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The effects of anonymity in volunteer's dilemmas

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ABSTRACT

Groups often face volunteer's dilemmas—situations in which a single member's contribution is both necessary and sufficient to benefit all, such that additional contributions create inefficiency. In Experiments 1 and 2 (total $N = 332$), we examined whether removing anonymity promotes volunteering in incentivized two-person volunteer's dilemma games. Results showed that removing anonymity increased volunteering rates when players' volunteering costs were equal or only moderately different within a dyad. However, when the cost difference was large, the volunteering rates of high-cost players, whose contributions were especially likely to create inefficiency, remained low even when anonymity was removed. Experiment 3 ($N = 346$) demonstrated that abstaining from volunteering was unlikely to damage these high-cost players' reputations. These findings identify a boundary condition of the effects of removing anonymity: its ability to promote cooperative behavior is constrained by a heightened risk of inefficiency.

1. Introduction

Groups often face situations in which a single member must bear a cost for the benefit of all, a phenomenon colloquially known as “taking one for the team.” In workplaces, for instance, tasks that are called “office housework” (Jang et al., 2021), such as cleaning shared spaces (Tham et al., 2022a), booking a meeting room (Doğan, 2020), and writing a meeting summary (Kurz et al., 2018), typically fall to a single employee. Similar situations arise in other contexts, including the development of open-source software (Johnson, 2002) and the creation of Wikipedia articles (Hillenbrand & Winter, 2018), both of which often rely on a single volunteer's effort. These scenarios all exemplify the *volunteer's dilemma*.

The volunteer's dilemma is a type of social dilemma in which one group member's contribution is both necessary and sufficient to produce a public good and benefit all members (Diekmann, 1985; Krueger, 2019). In the basic two-person volunteer's dilemma game¹ (Fig. 1), each player decides whether to volunteer. Volunteering entails a cost, K . If at least one player volunteers, both receive a payoff, U , where $U > K > 0$.

Because the payoff does not increase when more than one player volunteers, simultaneous volunteering reduces overall efficiency—an outcome termed *over-volunteering* (Heck & Krueger, 2017). Conversely, if neither player volunteers, no one receives any payoff—an outcome referred to as *under-volunteering* (Heck & Krueger, 2017).

Because under-volunteering is the most problematic, a key question is how to avoid it. Several theoretical perspectives suggest that removing anonymity² can promote cooperative behavior, as individuals benefit from being seen as cooperative. One such perspective is indirect reciprocity, which posits that individuals who help others are more likely to be helped in subsequent interactions with new partners (e.g., Alexander, 1987; Leimar & Hammerstein, 2001; Milinski et al., 2002; Nowak & Sigmund, 1998; Wedekind & Milinski, 2000). Another perspective is competitive altruism (also referred to as reputation-based partner choice), which suggests that incurring costs to cooperate serves as a signal of one's willingness and ability to do so, and that those who demonstrate greater cooperativeness are more likely to be chosen as future social partners (e.g., Barclay, 2004; Barclay & Willer, 2007; Roberts, 1998; Sylwester & Roberts, 2013).

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¹ See the Supplemental Material for differences between two-person volunteer's dilemma games and other major two-person games, particularly prisoner's dilemma and donation games.

² Piazza and Bering (2008) emphasized that anonymity and privacy are conceptually distinct. Anonymity refers to whether a person is personally identifiable to others, whereas privacy refers to whether a person's decision is observable to others. As they note, while removing privacy does not necessarily entail a breach of anonymity, removing anonymity entails a breach of privacy. In the present research, we focus on anonymity, adopting Piazza and Bering's (2008) definition.

		Player 2	
		Volunteer	Do not volunteer
Player 1	Volunteer	<u>$U - K$</u> , <u>$U - K$</u>	<u>$U - K$</u> , <u>U</u>
	Do not volunteer	<u>U</u> , <u>$U - K$</u>	<u>0</u> , <u>0</u>

Over-volunteering Under-volunteering

Fig. 1. Payoff matrix of a two-person volunteer's dilemma game. *Note.* In each cell, the row player's (Player 1's) payoff is underlined and listed first, followed by the column player's (Player 2's) payoff. K denotes the cost of volunteering, and U denotes the benefit received by both players if at least one player volunteers, where $U > K > 0$.

In line with these theoretical perspectives, empirical research has consistently shown that individuals behave more cooperatively when they are not anonymous than when they are (e.g., Andreoni & Petrie, 2004; Filiz-Ozbay & Ozbay, 2013; Fox & Guyer, 1978; Kurzban et al., 2007; Manna & Stringhi, 2025; Rege & Telle, 2004; Piazza & Bering, 2008; Reinstein & Riener, 2012; Soetevent, 2005; Wang et al., 2017; for reviews, see Bradley et al., 2018; Wu et al., 2016). However, this body of work has primarily focused on situations in which all contributions benefit others, while giving little attention to cases in which excessive contributions can be inefficient, such as the volunteer's dilemma.

The present research examines whether removing anonymity facilitates volunteering—and thereby reduces under-volunteering—in volunteer's dilemmas, despite the risk of inefficiency. Two perspectives yield different predictions. On the one hand, theoretical perspectives that emphasize the reputational benefits of cooperation, particularly the theory of competitive altruism, suggest that removing anonymity should promote volunteering even though it may lead to inefficient over-volunteering. What matters most for being chosen as a social partner is demonstrating one's willingness and ability to incur costs to contribute, rather than ensuring that one's contributions maximize efficiency (Barclay et al., 2021; Roberts et al., 2021). On the other hand, research on economic decision-making suggests that efficiency, specifically maximizing collective payoffs, is a fundamental concern (Bar-Hillel & Yaari, 1993; Charness & Rabin, 2002; Van Lange et al., 1997). From this latter perspective, removing anonymity may have limited effects on volunteering due to the risk of inefficiency, and thus may not reduce under-volunteering.

The most relevant study was conducted by Van Vugt and Hardy (2010). They examined whether participants would contribute to a public good even after being told that sufficient contributions had already been made by their group members (who, in fact, did not exist) and that any additional contribution would be inefficient. Participants were more likely to contribute when they were led to believe their decisions would be visible to other members—that is, when privacy (not anonymity) was removed (see Footnote 1 for the distinction between privacy and anonymity). This finding is informative because it shows that cooperative behavior increases even when it is described as inefficient. Although the study did not manipulate anonymity, the fact that removing privacy increased wasteful contributions suggests that removing anonymity could produce effects of similar or potentially greater magnitude. However, the study has a critical limitation: participants were told that others had already contributed sufficiently, a situation that a meta-analysis suggests rarely occurs in real groups (Croson & Marks, 2000). It therefore remains an open question whether removing anonymity encourages cooperative behavior in volunteer's dilemmas under more typical conditions, where others' contributions involve uncertainty and are not unrealistically high.

2. Present research

To examine the effects of anonymity in volunteer's dilemmas, we conducted a series of incentivized two-person volunteer's dilemma games (Fig. 2a) using a lever-pulling paradigm (Tham et al., 2022b; Tham et al., 2025). Participants were randomly paired and played a game with the same partner for 24 rounds. In each round, they decided whether to “pull the lever” (i.e., volunteer), which incurred a cost, without knowing their partner's choice. We compared a *non-anonymous* condition, in which participants played the game knowing their identity would be disclosed to other participants afterward, and an *anonymous* condition, in which their identities were never disclosed (Fig. 2b).

Experiment 1 examined a two-person *symmetric* volunteer's dilemma game, in which the volunteering cost was the same for both players (Fig. 2a, left). Experiment 2 extended this by investigating *asymmetric* volunteer's dilemma games, in which one player needed to incur a higher cost than the other to volunteer (i.e., K for the row player differed from that for the column player in Fig. 1; Fig. 2a, middle and right). Finally, Experiment 3 used a vignette experiment to explore the psychological mechanisms underlying the behavioral patterns observed in Experiments 1 and 2.

This research was approved by the institutional review board of the University of Tokyo. We report how we determined our sample size, all studies, manipulations, measures, and data exclusions in the main text. The Supplemental Material includes experimental instructions and additional analyses. All data and analysis code are available at [URL for peer-review: <https://osf.io/ctfjy/>]. No additional data were collected after analyses began for any study. Data were analyzed using R, version 4.3.1 (R Core Team, 2023). oTree (Chen et al., 2016) was used in Experiments 1 and 2, and Qualtrics (Qualtrics, 2020) was used in all experiments. Experiments 1 and 2 were not preregistered, as we were not yet aware of the importance of preregistration at the time of conducting these experiments. Experiment 3 was preregistered prior to data collection at [URL for peer review: <https://aspredicted.org/37sv-238k.pdf>].

3. Experiment 1

3.1. Methods

We conducted a symmetric volunteer's dilemma game (Fig. 2a, left), comparing the non-anonymous and anonymous conditions (Fig. 2b), to examine the effect of anonymity on the frequency of under-volunteering.

3.1.1. Participants

We planned to conduct a two-tailed two-sample t -test to examine the effect of anonymity on under-volunteering. Based on the study by Van Vugt and Hardy (2010), which showed that the effect of privacy was large ($\eta^2 = 0.16$), we conducted an a priori power analysis using G*Power 3.1.9.7 (Faul et al., 2007) to determine the number of dyads required to detect a large effect ($d = 0.80$) in the t -test with $\alpha = 0.05$ and $\beta = 0.20$. The required sample size was 52 dyads (i.e., 104 participants). We recruited 120 students from two universities in Japan (67 men, 52 women, 1 unidentified; $M_{\text{age}} = 19.66$, $SD = 1.17$), assigning 62 to the non-anonymous condition and 58 to the anonymous condition. This sample size provided 80% power to detect an effect size of $d = 0.52$ in a two-tailed two-sample t -test with a 5% false-positive rate, which was calculated using G*Power 3.1.9.7 (Faul et al., 2007). Participants received course credit for their participation and a digital gift card. The value of this gift card was determined by the number of tokens earned in the game (10 tokens = 1 Japanese yen). On average, participants earned 972.92 ($SD = 274.34$) tokens.

3.1.2. Procedure

Anonymous condition: Participants were informed that they would

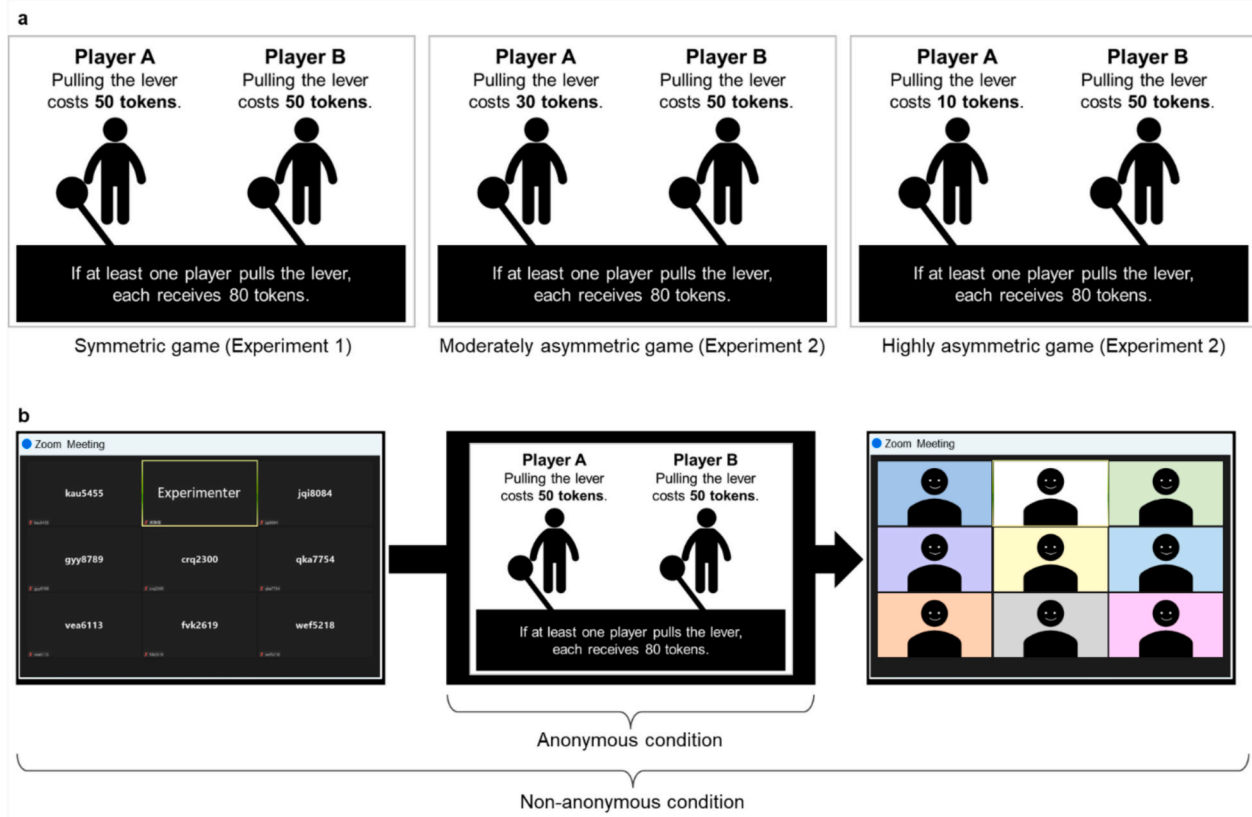


Fig. 2. Volunteer's dilemma games (a) and procedures (b) in Experiments 1 and 2. *Note.* (a) In Experiment 1, the volunteering cost was 50 tokens for both players. In Experiment 2, the volunteering cost was 30 tokens for Player A and 50 tokens for Player B in the moderately asymmetric game, and 10 tokens for Player A and 50 tokens for Player B in the highly asymmetric game. (b) In the non-anonymous condition, participants showed their faces to their partners and other participants via an online meeting after completing the game. In the anonymous condition, participants remained anonymous.

be paired with another participant to complete a task, which was the symmetric volunteer's dilemma game. They then read the rules of the task: Players A and B each decided whether to pull the lever (i.e., volunteer); pulling the lever cost 50 tokens ($K = 50$); and if at least one player pulled the lever, both players received 80 tokens ($U = 80$). Throughout the experiment, the game was referred to as a "task," and volunteering was referred to as "pulling the lever." After reading the rules and correctly answering all comprehension questions, participants were randomly paired, assigned the role of Player A or B, and told that they would complete the task with their partner for between 20 and 30 rounds. The task always consisted of 24 rounds, but the exact number was not disclosed in advance to avoid end-game effects (Rapoport & Dale, 1966). In each round, participants decided whether to pull the lever without knowing their partner's choice. After each round, they were informed of who had pulled the lever and how many tokens each player had earned. Throughout the task, an image that made the symmetry in volunteering costs within each dyad explicit (Fig. 2a, left) was displayed. After the final round, participants reported how satisfied they were with the number of times their partner had pulled the lever and how satisfied they presumed their partner was with the number of times they had pulled the lever, both on a 5-point scale.

Non-anonymous condition: Participants joined an online Zoom meeting (Zoom Video Communications, Inc, 2021) and were initially anonymized through the following procedure. First, upon joining, they were placed in a waiting room where they saw only an instruction to wait and could not see or interact with other participants. Second, participants were admitted to the main room one at a time, given randomly generated display names, instructed to keep their cameras or microphones off until the end of the session, and then returned to the waiting room. Once all participants had been anonymized in this way,

they were re-admitted to the main room (Fig. 2b, left) and informed that they would be paired with another participant to complete a task. They were also told that after completing the task, they would be asked to turn on their cameras and microphones to reveal who had been paired. Participants then read the rules of the task, were randomly paired, and completed the task, as in the anonymous condition (Fig. 2b, middle). After all dyads finished, participants turned on their cameras and microphones (Fig. 2b, right) and were informed of who had been paired. Participants were kept anonymous during the task to prevent potential confounds (e.g., other participants' gender; Balliet et al., 2011).

3.2. Results

3.2.1. Overall effects of anonymity

Volunteering: We first examined whether anonymity affected volunteering rates. As shown in Fig. 3a, the mean volunteering rate was higher in the non-anonymous condition ($M = 0.58$, $SD = 0.22$) than in the anonymous condition ($M = 0.47$, $SD = 0.17$). A hierarchical linear model with the independent variable being anonymity, allowing intercepts to vary by dyad, revealed that this difference was statistically significant, $b = 0.11$, 95% CI [0.03, 0.19], $t(58) = 2.54$, $p = .014$, $d = 0.23$.

Under- and over-volunteering: As shown in Fig. 3b, removing anonymity successfully reduced under-volunteering. Under-volunteering rates were significantly lower in the non-anonymous condition ($M = 0.12$, $SD = 0.15$) than in the anonymous condition ($M = 0.21$, $SD = 0.19$), $t(54.24) = 2.15$, $p = .036$, $d = 0.57$. In contrast, removing anonymity increased over-volunteering (Fig. 3c). Over-volunteering rates were higher in the non-anonymous condition ($M = 0.28$, $SD = 0.31$) than in the anonymous condition ($M = 0.16$, $SD = 0.17$). Although this

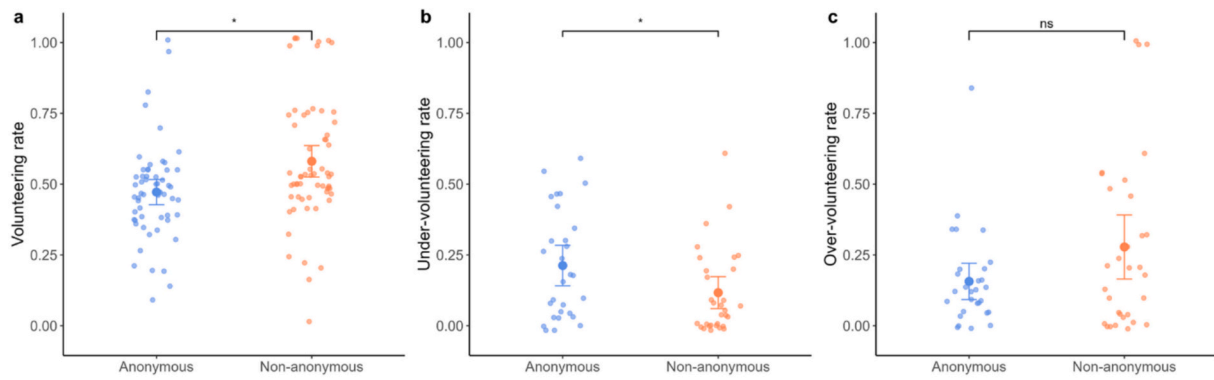


Fig. 3. Volunteering (a), under-volunteering (b), and over-volunteering rates (c) in the symmetric volunteer's dilemma game (Experiment 1). *Note.* Light-colored small dots represent individual data points. Dark-colored dots and error bars represent means and 95% confidence intervals. Asterisks indicate $p < .05$, and “ns” indicates $p \geq .05$.

increase in over-volunteering was not statistically significant, $t(47.00) = 1.91$, $p = .062$, $d = 0.49$, its negative effect on collective payoffs (i.e., efficiency) offset the positive effect of reduced under-volunteering, resulting in no overall effect of anonymity on collective payoffs (Fig. S1–1 in the Supplemental Material).

3.2.2. Dynamic effects of anonymity

As exploratory analyses, we examined the dynamic effects of anonymity on participants' decision-making—specifically, whether the effect of anonymity changed over time and whether anonymity moderated how participants responded to the previous round's outcome. We first found that the tendency for volunteering rates to be higher in the non-anonymous condition than in the anonymous condition was stable

across rounds (Fig. 4). A hierarchical logistic model with the dependent variable being whether participants volunteered and the independent variables being anonymity, round, and their interaction, allowing intercepts to vary by player and dyad, showed that while the main effect of anonymity was significant, $b = 0.55$, 95% CI [0.03, 1.07], $z = 2.07$, $p = .039$, OR = 1.73, the main effect of round, $b = -0.01$, 95% CI [-0.02, 0.01], $z = 1.01$, $p = .312$, OR = 0.99, and their interaction effect were not, $b = -0.00$, 95% CI [-0.02, 0.02], $z = 0.01$, $p = .994$, OR = 1.00.

Stability across rounds, however, does not rule out the possibility of short-run dynamics—specifically, whether participants adjust their decision-making based on what happened in the preceding round. To test this, we used a hierarchical logistic model in which the dependent variable was whether a participant volunteered in round t , and the

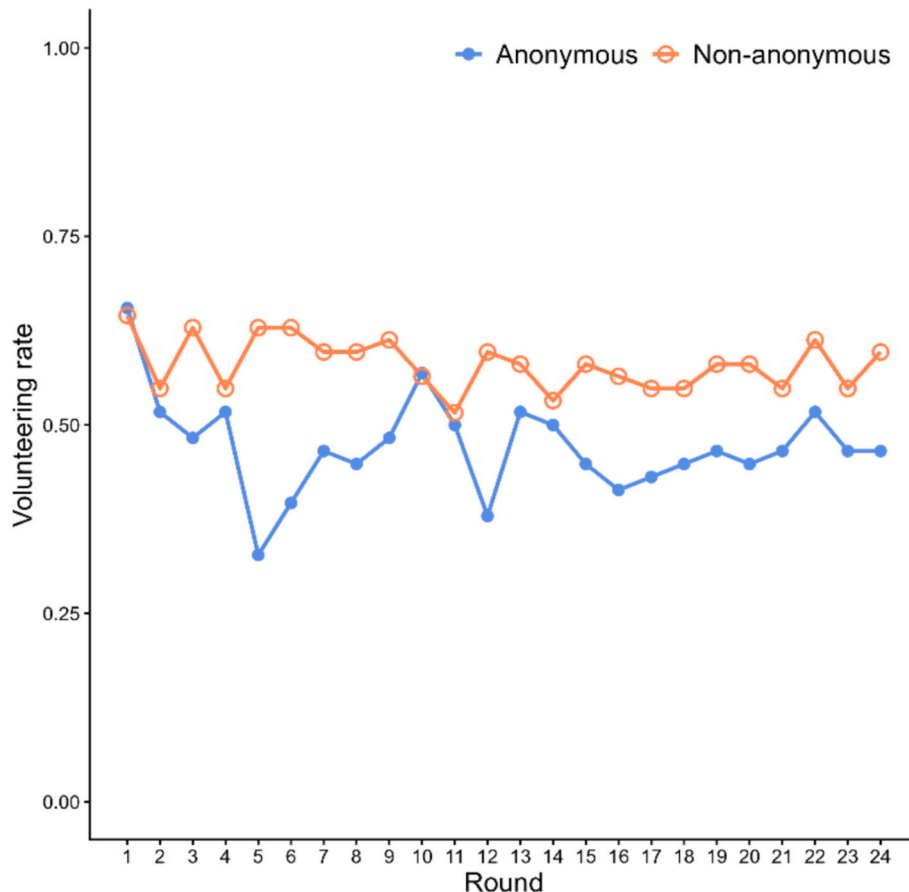


Fig. 4. Volunteering rates across rounds in the symmetric volunteer's dilemma game (Experiment 1).

independent variables were anonymity, whether the participant volunteered in round $t - 1$, whether their partner volunteered in round $t - 1$, and their interactions, with random intercepts for players and dyads. This analysis yielded three key findings. First, consistent with the results above, participants were more likely to volunteer in the non-anonymous condition than in the anonymous condition, $b = 1.06$, 95% CI [0.40, 1.72], $z = 3.14$, $p = .002$, OR = 2.88.

Second, participants tended to take turns volunteering, which aligns with previous findings on symmetric volunteer's dilemma games (Diekmann & Przepiorka, 2016; Przepiorka et al., 2021; Przepiorka et al., 2022; Tham et al., 2022b). Participants were less likely to volunteer in round t when they had volunteered in round $t - 1$, $b = -1.14$, 95% CI [-1.56, -0.73], $z = 5.45$, $p < .001$, OR = 0.32, and more likely to volunteer in round t when their partner had volunteered in round $t - 1$, $b = 2.00$, 95% CI [1.61, 2.40], $z = 10.00$, $p < .001$, OR = 7.42.

Third, and most importantly, removing anonymity increased the probability of volunteering not only after the focal player had not volunteered and their partner had, which facilitated turn-taking, but also after neither player had volunteered, which reduced under-volunteering, and after both players had volunteered, which increased over-volunteering. Specifically, we found a significant interaction effect among three variables in the model, $b = 1.40$, 95% CI [0.49, 2.30], $z = 3.02$, $p = .003$, OR = 4.05. Results of a post-hoc analysis showed that the probability of volunteering in round t did not differ between conditions when only the focal player's partner had volunteered in round $t - 1$, $b = 0.77$, 95% CI [0.17, 1.38], $z = 2.51$, $p = .012$, OR = 2.17; neither player had volunteered in round $t - 1$, $b = 1.06$, 95% CI [0.40, 1.72], $z = 3.14$, $p = .002$, OR = 2.88; and both players had volunteered in round $t - 1$, $b = 0.98$, 95% CI [0.34, 1.62], $z = 3.00$, $p = .003$, OR = 2.66. In contrast, the probability of volunteering in round t did not differ between conditions when only the focal player had volunteered in round $t - 1$, $b = -0.14$, 95% CI [-0.75, 0.48], $z = 0.44$, $p = .663$, OR = 0.87. Full results are reported in Table S1–1, and transition probabilities from the outcome of round $t - 1$ to the outcome of round t are summarized in Fig. S1–4 in the Supplemental Material.

3.3. Discussion

Experiment 1 showed that removing anonymity increased overall volunteering rates. In addition, it affected how participants adjusted their decision-making in response to the preceding outcome. Participants in the non-anonymous condition were more likely than those in the anonymous condition to volunteer when neither player had volunteered, or when both players had volunteered, in the previous round. This pattern reduced under-volunteering while slightly increasing over-volunteering. Together, the findings are consistent with the theory of competitive altruism, which suggests that individuals are more likely to cooperate when their reputations are at stake, even when additional volunteering can be inefficient.

A limitation of Experiment 1 is that it focused exclusively on symmetric settings, where all group members were homogeneous in terms of their costs and benefits. However, heterogeneity is a defining feature of many real-world groups (Hauser et al., 2019; Scheffer et al., 2017). For example, in workplace contexts, employees often differ in the costs they incur when performing office housework. Previous research has modeled such heterogeneity using asymmetric volunteer's dilemma games, where players with lower costs are referred to as *stronger* players and those with higher costs as *weaker* players (e.g., Diekmann, 1993; Diekmann & Przepiorka, 2015, 2016; He et al., 2014; He et al., 2015; Healy & Pate, 2018; Kawagoe et al., 2023; Przepiorka et al., 2021, 2022; Przepiorka & Diekmann, 2013, 2018; Tham et al., 2025; Weesie, 1993).

In asymmetric volunteer's dilemma games, overall efficiency is maximized when only the strongest player volunteers, because this minimizes the overall cost of volunteering (Tham et al., 2025).

Consequently, weaker players face a sharper trade-off between appearing cooperative and avoiding inefficiency than do players in symmetric volunteer's dilemma games. Experiment 2, therefore, investigated asymmetric volunteer's dilemma games to test whether the effects of anonymity observed in Experiment 1 generalize to contexts in which concerns about the risk of inefficiency are heightened.

4. Experiment 2

4.1. Methods

We conducted two types of asymmetric volunteer's dilemma games—*moderately* (Fig. 2a, middle) and *highly* asymmetric games (Fig. 2a, right)—and compared the non-anonymous and anonymous conditions (Fig. 2b).

4.1.1. Participants

We planned to conduct a 2 (anonymity: non-anonymous, anonymous) $\times$ 2 (asymmetry degree: moderate, high) between-dyads ANOVA to examine the effect of anonymity on under-volunteering. An a priori power analysis using MorePower 6.0.1 (Campbell & Thompson, 2012) indicated that at least 56 dyads (i.e., 112 participants) were required to detect a large size of the main effects ($\eta^2 = 0.14$) in the ANOVA with $\alpha = 0.05$ and $\beta = 0.20$. We recruited 212 students from a university in Japan (127 men, 85 women; $M_{\text{age}} = 19.92$, $SD = 1.36$). This sample size provided 80% power to detect an effect size of $\eta^2 = 0.04$ in the ANOVA with a 5% false-positive rate, which was calculated using MorePower 6.0.1 (Campbell & Thompson, 2012).

During recruitment, we informed participants that they would receive course credit for their participation and that those who earned more tokens in the experiment would have a better chance of receiving a digital gift card as a bonus. On average, participants earned 1289.29 ($SD = 446.39$) tokens, and we sent a digital gift card worth 100 Japanese yen to those who earned 1450 tokens or more ($N = 84$). Neither the threshold for the bonus nor the specific bonus amount was disclosed in advance to sufficiently incentivize participants.

4.1.2. Procedure

The procedure was similar to Experiment 1, with one major difference: participants played either the moderately or highly asymmetric game instead of the symmetric game. In the moderately asymmetric game, pulling the lever cost 30 tokens for Player A (i.e., the strong player; $K_S = 30$) and 50 tokens for Player B (i.e., the weak player; $K_W = 50$). In the highly asymmetric game, the cost was 10 tokens for Player A (i.e., the strong player; $K_S = 10$) and 50 tokens for Player B (i.e., the weak player; $K_W = 50$). In both games, both players received 80 tokens if at least one player pulled the lever ($U = 80$). Across all rounds, participants viewed an image that made the difference in volunteering costs within each dyad explicit (Fig. 2a, middle or right).

After the final round, participants completed the measures from Experiment 1 (perceived and presumed satisfaction) and additionally reported: the number of times they thought Players A and B should have pulled the lever, the number of times they presumed their partner thought Players A and B should have pulled the lever, and the information they had focused on during the task. Throughout the experiment, the game was referred to as a “task,” volunteering as “pulling the lever,” the strong player as “Player A,” and the weak player as “Player B.”

4.2. Results

4.2.1. Overall effects of anonymity on volunteering

As shown in Fig. 5a, removing anonymity increased volunteering rates in the moderately asymmetric game but not in the highly asymmetric game. In the moderately asymmetric game, the mean volunteering rate of strong players was significantly higher in the non-anonymous condition ($M = 0.79$, $SD = 0.21$) than in the anonymous

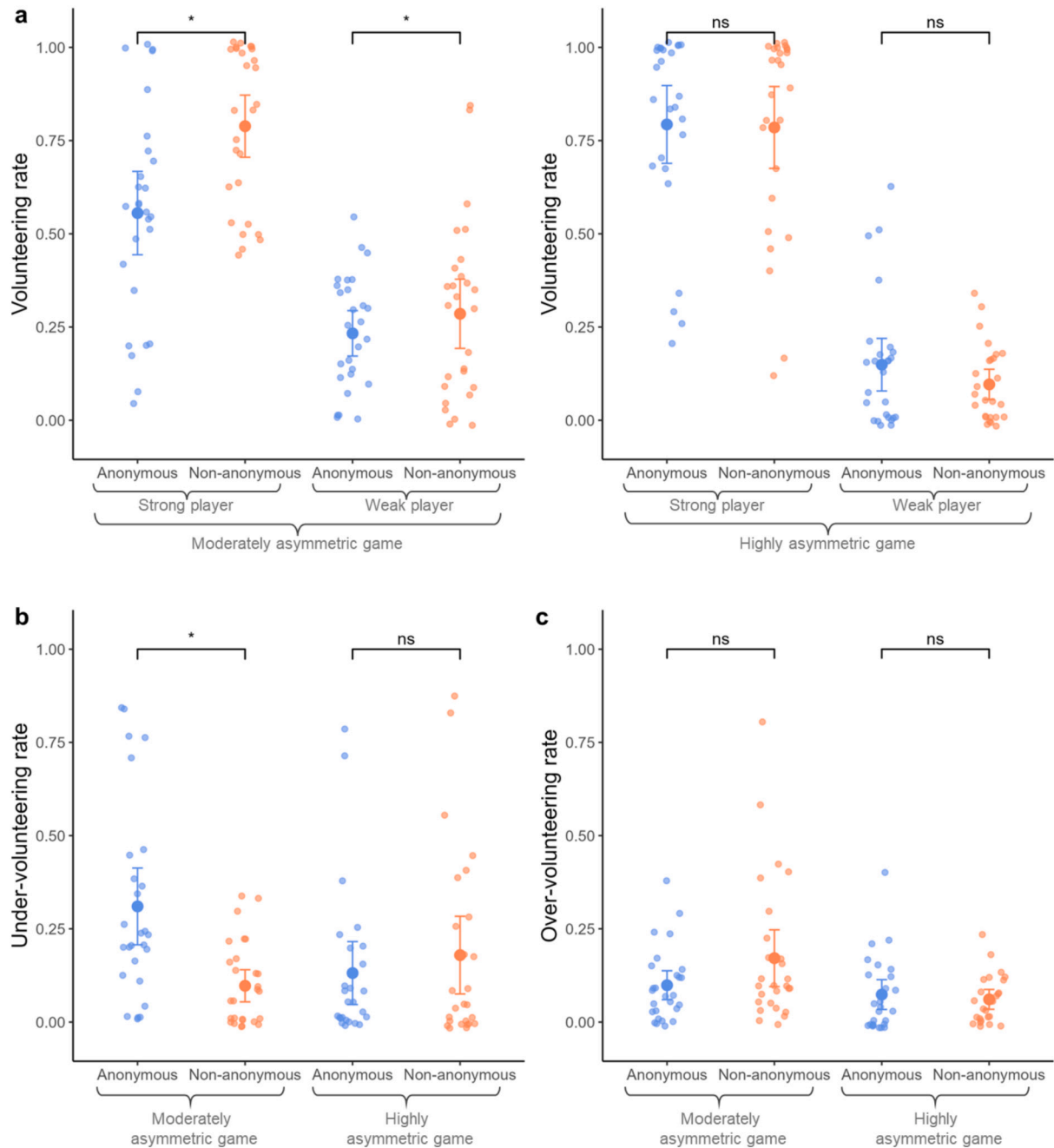


Fig. 5. Volunteering (a), under-volunteering (b), and over-volunteering rates (c) in the asymmetric volunteer's dilemma games (Experiment 2). *Note.* Light-colored small dots represent individual data points. Dark-colored dots and error bars represent means and 95% confidence intervals. Asterisks indicate $p < .05$, and "ns" indicates $p \geq .05$.

condition ($M = 0.56$, $SD = 0.28$), and that of weak players was also significantly higher in the non-anonymous condition ($M = 0.29$, $SD = 0.23$) than in the anonymous condition ($M = 0.23$, $SD = 0.15$). In the highly asymmetric game, the mean volunteering rate of strong players did not differ between the non-anonymous ($M = 0.79$, $SD = 0.27$) and anonymous conditions ($M = 0.79$, $SD = 0.26$), and that of weak players did not differ between the non-anonymous ($M = 0.10$, $SD = 0.10$) and anonymous conditions ($M = 0.15$, $SD = 0.17$).

A 2 (anonymity) $\times$ 2 (asymmetry degree) $\times$ 2 (role) ANOVA revealed significant main effects of anonymity, $F(1, 102) = 4.95$, $p = .028$, $\eta^2 = 0.02$, and role, $F(1, 102) = 247.62$, $p < .001$, $\eta^2 = 0.61$, and a nonsignificant main effect of asymmetry degree, $F(1, 102) = 0.15$, $p = .701$, $\eta^2 = 0.00$. The interaction effects between anonymity and asymmetry

degree, $F(1, 102) = 11.77$, $p < .001$, $\eta^2 = 0.04$, and between asymmetry degree and role, $F(1, 102) = 13.69$, $p < .001$, $\eta^2 = 0.08$, were significant, while the interaction effects between anonymity and role, $F(1, 102) = 2.70$, $p = .103$, $\eta^2 = 0.02$, and among the three variables, $F(1, 102) = 0.98$, $p = .325$, $\eta^2 = 0.01$, were not. To examine the interaction effect between anonymity and asymmetry degree, we conducted a post-hoc pairwise comparison test. The results showed that the effect of anonymity was significant in the moderately asymmetric game, $t(102) = 4.04$, $p < .001$, $d = 0.41$, but not in the highly asymmetric game, $t(102) = 0.85$, $p = .400$, $d = 0.09$.

The ANOVA also showed that strong players volunteered more frequently than weak players across conditions, which is consistent with prior findings on asymmetric volunteer's dilemma games (Diekmann &

Przepiorka, 2015, 2016; Healy & Pate, 2018; Kawagoe et al., 2023; Przepiorka et al., 2021, 2022; Przepiorka & Diekmann, 2013, 2018; Tham et al., 2025). Collapsing data from both conditions, the mean volunteering rates were 67.2% for strong players and 25.9% for weak players in the moderately asymmetric game, and 78.9% for strong players and 12.3% for weak players in the highly asymmetric game.

Consistent with previous findings (Diekmann & Przepiorka, 2016; Przepiorka et al., 2022; Tham et al., 2025), greater cost asymmetry among group members amplified differences in their volunteering rates. The ANOVA indicated that the interaction effect between asymmetry degree and role was significant, and a post-hoc pairwise comparison test showed that the effect size of role was larger in the highly asymmetric game, $t(102) = 13.62$, $p < .001$, $d = 1.92$, than in the moderately asymmetric game, $t(102) = 8.59$, $p < .001$, $d = 1.19$.

4.2.2. Overall effects of anonymity on under- and over-volunteering

Fig. 5b shows that while removing anonymity successfully reduced under-volunteering in the moderately asymmetric game, it did not in the highly asymmetric game. In the moderately asymmetric game, under-volunteering rates were lower in the non-anonymous condition ($M = 0.10$, $SD = 0.11$) than in the anonymous condition ($M = 0.31$, $SD = 0.26$). In the highly asymmetric game, it was not lower in the non-anonymous condition ($M = 0.18$, $SD = 0.26$) than in the anonymous condition ($M = 0.13$, $SD = 0.21$). A 2 (anonymity) $\times$ 2 (asymmetry degree) ANOVA revealed no significant main effects of anonymity, $F(1, 102) = 3.81$, $p = .054$, $\eta^2 = 0.04$, and asymmetry degree, $F(1, 102) = 1.31$, $p = .256$, $\eta^2 = 0.01$, and a significant interaction effect, $F(1, 102) = 9.55$, $p = .003$, $\eta^2 = 0.09$. A post-hoc pairwise comparison revealed that the effect of anonymity was significant in the moderately asymmetric game, $t(102) = 3.60$, $p < .001$, $d = 0.98$, but not in the highly asymmetric game, $t(102) = 0.80$, $p = .427$, $d = 0.22$.

We also examined over-volunteering rates (Fig. 5c) and found that in the moderately asymmetric game, they were slightly (but not statistically significantly) higher in the non-anonymous condition ($M = 0.17$, $SD = 0.19$) than in the anonymous condition ($M = 0.10$, $SD = 0.10$). In contrast, in the highly asymmetric game, over-volunteering rates were not higher in the non-anonymous condition ($M = 0.06$, $SD = 0.07$) than in the anonymous condition ($M = 0.07$, $SD = 0.10$). A 2 (anonymity) $\times$ 2 (asymmetry degree) ANOVA revealed that the main effect of anonymity, $F(1, 102) = 1.54$, $p = .218$, $\eta^2 = 0.02$, and the interaction effect between anonymity and asymmetry degree, $F(1, 102) = 3.14$, $p = .079$, $\eta^2 = 0.03$, were not significant. The main effect of asymmetry degree was significant, $F(1, 102) = 7.91$, $p = .006$, $\eta^2 = 0.07$.

4.2.3. Dynamic effects of anonymity

As in Experiment 1, we conducted exploratory analyses to examine whether the effect of anonymity changed over time and whether anonymity moderated how participants responded to the previous round's outcome. We first found that the effect of anonymity did not vary over time in both games (Fig. 6). We used a hierarchical logistic model with the dependent variable being whether participants volunteered and the independent variables being anonymity, role, round, and their interactions, allowing intercepts to vary by dyad. In the moderately asymmetric game, the interaction effect between anonymity and round, $b = 0.01$, 95% CI $[-0.03, 0.04]$, $z = 0.16$, $p = .875$, OR = 1.00, and the interaction effect among the three variables were not significant, $b = 0.02$, 95% CI $[-0.03, 0.08]$, $z = 0.86$, $p = .388$, OR = 1.02. Similarly, in the highly asymmetric game, the interaction effect between anonymity and round, $b = -0.00$, 95% CI $[-0.05, 0.04]$, $z = 0.18$, $p = .858$, OR = 1.00, and the interaction effect among the three variables were not significant, $b = -0.06$, 95% CI $[-0.13, 0.01]$, $z = 1.67$, $p = .094$, OR = 0.94. Full results are reported in Tables S2-1 and S2-2 in the Supplemental Material.

We next examined whether anonymity moderated how participants responded to the previous round's outcome. We used a hierarchical logistic model in which the dependent variable was whether a participant volunteered in round t , and the independent variables were anonymity, whether the participant volunteered in round $t - 1$, whether their partner volunteered in round $t - 1$, and their interactions, with random intercepts for dyads. Across both games and roles, the interactions involving anonymity were not significant, indicating no evidence that anonymity moderated responses to the previous round's outcome. Full results are reported in Tables S2-3 and S2-4, and transition probabilities from the outcome of round $t - 1$ to the outcome of round t are summarized in Figs. S2-2 and S2-3 in the Supplemental Material.

4.3. Discussion

As predicted by the theory of competitive altruism, Experiments 1 and 2 demonstrated that removing anonymity increased volunteering and reduced under-volunteering in the symmetric and moderately asymmetric games, even though increased volunteering can be inefficient. However, Experiment 2 also showed that removing anonymity had little effect in the highly asymmetric game. In that game, strong players frequently volunteered while weak players rarely did, regardless of anonymity. The absence of an effect of anonymity on strong players' volunteering rates was likely due to a ceiling effect: their low volunteering cost ($K_S = 10$) relative to the benefit ($U = 80$) already provided a

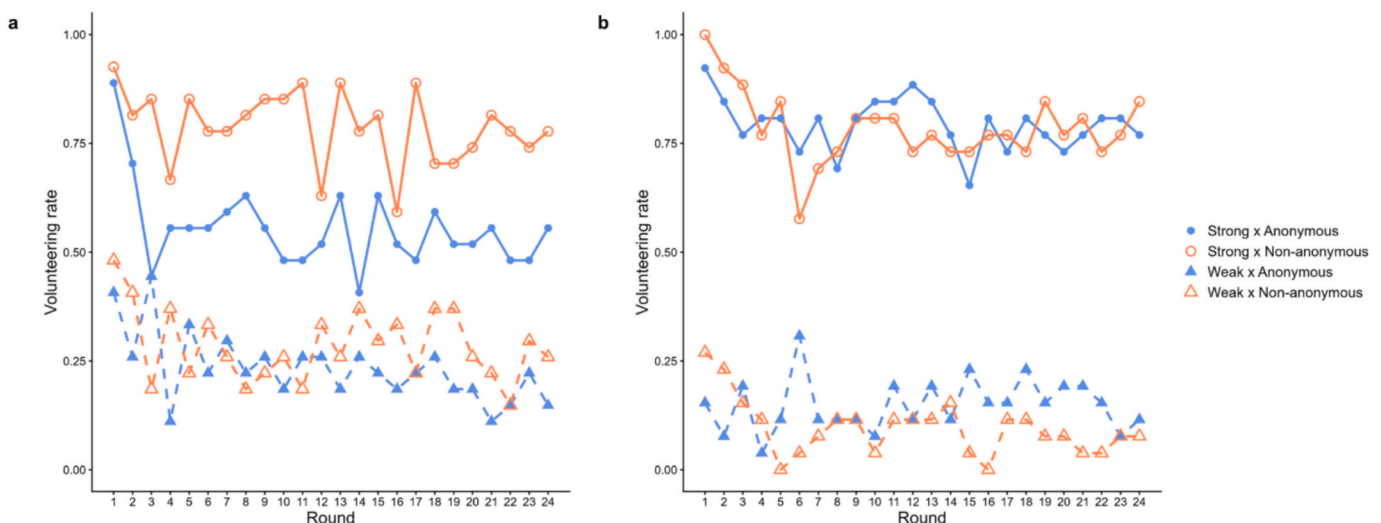


Fig. 6. Volunteering rates across rounds in the moderately (a) and highly asymmetric volunteer's dilemma games (b) (Experiment 2).

strong financial incentive to volunteer in the anonymous setting, leaving little room for a breach of anonymity to further increase their volunteering rates. This pattern, therefore, does not contradict the predictions of competitive altruism.

In contrast, weak players' persistently low volunteering rates, even in the non-anonymous condition, appear inconsistent with the perspective of competitive altruism. Because volunteer's dilemmas often involve a trade-off between appearing cooperative and avoiding inefficiency, two explanations may account for this pattern. First, weak players in the highly asymmetric game faced a particularly high risk of inefficiency. Given their partners' high volunteering rates even in the anonymous condition, any increase in weak players' volunteering would have reduced collective net payoffs and undermined efficiency (see Fig. S2–4 in the Supplemental Material).

Second, weak players in the highly asymmetric game may have faced weaker reputational incentives. Specifically, they may have expected to gain less reputational benefit from volunteering or to incur less reputational harm from not volunteering, possibly because their contributions carried a higher risk of creating inefficiency. While the risk of inefficiency itself likely provides the primary explanation for the weak players' consistently low volunteering rates, it does not preclude this second explanation. Experiment 3, therefore, examined how weak players in the highly asymmetric game were evaluated relative to other players, depending on their volunteering rates.

5. Experiment 3

5.1. Methods

We conducted an online vignette experiment to investigate whether weak players in the highly asymmetric game were expected to gain less reputational benefit from volunteering or to incur less reputational harm from not volunteering. Specifically, we examined the effects of a target's role and volunteering rate on their reputation across the symmetric, moderately asymmetric, and highly asymmetric games. The experiment employed a 5 (role: a player in the symmetric game, the strong player in the moderately asymmetric game, the weak player in the moderately asymmetric game, the strong player in the highly asymmetric game, the weak player in the highly asymmetric game) $\times$ 3 (volunteering rate: low, medium, high) between-participants design, with the target's reputation as the dependent variable.

5.1.1. Participants

An a priori power analysis using MorePower 6.0.1 (Campbell & Thompson, 2012) indicated that at least 270 participants were required to detect a medium effect size ($\eta^2 = 0.06$) in a 5 (role) $\times$ 3 (volunteering rate) between-participants ANOVA with $\alpha = 0.05$ and $\beta = 0.20$. We recruited 372 participants (198 men, 173 women, 1 unidentified; $M_{\text{age}} = 43.15$, $SD = 9.70$) through a Japanese crowdsourcing platform provided by the CrowdWorks, Inc. (2025). Participants received 150 Japanese yen as compensation for their participation. Data from 26 participants who failed an attention check were removed. All analyses were conducted on the remaining 346 participants (182 men, 164 women; $M_{\text{age}} = 43.18$, $SD = 9.71$). This sample size provided 80% power to detect an effect size of $\eta^2 = 0.04$ in the ANOVA with a 5% false-positive rate, which was calculated using MorePower 6.0.1 (Campbell & Thompson, 2012).

5.1.2. Procedure

Participants first read the rules of a volunteer's dilemma game, which was either the symmetric, moderately asymmetric, or highly asymmetric game. After correctly answering comprehension questions, they were asked to evaluate a target based on the target's actions across six rounds of the game. The target's actions varied according to the volunteering rate condition: in the *low* condition, the target volunteered only in the first round; in the *medium* condition, the target volunteered in the first

three rounds; and in the *high* condition, the target volunteered in the first five rounds.

In all conditions, the target's partner was depicted as volunteering in every round. The partner's high volunteering rate reflected our focus on weak players in the highly asymmetric game, whose partners (i.e., strong players) frequently volunteered in Experiment 2. The partner's consistent actions ensured that the target's actions would be interpreted as intentional, which was crucial for prompting participants to evaluate the target (Carlson et al., 2022; Manrique et al., 2021).

Participants then rated how much they believed most people would like the target on a 7-point scale ranging from -3 (not at all) to 3 (extremely). As preregistered, this variable (hereafter, likability) served as the primary dependent variable. Following previous research that assessed the reputation of a target in a vignette (Kawamura & Kusumi, 2020), participants also indicated how much they believed most people would perceive the target's actions as typical and how much they would respect the target. On subsequent pages, participants provided the same ratings from their own perspective. Finally, they completed an attention check asking how many times the target had volunteered. Data from participants who failed to answer this correctly were excluded from all analyses.

5.2. Results

Fig. 7 presents reported likability as a function of the target's role and volunteering rate. A 5 (role) $\times$ 3 (volunteering rate) ANOVA revealed significant main effects of role, $F(4, 331) = 13.28$, $p < .001$, $\eta^2 = 0.12$, and volunteering rate, $F(2, 331) = 27.36$, $p < .001$, $\eta^2 = 0.12$, and a nonsignificant interaction effect, $F(8, 331) = 0.73$, $p = .668$, $\eta^2 = 0.01$. Since the main effect of the target's role was significant, we conducted post-hoc pairwise comparisons. The results showed that the likability of the weak player in the highly asymmetric game ($M = 0.12$, $SD = 1.16$) was slightly higher than that of the weak player in the moderately asymmetric game ($M = -0.41$, $SD = 1.25$), $t(331) = 2.71$, $p = .071$, $d = 0.46$, and significantly higher than that of a player in the symmetric game ($M = -0.96$, $SD = 1.19$), $t(331) = 5.41$, $p < .001$, $d = 0.93$, the strong player in the moderately asymmetric game ($M = -0.97$, $SD = 1.25$), $t(331) = 5.61$, $p < .001$, $d = 0.94$, and the strong player in the highly asymmetric game ($M = -1.01$, $SD = 1.19$), $t(331) = 6.01$, $p < .001$, $d = 1.03$, regardless of volunteering rate (see Table S3–2 in the Supplemental Material for full results). These results do not support the possibility that weak players in the highly asymmetric game were expected to gain less reputational benefit from volunteering. Instead, they support the possibility that such players were expected to incur less reputational harm from not volunteering.

Consistent with this interpretation, further analyses revealed that the weak player in the highly asymmetric game did not earn a negative reputation even when their volunteering rate was low—a pattern not observed for the other players. Specifically, in the low volunteering rate condition, the likability of the weak player in the highly asymmetric game was not significantly different from zero ($M = -0.30$, $SD = 0.88$, $t(22) = 1.67$, $p = .110$, $d = 0.35$), whereas that of the other players was significantly below zero (the weak player in the moderately asymmetric game: $M = -1.14$, $SD = 1.32$, $t(21) = 4.04$, $p = .001$, $d = 0.86$; a player in the symmetric game: $M = -1.40$, $SD = 0.91$, $t(24) = 7.67$, $p < .001$, $d = 1.53$; the strong player in the moderately asymmetric game: $M = -1.72$, $SD = 1.10$, $t(24) = 7.82$, $p < .001$, $d = 1.56$; the strong player in the highly asymmetric game: $M = -1.65$, $SD = 1.04$, $t(19) = 7.10$, $p < .001$, $d = 1.59$) (see Table S3–3 in the Supplemental Material for results from the medium and high volunteering rate conditions).

5.3. Discussion

Experiment 3 investigated whether the low volunteering rates of weak players in the highly asymmetric game, even when anonymity was removed, could be explained by their limited reputational benefits from

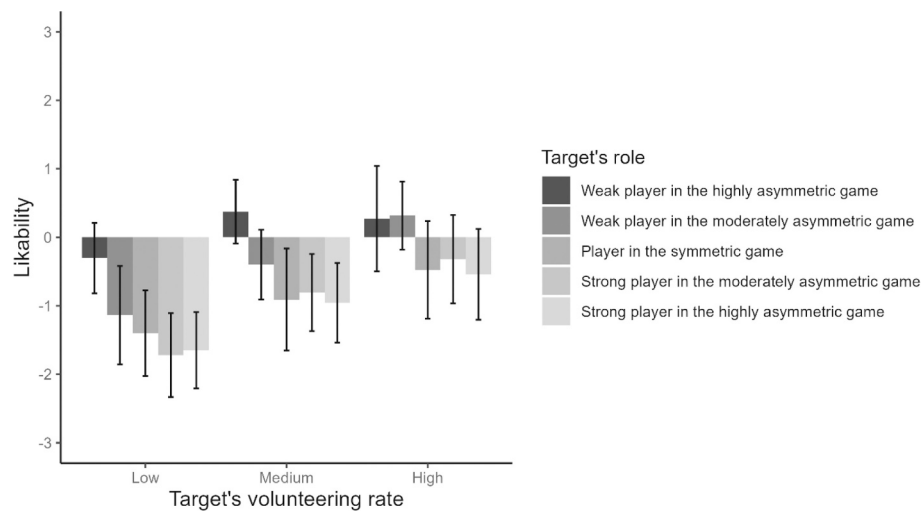


Fig. 7. Likability by the target's role and volunteering rate (Experiment 3). Note. Error bars represent 95% confidence intervals.

volunteering or by limited reputational harm from not volunteering. The results supported the latter: any decision—including abstaining from volunteering—was less likely to damage their reputations, particularly their likability. Furthermore, unlike other players, weak players in the highly asymmetric game were not evaluated negatively even when their volunteering rates were low.

In sum, while all players in volunteer's dilemma games faced some risk of creating inefficiency when they volunteered, weak players in the highly asymmetric game confronted an especially heightened risk. In addition, possibly because of this heightened risk, they were unlikely to earn a negative reputation for abstaining. These findings help explain their persistently low volunteering rates, regardless of whether anonymity was removed.

6. General discussion

Groups frequently face volunteer's dilemmas, in which a single member's effort is both necessary and sufficient to produce a public good and benefit all. In these situations, under-volunteering (i.e., no one volunteering) is the most problematic outcome, but over-volunteering (i.e., more than one member volunteering) is also undesirable because it reduces overall efficiency. Prior studies have consistently shown that removing anonymity encourages cooperative behavior (e.g., Bradley et al., 2018; Wu et al., 2016), suggesting that it may be effective in promoting volunteering and reducing under-volunteering in volunteer's dilemmas. However, they have primarily focused on situations in which all contributions benefit others, leaving open the question of whether removing anonymity is effective when contributions can create inefficiency. From the perspective of competitive altruism, removing anonymity should promote cooperative behavior, even at the expense of efficiency, because it allows individuals to signal their willingness and ability to contribute (e.g., Roberts, 1998). By contrast, research on economic decision-making emphasizes efficiency as a fundamental concern (e.g., Van Lange et al., 1997), and thus predicts that the effects of removing anonymity will be limited in volunteer's dilemmas.

The present research examined how individuals navigate this trade-off between appearing cooperative and avoiding inefficiency in incentivized volunteer's dilemma games. Experiment 1 investigated a basic, symmetric volunteer's dilemma game. Consistent with the predictions of competitive altruism, removing anonymity increased volunteering and reduced under-volunteering. Experiment 2 extended this to asymmetric games, where overall efficiency is maximized if only strong players volunteer, leaving weak players with a sharper trade-off between appearing cooperative and avoiding inefficiency. The results showed that while removing anonymity increased both players' volunteering

rates and reduced under-volunteering in the moderately asymmetric game, it had no effect in the highly asymmetric game.

In the highly asymmetric game, strong players frequently volunteered while weak players rarely did, regardless of anonymity. The absence of an effect of anonymity on the strong players' volunteering rates is likely because their low volunteering cost provided a strong financial incentive to volunteer even in the anonymous setting. This pattern, therefore, does not contradict the predictions of competitive altruism. In contrast, the persistently low volunteering rates of weak players, even in the non-anonymous setting, appear inconsistent with the perspective of competitive altruism. However, this pattern can be explained by taking efficiency concerns into account. Weak players in the highly asymmetric game faced a particularly high risk that their contributions would create inefficiency. Experiment 3 showed that, possibly due to this high risk, only weak players in the highly asymmetric game were unlikely to earn a negative reputation even when they abstained from volunteering.

These findings have both theoretical and practical implications. Theoretically, they provide initial evidence that removing anonymity does not consistently promote cooperative behavior in situations where contributions may reduce overall efficiency. Although competitive altruism predicts that removing anonymity should promote cooperative behavior even at the expense of efficiency, our results suggest that its effects are constrained when the risk of inefficiency is high. In other words, individuals consider not only how cooperative they appear but also the potential impact of their actions on overall efficiency, as suggested by research on economic decision-making that emphasizes efficiency as a fundamental concern (e.g., Van Lange et al., 1997).

Practically, our findings imply that interventions that reduce anonymity in volunteer's dilemma situations may promote volunteering when contribution costs are similar or only moderately different across group members, but are less likely to do so when costs vary greatly. In addition, the exploratory analyses from Experiment 1 suggest that, when anonymity is removed, providing timely feedback after no one volunteers may encourage subsequent volunteering and thereby help produce a public good. However, because we did not find comparable evidence in Experiment 2, this practical implication may be limited to settings in which contribution costs are similar across members.

In the present research, we moved beyond the basic two-person symmetric volunteer's dilemma game to examine two-person asymmetric volunteer's dilemma games. Although we could have extended the design to N -person volunteer's dilemma games, and both cost asymmetry and larger group sizes are common in everyday life, we focused on cost asymmetry because it provides a cleaner test of the two competing perspectives: one based on the theory of competitive altruism

and the other on research emphasizing efficiency as a fundamental concern. Both increasing cost asymmetry and increasing group size can sharpen the trade-off between appearing cooperative and avoiding inefficiency. However, increasing group size also creates substantial coordination difficulties in determining who should volunteer and when (Tham et al., 2025). This can introduce confounds related to players' negotiation and risk-management skills and complicate inference about the effects of anonymity.

Nevertheless, extending our findings to *N*-person settings is an important direction for future work, especially for strengthening the practical implications of the present research. Our results generate testable predictions as to how group size might matter. For example, because we found that anonymity had weaker effects when additional volunteering was especially likely to be inefficient, the effect of removing anonymity may be smaller in larger groups, where redundant volunteering becomes more probable. Testing the effects of group size will require examining a range of group sizes, as prior work has done—for instance, Goeree et al. (2017) studied symmetric games with 2, 3, 6, 9, and 12 players, and Kopányi-Peuker (2019) studied symmetric games with 3, 15, 39, and 100 players. Importantly, future research should also incorporate cost asymmetry, because our findings indicate that the effects of anonymity depend on it. In *N*-person groups, there are many plausible cost distributions, ranging from settings with a single strong player and multiple equally weak players (as in much prior work; Diekmann, 1993; Diekmann & Przepiorka, 2015, 2016; He et al., 2014, 2015; Przepiorka et al., 2021, 2022; Tham et al., 2025) to settings with more continuous cost heterogeneity (e.g., uniform, normal, or power-law distributions). Future studies extending the present findings to *N*-person games are therefore recommended to carefully specify the real-world situation of interest and select group sizes and cost structures that plausibly represent it.

To conclude, the present research reveals a more nuanced role of anonymity in cooperative behavior than previously understood. Specifically, it shows that efficiency concerns can constrain the extent to which removing anonymity promotes cooperative behavior. We hope these findings will stimulate future research to further examine the boundary conditions of the effects of anonymity and deepen our understanding of human cooperation.

Open practices

All materials, data, and R codes are available at <https://osf.io/ctfyj/>. Experiment 3 was preregistered prior to data collection at <https://aspre dictated.org/37sv-238k.pdf>.

CRedit authorship contribution statement

Yukari Jessica Tham: Writing – review & editing, Writing – original draft, Visualization, Methodology, Investigation, Funding acquisition, Formal analysis, Data curation, Conceptualization. **Yohsuke Ohtsubo:** Writing – review & editing, Supervision, Methodology, Conceptualization. **Kaori Karasawa:** Writing – review & editing, Supervision, Resources, Methodology, Conceptualization.

Declaration of generative AI and AI-assisted technologies in the writing process

During the preparation of this manuscript, the authors used ChatGPT 5 to proofread it. After using this tool, the authors reviewed and edited the content as needed and take full responsibility for the content of the publication.

Declaration of competing interest

The authors declare no competing interests. This work was supported by the Japan Society for the Promotion of Science (KAKENHI 20J22775,

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Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.jesp.2026.104929>.

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