particular about things. I cannot be quiet and I make merry when I am delighted. I am ready to keep company with everyone.
O	1	Big-hearted, Laid back, Unassuming
	2	I have a lot of friends. I am ready to keep company with everyone. I cannot be quiet and I make merry when I am delighted. I am not particular about things.
AB	1	Dual personality, Two-faced, Oddball, Hard to understand
	2	I do not change my idea after I present it. I make an effort toward my goal. I sometimes burst into a rage. I often change my mind.

Contemporary Trends and Issues

Self-fulfilling prophecy is a phenomenon in which a person who believes in a certain prophecy begins to behave accordingly, and thereby the prophecy becomes reality. Psychologists have examined a classic example: astrology [38-39]. As stated above, half or more of the people in Japan, South Korea, and Taiwan believe in the relationship between blood type and personality [15, 17-20]. Therefore, the self-fulfilling knowledge of astrology suggests that a person's personality would changes in the direction of personality traits associated with their blood type, at least theoretically.

Based on this hypothesis of self-fulfilling prophecy, several large-scale Japanese academic surveys clearly validated the phenomenon. Archetypical sample sizes for these were several thousands or more [40-42]. However, respondents without knowledge of astrology or blood type traits, showed no consistent statistical differences [40]. Therefore, the current scientific consensus is that these differences are caused by "contamination by knowledge," or self-fulfilling prophecy [15, 17-18, 21-22, 36, 38-39, ,41-42].

Some studies have focused on biological factors: in 2015, a Japanese study using DNA testing methods and the Temperament and Character Inventory (TCI) personality test, which assumes the influence of neurotransmitters, found that among 1,427 participants, those with blood type A tended to be "persistent,", as predicted [43]. Another researcher in the United States assessed both the ABO phenotype and its genotype and investigated the association of disequilibrium between the ABO genes and the DBH genes [44-45].

Personality is influenced by genetic factors, i.e., gender or age, and these interactions are considered as non-linear [46-49]. However, the majority of previous studies have assumed that the effect of blood type was linear, regardless of the nature of these factors [12-13, 15-19, 21-37]. Statistical methods used in the design of questionnaire-based personality tests, i.e., correlation or factor analysis, basically assume a linear relationship between variables. Therefore, there is no theoretical guarantee that traditional personality tests based on these statistical methods could properly handle real non-linear data.

PARTICIPANTS AND METHODS

Participants

The data for the survey was collected through an Internet research company, using the method of crowdsourcing. The survey was conducted in 2021 with a sample of 3,000 Japanese respondents between the ages of 20 and 59. The participants were asked to rate a total of eight items corresponding to four blood types (A, B, O, AB), using a score from one to five to indicate how closely each item matched their own personality traits (the larger the number, the more fitting the trait). The participants were also asked to indicate which blood type they thought these eight items corresponded to. In addition, we provided them with a score from one to three indicating the strength of the relationship (the higher the number, the stronger the relationship) and a score from one to four indicating their knowledge of blood type personality theory (the higher the number, the more knowledgeable they were).

In line with the methods of the aforementioned psychological personality tests, we deliberately selected the traits that would certainly make a difference, i.e., the common stereotype of the traits consistent with prior academic studies, showing a large difference and a mean value close to 50%, not showing extreme values, and being consistent with prior research in other studies. The results are as follows:
Type A: Meticulous, nervous
Type B: Self-paced, self-centered
Type O: Big-hearted, laid-back
Type AB: Easily misunderstood, dual personality

A simplified Big Five personality test, the Ten-Item Personality Inventory (TIPI) [10], Japanese version (TIPI-J) [11], was also conducted simultaneously with these same participants.

Since this study was not a medical study involving human subjects, the research ethics review committee determined that there were no ethical issues with using only information that was already unlinked and anonymized.

The questions regarding blood type traits for this study were extracted from the reviewed scientific papers (Table 2). These items were again checked by a crowdsourcing company that had passed the Japanese privacy review (JIS Q 15001) mentioned earlier. The company confirmed that there were no problems with the questionnaire items. The company provides anonymized data to its clients and obtains informed consent from respondents prior to its surveys. In this survey, the blood type of the participants was determined by self-reporting, as most Japanese people know their own blood type; it was common practice in Japan until recently to test the blood type of newborns. As the result, only 166 out of 3,000 respondents (5.5% of the total) did not know their own blood type, so we used data from the remaining

2,834 individuals whose blood types were known. All samples were evenly distributed by age and gender in 10-year increments (Appendix). The distributions of participants' blood types were almost equal to the Japanese average [50].

ANALYTICAL METHODS

First, we tested whether AI predicts participants' blood types more than chance. Second, to focus on whether the self-fulfilling prophecy phenomenon was occurring, we conducted an analysis using data from participants who either "do not know their blood type traits" or "do not believe in the relationship" (hereafter referred to as the "no knowledge" group).

The analysis methods for personality are as follows:
Analysis 1: Blood type prediction using AI with blood type traits
Analysis 2: Blood type prediction using AI with TIPI-J
Analysis 3: ANOVA for blood type and its traits for all participants
Analysis 4: ANOVA for blood type and its traits for the "no knowledge" group
Analysis 5: ANOVA for blood type and TIPI-J for all participants

All the data was stored in Microsoft Azure, and Microsoft Azure Machine Learning Studio was used for predictions. The algorithms we used were Multiclass Logistic Regression, Multiclass Neural Network, Multiclass Decision Jungle, and Multiclass Decision Forest. Predictions were run four times each (random seeds from one to four), and the average values were used as the accuracy rates.

We conducted an analysis of variance (ANOVA) using self-reported ABO phenotypes (O, A, B, AB) with personality trait scores as the dependent variable. The alpha ratio was set at 0.05. Prior to the ANOVA analysis, the normality of the distribution was checked for each personality trait score, and it was normally distributed. The data were analyzed using jamovi software version 1.2.27. The effect sizes [51] were also calculated.

RESULTS

Analysis 1: Blood Type Predictions with Blood Type Trait

The results for the Multiclass Logistic Regression, Multiclass Neural Network, Multiclass Decision Jungle, and Multiclass Decision Forest algorithms showed accuracies of 0.434, 0.418, 0.395, and 0.356, respectively (Chart 1).

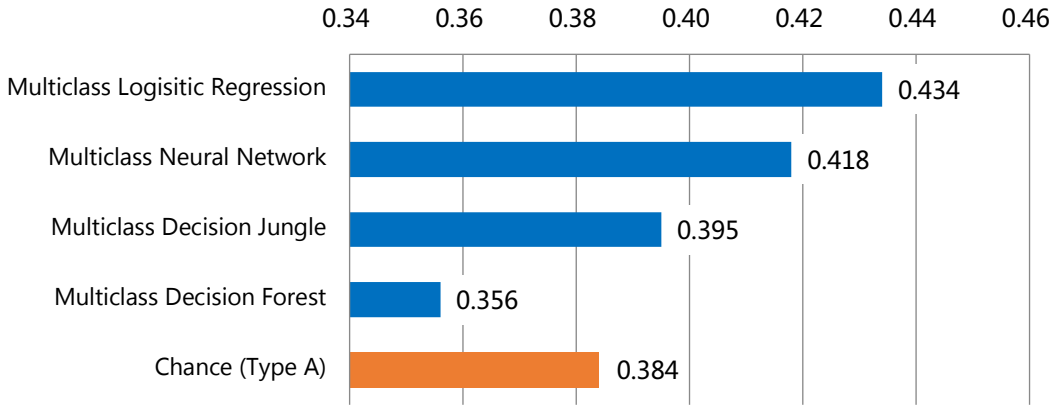


Chart 1. Accuracy of Blood Type Predictions with Blood Type Traits

Analysis 2: Blood type prediction using AI with TIPI-J

The results for Multiclass Logistic Regression, Multiclass Neural Network, Multiclass Decision Jungle, and Multiclass Decision Forest algorithms showed accuracies of 0.376, 0.375, 0.344, and 0.323, respectively (Chart 2).

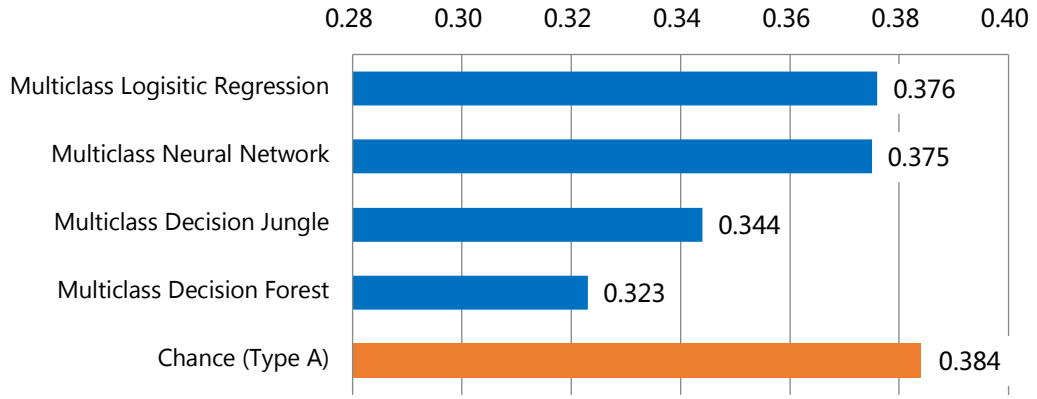


Chart 2. Accuracy of Blood Type Predictions with TIPI-J

As mentioned above, type A is the most common blood type among Japanese people, accounting for 0.384 (1,089 persons) of the total number of participants in this study. Therefore, if AI simply predicted each participant to be type A, the accuracy would have been 0.384. Microsoft Azure Machine Learning Studio predicted the blood type with a lower accuracy than this value in all cases.

Analysis 3: ANOVA for Blood Type and Its Traits for All Participants

In the survey's ANOVA result (Table 3), all four types showed the same results as those shown for blood type traits in the preceding psychology papers (Table 2). The score for each blood type was the sum of the two question items that corresponded to that blood type. All types were statistically significant at $p < 0.05$, and after the Bonferroni's correction. The magnitude of the difference: $\eta 2 = 0.035$ at the maximum, thus all the effect sizes were small. All of the responses were consistent with the most common stereotypes of blood types that respondents expected.

Table 3. Result of ANOVA for Traits Scores and Blood Type

Blood Type Traits	Average Scores by Blood Type: A (N = 1,089)	B (N = 616)	O (N = 844)	AB (N = 285)	*F*	η^2	*p*
A	**6.73**	5.98	6.05	6.31	34.10	0.035	**<0.001 ***
B	6.35	**6.92**	6.46	6.43	16.52	0.017	**<0.001 ***
O	6.17	6.36	**6.88**	6.15	34.68	0.035	**<0.001 ***
AB	5.55	5.55	5.51	**6.51**	30.08	0.031	**<0.001 ***

Note. Highest scores that match with blood type traits, and $p < 0.05$ are highlighted in bold. * $p < 0.05$ after the Bonferroni's correction

On the question item "Do you think blood type and personality are related?", 8.2% of the respondents answered "related," 51.7% answered "somewhat related," 26.3% answered "not related," and 13.8% answered "I don't know." On the question item "Do you know the traits and

compatibilities of blood types?", 4.0% answered "I know a lot," 37.8% answered "I know some," 40.5% answered "I know a little," and 17.7% answered "I don't know at all."

Analysis 4: ANOVA for Blood Type and Its Traits of the "No Knowledge" Group

In the survey's ANOVA result (Table 4), all four types showed the same results as those shown for blood type traits in the preceding psychology papers (Table 2). The score for each blood type was the sum of the two question items that corresponded to that blood type. Three types were statistically significant at $p < 0.05$, and after the Bonferroni's correction. The magnitude of the difference: $\eta 2 = 0.039$ at the maximum, thus all the effect sizes were small.

Table 4. Result of ANOVA for Traits Scores and Blood Type

Blood Type Traits	Average Scores by Blood Type				F	η^2	p
	A (N = 207)	B (N = 152)	O (N = 182)	AB (N = 54)			
A	**6.73**	5.98	6.05	6.31	A	**6.73**	5.98
B	6.35	**6.92**	6.46	6.43	B	6.35	**6.92**
O	6.17	6.36	**6.88**	6.15	O	6.17	6.36
AB	5.55	5.55	5.51	**6.51**	AB	5.55	5.55

Note. Highest scores that match with blood type traits, and $p < 0.05$ are highlighted in bold. * $p < 0.05$ after the Bonferroni's correction

Analysis 5: ANOVA for TIPI-J by Blood Type

In the survey's ANOVA result (Table 5), two factors were statistically significant at $p < 0.05$, and one after the Bonferroni's correction. The magnitude of the difference: $\eta 2 = 0.005$ at the maximum, thus all the effect sizes were considerably small.

Table 5. Result of ANOVA for Traits Scores and Blood Type

Factors	Average Scores by Blood Type				F	η^2	p
	A (N = 1,089)	B (N = 616)	O (N = 844)	AB (N = 285)			
Extraversion	3.71	3.78	3.74	3.78	0.52	0.001	0.669
Agreeableness	4.72	4.64	4.71	4.65	0.88	0.001	0.451
Conscientiousness	3.69	3.55	3.52	3.56	2.98	0.003	**0.030**
Neuroticisms	4.33	4.26	4.29	4.31	0.54	0.001	0.653
Openness	3.76	3.93	3.85	3.99	4.40	0.005	**0.004 ***

Note. Highest scores that match with blood type traits, and $p < 0.05$ are highlighted in bold. * $p < 0.05$ after the Bonferroni's correction

DISCUSSION AND CONCLUSION

Using blood type personality traits, AI predicted the participants' blood types more accurately than chance with the exception of one algorithm. We observed a clear and consistent relationship between blood type and self-reported personality among all four types. The same traits were also observed in the groups that did not know their blood type, although the differences were smaller. On the contrary, when using the simplified Big Five personality test (TIPI-J), AI could not predict the participants' blood type more accurately than chance, and there was little difference among blood types, which corresponds to the typical past results.

Previous studies by psychologists found no differences in personality by blood type, and even if there were differences predicted by blood type, they were thought to be the result of a self-fulfilling prophecy phenomenon [14, 16-17, 20, 28, 35-36, 37-41]. However, when using the blood type personality traits, the same differences in scores were found in the "no knowledge" group, although the values were smaller. Therefore, the differences by blood type were most likely not due to the self-fulfilling prophecy phenomenon, but actually existed, and the differences in the "no knowledge" group were not due to Type II errors.

In this study, the following four algorithms were used: Multiclass Logistic Regression, Multiclass Neural Network, Multiclass Decision Jungle, and Multiclass Decision Forest. The first one showed the highest accuracy for both blood type personality traits and the TIPI-J, which may indicate that the personality test data are closer to linear than expected, since this algorithm is mainly used for linear predictions.

These results provide a new, albeit hypothetical, framework for examining how genes influence human personality. On the other hand, the sample in this study was limited to Japanese populations, the sample size of the AI training data was small, and the study was used on an experimental basis. Future studies with larger, more global datasets are needed to clarify the true impact and to improve algorithms and methodologies.

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