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Blood Type and Blood Donation Behavior

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Abstract

We empirically investigated how voluntary helping behavior is influenced by the number of its potential recipients by using a nationwide survey in Japan (N = 1,333) and examining the relationship between blood type and blood donation behavior. It is generally known in Japan that type O blood can be medically transfused to individuals of all blood groups; therefore, the potential transfusion recipients' number of the type O blood is the largest among the four blood groups. Our empirical analysis revealed that people with type O blood were more likely to have donated blood in the past than those with the other blood types. This association was stronger in a subsample of individuals who had knowledge relating to the above-mentioned widespread utility of type O blood. In addition, our empirical analysis arrested the concern that potential blood-type differences in altruistic attitudes might explain their differences in blood donation behavior, by confirming that type O blood was not significantly related to other altruistic behaviors (i.e., registration for bone-marrow donation, intention to donate organs, and making monetary donations) or attitudes (i.e., general trust, altruism, reciprocity, and agreeableness). After conducting further analyses, we concluded that the vast number of potential recipients of type O blood causes different patterns of Japanese people's blood donation behavior across the four blood groups. This study added to the literature the real-world evidence concerning how having many potential recipients affect people's behavior of providing common goods.

Keywords: Inborn quality, ABO blood group, blood donation, common pool resource

JEL Classification Codes: I10, D64, C30

1. Introduction

Historically, humans have provided goods that benefit other members of the same group through collective action projects, including food procurement, irrigation development, and collective protection. We currently do this through monetary donations, volunteer activities, and blood donations. The characteristics and mechanisms of these behaviors have been of interest in many research areas (Bekkers & Wiepking, 2011).

Imagine that the goods provided by you have many potential recipients; in other words, many members in the same group are waiting to consume the goods, which only one member can consume at a time. How would this influence your providing behavior? The current study answered this question, by examining the relationship between Japanese people's blood type and blood donation behavior.

When the number of potential recipients differs among suppliers, it means that an expected gain of profit from their contribution behavior is *heterogeneous*. To illustrate, imagine that two members—A and B—belong to the same group. Member A is good at acquiring "Good A" because of their natural ability, and "Good A" is needed by many other members of the same group. On the contrary, Member B is good at acquiring "Good B" because of their natural ability; but "Good B" is needed by a smaller number of other members than "Good A." How will the A's and B's acquisition behavior differ? It is more likely that "Good A" will be consumed by the other group members without disposal, and Member A will profit from having contributed to their group. Therefore, it is possible that Member A will make more efforts to acquire "Good A" and provide it to their group members. In contrast, as we will explain in detail later, it is also possible that, since member A can more quickly and efficiently profit from providing "Good A" and contributing to their group, there will be more time and resources for them to acquire and consume other goods that benefit themselves.

Previous behavioral science studies, including evolutionary psychology, social psychology, and behavioral economics, have implicitly assumed that an individual's profit gain from contribution behavior is *homogeneous* (see the reviews of Chaudhuri, 2011; Engel, 2011; Ledyard, 1995). Under this assumption, researchers have analyzed how social, environmental, institutional, and personal factors influence individuals' contribution behavior. However, in practice, the profit gain from contribution behavior is often *heterogeneous* among them. For example, in primitive societies, the types of food individuals can procure and how easily they can procure them vary with their physical ability. In modern enterprises, the profit gain from contributing to the organization also varies depending on the ability, position, and status of the staff. In fact, staff will consider heterogeneity and decide how they contribute to the organization (Ployhart et al., 2014).

Recent behavioral science studies have started to investigate contribution behavior under the assumption that an individual's profit gain from contribution behavior is *heterogeneous* (Barclay & Reeve, 2012; Brock et al., 2013; Exley, 2016; Kölle, 2015; Krawczyk & Le Lec, 2010). For example, in evolutionary psychology, Barclay and Reeve (2012) constructed a model that allows for differences in the size of the profit gain from contribution behavior, the cost of gaining the profit, and the opportunity cost of selecting the contribution behavior; then, Barclay theoretically analyzed the effects of the differences in each element on individuals' behavior. Some economics studies posited a model that allows for probabilistic differences in the way individuals profit from their contribution behavior (Brock et al., 2013; Exley, 2016; Krawczyk & Le Lec, 2010). In this setting, individuals' profit gain from their contribution behavior is heterogeneous among them after calculating the expected value. These prior studies conducted laboratory experiments and examined participants' contribution behavior. However, to our knowledge, few studies have conducted such

investigations outside laboratories, with one exception of Wildman and Hollingsworth's study (2009) detailed in Section 2.

This study adds to the literature real-world evidence concerning how having many potential recipients influence people's behavior of providing common goods. Specifically, we examined a nationwide sample in Japan to determine the relationship between blood type and blood donation behavior. We focused on this relationship for two reasons. First, the range of blood transfusion recipients differs widely across blood type. As shown in Figure 1, type O blood can be medically transfused to all individuals, regardless of blood type (Ministry of Health, Labor and Welfare in Japan, 2017). In contrast, individuals with blood type A or B can provide transfusions for those with the same blood type or those with blood type AB. Moreover, individuals with blood type AB can provide transfusions only for those with the same blood type.

In other words, the number of potential blood transfusion recipients of type O blood is exceptionally the largest among the four blood types. As an example, with a sample of 100 Japanese people, the number of the potential recipients of blood types A, O, B, and AB are 50, 100, 30, and 10, respectively because the distribution of blood groups across Japan is approximately A: O: B: AB = 4: 3: 2: 1 (Japanese Red Cross Tokyo Metropolitan Blood Center, 2020).

[Insert Figure 1 here]

Second, people cannot select their blood type; therefore, blood type is exogenous. Consequently, we can determine blood type as the starting point and identify its effect on blood donation behavior. Here, we do not need to worry about the concern of reverse causality—that donating blood might change a donor's blood type to a certain blood type—or that, after

knowing the wide range of transfusion recipients of type O blood, people might change their blood type to type O.

Considering these two features, we examined the effect of the number of potential recipients by observing how the blood donation behaviors of Japanese people differ across the four blood groups. We employed a Japanese sample because almost all Japanese people (99.7% of our sample), including both blood donors and non-blood donors,[1] know their own blood type. As explained further below, this seems not the case in other countries, and it has been reported that approximately 30% of the American and 50% of the British populations know their own blood type (Ciepiela et al., 2017). In addition, many Japanese people (73.9% of our sample) knew that type O blood could be transfused to individuals with the other blood types. The first characteristic strengthens the validity of our study setting, where blood type is exogenously assigned to people. We did not need to worry about whether some people would find out their own blood type only after donating blood, in addition to the two preceding concerns. The second characteristic allowed us to analyze the relationship between blood type and blood donation behavior, based more firmly on the premise that many of the sample knew about the difference in the range of blood transfusion recipients across the four blood groups.

Does having type O blood, which has the largest number of potential blood transfusion recipients, promote or inhibit the individual's blood donation behavior? The literature in behavioral science indicates both possibilities. Therefore, which possibility emerges in the real-world depends on empirical analysis.

The first possibility is that people with type O blood are more likely to donate their blood than those with the other blood types. Recent economic studies introduced different probabilities with which individuals profit from their contribution behavior, and experimentally

[1] This study calls people who have not donated their blood in the past "non-blood donors."

showed that those with a high probability were likely to display contribution behavior (Brock et al., 2013; Exley, 2016; Krawczyk & Le Lec, 2010). When the number of potential recipients is vast, the donors expect that their blood will be used for transfusions. Since blood has a short expiration date, donated blood may be discarded rather than used for transfusions (Japanese Red Cross Tokai Hokuriku Blood Center, 2020). In other words, having many potential blood transfusion recipients means there is a lower probability that the donated blood will be discarded as compared to having fewer potential recipients. Consequently, people with type O blood are more likely to gain some altruistic or reputational benefits of their blood being used for transfusions, the benefits overweight the costs of donating their blood, and then people with type O blood are more likely to donate their blood than their counterparts.

The second possibility is that people with type O blood are less likely to donate their blood than those with the other blood types. In general, the benefit gain from the same behavior diminishes with frequency. Thus, people would prefer combining blood donation behavior and other behaviors that benefit themselves as opposed to repeatedly donating their blood. Since people with type O blood more quickly and efficiently gain the benefits from their blood being used for transfusions, they would have more time and resources to display other behaviors. Consequently, people with type O blood might donate their blood less often as compared to people with other blood types. This phenomenon is called “crowding out” in economics (Andreoni, 1989, 1990, 1993).

Psychological studies revealed another aspect of why people with type O blood might be less motivated to donate their blood as compared to their counterparts. Studies have shown that people display helping behaviors when they see a small number of specific recipients compared to when they see a large number of unspecific recipients (Kogut & Ritov, 2005a, b,

2007; Slovic, 2007). Consequently, one might predict that people with type O blood will be less likely to donate their blood as compared to their counterparts.[2]

This study empirically investigated which of these two possibilities will emerge by employing a Japanese sample. We hypothesized that people with type O blood will donate their blood differently than people with the other blood types. In addition, if we identified a different pattern of blood donation behavior between individuals with different blood types, we investigated whether the cause of such behavior is because type O blood can be medically transfused to all individuals, regardless of blood type.

Before entering the next section, we should note that if we find that people with type O blood are more likely to donate blood than those with the other blood types, it might mean that the blood donation behavior of those with type O blood is promoted because of the first possibility or that the behavior of those with the other blood types is inhibited because of the opposite action of the first one. In our empirical analysis, we compared the blood donation behaviors of people with type O blood with those of their counterparts while bearing in mind that each side has its own action.

[2] Another approach can predict both positive and negative possibilities. We assume that people perceive others to whom their blood can be transfused as members who belong to the same group. Since people tend to identify others who share something in common, even if it is trivial, as in-group members (Chen & Li, 2009), this assumption is plausible. Under this assumption, people with blood type O will feel that the size of the group they belong to is large, because people with blood types A, B, and AB are also their group members. First, the large size of their group means many group members will need a blood transfusion. If people with blood type O look at this feature, it is predicted that they will be more likely to donate their blood because of its expected high demand (Andreoni, 2007). Second, the large size of their group also means many other group members can donate their blood. If people with blood type O look at this feature, it is predicted that they will be less likely to donate their blood and yield that responsibility to the other group members (Panchanathan et al., 2013).

2. Data and Methodology

2.1 Data Overview

To conduct our investigation, we used a dataset from a nationwide survey conducted in Japan, the Preference Parameters Study of Osaka University (PPSOU; Osaka University, 2017). To our knowledge, this is the only survey that included information concerning both Japanese respondents' blood type and blood donation behavior. We received permission for research use of this dataset from the Institute of Social and Economic Research at Osaka University. The PPSOU data are available for research use upon reasonable request (http://www.iser.osaka-u.ac.jp/survey_data/eng_application.html).

The PPSOU survey is a panel survey that has been conducted annually since 2003. In the first wave in 2003, a nationally representative sample of individuals aged 20 to 69 years was obtained by using two-stage stratified random sampling by a self-administered placement method. The PPSOU survey is based on the concepts of economic psychology and behavioral economics. Thus, it collects respondents' unique information, including economic preferences, personalities, and behavioral and psychological attributes, in addition to their basic socio-economic characteristics. The PPSOU data have been used for vast empirical research in psychology and behavioral economics (Hanaoka et al., 2018; Ikeda et al., 2010, etc.).

The current study used the cross-sectional dataset in the 2017 wave, because only this wave included questions to identify respondents' blood type, blood donation behavior, and the knowledge of the range of transfusion recipients of type O blood. The 2017 wave collected 1,517 valid responses for the current study (the valid response rate was 71.8%) and captured their characteristics, attributes, and circumstances in 2016. We excluded from the dataset 180 respondents who were not 69 years old or younger in 2016, because 69 years old is the oldest

age at which people in Japan can donate blood. We also excluded 4 respondents who answered they did not know their own blood type. Our final sample size was 1,333.

Although the PPSOU survey has sometimes added a new sample to keep it nationally representative, the 2017 sample somewhat deviates from that. In fact, the youngest person in our sample is 26-years-old in 2016, and thus our sample does not include any members of the general population aged 16–25 years, who can legally donate blood. Consequently, our sample includes a relatively large proportion of the respondents in their forties, fifties, and sixties. However, this feature would not impede our analysis of Japanese people's blood donation behaviors, because the rate of blood donation among younger generations is showing a declining trend and, at present, people in their forties are the primary blood donors in Japan. In addition, the rate of blood donation among elderly generations (the fifties and sixties) is showing an increasing trend (Japanese Red Cross, 2017).

2.2 Data Features

Using a Japanese sample for this analysis provides some essential advantages. First, our Japanese sample generally knew their own blood type (99.7%); this is not the case in other countries. It has been reported that, in general, approximately 30% of the American and 50% of the British populations know their own blood type (Ciepiela et al., 2017). We also found that only 33.2% of the American pregnant women knew it in one study (Shah et al., 2011), and 56% of the Canadian participants knew it in the other study (Blider-Candield & Cotterchio, 2014).

Second, 73.9% of our sample knew that type O blood could be transfused to individuals with the other blood types. We learned from private interviews with medical practitioners that the transfusions of type O blood to people in the other blood groups is limited to emergency situations, and the actual frequency of such transfusions is low. That is, the knowledge is shared

by ordinary (non-clinical) Japanese people. This feature helps elucidate the pure impact of possessing type O blood and the knowledge relating to this blood type on the suppliers' voluntary blood donation behavior. If type O blood was frequently transfused to individuals with the other blood types in real medical situations, type O blood would have been more in demand, and blood donor centers would have more frequently made requests that people with type O blood donate blood. Consequently, such frequent requests might have promoted the blood donation behaviors of people with this blood type, even if they did not have the knowledge relating to blood type and blood transfusions. However, in the current study, we can ignore this concern.[3]

Third, the distribution of Japanese people's blood groups is well-dispersed. If almost all members of the sample had a single particular blood type, we could not have investigated our research question. Again, according to the Japanese Red Cross Tokyo Metropolitan Blood Center (2020), the distribution of blood groups across Japan (approximate value) is A: O: B: AB = 4: 3: 2: 1, and the distribution of blood groups in our sample was as follows: 38.9% for A, 30.2% for O, 21.2% for B, and 9.7% for AB. Thus, the distribution of blood groups in our sample is consistent with that seen across Japan.

Fourth, we can ignore any possible effects caused by people with Rh-negative blood, because the proportion of people with Rh-negative blood is quite small, approximately 0.5%, in Japan (Ibaraki Red Cross Blood Center, 2020). The proportion rises to 19% in Australia, as one example (Australian Red Cross, 2020). This Japan's feature allowed us to focus on a simple relationship diagram, where individuals with type O blood Rh-positive can provide

[3] When transfusions of type O blood to people in the other blood groups are limited to emergency situations, it implies the objective probability that type O blood being used for transfusions will only be slightly higher than that for the other blood groups. However, according to prospect theory in behavioral economics, people tend to overestimate small probabilities (Tversky & Kahneman, 1992). Thus, even if people know the above fact, they could be sensitive to the slight difference in the probability of the blood being used for transfusion.

transfusions for those with Rh-positive in all blood groups. Rh-negative blood is another kind of universal blood, which can be transfused to individuals with Rh-positive blood. If the proportion of people with Rh-negative blood was larger in Japan, the relationship diagram relating people who received a blood transfusion would have been more complicated, and the predicted effect of type O blood would also have been more complicated.

Additionally, using the PPSOU dataset enabled us to directly investigate (and reject) the possibility that other mechanisms could explain our results. One major concern is that economic preferences, personalities, and behavioral and psychological attributes may differ across blood groups, which would cause different patterns of blood donation behaviors across the groups. For example, people with type O blood likely donate their blood, possibly because they have more altruistic attitudes when compared to people with other blood types. Several psychological studies have already rejected the validity of this concern for samples from several countries, including Japan (Cramer & Imaike, 2002; Nawata, 2014; Rogers & Glendon, 2003; Wu et al., 2005); however, some people in Japan might still believe that blood type determines economic preferences, personalities, and behavioral and psychological attributes, and holding such a belief might unconsciously characterize their economic preferences, personalities, and behavioral and psychological attributes.

By using the PPSOU dataset, we addressed the above concern directly. The PPSOU survey collects information relating to respondents' economic preferences, personalities, and behavioral and psychological attributes, including altruistic attitudes. In our analysis, we investigated the effect of blood type on blood donation behavior after controlling for such characteristics; concurrently, we also examined whether these characteristics differ across blood groups.

Furthermore, we sought to reconfirm the advantages of using the PPSOU dataset by comparing it with a dataset used in a related study. To our knowledge, only one empirical study by Wildman and Hollingsworth (2009) focused on different ranges of blood transfusion recipients across blood type and analyzed the relationship between blood type and blood donation behavior. Using the blood donors' dataset of the Australian Red Cross, they reported quite complex results. Australian female blood donors with type O blood Rh-negative (the most universal blood) had a lower frequency of blood donations as compared to those with type O blood Rh-positive, who had a higher frequency of blood donations as compared to those with type A blood Rh-positive and with type AB blood Rh-positive. Also, Australian male blood donors with type O blood Rh-positive had a lower frequency of blood donations as compared to those with type B blood Rh-positive.

We recognize that their study is quite novel in being the first to examine the relationship between blood type and blood donation behavior. Nevertheless, it is worthwhile to readdress this question with our PPSOU data. First, their sample did not contain people who have never given their blood in the past. That is, their study did not investigate how having type O blood influences the first-time blood donation behavior of such the people.

Second, the proportion of the Australian people with Rh-negative blood (17.3% of their sample) is higher than that of the Japanese people. Therefore, the relationship diagram relating people who received a blood transfusion could be more complicated in Australia than in Japan. Actually, their reported results were complex.

Third, their dataset did not include information concerning the sample's knowledge of the ranges of blood transfusion recipients across blood type, preferences, personality traits, and behavioral and psychological attributes; therefore, it is difficult to empirically explore the background mechanism for their results.

As reported above, the Australian female blood donors with type O blood Rh-negative donated their blood less frequently than those with type O blood Rh-positive, which might be consistent with the second prediction we noted in our Introduction; that is, since they more quickly and efficiently benefited from their blood being used for transfusions, there might be more time and resources for them to take other behaviors. The authors themselves presented another interpretation that the demand for type O blood Rh-negative creates an expectation that those with this blood type should donate, and such an expectation could decrease the reputational benefit they gain from their blood donation; however, it is difficult to empirically confirm which interpretation is plausible, because their dataset did not include information concerning the sample's preferences, personality traits, and behavioral and psychological attributes.

2.3 Variables and Descriptive Statistics

2.3.1 Blood donation behavior

The PPSOU survey asked respondents whether they had donated blood at least once in the past few years and, furthermore, whether they had donated blood once or more within the past year. We set up two binary dependent variables that correspond to answers for those questions. The respondents who answered 'yes' to the latter question were coded as necessarily answering 'yes' to the former question as well.

In addition, the survey ascertained whether the respondents, who had not donated blood in the past, had behaved in that way for some health reasons. We used their responses in our further analysis.

2.3.2 Blood type

The PPSOU survey asked respondents whether their blood type is A, B, O, or AB. Although this survey allowed them to answer that they did not know their blood type, only four of our sample did not. In addition, although the respondents' blood type was self-reported in this survey, medical studies have already confirmed that such self-reported ABO blood type is highly accurate (Alkebsi et al., 2019; Bider-Canfield & Cotterchio, 2014; Ito et al., 2001). We set up four binary independent variables that identify whether the respondents' blood type is A, B, O, or AB, respectively.

2.3.3 Knowledge of the range of transfusion recipients of type O blood

The PPSOU survey asked respondents whether they thought whether the statement, which is "type O blood can be transfused to individuals with the other blood types," is correct or incorrect. We identified those who responded that this statement is correct as having the knowledge of the range of transfusion recipients of type O blood.

2.3.4 Covariates

Our analysis included covariates to control for the effects of respondents' socio-economic attributes, health status, economic preferences, personalities, and behavioral and psychological attributes. As some examples, the PPSOU survey included the questions of Ten Item Personality Inventory (TIPI), which was developed by Gosling et al. (2003), and was translated into Japanese by Oshio et al. (2012). Our analysis controlled for the effects of the respondents' big five personality traits (extroversion, agreeableness, conscientiousness, neuroticism, and openness to experiences; their Cronbach alpha coefficients were 0.65, 0.36, 0.46, 0.40, and

0.48, respectively).[4] Our analysis also used their responses to some statements (e.g. "I feel happy when I do a good deed that I think benefits others") in order to consider potential differences in behavioral and psychological attributes across blood groups.

Table 1 in the next subsection showed the details, and Online Appendix A in the supplementary information introduced questions and variables of health status, economic preferences, personalities, and behavioral and psychological attributes.

2.3.5 Descriptive statistics

Table 1 shows that 11.6% of our sample have donated blood at least once within the past few years and that 5.5% have done so once or more within the past year. According to the website of the Japanese Red Cross (2017), 5.6% of the Japanese population donated blood in 2016, which is a similar percentage to that shown in our sample. Additionally, as mentioned earlier, the distribution of blood type across Japan is consistent with that in our sample, and 73.9% of our sample knew that type O blood could be transfused to individuals with the other blood types.

[Insert Table 1 here]

2.4 Analytic Strategy

Since our two dependent variables are binary, we used a logistic regression for the estimation. We also applied to the estimation robust standard errors clustered at the respondents' prefecture level.

[4] With the exception of neuroticism's coefficient, the coefficients in our sample are almost consistent with those reported in the original paper of Gosling et al. (2003), which were 0.68 (extroversion), 0.40 (agreeableness), 0.50 (conscientiousness), 0.73 (neuroticism), and 0.45 (openness to experiences).

In the basic analysis, we conducted the regression with a full sample, clarifying the relationship between blood type and blood donation behavior. When a different pattern of blood donation behavior was found for people with type O blood, we next investigated whether such a result was generated because type O blood has a wider population of potential recipients than the other blood types. For the latter analysis, we conducted the regression with the subsamples. We divided the full sample into two groups: those who answered that the statement "type O blood can be transfused to individuals with the other blood types" is correct, and those who answered that it is incorrect. We then investigated whether the estimated parameter of type O blood was significantly different from zero in the former group but not the latter. If so, it would have directly supported that people with type O blood donate their blood differently, because of their large number of potential recipients.

In the further analysis, we examined (and rejected) the other possible explanations for our results. In so doing, we further confirmed our interpretations of the results. All the statistical analyses were conducted with Stata version 15 (LightStone Corp, Tokyo, Japan).

3. Results

3.1 Basic Results

The proportions of respondents who had donated blood at least once within the past few years were 9.6% (in our blood type A group), 14.9% (blood type O), 9.6% (blood type B), and 14.0% (blood type AB) (chi-square (3) = 9.013, $p = 0.046$).

Table 2 shows the results of logistic regressions with the full sample. In columns 1 to 3, the estimated parameter of the type O blood variable was positive and significant (all p values <.01 except for column 1, p's<.05), which indicates that people with type O blood were more likely to have donated blood at least once within the past few years than were people with the

other blood types. In particular, column 3 shows that they were especially more likely to have done so than people with blood type A, whose blood donation behaviors were similar to those of people with blood type B. These results remained stable also when using another dependent variable—respondents who donated blood once or more within the past year. The findings here are consistent with our first prediction.

[Insert Table 2 here]

Intriguingly, column 6 shows that people with type AB blood were more likely to have donated blood once or more within the past year than were people with blood type A (p's<.05). Although this finding is confusing at first glance, it might be consistent with our second prediction; i.e., respondents recognized a small number of specific recipients, and thus they were promoted to donate their blood. However, the type AB blood's effect does not seem to be robust, because it became weakened in column 3 (p's<.10).

In sum, we found a different pattern of blood donation behavior for people with type O blood, as we expected. Following our analytic strategy, the next step was to investigate whether this result was generated because type O blood has a wider population of potential recipients than the other blood types.

Table 3 shows the results of logistic regressions with the subsamples. The results revealed that the type O blood variable had a significant positive impact on blood donation behaviors but only for the subsample of respondents who answered that the statement "type O blood can be transfused to individuals with the other blood types" is correct (columns 1 to 4; all p's<.01 except for column 3, p's<.05). In contrast, columns 5 to 8 showed dissimilar results when we used the other subsample—those who answered that the statement is incorrect.

When using the smaller size sample in the former case than in the full sample analysis case, the coefficient size of the type O blood variable and its significance were indifferent from

those in the full sample analysis case (of course, we cannot completely deny the possibility that the latter results were influenced by their further small sample size). The findings more directly support that people with type O blood were likely to have donated their blood because of the large number of potential recipients.

[Insert Table 3 here]

We discuss here the validity of our subsample analysis in the step 2, which supposed that having type O blood is correlated with possessing the knowledge relating to this blood type and that the covariates' coefficients differ between the two subsample groups. In fact, there was a weak positive correlation between the type O blood variable and the knowledge variable. This means that people with type O blood were more likely to have the knowledge relating to their blood type as compared to their counterparts. This intuitively understandable finding does not impede but rather supports our interpretation that people with type O blood were likely to have donated blood because of the knowledge of the large number of potential recipients.

Figure 2 presents the marginal effects of the type O blood variable in the selected model specifications. The likelihood to have donated blood within the past few years was 4.7–6.4% higher in people with type O blood than in people with the other blood types, when using the full sample and the subsample of respondents who answered that the statement "type O blood can be transfused to individuals with the other blood types" is correct. However, when using the other subsample, we cannot reject the null hypothesis that the marginal effect of the type O blood variable was indifferent from zero.

[Insert Figure 2 here]

Finally, we checked that estimations using the probit regression model and the linear probability model produced similar results. We also found similar tendencies from estimations using sampling weights: however, the significance for the type O blood's effect became a little

weakened. Considering that the PPSOU survey is a panel survey and its sample consequently includes a relatively large proportion of elderly respondents, the result indicates the possibility that the relationship between having type O blood and blood donation behavior is observed mainly among them. We then confirmed this possibility, by dividing the sample into those who are relatively young and those who are elderly and conducting the estimation (please see Online Appendix B in the supplementary information).

3.2 Further Results

3.2.1 The first concern: altruistic attitudes

This section examined (and rejected) the other possible explanations for our results. First, we arrested the concern that people with type O blood (vs. the other types) were more likely to have donated their blood, possibly because they had more altruistic attitudes. We wish to restate that our model specification included covariates related to economic preferences, personalities, and behavioral and psychological attributes, including some altruistic attitudes, to consider their potential differences across blood groups; however, it is still possible that these covariates failed to sufficiently control for the differences. If unobserved altruistic factors remained after controlling for these covariates and if the type O blood variable was a proxy one for the factors, the type O blood variable should have had a significantly positive effect not only on blood donation behaviors but also on the other altruistic behaviors. Thus, we checked the effects of the type O blood on the other altruistic behaviors, as a negative control (Lipsitch et al., 2010).

Table 4 presents results that negate the first concern. Rows 1 to 8 show that the type O blood variable had no effect on the other altruistic behaviors, including registering for bone-marrow donation, organ-donation intention, and making monetary donations. In addition, rows 9 to 12 show that, after controlling for socio-economic and health status attributes, economic

preferences, and the other personalities, and behavioral and psychological attributes aside from the dependent variable, we did not find any significant relationship between type O blood and any altruistic attitudes. These findings deny the explanation that, since they naturally had more altruistic attitudes, people with type O blood were more likely to have donated blood than their counterparts.

[Insert Table 4 here]

3.2.2 The second concern: health status

We addressed the concern that people with type O blood were more likely to donate blood, possibly because they were healthier than people with other blood types. In fact, medical studies have reported that the risks of contracting diseases indeed differ between blood groups (He et al., 2012; Wolpin et al., 2009, etc.). We again wish to state that our model specifications included and controlled for variables that captured respondents' current health conditions; however, these variables might have failed to represent differences in terms of congenital or chronic health conditions.

To address this concern, we conducted the regression after excluding respondents who reported, "I have donated blood; but I have not donated within the past few years because of my health condition" or "I want to donate my blood; but I cannot because of my health condition." Since the results shown in Table 5 were robustly similar to those previously obtained, we propose that this second concern was not a significant factor.

[Insert Table 5 here]

3.2.3 The third concern: demand

We addressed the concern that people with type O blood were more likely to donate blood, possibly because type O blood was more in demand than the other types of blood. For example, blood donor centers might frequently make requests that people with type O blood donate blood. To consider the possible difference in demand, we controlled for information relating to the inventory ratio of stocks for each blood type in a prefecture, where each respondent lives. If the inventory ratio of stocks of a particular blood type is low in a prefecture, it would be likely that the blood donor centers in the area would request that people with that blood type donate blood. The Ministry of Health, Labor and Welfare in Japan (2012) published weekly reports concerning the inventory ratios of stocks of blood types for all prefectures in 2012. Using this information, we created variables relating to the annual averages and standard deviations of these inventory ratios of stocks in a prefecture, in which each respondent lives.[5] Table 6 shows that type O blood's parameter remained positive and significant even after controlling for the information concerning the inventory ratio of stocks for blood types. Therefore, this third concern is not crucial.

[Insert Table 6 here]

3.2.4 The fourth concern: Rh-negative

We addressed the concern that people with type O blood Rh-negative were more likely to donate blood than those with the other blood types and this behavior consequently shaped our results. Type O blood Rh-negative is quite rare in Japan; therefore, people with this blood type might think that providing donations of this blood type is also rare. This rarity could make them

[5] The Ministry of Health, Labor and Welfare in Japan published the report every week only in 2012. Thus, our analysis assumed that the annual averages and standard deviations of the inventory ratios of stocks of blood types are almost indifferent from 2012 to 2016.

more likely to donate their blood to others within the same group; consequently, this has the potential to negate our hypothesis.

Our survey did not capture whether a respondent had Rh-positive or Rh-negative blood, and we could not directly control its effect in our estimations. According to the Ibaraki Red Cross Blood Center (2020), only 0.15% of the Japanese population has O Rh-negative blood (a proportion of 1:670 people). Therefore, our type O blood sample (N = 403) included very few people with type O blood Rh-negative. Even if there were such individuals in the sample, their proportion is likely to have been extremely small (i.e., one or two people), meaning they would not have greatly influenced our estimation results. As an illustration, we shall imagine that there existed two people with type O blood Rh-negative, and both donated their blood. Even after excluding the two observations, the ratio of blood donors among people with type O blood would be 14.5%, which is almost indifferent from that in the full sample (14.9%). Therefore, this fourth concern was not a significant factor.

4. Discussion, Limitation, and Conclusion

This study examined the relationship between blood type and blood donation behavior to investigate the effect of differences in the number of potential recipients on the behavior of providing common goods. We focused on this relationship because type O blood can be medically transfused to all individuals; thus, the number of potential recipients of type O blood is exceptionally the largest among the four types. We analyzed responses from a nationwide questionnaire survey in Japan. We did so because almost all Japanese people know their own blood type, and many know that type O blood can be medically transfused to all individuals.

We found from our basic analysis that people with type O blood were more likely to have donated their blood in the past than those with the other blood types. We further found a

strong positive association between having type O blood and blood donation behavior in a subsample of individuals who knew that type O blood could be medically transfused to individuals of all blood groups. Based on these results, we interpreted that the more frequent blood donation behavior of those with type O blood was characterized by the large number of their potential blood transfusion recipients.

Furthermore, we strengthened this interpretation by denying the concerns that the other factors completely explained the above association between blood type and blood donation behavior. As one example, as previous psychological studies had done, we examined whether economic preferences, personalities, and behavioral and psychological attributes, including altruistic attitudes, varied by blood type. We confirmed that their differences did not explain the blood type differences in blood donation behavior.

When the number of potential recipients differs among the suppliers, it means that a supplier's profit gain from contribution behavior is *heterogeneous* among them. Previous studies in evolutionary psychology, social psychology, and behavioral economics analyzed their helping behavior under the assumption that the profit gain from contribution behavior is *homogeneous* (Chaudhuri, 2011; Engel, 2011; Ledyard, 1995). However, recent behavioral science studies have started to theorize the effect of the *heterogeneous* gain and used laboratory experiments to empirically test their theoretical predictions (Barclay, 2012; Brock et al., 2013; Exley, 2016; Kölle, 2015; Krawczyk & Le Lec, 2010). This study added evidence outside the laboratory to the literature.

Theoretically, people with type O blood—those with the largest number of potential blood transfusion recipients—may be more likely to donate their blood as compared to their counterparts. In contrast, they also may be less likely to do so; for example, because there are

many unspecified potential recipients. Our results show that the former was supported in a real-world setting of Japanese people's blood donation behaviors.

Next, we discuss why people with type AB blood were as likely to donate their blood as those with type O blood in the past. The number of potential blood transfusion recipients is smallest for those with type AB blood among the four blood groups. They might be promoted to donate by the specified small number of potential recipients; that is, their blood donation behavior might support the latter prediction.

However, this tendency was unstable. When we changed the dependent variable from blood donation experience within the past year to that within the past few years, the type AB blood's effect became weakened (*p's*<.10). Furthermore, we did not find their significant effect from some specifications in our further analysis. In our sample, the proportion of the people with type AB blood was 9.7%, and the proportion of the people who donated blood within the past year was 5.5%. Thus, we cannot deny the concern that these small proportions accidentally generated the above tendency.

We did not find any differences in blood donation behavior between people with blood type A and B, probably because the difference in the number of the potential blood transfusion recipients between them is relatively small (see the Introduction). Thus, we examined how blood donation behaviors differ between the following two cases: one case where the number of potential blood transfusion recipients is large (people with type O blood), and the other case where its number is small (those with blood type A and B). We expect future research to investigate how helping behaviors differ as the number of potential recipients changes linearly.

Here, we consider reciprocal altruism theories in evolutionary psychology (Barclay & Willer, 2007; Nowak & Sigmund, 1998a, b; Takahashi & Mashima, 2006; Trivers, 1971), discussing the mechanism of *why* people with type O blood frequently donated their blood in

this study. The theories states that people behave altruistically toward those with whom they have no direct relationship, because they can enhance their social reputation through their altruistic behavior. Thus, the frequent blood donation behavior of people with type O blood might be caused by said reputational benefit. However, they might donate their blood in anonymous settings. In such a case, their blood donation behavior is not observed by others, and it is difficult for them to gain the reputational benefit from their behaviors being directly observed. Some studies in evolutionary psychology have noted that people display helping behavior also in anonymous settings, because their helping behavior in non-anonymous settings spill-overs in anonymous settings (Delton et al., 2011; Kiyonari et al, 2000).

However, it is difficult to completely determine whether our study setting is anonymous or non-anonymous. When people enter a blood donation center, passersby outside might witness their actions. The other blood donors inside might also witness their blood donation behavior. Furthermore, their blood donation behavior is observed and recorded by the Japanese Red Cross. We expect to future research to overcome this limitation and, after experimentally devising anonymous or non-anonymous settings, examine the differences in helping behavior per the number of potential recipients.

One related experimental study in evolutionary psychology showed that people are less likely to cooperate in a public goods game with a threshold, or a situation in which any amount of public goods provided above the threshold is not returned to the group (Van Vugt & Hardy, 2009). The study also showed that, in a non-anonymous setting, they consider the reciprocal concern and continue to provide the public good even after the threshold is exceeded. This study is similar to our study, because both focused on a situation in which helping behavior may be wasted. In contrast, there are differences between the two. For example, in the earlier study, all the provided public goods were wasted after the threshold was exceeded; while, in

our study, donated blood was only *possibly* wasted. In addition, the earlier study focused on monetary support and our study focused on physical support. Considering these differences, we still expect future research to explore how different the helping behaviors we focused are in anonymous and non-anonymous settings.

Our findings can practically contribute to blood collection activities. Existing studies have examined which monetary or non-monetary incentive promotes blood donation behavior (see the review of Chell et al., 2017). The current study revealed that people's likelihood to donate their blood depends on whether (they think that) their blood is more likely to be used for transfusions. Concretely, the probability of having donated their blood in the past varied by around 5%, depending on whether their blood type was O, and this variation is not small. To encourage blood donation behaviors, it could be vital to inform people with type O blood that, in an emergency, their donated blood could be used for all transfusions, regardless of blood type. In contrast, people with the other blood types (in particular, blood types A and B) might lose their will to donate their blood if they know this feature of type O blood. Therefore, it could be also critical not to discourage people with blood types A and B from donating their blood by informing them that types A and B blood are also needed as much as type O blood.

Finally, we should note that our study does not guarantee that the similar findings will be observed outside of Japan. Also, although there exist two types of blood donation, including whole blood donation and component blood donation, our dataset does not distinguish between the two. Therefore, our study did not reveal which type of blood donation behavior is promoted by having type O blood. However, despite some limitations, our study added a new insight to the literature, by providing the real-world evidence concerning how having many potential recipients influence people's behavior of providing common goods and then discussing how the evidence contributes in practice.

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Conflict of interest

We declare no conflicts of interest.

Figure 1. Difference in the number of transfusion recipients for each blood group

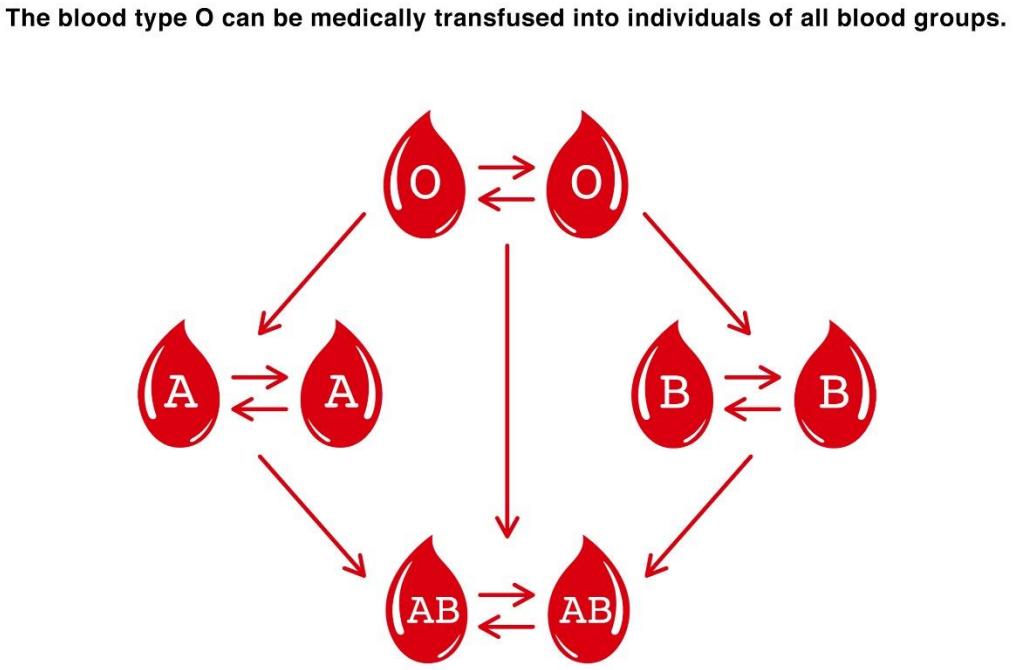
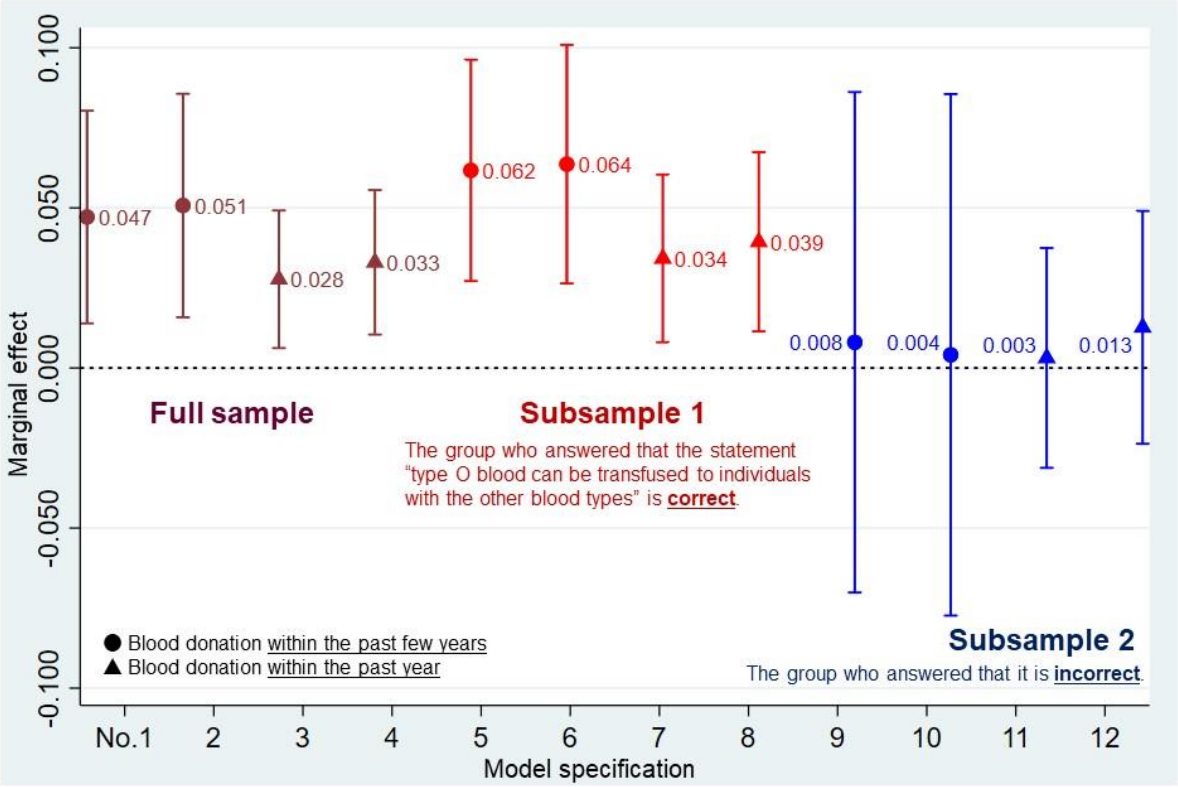


Figure 2. Marginal effect of having type O blood (with 95% CI)



Notes: The specifications with an uneven number include blood type O dummy variable, while those with an even number include not only blood type O dummy variable but also blood type B and AB dummy variables. Also, all the specifications include covariates of socio-economic attributes, health status, economic preferences, personalities, and behavioral and psychological attributes.

Table 1. Descriptive statistics

Number of observations = 1,333				
Variables name	**Mean**	***SD***	**Min**	**Max**
1. Blood-donation behavior				
Have donated blood at least once within the past few years (yes=1; no=0)	0.116	0.321	0	1
Have donated blood once or more within the past year (yes=1; no=0)	0.055	0.228	0	1
2. Blood type				
Blood type A (yes=1; no=0)	0.389	0.488	0	1
Blood type O (yes=1; no=0)	0.302	0.459	0	1
Blood type B (yes=1; no=0)	0.212	0.409	0	1
Blood type AB (yes=1; no=0)	0.097	0.296	0	1
3. Knowledge of the range of transfusion recipients of type O blood				
Type O blood can be transfused to individuals with the other blood types (correct=1; incorrect=0)	0.739	0.439	0	1
4.1. Covariates: Socio-economic attributes (in 2016)				
Age (years)	53.084	10.130	26	69
Gender (female=1; male=0)	0.535	0.499	0	1
Married (yes=1; no=0)	0.806	0.396	0	1
Household income levels (10,000 yen)	642.236	400.072	50	2,100
Educational years	13.288	2.035	9	21
4.2. Covariates: Health status				
Body mass index	22.848	3.379	13.333	44.983
Subjective health status	3.327	0.918	1	5
Mental illness	2.615	0.839	1	5
4.3. Covariates: Economic preferences				
Time discounting factor	0.882	0.224	-1.837	1.126
Absolute risk aversion	0.000023	0.000057	-0.000400	0.000133
4.4. Covariates: Personality traits				
Extraversion	8.157	2.485	2	14
Agreeableness	10.086	1.774	3	14
Conscientiousness	8.114	2.087	2	14
Neuroticism	7.828	2.042	2	14
Openness to experience	7.790	2.109	2	14
4.5. Covariates: Behavioral and psychological attributes				
General trust "In general, most people are trustworthy."	3.209	0.720	1	5
Altruism "I feel happy when I do a good deed that I think benefits others."	3.791	0.658	1	5
Reciprocity "If someone does me a favor, I am prepared to return it."	3.735	0.529	1	5
Conformity "Behaving similarly to people around me makes me feel comfortable."	2.905	0.873	1	5
Social norm "I never cut into a line of people."	4.342	0.949	1	5
Religious attitude "I am deeply religious."	1.662	1.033	1	5
Belief in fortune-telling based on blood-types "A person's blood type indicates their character."	2.794	0.967	1	5

Note: The supplementary information introduces questions and variables of health status, economic preferences, personalities, and behavioral and psychological attributes.

Table 2. Full-sample analysis

Estimation method: Logistic regression (coefficient)	*Dependent variable:*					
	I have donated blood at least once within the past few years			I have donated blood once or more within the past year		
	1	2	3	4	5	6
Blood type O	0.421**	0.496***	0.535***	0.481**	0.565**	0.674***
	(0.176)	(0.184)	(0.192)	(0.237)	(0.229)	(0.248)
Blood type B			-0.081			0.026
			(0.227)			(0.359)
Blood type AB			0.397*			0.600**
			(0.234)			(0.305)
Covariates:						
Socio-economic status	×	×	×	×	×	×
Health status		×	×		×	×
Economic preferences		×	×		×	×
Personalities		×	×		×	×
Behavioral and psychological attributes		×	×		×	×
Number of observations	1,333	1,333	1,333	1,333	1,333	1,333
Log pseudo-likelihood	-452.510	-433.801	-432.785	-268.129	-254.745	-253.779

Notes: This table shows the logistic regressions of blood type on blood donation behavior. Standard errors are reported in brackets. Significantly different from zero at the *10% level, **5% level, and ***1% level. The baseline in columns 1, 2, 4, and 5 is blood type A, B, or AB. The baseline in columns 3 and 6 is blood type A.

Table 3. Subsample analysis

Estimation method:	*Dependent variable:*							
Logistic regression (coefficient)	I have donated blood at least once within the past few years		I have donated blood once or more within the past year		I have donated blood at least once within the past few years		I have donated blood once or more within the past year	
	1	2	3	4	5	6	7	8
Blood type O	0.681***	0.704***	0.682**	0.787***	0.084	0.043	0.077	0.312
	(0.213)	(0.225)	(0.277)	(0.304)	(0.416)	(0.435)	(0.430)	(0.459)
Blood type B		-0.127		0.069		-0.120		0.221
		(0.270)		(0.351)		(0.382)		(0.602)
Blood type AB		0.458		0.572		-0.026		0.744
		(0.293)		(0.389)		(0.453)		(0.847)
Subsample:	**Subsample 1** who answered that the statement, which is "type O blood can be transfused to individuals with the other blood types," is **correct**.				**Subsample 2** who answered that it is **incorrect**.			
Number of observations	985	985	985	985	348	348	348	348
Log pseudo-likelihood	-305.795	-304.924	-188.174	-187.642	-112.277	-112.248	-56.383	-56.035

Notes: This table shows the logistic regressions of blood type on blood donation behavior. Standard errors are reported in brackets. Significantly different from zero at the *10% level, **5% level, and ***1% level. The baseline in columns 1, 3, 5, and 7 is blood type A, B, or AB. The baseline in columns 2, 4, 6, and 8 is blood type A. All the model specifications include covariates of socio-economic status, health status, economic preferences, personalities, and behavioral and psychological attributes.

Table 4. The first concern: altruistic attitudes

Number of observations = 1,333		**Independent variable:** Blood type O
1. Dependent variable: Other altruistic behaviors		
1.1. Bone-marrow donation		
(1)	I have registered as a bone-marrow donor.	-0.332
		(0.450)
(2)	I have registered as a bone-marrow donor, or	0.061
	I want to register as a bone-marrow donor, but I have not yet.	(0.177)
(3)	I have registered as a bone-marrow donor,	-0.118
	I want to register as a bone-marrow donor, but I have not yet, or	(0.127)
	I want to register as a bone-marrow donor, but I cannot register because of my age or health	
1.2. Organ donation		
(4)	I have signed an organ-donation consent form.	-0.270
		(0.203)
(5)	I have signed an organ-donation consent form, or	-0.012
	I have a will, but I have not signed it yet.	(0.151)
1.3. Monetary donation		
(6)	Entire monetary donations for the past year	-4,366.546
		(4,821.701)
(7)	Monetary donations to disaster aid	-82.231
		(388.926)
(8)	Monetary donations to religious groups	-9,147.630
		(7,699.593)
2. Dependent variable: Altruistic attitudes		
(9)	General trust "In general, most people are trustworthy."	0.003
		(0.038)
(10)	Altruism "I feel happy when I do a good deed that I think benefits others."	-0.040
		(0.030)
(11)	Reciprocity "If someone does me a favor, I am prepared to return it."	0.045
		(0.031)
(12)	Agreeableness (a Big 5 personality trait)	-0.055
		(0.103)

Notes: Significantly different from zero at the *10% level, **5% level, and ***1% level. Since the dependent variables in rows 1 to 5 are binary, we use logistic regression for the estimations. For the experience of monetary donations in rows 6 to 8, the original question items are as follows: "not making a donation," "1 yen ~ 5,000 yen," ..., "500,000 yen ~ 1,000,000 yen," "1,000,000 yen or more." Therefore, when the dependent variable is experience of monetary donation, we use interval regression for the estimations. The altruistic attitudes in rows 9 to 12 are ordinal variables whose values are 5, 4, 3, 2, and 1. Therefore, we regard them as continuous variables and use OLS regression for the estimations. The baseline in all the model specifications blood type A, B, or AB. All the model specifications also include covariates of socio-economic status, health status, economic preferences, personalities, and behavioral and psychological attributes.

Table 5. The second concern: health status

Estimation method:	*Dependent variable:*							
Logistic regression (coefficient)	I have donated blood at least once within the past few years		I have donated blood once or more within the past year		I have donated blood at least once within the past few years		I have donated blood once or more within the past year	
	1	2	3	4	5	6	7	8
Blood type O	0.512***	0.544***	0.557**	0.647**	0.475**	0.521***	0.514**	0.617**
	(0.184)	(0.195)	(0.232)	(0.254)	(0.190)	(0.202)	(0.234)	(0.256)
Blood type B		-0.104		-0.029		-0.060		0.017
		(0.228)		(0.363)		(0.225)		(0.348)
Blood type AB		0.415		0.597*		0.412*		0.587*
		(0.254)		(0.314)		(0.247)		(0.313)
Excluded respondents:	**We excluded** the respondents who answered: "I have donated blood; but I have not donated within the past few years because of my health condition."				**We excluded** the respondents who answered: "I have donated blood; but I have not donated within the past few years because of my health condition," or "I want to donate my blood; but I cannot because of my health condition."			
Number of observations	1,097	1,097	1,097	1,097	946	946	946	946
Log pseudo-likelihood	-403.713	-402.595	-242.268	-241.261	-386.327	-385.366	-235.012	-234.100

Notes: This table shows the logistic regressions of blood type on blood donation behavior. Standard errors are reported in brackets. Significantly different from zero at the *10% level, **5% level, and ***1% level. The baseline in columns 1, 3, 5, and 7 is blood type A, B, or AB. The baseline in columns 2, 4, 6, and 8 is blood type A. All the model specifications include covariates of socio-economic status, health status, economic preferences, personalities, and behavioral and psychological attributes.

Table 6. The third concern: demand

Estimation method:	*Dependent variable:*					
Logistic regression (coefficient)	I have donated blood at least once within the past few years			I have donated blood once or more within the past year		
	1	2	3	4	5	6
Blood type O	0.489***	0.509***	0.527***	0.574**	0.562**	0.690**
	(0.188)	(0.186)	(0.199)	(0.243)	(0.251)	(0.271)
Blood type B			-0.112			0.088
			(0.221)			(0.366)
Blood type AB			0.330			0.563*
			(0.235)			(0.303)
Additional covariates:						
Annual average of the inventory ratio of stocks of blood groups for each respondent's prefecture	×	×	×	×	×	×
Annual standard deviation of the inventory ratio of stocks of blood groups in each respondent's prefecture		×	×		×	×
Number of observations	1,333	1,333	1,333	1,333	1,333	1,333
Log pseudo-likelihood	-432.901	-428.872	-428.070	-252.776	-251.321	-250.537

Notes: This table shows the logistic regressions of blood type on blood donation behavior. Standard errors are reported in brackets. Significantly different from zero at the *10% level, **5% level, and ***1% level. The baseline in columns 1, 2, 4, and 5 is blood type A, B, or AB. The baseline in columns 3 and 6 is blood type A. All the model specifications include covariates of socio-economic status, health status, economic preferences, personalities, and behavioral and psychological attributes.

Online Appendix A. Questions and variables

The following are survey questions for capturing respondent's health status, economic preferences, personalities, and behavioral and psychological attributes. We added explanations for how we created the variables from the answers (if necessary).

1. Health status

a) *BMI:* What is your height and weight?

Height: _____centimeters, Weight: _____kilograms

Note: We calculated out the indicator of BMI, using the following equation:

$$\text{BMI} = \text{Weight in kilograms} \div (\text{Height in meters})^2$$

b) *Subjective health status:* How would you describe your current health status: Is it excellent, very good, good, fair, or poor?

1. Excellent
2. Very good
3. Good
4. Fair
5. Poor

Note: We reconstructed the answers on the opposite scale from 1 to 5, where "1" means "poor" and "5" means "excellent."

c) *Mental illness:* How true for you is each of the following statements? Answer for each on a scale from 1 to 5, where "1" means "it is particularly true for you" and "5" means "it doesn't hold true at all for you."

- I have been feeling stressed lately
- I have been feeling depressed lately
- I haven't been sleeping well lately
- I have been feeling lonely lately

Notes: First, we reconstructed the answers on the opposite scale from 1 to 5, where "1" means "it doesn't hold true at all for you" and "5" means "it is particularly true for you." Second, we calculated out the indicator of mental illness, by summing up the answers for the fours statements and dividing the value by 4.

2. Economic preferences

a) *Time discounting factor:* Suppose that you are to receive money from someone. You can either choose to receive the money today, or 7 days from today, but the amounts

will be different. Compare the amounts and dates below in Option "A" and Option "B," and indicate which option you prefer for each of the nine choices.

Option A	or	Option B	Which ONE do you prefer?	
Receive today		Receive 7 days from today	Option A	Option B
JPY 3,005		JPY 3,014	A	B
JPY 3,003		JPY 3,297	A	B
JPY 3,008		JPY 3,037	A	B
JPY 3,000		JPY 3,000	A	B
JPY 3,005		JPY 5,951	A	B
JPY 3,009		JPY 3,068	A	B
JPY 3,001		JPY 3,119	A	B
JPY 3,002		JPY 2,996	A	B
JPY 3,008		JPY 3,011	A	B

Notes: As similarly in the literature (Harrison et al., 2002), we asked the respondents to choose between two options, "A" and "B." For example, we asked them to choose between "A"—receiving today JPY 3,005, and "B"—receiving in 7days JPY 5,951. From each situation, we obtained response data, which revealed the switching point, where each respondent switched his or her choice from option "A" to "B." At the switching point, the today's option is equivalent to the delayed option.

We calculate out time discounting factor using the following way. We first take the average of the two monetary amounts for Option A at the point of switching from

Option B to Option A. Second, we divide the numerator by the average of the two monetary amounts for Option B at the switching point.

In general, the respondents with a low time discounting factor are predicted to take impatient behavior.

b) *Absolute risk aversion:* Suppose that there is a "speed lottery" with a 50% chance of winning JPY 100,000 (USD 1,000). If you win, you receive a prize right away. If you lose, you receive nothing. How much would you spend to buy a ticket for this lottery? Choose Option "A" if you would buy the ticket at that price, or choose Option "B" if you would not.

Price of the "speed lottery" ticket	Which ONE do you prefer?	
	Option A (buy the "speed lottery" ticket)	Option B (DO NOT buy the "speed lottery" ticket)
JPY 10	**A**	**B**
JPY 2,000	**A**	**B**
JPY 4,000	**A**	**B**
JPY 8,000	**A**	**B**
JPY 15,000	**A**	**B**
JPY 25,000	**A**	**B**
JPY 35,000	**A**	**B**
JPY 45,000	**A**	**B**
JPY 50,000	**A**	**B**

Notes: we use answers for a hypothetical question related to a speed lottery and measure a respondent's risk tolerance from absolutely risk neutral to absolutely risk averse. This approach to elicit risk aversion using a hypothetical lottery is also taken by previous studies (Cramer et al., 2002; Guiso & Paiella, 2004; Hartog et al., 2002).

Specifically, this question asks respondents about their willingness to pay (π_1) for a hypothetical lottery with a 50 percent chance of winning JPY 100,000 (USD 1,000) or nothing otherwise. Since the expected value of the lottery is JPY 50,000 (USD 500), we interpret this to mean that a respondent whose π_1 is lower than the expected value is more risk averse. We calculate the indicator of absolute risk aversion using the following equation:

$$\text{Absolute Risk Aversion} = \frac{50{,}000 - \pi_1}{0.5(0.5 \times 100{,}000^2 - 2 \times 0.5 \times 100{,}000 \times \pi_1 + \pi_1^2)}$$

In general, the respondents with a low indicator of absolute risk aversion are predicted to take risk-tolerant behavior.

3. Personality traits

Big 5 personality traits: Please circle ONE applicable number next to each statement to indicate the extent to which you agree or disagree with that statement. You should rate the extent to which the pair of traits applies to you, even if one characteristic applies more strongly than the other.

I see myself as;	Disagree Strongly	Disagree Moderately	Disagree A Little	Neither Agree Nor Disagree	Agree A Little	Agree Moderately	Agree Strongly
A: Extraverted, enthusiastic	1	2	3	4	5	6	7
B: Critical, quarrelsome	1	2	3	4	5	6	7
C: Dependable, self-disciplined	1	2	3	4	5	6	7
D: Anxious, easiliy upset	1	2	3	4	5	6	7
E: Open to new experiences, complex	1	2	3	4	5	6	7
F: Reserved, quiet	1	2	3	4	5	6	7
G: Sympathetic, warm	1	2	3	4	5	6	7
H: Disorganized, careless	1	2	3	4	5	6	7
I: Calm, emotionally stable	1	2	3	4	5	6	7
J: Conventional, uncreative	1	2	3	4	5	6	7

Notes: The Big 5 personality traits are a unifying framework comprising five basic characteristics: *extroversion, agreeableness, conscientiousness, neuroticism, and openness to experiences*. The 2017 PPSOU survey included the questions of Ten Item Personality Inventory (TIPI), which was developed by Gosling et al. (2003), and was translated into Japanese by Oshio et al. (2012).

4. Behavioral and psychological attributes

a) *Altruism, trust, and belief in fortune-telling based on blood-types:* To what extent do you agree with each of the following statements? Answer on a scale from 1 to 5, where "1" means "you agree completely" and "5" means "you disagree completely." Of course, you may choose any number in between.

- *Altruism:* I feel happy when I do a good deed that I think benefits others (such as picking up trash in a park)
- *Trust:* In general, most people are trustworthy
- *Belief in fortune-telling based on blood-types:* A person's blood type indicates their character

Note: For our analysis, we reconstructed the answers on the opposite scale from 1 to 5, where "1" means "you disagree completely" and "5" means "you agree completely."

b) *Reciprocity, conformity, social norm, and religious attitude:* How true for you is each of the following statements? Answer for each on a scale from 1 to 5, where "1" means "it is particularly true for you" and "5" means "it doesn't hold true at all for you."

- *Reciprocity 1:* If someone does me a favor, I am prepared to return it

- *Reciprocity 2:* I go out of my way to help somebody who has been kind to me before
- *Reciprocity 3:* I am ready to undergo personal costs to help somebody who helped me before
- *Conformity:* Behaving similarly to people around me makes me feel comfortable
- *Social norm:* I never cut into a line of people
- *Religious attitude:* I am deeply religious

Notes: We reconstructed the answers on the opposite scale from 1 to 5, where "1" means "it doesn't hold true at all for you" and "5" means "it is particularly true for you." In addition, we respectively calculated out the indicator of negative reciprocity, by summing up the answers for the three statements and dividing the value by 3.

Online Appendix B. Age-group difference in the relationship between blood-type and blood donation behavior

Estimation method:	*Dependent variable:*							
Logistic regression (coefficient)	I have donated blood at least once within the past few years		I have donated blood once or more within the past year		I have donated blood at least once within the past few years		I have donated blood once or more within the past year	
	1	2	3	4	5	6	7	8
Blood type O	0.379	0.319	0.504*	0.586*	0.773***	1.006***	0.922**	1.081***
	(0.262)	(0.256)	(0.294)	(0.310)	(0.250)	(0.277)	(0.376)	(0.403)
Blood type B		-0.371		-0.216		0.529		0.508
		(0.257)		(0.471)		(0.405)		(0.547)
Blood type AB		0.326		0.811**		0.507		0.022
		(0.291)		(0.344)		(0.541)		(0.774)
Subsample:	The respondents aged **26 to 54**				The respondents aged **55 to 69**			
Number of observations	699	699	699	699	634	634	634	634
Log pseudo-likelihood	-255.257	-253.905	-148.186	-146.662	-166.021	-165.163	-92.211	-91.878

Notes: This table shows the logistic regressions of blood type on blood donation behavior. Standard errors are reported in brackets. Significantly different from zero at the *10% level, **5% level, and ***1% level. The baseline in columns 1, 3, 5, and 7 is blood type A, B, or AB. The baseline in columns 2, 4, 6, and 8 is blood type A. All the model specifications include covariates of socio-economic status, health status, economic preferences, personalities, and behavioral and psychological attributes.

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