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Equality and Efficiency Shape Cooperation in Multiple-Public-Goods Provision Problems

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The functioning of groups and societies requires that individuals cooperate on public goods such as healthcare and state defense. More often than not, individuals face multiple public goods and must choose on which to cooperate, if at all. Such decisions can be difficult when public goods are attractive on one dimension (e.g., being "efficient" in providing comparatively high returns) and unattractive on another (e.g., creating inequality by providing some group members greater returns than others). We examined how people manage such decision conflicts in five preregistered experiments ($N = 900$) that confronted participants with two public goods that varied in efficiency and (in)equality of returns. People cooperated more on the comparatively efficient public good and on the equal-return (vs. unequal-return) public good (Experiment 1), yet when the unequal-returns public good was also the most efficient, individuals cooperated comparatively more on this unequal-but-efficient public good when they themselves benefitted the most from inequality (Experiments 2–4). Low beneficiaries largely ignored public goods efficiency and preferentially cooperated on the equal- rather than unequal-returns public good. Expectations (Experiments 2–4), preferences for revising the multiple-public-goods provision problems' choice architecture (Experiments 3–4), and descriptive norms held by uninvolved arbitrators (Experiment 5) echoed these cooperation patterns, but uninvolved arbitrators deemed it socially appropriate to cooperate more on the equal than the unequal public good regardless of beneficiary position. We discuss implications for theory and policy on cooperation.

Public Significance Statement
Individuals within groups can often choose to cooperate on a variety of public goods, requiring decisions on where (not) to invest personal resources. We show that such decisions depend on key features of public goods—how efficient they are and whether returns are distributed unequally, benefitting some more than others. The observed patterns of cooperation—with cooperation highest on more efficient-but-unequal public goods—may be alarming, potentially harming the weakest in a group, undermining group cohesion, and seeding conflict. However, overall cooperation and thus group welfare are increased when group members have multiple public goods that are misaligned in terms of efficiency and equality in returns. Thus, individuals in multiple-public-goods provision problems tend to cooperate more than previously observed in single-public goods problems, keeping less to themselves and contributing more to the welfare of the group.

Keywords: social dilemma, tragedy of the commons, decision making, fairness

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Humans have a strong capacity to cooperate with others and thereby create levels of protection and prosperity they could never achieve individually. For example, through mutual and sustained cooperation, groups can prevent depletion of natural resources, combat climate change, create publicly accessible healthcare and education, and organize state defense (e.g., Hardin, 1968; Ostrom, 1998; Spadaro et al., 2022; van Dijk & De Dreu, 2021; Van Lange et al., 2018; Weber et al., 2004). At the same time, mutual and sustained cooperation is

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not a given. When individuals benefit from public goods regardless of their own contributions, they may be tempted to withhold cooperation and instead rely on others to create public goods and services. Public goods provision thus requires individuals to overcome this "free-riding" temptation and to trust that others do the same (Pruitt & Kimmel, 1977; Tomasello & Vaish, 2013; van Dijk & De Dreu, 2021). Indeed, free-riding is reduced, and public goods provision maintained, when individuals hold prosocial preferences toward (members of) their group (Balliet et al., 2009; De Dreu et al., 2000), when they expect others to cooperate, and when they sanction other's free-riding and reward other's cooperation (for recent reviews, see, e.g., Balliet et al., 2011; Fehr & Schurtenberger, 2018; Thielmann et al., 2020; Tyler & Blader, 2003; van Dijk & De Dreu, 2021; Van Lange et al., 2013).

Our understanding of cooperation on public goods is constrained by the fact that theory and research have largely failed to consider that individuals often have a choice among several public goods to cooperate on, and that they may free-ride on some public goods and contribute to others. As an exception, Donahue and colleagues used evolutionary simulations to show that collaborating with others on multiple, parallel projects can increase overall cooperation (Donahue et al., 2020). Indeed, individuals can cooperate on a range of community initiatives for public playgrounds or public parking spaces, they can choose from multiple charities for tax deductible donations, and they may belong to several groups, each with its own public good (De Dreu et al., 2023). In such multiple-public-goods situations, individuals with limited resources need to select which public goods to cooperate on and which ones to leave aside. What may appear as selfish free-riding can then also be understood as the inevitable consequence of the cooperative decision to contribute substantially to another public good (Gross & De Dreu, 2019). For example, an employee leaving early from work to volunteer at a local community service for the poor may be reprimanded for shirking or rewarded for sustained contributions to societal well-being.

Here we extend theory and research on cooperation by examining how individuals solve multiple-public-goods provision problems and, when given a say, how they modify the given choice architecture. Because multiple-public-goods problems have not been experimentally studied thus far, we focus here on two fundamental design features that differentiate among public goods and may render them more or less attractive targets for cooperation: (a) How much cooperation helps to establish collective welfare (henceforth efficiency; Engelmann & Strobel, 2004; Komorita & Parks, 1995) and (b) the extent to which returns from the public good are equally or unequally distributed among group members (henceforth [in]equality in returns; Hauser et al., 2019; Nikiforakis et al., 2012; Reuben & Riedl, 2013; van Dijk & Wilke, 1995). We argue and show that when given a choice, people prefer to contribute to public goods that are higher in efficiency and provide equal rather than unequal returns. Our main question, however, is how individuals regulate decision conflict that arises when the most efficient public good creates unequal returns and the least efficient public good facilitates an equal distribution of wealth. Hypotheses are developed below and tested in four preregistered and fully incentivized experiments.

Efficiency and Equality Attract

In economic theory, individuals are assumed to choose the strategy that maximizes personal wealth, and when cooperation is personally costly, such cooperation should not be observed. Per this perspective, as long as the defining features of a social dilemma are maintained and free-riding remains in the individual's best interest, neither the public good's efficiency nor its (in)equality in returns should matter (R. M. Dawes, 1980; van Dijk & De Dreu, 2021). This conjecture contrasts with empirical findings that cooperation is common and frequent, even when it comes at a potential cost to individual interests (Kerr & Kaufman-Gilliland, 1994; Lojowska et al., 2023; Ostrom, 1998; Rand & Nowak, 2013; van Dijk & De Dreu, 2021; Van Lange, 1999; van Vugt & Hardy, 2009; Weber & Murnighan, 2008). In addition, experiments have revealed that larger rather than smaller returns from public goods (i.e., efficiency) further boost such cooperation (e.g., Engelmann & Strobel, 2004; Gunnthorsdottir et al., 2007; Isaac & Walker, 1998; Lugovskyy et al., 2017; Rapoport, 1967; Reuben & Riedl, 2013; van den Berg et al., 2020; Vlaev & Chater, 2006; C. Yu et al., 2009; Zelmer, 2003). Finally, a small body of work on nested-social dilemmas suggests that people prefer cooperating on public goods that benefit in-group members over cooperating on universal public goods that benefit in- and out-group members alike (e.g., De Dreu et al., 2020; Wit & Kerr, 2002). Whereas this may reflect so-called parochialism (Aaldering & Böhm, 2020; Aaldering et al., 2018; De Dreu et al., 2020, 2023; Gross et al., 2023; Halevy et al., 2012), findings may also reflect a preference for cooperating on efficient (in-group) rather than less efficient (universal) public goods. Accordingly, we expect to replicate a preference for efficiency, such that when given a choice between multiple public goods, individuals are more likely to cooperate on those public goods that are more efficient (Replication Hypothesis 1).

Independent of their efficiency, public goods may provide all involved individuals with equal returns. This is, however, not imperative. For example, some tax-paying citizens benefit more from public health care than others. Such inequality in returns matters for cooperation (Buttrick & Oishi, 2017; Côté et al., 2015; Cozzolino, 2011; Fehr & Schmidt, 1999; Goudarzi et al., 2022; Samuelson & Messick, 1986; Sommet et al., 2022; van Dijk & Wilke, 1993). Research using a single-public-good dilemma has shown that group-level earnings are lower when the public good provides unequal rather than equal returns (Bagnoli & McKee, 1991; Fischbacher et al., 2014; Fisher et al., 1995; Gifford & Hine, 1997; Nikiforakis et al., 2012; Reuben & Riedl, 2009). This suggests that individuals cooperate more on public goods with equal rather than unequal returns (also see Tyler & Blader, 2003). Furthermore, people typically cooperate more on public goods that benefit their in-group at no cost to out-groups than on public goods that benefit the in-group and simultaneously hurt out-group members (e.g., Aaldering et al., 2018; De Dreu, 2010; Halevy et al., 2008; Weisel & Böhm, 2015). Again, this suggests that individuals find public goods that create inequality less attractive to cooperate on than public goods that create equality. Accordingly, we expect to replicate earlier findings that when given a choice, individuals prefer cooperating on public goods with equal rather than unequal returns (Replication Hypothesis 2).

Interestingly, Zelmer (2003) finds no effect of unequal benefits on group-level public good cooperation in her meta-analysis. To establish whether unequal benefits from a public good truly affect people's decision making, we believe it is essential to also examine individual-level preferences to cooperate among those who may gain more or less from an unequal public good. Relatedly, past findings that individuals

generally prefer equal over unequal distributions of wealth, but are particularly averse to earning less than others (Adams, 1965; Boecker et al., 2022; De Dreu et al., 1994; Deutsch, 1985; Fehr & Schmidt, 1999; Loewenstein et al., 1989; Messick & Sentis, 1985), suggest a possible qualification to Replication Hypothesis 2. The fact that especially low (compared to high) beneficiaries in public goods with unequal returns withhold cooperation and are more likely to free-ride (Brañas-Garza et al., 2021; Doğan et al., 2018; Fischbacher et al., 2014; Fisher et al., 1995; Koch et al., 2021; Kölle, 2015; Marwell & Ames, 1979; Robbett, 2016; Wit et al., 1992; but see Goetze & Galderisi, 1989) suggests that public goods with unequal returns are particularly unattractive to low (compared to high) beneficiaries. Accordingly, we predict that, when given a choice, especially low (compared to high) beneficiaries are more likely to contribute to those public goods with an equal rather than unequal "return on investment" (Replication Hypothesis 2a).

When Efficiency and Equality Misalign

Individuals who can cooperate on several public goods may experience decision conflict when those public goods that are most efficient also generate inequality in returns and thus create wealth disparities among group members. For example, individuals may have difficulty choosing between two collective healthcare schemes when one scheme gives everyone the same benefits and the other giving an overall greater return yet some significantly more benefits than others.

How individuals choose between inefficient-but-equal-returns and efficient-but-unequal-returns public goods is unknown, to the best of the authors' knowledge. One possibility is that decision conflict leads people away from contributing at all. If true, we should observe lower overall cooperation and more selfish keeping when public good efficiency and equality in returns are misaligned compared to aligned. Evidence for this would resonate with extant work showing that competing decision goals can evoke choice overload, leading to decision inertia (Chernev et al., 2012; Evans et al., 2015; Otto et al., 2016; Tversky & Shafir, 1992; Van Harreveld et al., 2009; Yamagishi et al., 2017) or to persistence with suboptimal decisions (Janis & Mann, 1977).

Another possibility is that individuals solve the decision conflict that emerges when public goods' efficiency and equality in returns are misaligned by prioritizing one over the other (Choshen-Hillel & Yaniv, 2011). When equality in returns is valued less than efficiency, we would expect people to contribute more to public goods with higher rather than lower efficiency, regardless of how (un)equal returns are distributed among group members. Evidence for this possibility would resonate with work showing that concerns for overall group welfare outweigh concerns for equality (Balafoutas et al., 2012; Bland & Nikiforakis, 2015; Cabrales et al., 2010; Choshen-Hillel et al., 2015; Engelmann & Strobel, 2004; Matania & Yaniv, 2007; Yang et al., 2016). When, in contrast, equality in returns is valued more than efficiency, we would expect people to contribute more to public goods with equal rather than unequal returns regardless of their efficiency (Loewenstein et al., 1989; Mitchell et al., 1993; Shaw, 2013). This would further resonate with work showing that people prefer to forgo a prize rather than allocating it an inequitable manner, when they can be held responsible for the decision (Gordon-Hecker, Rosensaft-Eshel, et al., 2017).

Based on above-referenced studies on social preferences and inequity aversion, we expect especially low compared to high beneficiaries to prioritize equality in returns and, hence, accept the efficiency loss needed to avoid inequality. Stated more generally, we anticipate that the degree to which an individual benefits from a public good relative to other group members will condition how that individual solves the decision conflict that arises when the most efficient public good provides unequal rather than equal returns. Accordingly, our main hypothesis is that low beneficiaries cooperate more on an inefficient-but-equal-returns public good than an efficient-but-unequal-returns public good (Hypothesis 3a), with the reverse emerging among high beneficiaries (Hypothesis 3b).

The Present Research

In four studies designed to test our hypotheses, we organized individuals in groups of three and gave them the possibility to contribute none, all, or part of a personal endowment to two public goods, the equal-returns public good and the unequal-returns public good (Figure 1A). For each public good, not contributing (vs. contributing) constitutes free-riding and maximizes personal earnings. Conversely, contributing (vs. not contributing) constitutes cooperative behavior and maximizes collective earnings. We varied the efficiency of the public goods by modifying the multipliers of personal investments in the equal-returns and unequal-returns public goods, rendering the efficiency from the latter compared to the former higher, equal, or lower. Inequality in returns was manipulated between both public goods independently of their efficiency. Returns from the equal public good were distributed equally among the three group members, whereas returns from the unequal public good were distributed unequally such that one individual would be the low beneficiary, one the intermediate beneficiary, and one the high beneficiary of that public good (for more detail, see the Method section) (Figure 1B). An individual's earnings were thus the sum of (a) the remainder of their endowment after having made contributions to both public goods, (b) the 33% share from the equal public good, and (c) their position-dependent share from the unequal public good.

Within this general setup, we tested (a) Replication Hypothesis 1 that individuals cooperate more on the more rather than less efficient public good; (b) Replication Hypothesis 2 and 2a that individuals cooperate more on the equal-returns public good than the unequal-returns public good, especially when the individual is a low rather than high beneficiary from the unequal public good; and (c) Hypothesis 3 that when the equal-returns public good is less efficient than the unequal-returns public good, low beneficiaries cooperate more on the equal-returns than the unequal-returns public good (Hypothesis 3a), whereas high beneficiaries cooperate more on the unequal- than the equal-returns public good (Hypothesis 3b). In an additional fifth experiment, we explore how uninvolved third parties solve the decision conflict of efficiency versus equality presented in the Multiple-Public-Goods game, in terms of injunctive and descriptive norms. We return to this after reporting the results of our first four experiments.

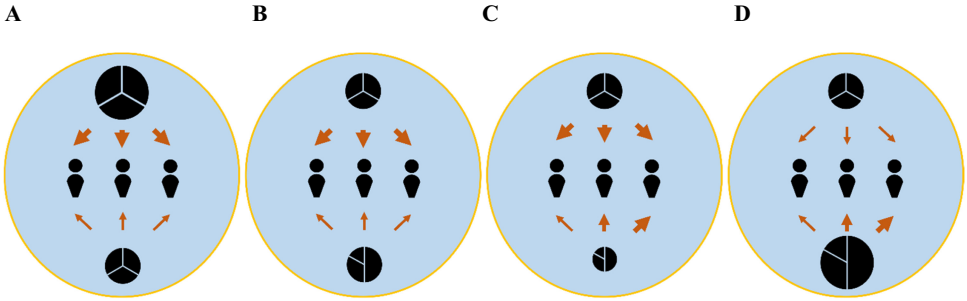
Experiments 1 and 2

Method

Research Ethics, Sample Size, and Participants

Experimental protocols and hypotheses received ethics approval (2020-03-30-R. Pliskin-V1-2344), and participants gave their informed consent before participating and received full debriefing

Figure 1
The Multiple-Public-Goods Provision Problem



Note. Three individuals can contribute out of a personal endowment to two public goods depicted as black circles that vary in their efficiency, depicted by the circle's surfaces (A), provide (un)equal returns to group members, depicted as the part of the circle and the thickness of the arrows (B), where the equal-returns public good is more efficient than the unequal-returns public good (no decision conflict) (C), or where the equal-returns public good is less efficient than the unequal returns public good (decision conflict) (D). Experiments 1 and 2 examined public good provision in (A); Experiments 2–4 examined public good provision in (B) through (D). See the online article for the color version of this figure.

upon the completion of the study. Studies were incentivized and involved no deception. Including the baseline payment of 3.75 GBP/4.66 USD and earnings from the various decision tasks, participants earned a total average of 9.51 GBP/12.52 USD.

Experiment 1 involved a 2 (public good returns: equal vs. unequal) × 3 (relative efficiency of the unequal-returns public good: lower, equal, or higher than the equal-returns public good) within-subjects factorial design. We additionally included participants' beneficiary position (low vs. intermediate vs. high beneficiary) as a between-subjects factor only for Experiment 2, in which participants knew their position. We employed G*Power (Faul et al., 2009) to estimate required sample sizes for within-subject comparisons with $\beta = 0.90$ and $\alpha = .05$, assuming a low-to-medium effect size of $f = .25$. Experiment 1 involved $N = 34$ participants ($M_{age} = 25.41$ years, $SD = 4.93$; 19 women, 14 men, one preferred not to share), and Experiment 2 involved $N = 105$ participants ($M_{age} = 26.62$ years, $SD = 5.13$; 61 women, 43 men, one self-identified). Both experiments were programmed in Qualtrics (Qualtrics, Provo, Utah, United States of America) and implemented online via Prolific Academic (https://www.prolific.co) with participants based in the United Kingdom or United States of America.

Transparency and Openness

In line with the transparency and openness promotion guidelines (Nosek et al., 2015), we cite all data and methods developed by others in the main text as well as the references and provide our materials, *R* code, and data on https://osf.io/84wsg/. Experimental protocols and hypotheses were preregistered (Experiments 1 and 2: https://aspredicted.org/IIV_LVO; Experiment 3: https://aspredicted.org/OAL_YEY; Experiments 4 and 5: https://aspredicted.org/V3M_32L), along with the plan to apply general linear model analysis for repeated measures, followed by contrast analyses.

Procedure

Both experiments had data collected in two phases, approximately 1 week apart. In Part 1, participants completed several personality measures, including the social value orientation (SVO) slider (Murphy et al., 2011) capturing SVO and inequality aversion. The other personality measures served research questions outside the scope of the present manuscript and are reported in Hoenig et al. (2023) (see https://aspredicted.org/IIV_LVO). The very few and minor deviations from the preregistration are detailed in the online supplemental materials. In the information letter, participants learned that they would receive a bonus earning from the SVO slider task based on their own decisions and those of another participant, randomly paired with them. One week later, participants were invited for Part 2 of the study. They reasserted informed consent and were informed that they would be paired with two other participants to form a group of three individuals. They read that each individual would make decisions that would influence their personal earnings as well as those of the other two group members. Specifically, they were told that they would receive a bonus payment calculated as their average earnings from four randomly selected rounds of the experimental task. As none of our experiments included deception, this information was truthful, with matching implemented once we completed the data collection. Following task instructions and comprehension questions, participants made a series of contribution decisions in various multiple-public-goods scenarios (screenshots of the decision screen are given in Figure S1 in the online supplemental materials). Upon the completion of the decision-making task, participants were fully debriefed.

Multiple-Public-Goods Tasks

For each decision trial, participants received an endowment of 10 monetary units (MUs) and were instructed how they could contribute to two public goods. We explained that contributions would be deducted from their endowment yet would provide a "return on investment" to each of the individuals in their group, themselves included. For each of the two public goods, the return on investment was operationalized at the range of $0 <$ marginal per capita return (MPCR; i.e., the smallest possible return on investment) < 1. Accordingly, it was always individually rational not to invest anything in either public good (viz., free-riding), and it was always

collectively rational to invest one's entire endowment in one or both public goods.

In total, participants made decisions in 12 trials, each involving the possibility to keep and/or contribute to one or two public goods. Although for each participant the 12 trials were presented in random order, conceptually they grouped in two distinct "blocks": one designed to test Replication Hypothesis 1 and one designed to test Replication Hypotheses 2 and Main Hypothesis 3. Specifically, in the three trials of the former block, both public goods gave equal returns to the three group members, yet one public good was always more efficient than the other (also see Figure 1A). As varying the efficiency of one public good also affects the total efficiency across public goods, in one of the three trials the overall efficiency was low (i.e., multiplier = 1.3 vs. multiplier = 1.1), in one it was high (i.e., 1.7 vs. 1.5) and in one it was intermediate (i.e., 1.5 vs. 1.3). Accordingly, in our analyses we controlled for total efficiency of both public goods combined. According to Replication Hypothesis 1, individuals should contribute more to the more efficient of the two public goods, and overall cooperation may be stronger when overall efficiency of both public goods combined is higher (i.e., averaged multiplier = 1.6 vs. 1.4 vs. 1.2).

The second block, comprising nine trials, also varied the equality in returns between the two public goods, with one (introduced as "Pool A") offering equal returns and the other ("Pool B") providing unequal returns. The calculation of payoffs was explained to participants in a stylized form to ensure understandability and reduce demand characteristics. Participants were instructed that each group member would receive one-third of the payoffs from the equal-returns public good. Regarding the unequal public good, the example provided in the instructions depicted the low beneficiary earning one-sixth, the intermediate beneficiary earning one-third, and the high beneficiary earning half of the returns. During the actual decision trials, differences between the beneficiaries were more subtle. For example, from an unequal public good with an overall efficiency of 1.5, the low beneficiary received 0.43 MU from each MU contributed (by themselves and the other two group members). The intermediate beneficiary in this case received 0.50 MU per MU contributed, and the high beneficiary received 0.56 per MU contributed. Participants always saw on the decision screen how much one contributed MU would mean to them and their group members in their returns (e.g., for a low beneficiary: 0.43 to oneself, 0.50 to the intermediary, and 0.56 to the high beneficiary; also see Figure S1 in the online supplemental materials for an example).

To control for inherent variation in overall efficiency that comes with the manipulation of relative efficiency within a multiple-public-goods problem, we again varied the total efficiency (i.e., the combined multiplier) across these nine trials. Thus, the nine trials orthogonally crossed the multiplier of the equal-returns public good (1.7, 1.5, or 1.3) with that of the unequal-returns public good (1.9, 1.7, 1.5, 1.3, 1.1). Accordingly, in three trials, the equal-returns public good was more efficient than the unequal-returns public good (1.7 vs. 1.5, or 1.5 vs. 1.3, or 1.3 vs. 1.1), in another three it was identical (1.7 and 1.7, or 1.5 and 1.5, or 1.3 and 1.3) and in the final three it was lower (1.3 vs. 1.5, or 1.5 vs. 1.7, or 1.7 vs. 1.9; see Table S1 in the online supplemental materials for the MPCRs for all trials).

From the individual beneficiaries' perspective, the three conditions thus looked as follows: When both public goods had the same efficiency, low beneficiaries earned less from the unequal-returns public good than from the equal-returns public good. Confronted with a more efficient unequal public good, they earned the same from both public goods. Confronted with a more efficient equal public good, low beneficiaries earned less from the unequal public good, with the difference in MPCRs larger than when both public goods provide the same group-level efficiency. Intermediate beneficiaries earned the same from both public goods when these had the same group-level efficiency. Confronted with a more efficient unequal public good, they earned more from the unequal than from the equal public good. Confronted with a more efficient equal public good, intermediate beneficiaries earned less from the unequal public good. Lastly, high beneficiaries earned more from the unequal than from the equal public good when public goods had the same group-level efficiency. Confronted with a more efficient unequal public good, they also earned more from the unequal than from the equal public good, with the difference in MPCRs larger than when both public goods provide the same group-level efficiency. Confronted with a more efficient equal public good, high beneficiaries earned the same from both public goods.

Beneficiary Position. To test Replication Hypothesis 2 and Main Hypothesis 3, we grouped trials in a three-level (relative efficiency of the unequal-returns public good: falling short of, matching, or exceeding the equal-returns public good) within-subject factorial design. In both experiments, it was made clear to participants that they would be randomly assigned to one position in which they would stay for the whole experiment. Participants in Experiment 1 were not informed about their position, and thus did not know whether they were the low, intermediate, or high beneficiary from the public good with unequal return. This allowed for a "clean" test of Replication Hypothesis 2 that, when given a choice, people prefer to cooperate on equal-returns rather than unequal-returns public goods. In Experiment 2, participants were informed about their beneficiary position, which allowed us to test Replication Hypotheses 2 and 2a, and Main Hypotheses 3a and 3b. Experiment 2 thus had a 3 (relative efficiency of the unequal-returns public good: falling short of, matching or exceeding the equal-returns public good) × 3 (beneficiary position: low vs. intermediate vs. high) with the second factor between subjects.

Measures and Statistical Analyses

For each decision trial, we recorded how much individuals contributed from their 10 MUs to the two public goods. A decision trial concluded by asking individuals to indicate how much they expected the other two individuals in their group to have contributed to each public good. This measure of expectations was included for exploratory reasons.

Cooperation. To test Replication Hypothesis 1, we collapsed across the data from the three relevant decision trials from Experiments 1 and 2 (total $N = 139$) and performed a paired-samples Wilcoxon test. All remaining hypotheses were tested with the data of Experiments 1 and 2 separately, using mixed-model analyses of variance (ANOVAs), implemented with the R-package afex. Whenever appropriate, degrees of freedom and p-values were Greenhouse–Geisser-corrected and Tukey-adjusted for multiple comparisons. To test Replication Hypothesis 2, we performed a 3 (efficiency condition: unequal-public good efficiency falling short of, matching, or exceeding equal-public good efficiency) × 2 (public good: equal-returns public good vs. unequal-returns public good) mixed-model ANOVA with repeated measures. In Experiment 2, we performed a mixed 3 (between: low, intermediate, or high beneficiary position) × 3

(within: efficiency condition: unequal-public good efficiency falling short of, matching, or exceeding equal-public good efficiency) × 2 (within: public good: equal-returns public good vs. unequal-returns public good) ANOVA in *R*.[1]

Expectations. To assess participants' expectations of their fellow group members' cooperation, we asked after each decision round "How do you expect member [1, 2, 3] to allocate their endowment?" Participants indicated on a scale from 0 to 10 how many MUs they expected their fellow members to keep and contribute to the equal public good and the unequal public good. Each participant thus indicated their expectation twice after each round, once toward each other member in their group. To incentivize participants to report actual expectations, we informed them that they would earn a bonus of 5 MUs if their indications matched the actual decisions made by the other two members in one randomly selected round. We only report expectations from Experiment 2, in which participants were aware of their and the other members' beneficiary positions and could thus form meaningful expectations of the others' behavior.

To test differences in expected contributions, we split the analyses per position and performed three separate rmANOVAs including efficiency condition and the target of the expectation as predictors. For ease of interpretation, we further conducted three rmANOVAs with the dependent variable being a difference score of expected equal public good contributions minus expected unequal public good contributions. Positive values thus indicate relatively higher expected cooperation on the equal public good, while negative values indicate relatively higher expected cooperation on the unequal public good.

SVO and Inequality Aversion. From the first part of the SVO-slider measure, we obtained the continuous SVO angle. From the second part, we derived the inequality aversion index, ranging between 0 (*perfect inequality aversion*) and 1 (*perfect joint gain maximization*) (Ackermann & Murphy, 2012). Whereas Experiment 1 had too small a sample to test for possible interactions with social values orientation or inequality aversion, in Experiment 2 and subsequent experiments we used mixed-effect models in *R* to explore how cooperation in the multiple-public-goods game is conditioned by either SVO or inequality aversion. Few effects emerged and often did not replicate across experiments, and we thus exclude these analyses below (but full model results can be found in Tables S15 and S16 in the online supplemental materials).

Results

Descriptive Statistics

Table 1 shows the means and standard deviations of cooperation when the unequal-returns public good fell short of, matched, or exceeded the efficiency of the equal-returns public good in Experiments 1–4. Table 2 presents means and standard deviations of expected cooperation as a function of the efficiency condition, one's own position, the target's position, and whether cooperation was expected on the equal versus unequal public good. Figure S6 in the online supplemental materials shows the distribution of the inequality aversion index in our samples.

Cooperation

Confirming Replication Hypothesis 1, when given a choice between two equal-returns public goods, participants contributed 44% of their endowment to the more efficient public good, and 9% to the less efficient public good (collapsed across Experiments 1 and 2: paired-samples Wilcoxon test, $V = 44{,}823$, $p < .001$, total $N = 139$; results replicate when analyzing the data of Experiments 1 and 2 separately). Replication Hypothesis 2, that individuals cooperate more on public goods with equal rather than unequal returns, received qualified support in Experiments 1 and 2. In Experiment 1, participants cooperated more on the equal- rather than unequal-returns public good when the equal public good met or exceeded the efficiency of the unequal public good. When the equal-returns public good was less efficient, they cooperated more on the unequal-returns public good—Efficiency Condition × Public Good: $F(1.36, 44.98) = 25.77$, $p < .002$, $\eta_p^2 = .44$ (Figure 2A). Moreover, contributions to the unequal public good appeared to increase disproportionately when it was also the more efficient public good—main effect of efficiency condition, $F(1.69, 55.69) = 3.33$, $p = .051$, $\eta_p^2 = .09$ (Table 1). While not significant here, we replicated this effect in Experiment 2 (see below).

Experiment 2 extended these results. Participants contributed 33% of their endowment to an equal-returns public good and 23% to an unequal-returns public good, $F(1, 102) = 18.16$, $p < .001$, $\eta_p^2 = .15$, again only when the equal public good matched or exceeded the efficiency of the unequal public good—Efficiency Condition × Public Good: $F(1.52, 153.84) = 58.47$, $p < .001$, $\eta_p^2 = .36$ (Table 1). When the unequal public good was more efficient, participants contributed more to the unequal public good. Also, as in Experiment 1, individuals cooperated most (least) overall when the most efficient public good gave unequal (equal) returns—efficiency condition: $F(1.97, 201.25) = 6.03$, $p = .003$, $\eta_p^2 = .06$. Possibly, public good efficiency weighs as much as, if not more than (in)equality in returns.

Unlike participants in Experiment 1, those in Experiment 2 knew whether they were the low, intermediate, or high beneficiary from the unequal-returns public good. Low (intermediate) beneficiaries contributed 33% (37%) of their endowment to the equal-returns public good and 16% (22%) to the unequal-returns public good. High beneficiaries, in contrast, contributed 28% to the equal-returns and 31% to the unequal-returns public good—Position × Public Good interaction: $F(2.00, 102.00) = 7.76$, $p = .001$, $\eta_p^2 = .13$. The high beneficiaries' preference for the unequal public good was stronger when the unequal-returns public good was more rather than equally or less efficient (Figure 2B).

Expectations

To understand why, besides potential personal gain maximization, high beneficiaries in Experiment 2 were most cooperative when the unequal-returns public good was most efficient, we analyzed their expectations regarding contributions made by the low

[1] Analyses including the across-public good efficiency as a predictor in the models showed, on average, that participants cooperated more when the overall efficiency was higher, yet also that results generalized across different levels of the cross-public good efficiency. The cross-public good efficiency is therefore further ignored, and contributions are always averaged across the three levels. Similarly, analyses including binary gender in the models revealed no reliable gender effects. Only in Experiment 4, men, on average, had a stronger preference than women for the unequal public good when it was more efficient. Experiments 1, 2, and 3 did not confirm this finding. Hence, participants' gender is also further ignored (but see Tables S5 and S6 in the online supplemental materials).

Table 1
Cooperation on Multiple PGs as a Function of Efficiency Condition and (In)Equality in Returns

	Contribution					
	Equal PG		Unequal PG		Total	
Relative efficiency	*M*	*SD*	*M*	*SD*	*M*	*SD*
Experiment 1 ($N = 34$)						
Equal PG > unequal PG	$4.44^{a,x}$	3.01	$1.01^{b,x}$	1.26	2.73^{x}	2.87
Equal PG = unequal PG	$3.17^{a,y}$	2.79	$2.59^{b,y}$	2.32	$2.88^{x,y}$	2.58
Equal PG < unequal PG	$1.71^{a,z}$	2.39	$4.35^{b,z}$	3.45	3.03^{y}	3.25
Total	3.11^{a}	2.96	2.65^{b}	2.85	2.88	2.91
Experiment 2 ($N = 105$)						
Equal PG > unequal PG	$4.10^{a,x}$	3.18	$1.17^{b,x}$	1.94	2.63^{x}	3.01
Equal PG = unequal PG	$3.58^{a,y}$	3.01	$1.99^{b,y}$	2.38	$2.79^{x,y}$	2.82
Equal PG < unequal PG	$2.13^{a,z}$	2.47	$3.62^{b,z}$	3.19	2.87^{y}	2.95
Total	3.27^{a}	3.02	2.26^{b}	2.75	2.77	2.93
Experiment 3 ($N = 369$)						
Equal PG > unequal PG	$4.09^{a,x}$	3.11	$1.11^{b,x}$	1.58	2.60^{x}	2.88
Equal PG = unequal PG	$3.32^{a,y}$	2.85	$1.89^{b,y}$	2.23	2.60^{x}	2.66
Equal PG < unequal PG	$2.29^{a,z}$	2.55	$3.32^{b,z}$	3.06	2.81^{y}	2.86
Total	3.23^{a}	2.94	2.11^{b}	2.54	2.67	2.80
Experiment 4 ($N = 273$)						
Equal PG > unequal PG	$3.91^{a,x}$	3.22	$1.37^{b,x}$	1.92	2.64^{x}	2.94
Equal PG = unequal PG	$3.31^{a,y}$	3.07	$2.19^{b,y}$	2.58	2.75^{x}	2.89
Equal PG < unequal PG	$2.17^{a,z}$	2.44	$3.65^{b,z}$	3.37	2.91^{y}	3.03
Total	3.13^{a}	3.02	2.40^{b}	2.85	2.77	2.96

Note. PG = public good.
[a,b] Contrasts between the columns, which are all significant. [x,y,z] Contrasts between rows. Different superscripts represent means that differ significantly from each other (e.g., [x] and [y] but not [x] and [x,y]).

and intermediate beneficiaries (Table 2 and Figure 3). This showed that expectations depended on the relative efficiency of the unequal-returns public good—Public Good × Target × Efficiency Condition: $F(1.44, 46.18) = 8.08$, $p = .003$, $\eta_p^2 = .20$. Per the difference scores for expectations regarding the two public goods in Figure 3, high beneficiaries expected low and intermediate beneficiaries to contribute more to the equal than unequal public good when the former was more or equally efficient. Intermediate (vs. low) beneficiaries were expected to contribute comparatively more to the unequal-returns public good when it was most efficient as well. In short, high beneficiaries cooperate substantially on the most efficient but unequal-returns public good and (erroneously) expect others to do the same (complementary analyses for low and intermediate beneficiary are presented in Figure S4A–S4D and Table S7 in the online supplemental materials).

Discussion of Experiments 1–2 and Introduction to Experiments 3–4

In Experiments 1 and 2, when given a choice among multiple public goods to cooperate on, individuals contributed more to efficient rather than inefficient public goods, and more to public

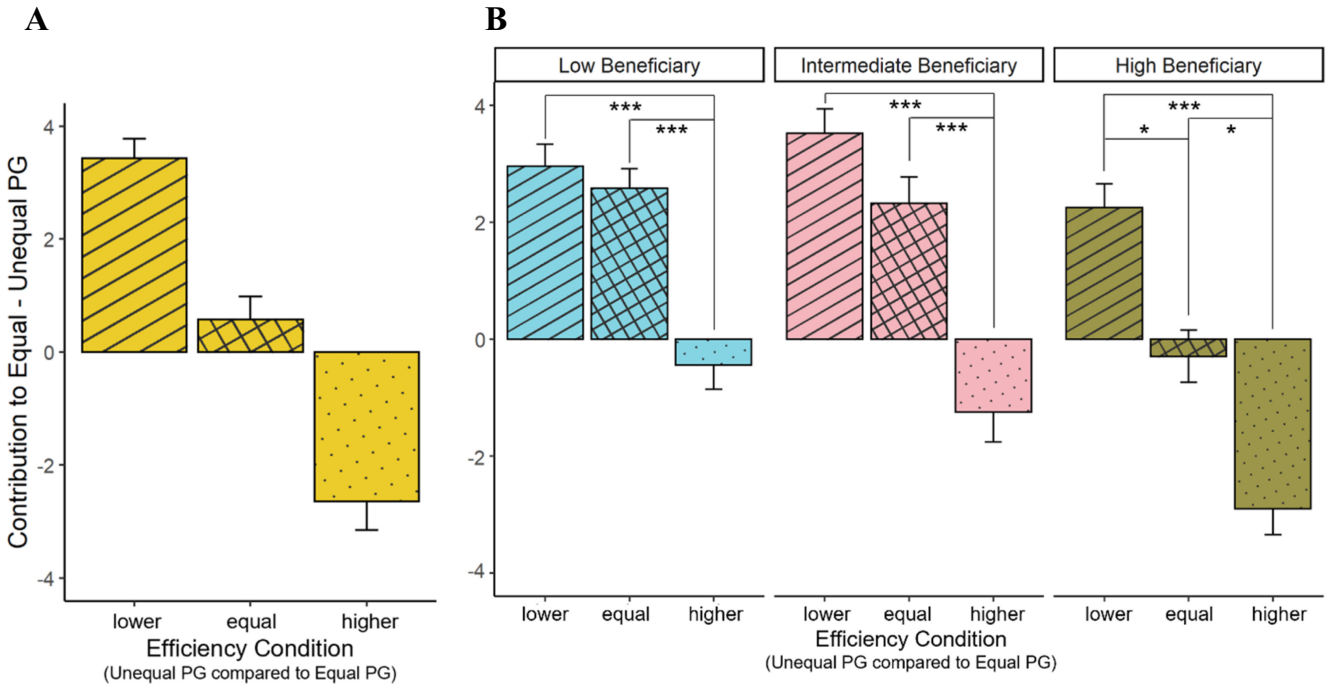
Table 2
Means (Standard Deviations) of the Expected Contributions to Multiple PGs as a Function of Efficiency Condition, Position, Target Position, and (In)Equality in Returns in Experiment 2

		Equal PG			Unequal PG		
Condition	Own position	LB[a]	IB	HB	LB	IB	HB
Equal PG > unequal PG	LB		3.76 (2.85)	3.00 (2.49)		1.22 (1.70)	2.40 (2.46)
	IB	4.68 (3.01)		3.84 (3.25)	1.00 (1.50)		2.02 (2.31)
	HB	4.23 (2.55)	4.15 (2.70)		1.24 (1.67)	1.51 (1.98)	
Equal PG = unequal PG	LB		3.18 (2.69)	1.76 (1.93)		2.08 (2.24)	3.88 (2.82)
	IB	4.62 (2.85)		2.35 (2.42)	1.24 (1.67)		4.06 (3.00)
	HB	3.83 (2.59)	3.13 (2.27)		1.54 (1.91)	2.49 (1.97)	
Equal PG < unequal PG	LB		1.86 (2.32)	1.29 (1.65)		3.28 (2.84)	4.42 (3.18)
	IB	2.86 (2.60)		1.46 (1.75)	2.73 (2.77)		4.66 (3.29)
	HB	2.48 (1.81)	1.58 (1.72)		2.96 (2.59)	4.36 (2.85)	

Note. PG = public good; LB = low beneficiary; IB = intermediate beneficiary; HB = high beneficiary.
[a] Target positions.

Figure 2

Cooperation as a Function of Efficiency Condition, (In-)Equality of Returns, and Position



Note. (A) Results for Experiment 1 and (B) results for Experiment 2, broken down by the participants' beneficiary positions. Displayed are means, error bars represent ± 1 standard error. Connectors show planned contrast. PG = public good. See the online article for the color version of this figure.
* $p < .05$. *** $p < .001$.

goods with equal rather than unequal returns. Crucially, however, findings suggest that when equality could not be attained without sacrificing efficiency, individuals who benefitted most from the unequal-returns public good substantially increased their cooperation on this unequal but highly efficient public good. This comparatively high cooperation matched the high beneficiaries' expectations about the contributions made by intermediary beneficiaries, perhaps reflecting a "noblesse oblige" among high beneficiaries. If true, high beneficiaries' contributions may depend on whether they acquired their position through luck (as in Experiments 1 and 2) or effort. Indeed, when positions are effort-based and "deserved" rather than the result of a lucky coincidence, people generally accept advantageous inequity more (Deutsch, 1985; Harth et al., 2008) and cooperation does not differ between low and high beneficiaries (Cappelen et al., 2007; Gee et al., 2017; van Dijk & Wilke, 1993).

Our first goal in Experiments 3 and 4 was, accordingly, to examine whether and to what extent results from Experiment 2 replicate when position assignment is based on effort rather than luck. Our second goal was to explore whether individuals hold different preferences about the choice architecture of the multiple-public-goods game, depending on how much they benefit from the unequal-returns public good. Following multiple-public-goods provision, individuals were given the opportunity to vote for changing the choice architecture of one more trial with a more efficient unequal public good. This allowed us to gain an additional perspective on individuals' preferences when being confronted with multiple public goods that differ in equality and efficiency.

Method

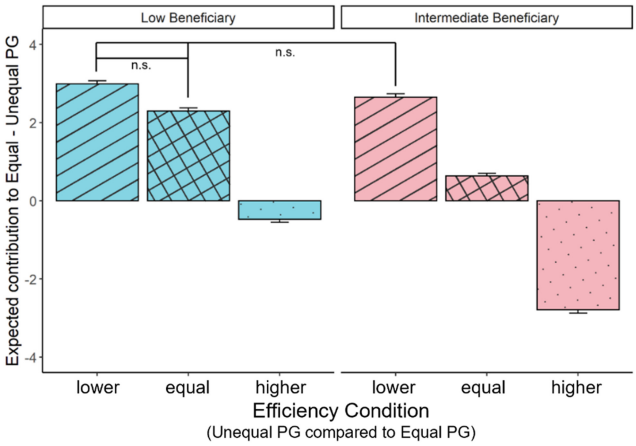
Research Ethics, Sample Size, and Participants

Both experiments received ethics approval (2020-09-01-R. Pliskin-V1-2595, 2021-03-02-R. Pliskin-V2-2928) and were preregistered on AsPredicted.com (Experiment 3: https://aspredicted.org/OAL_YEY; Experiment 4: https://aspredicted.org/V3M_32L). Participants gave informed consent and received full debriefing upon completion of each study. Studies were incentivized and involved no deception. Including the baseline payment of 3.75 GBP/4.66 USD (Experiment 3) and 4.10 GBP/5.49 USD (Experiment 4) and earnings from the various decision tasks, participants earned a total average of 9.04 GBP/11.88 USD and 9.84 GBP/10.93 USD, respectively.

Sample sizes were estimated a priori assuming a low-to-medium effect size of $f = .25$, $\beta = 0.90$, and $\alpha = .05$ for within-subject effects, yielding a required sample of $N = 162$ for each experiment. We decided to oversample for two reasons. First, we included personality measures for an unrelated project that required larger sample sizes (see the preregistrations). Second, adding the between-subjects position assignment doubled the required sample size, and we guaranteed there would be enough full groups after (a) removing dropouts after Part 1 in Experiment 3 and (b) matching participants in Experiment 4. According, using the Prolific platform, we recruited a total of $N = 400$ participants in Experiment 3, resulting in $N = 369$ participants after removing dropouts ($M_{age} = 26.23$, $SD_{age} = 5.02$; 222 women, 143 men, two preferred not to share, two

Figure 3

High Beneficiaries' Expectations About Cooperation on the Equal-Returns Relative to the Unequal-Returns PG by Low and Intermediate Beneficiaries (Experiment 2)



Note. Positive (negative) values represent relatively higher expected contributions to the equal (unequal) public good. Displayed are means, error bars represent ± 1 standard error. All contrasts differ significantly, except for the ones indicated with "n.s." PG = public good; n.s. = nonsignificant. See the online article for the color version of this figure.

self-identified; U.K. and U.S. residents). In Experiment 4, we recruited $N = 300$ participants, resulting in $N = 273$ after removing incomplete groups ($M_{age} = 33.15$, $SD = 10.69$; 142 women, 122 men, nine nonbinary or third gender; U.K. and U.S. residents).

Procedure

Procedures, experimental treatments, and materials were identical to those for Experiment 2, with two exceptions. First, half of the participants were randomly assigned to the beneficiary position (as in Experiment 2) and the other half were assigned based on their performance on an effort task prior to public-goods provision. Second, following the nine-round multiple-public-goods provision task, participants in Experiments 3 and 4 performed a separate "voting" task to assess their preferences for and aversions of possible configurations of multiple-public-goods provision problems.

Effort Tasks

In Experiment 3, participants completed two parts, with Part 1 implemented 3 days before Part 2. Part 1 included personality measures (as in Experiments 1 and 2) and an effort task based on which participants in the effort condition (but not the random condition) were assigned to be low, intermediate, or high beneficiary in the (Part 2) public good provision task. In Experiment 4, participants completed (in this order) the effort task, the main experiment, the voting task, and personality measures at one timepoint.

For the effort task, participants were randomly allocated to the effort (vs. random) condition and read (vs. did not read) that their performance on the task would determine their position in a subsequent task (which, in Experiment 3, they would complete in Part 2) from which they could earn additional money. Participants then performed a variation of the effort slider task (Gill & Prowse, 2012). In Experiment 3, they were presented with 60 sliders, grouped in sets of three (see Figure S2 in the online supplemental materials for visuals). A target integer number ranging from 1 to 200 was listed above each set, and participants needed to adjust as many sliders as possible to this number within a time limit of 2 min (as indicated by a countdown on the page). In Experiment 4, we modified the effort slider task to create a more powerful manipulation. The modified task consisted of 72 sliders presented in groups of three, with target numbers no longer confined to integers and ranging from 1 to 50, to be correctly adjusted in 4 min. Participants in Experiment 4 were assigned their position based on cutoff scores we obtained from the score distribution of uninvolved participants in a separate pilot study. Across experiments, performance was incentivized such that each correctly adjusted slider yielded 1 penny/U.S. cent, meaning that a maximum of 60 (Experiment 3) or 72 (Experiment 4) pence/cents could be earned from this task.

Before participants engaged in the multiple-public-goods tasks, those allocated to the effort condition were told that their position was based on their relative performance in the effort task, such that the 33% highest performers would be high beneficiaries, the 33% lowest performers would be low beneficiaries, and those in between would be intermediate beneficiaries. Those allocated to the random condition were told that their position in the multiple-public-goods tasks was assigned at random.

Voting Task

The voting task consisted of two phases and was a strategy-method adaptation of the relative efficiency condition when the unequal public good exceeded the efficiency of the equal public good. In Phase 1, participants were endowed with an extra 10 MUs to keep to themselves or spend on voting to remove or retain the equal-returns public good and/or to remove or retain the (more efficient) unequal-returns public good (see Figure S3 in the online supplemental materials for visuals). They were instructed that all votes to remove a public good would be tallied against votes to retain it, so that a public good would only be present if votes to retain it prevailed or matched the votes to remove it; otherwise, the public good would be removed from the set. Accordingly, participants could change the choice architecture of the multiple-public-goods provision problem. In the second phase, they indicated how much they would contribute to the public good(s) in each possible resulting scenario: when only the equal-returns public good would be removed, when only the (more efficient) unequal-returns public good would be removed, or when no public good would be removed. It was explained that the scenario would be selected based on the group's votes, and that decisions counted toward their earnings from this voting task.

Statistical Analyses

For contributions, expectations, SVO, and inequality aversion, we performed the same mixed-model ANOVAs as those used in Experiment 2, with the additional between-subjects factor position assignment (random or effort-based). Data for the voting tasks were analyzed in two ANOVAs. Voting decisions were submitted to a mixed 2 (position assignment: random or effort-based) × 3 (beneficiary position: low, intermediate, or high) × 4 (option to remove/retain the equal-returns public good or remove/retain the unequal-returns

public good) ANOVA. To examine cooperation in different "removal" scenarios, we performed a 2 (position assignment: random or effort-based) × 3 (beneficiary position: low, intermediate, or high) × 2 (public good: equal-returns vs. unequal-returns) × 2 (equal-returns public good removed or retained) × 2 (unequal-returns public good removed or retained) mixed-model ANOVA with position assignment and beneficiary position between subjects.

Results

Cooperation

As before, cooperation was highest overall when the unequal-returns public good was more efficient than the equal-returns public good (Experiment 3: 56%; Experiment 4: 58%; see Table 1) and lowest overall when the unequal-returns public good was less efficient—Experiment 3: 52%, $F(1.99, 721.01) = 22.02$, $p < .001$, $\eta_p^2 = .06$; Experiment 4: 53%, $F(1.97, 525.68) = 17.68$, $p < .001$, $\eta_p^2 = .06$ (see Table S9 in the online supplemental materials for test statistics). Participants contributed 33% (Experiment 4: 37%) of their endowment to the unequal-returns public good when it was more efficient than the equal-returns public good (Experiment 3: 23%; Experiment 4: 22%). Conversely, participants contributed 41% (39%) to the equal-returns public good when it was the more efficient one, and only 11% (14%) to the less efficient, unequal-returns public good—Efficiency Condition × Public Good; Experiment 3, $F(1.47, 535.28) = 162.59$, $p < .001$, $\eta_p^2 = .31$; Experiment 4, $F(1.38, 364.05) = 110.44$, $p < .001$, $\eta_p^2 = .29$.

As in Experiment 2, participant position shaped contributions to the two public goods (see Figure 4A and 4B)—Position × Public Good: Experiment 3, $F(2, 363) = 15.67$, $p < .001$, $\eta_p^2 = .08$; Experiment 4, $F(2, 267) = 15.95$, $p < .001$, $\eta_p^2 = .11$; Position × Public Good × Efficiency Condition: Experiment 3, $F(2.95, 535.28) = 6.51$, $p < .001$, $\eta_p^2 = .04$; Experiment 4, $F(2.73, 364.05) = 8.26$, $p < .001$, $\eta_p^2 = .06$. Low and intermediate beneficiaries cooperated more on the equal-returns public good when it was as efficient as (low: 35% and intermediate: 36%[2] of their endowment) or more efficient than (39% and 40%) the unequal-returns public good, compared to when the equal-returns public good was less efficient (27% and 22%). As can be seen in Table S1 in the online supplemental materials, however, low beneficiaries did not differentiate between the less efficient equal- and more efficient unequal-returns public goods, which provided them personally with the same return on investment (across experiments, 27% to the equal vs. 24% to the unequal public good)—Experiment 3, $t(1016) = 0.880$, $p = .379$; Experiment 4, $t(733) = 1.220$, $p = .223$. A markedly different pattern emerged for high beneficiaries who, as in Experiment 2, contributed more to the equal-returns public good when it met (29%) or exceeded (41%) the efficiency of the unequal-returns public good, than when it was less efficient (18%; for individuals' returns in the different conditions, see Table S1 in the online supplemental materials). Moreover, when the unequal-returns public good was also the most efficient, high beneficiaries (and to some lesser degree intermediate beneficiaries) contributed 46% of their endowment to the unequal-returns public good, considerably more than the 18% they contributed to the equal-returns public good.

Cooperation in Experiments 3 and 4 was not influenced by the way positions were assigned. Although in Experiment 3 random versus effort assignment of positions qualified the Position × Public Good × Efficiency effect, $F(2.95, 535.28) = 6.91$, $p < .001$, $\eta_p^2 = .04$, we did not find this complex effect in Experiment 4, $F(2.73, 364.05) = 1.52$, $p = .213$, $\eta_p^2 = .01$. We thus refrain from interpreting this four-way interaction and conclude that results for (interactions among) position, public good returns, and efficiency condition are not reliably conditioned by the basis for assigning participants to their beneficiary position.

Expectations

As in Experiment 2, high beneficiaries expected the low and intermediate beneficiaries in their group to contribute more to the equal-returns public good than to the unequal-returns alternative—Public Good: Experiment 3, $F(1, 125) = 55.79$, $p < .001$, $\eta_p^2 = .31$; Experiment 4, $F(1, 90) = 32.60$, $p < .001$, $\eta_p^2 = .27$; Public Good × Target: Experiment 3, $F(1, 125) = 85.39$, $p < .001$, $\eta_p^2 = .41$; Experiment 4, $F(1, 90) = 73.84$, $p < .001$, $\eta_p^2 = .45$ (see Table 3 for descriptive statistics; and Tables S7 and S8 in the online supplemental materials for full results). As in Experiment 2, we also found that high beneficiaries' expectations of contributions by low and intermediate beneficiaries depended on the relative efficiency of the unequal-returns public good—Public Good × Target × Efficiency Condition, $F(1.79, 223.17) = 22.24$, $p < .001$, $\eta_p^2 = .15$ and $F(1.89, 169.80) = 12.99$, $p < .001$, $\eta_p^2 = .13$ for Experiments 3 and 4, respectively (analyses of low and intermediate beneficiary are provided in Figure S5C–S5F and Table S7 in the online supplemental materials).

Figure 5A and 5B shows that high beneficiaries expected both low and intermediate beneficiaries to cooperate more on the equal- than on the unequal-returns public good when the equal public good was more efficient. High beneficiaries also expected the others to cooperate more on the equal than unequal public good when both public goods were equally efficient, although the difference in expected contributions was much smaller for intermediate beneficiaries whose personal return on investment was the same from both public goods. Intermediate more than low beneficiaries were, however, expected to contribute comparatively more to the unequal public good when it was the more efficient public good as well.

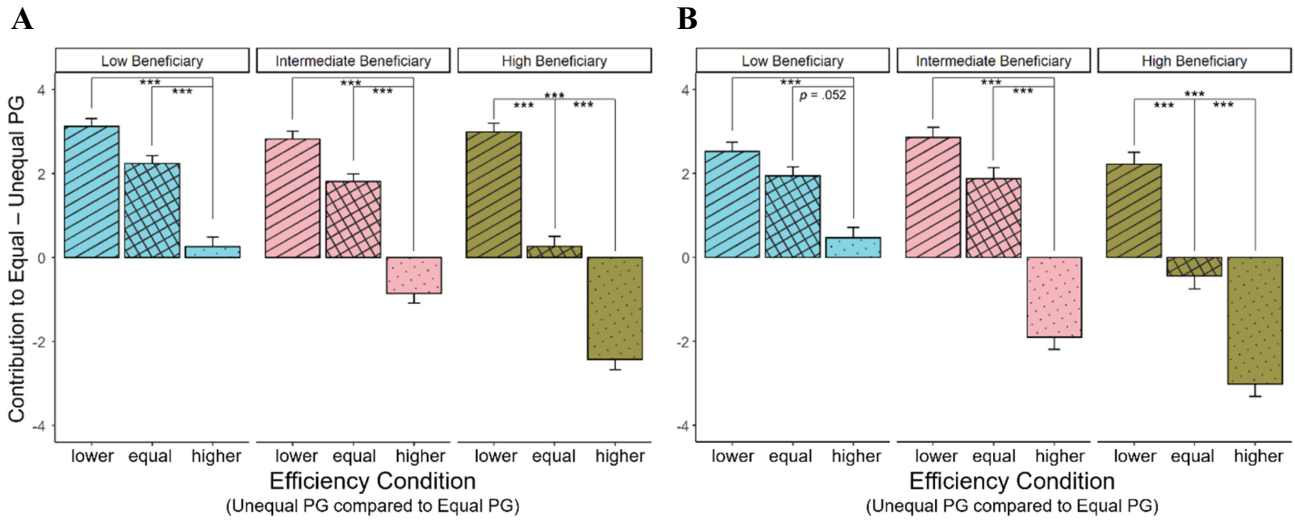
Reconfiguring Multiple-Public-Goods Problems

We concluded analyses by examining how participants reconfigured a multiple-public-goods problem in which efficiency cannot be maximized without creating inequality in returns. Participants in Experiments 3 and 4 invested, on average, 27% of their voting endowment in keeping the equal public good, significantly more than the 3% invested in removing it—Experiment 3, $F(2.55, 924.32) = 99.74$, $p < .001$, $\eta_p^2 = .22$; Experiment 4, $F(2.45, 653.54) = 61.70$, $p < .001$, $\eta_p^2 = .19$ (see Tables S10 and S12 in the online supplemental materials for test statistics and descriptives). In addition, only high beneficiaries invested significantly more in keeping (19%) than in removing (8%) the more efficient yet unequal public good—Experiment 3, $F(5.09, 924.32) = 3.49$, $p = .004$, $\eta_p^2 = .02$; Experiment 4, $F(4.90, 653.54) = 5.10$, $p < .001$, $\eta_p^2 = .04$ (Figure 6A and 6B). Especially low beneficiaries invested so that the more efficient but unequal public good would be removed from the multiple-public-goods problem they

[2] We report averaged percentages across Experiments 3 and 4, since the values were highly similar.

Figure 4

Cooperation as a Function of Efficiency Condition, Position, and (In-)Equality of Returns



Note. (A) Experiment 3 with $N = 369$ and (B) Experiment 4 with $N = 273$. Positive (negative) values represent relatively higher contributions to the equal-returns (unequal-returns) PG. Displayed are means, error bars represent ± 1 standard error. Connectors show planned contrast. PG = public good. See the online article for the color version of this figure.
*** $p < .001$.

faced, namely 14% of their voting endowment. Whether participants were assigned at random or based on effort had no significant influence on voting decisions.

In the second, "strategy method" phase of the voting task, participants responded to the possible outcomes of voting phase 1. Should the more efficient unequal-returns public good be removed and only the less efficient equal-returns alternative retained, low and intermediate beneficiaries would both contribute 26% of their endowment, which is more than when only the unequal-returns public good would have been retained (low beneficiary: 18%, intermediate beneficiary: 20%)—Position × Public Good × Equal Public Good Removed/Remained × Unequal Public Good Removed/Remained: Experiment 3, $F(2, 363) = 2.75$, $p = .065$, $\eta_p^2 = .02$; Experiment 4, $F(2, 267) = 3.06$, $p = .049$, $\eta_p^2 = .02$ (Figure 6C and 6D; see Tables S11 and S13 in the online supplemental materials).

This may seem surprising, because returns on investments are the same on an individual level (for low beneficiaries) or even higher for the unequal compared to the equal public good. At the same time, however, overall cooperation (vs. selfish keeping) dropped considerably from 48% of the endowment when both public goods would be remained to 27% when individuals could only cooperate on the equal-returns public good—Equal Public Good Removed/Remained × Unequal Public Good Removed/Remained: Experiment 3, $F(1, 363) = 332.57$, $p < .001$, $\eta_p^2 = .48$; Experiment 4, $F(1, 267) = 279.23$, $p < .001$, $\eta_p^2 = .51$).

Discussion Experiments 3 and 4 and Introduction to Experiment 5

Experiments 1–4 showed that cooperation and expectations depend on whether individuals are high versus low beneficiaries of unequal-returns public goods. Experiments 3 and 4 further showed that this general tendency was largely unaffected by how one's beneficiary position was acquired—through luck or based on merit. With substantial statistical power and different ways of manipulating effort, we cautiously conclude that cooperation in multiple-public-goods provision problems does not depend on the reason individuals benefit more or less from a public good's returns. Experiments 3 and 4 further showed, using a voting mechanism, that individuals on average prefer to retain the equal-returns public good and that low (but not intermediate or high) beneficiaries voted to remove the more efficient unequal-returns public good. Preferences in the "voting" task thus mirror cooperation patterns in the multiple-public-goods game.

Across experiments we consistently observed that low beneficiaries ignored the efficiency parameter when making contributions, expected others to preferentially contribute to equal-returns public goods and, when given a chance, voted out the unequal-but-efficient public good. High beneficiaries, in contrast, incorporated the efficiency parameter in their contributions, (erroneously) expected others to do the same, and voted to keep the unequal-but-efficient public good when given a chance. From a bird's eye perspective, these patterns of results suggest that participants were somewhat opportunistic in their cooperation and expectations—cooperating where it served them personally best and expecting others to do the same. Perhaps such opportunism is grounded in the participants' vested interest in the outcomes of multiple-public-goods provision, meaning that uninvolved third parties may hold different expectations and fairness norms about public good cooperation.

Extensive evidence suggests that cooperation is shaped by normative considerations (Balliet et al., 2011; Bicchieri, 2016; Fehr & Fischbacher, 2004; Fehr & Schurtenberger, 2018; Young, 2008). Such considerations can be more or less ambivalent: When third parties were asked to judge which contribution norm was fair in a single-unequal-public good game, participants heavily diverged from each other (Reuben & Riedl, 2013). Players in the game, on the other hand, converged on contribution rules, with low beneficiaries

Table 3
Means (Standard Deviations) of the Expected Contributions to Multiple PGs as a Function of Efficiency Condition, Position, Target Position, and (In)Equality in Returns

		Experiment 3						Experiment 4					
		Equal PG			Unequal PG			Equal PG			Unequal PG		
Condition	Own position	LB[a]	IB	HB	LB	IB	HB	LB	IB	HB	LB	IB	HB
Equal PG > unequal PG	LB		4.00 (2.66)	3.33 (2.65)		1.40 (1.67)	2.27 (2.21)		4.02 (2.88)	3.21 (2.57)		1.44 (1.68)	2.41 (2.21)
	IB	3.89 (2.81)		3.19 (2.73)	1.05 (1.47)		2.14 (2.18)	4.19 (3.21)		3.42 (3.00)	1.21 (1.65)		2.32 (2.34)
	HB	4.01 (2.94)	3.98 (2.87)		0.92 (1.41)	1.09 (1.61)		4.37 (3.25)	4.21 (3.31)		1.01 (1.47)	1.23 (1.76)	
Equal PG = unequal PG	LB		3.08 (2.36)	2.07 (2.11)		2.38 (2.25)	3.70 (2.85)		3.17 (2.39)	2.21 (2.15)		2.16 (2.01)	3.56 (2.76)
	IB	3.60 (2.49)		2.02 (2.16)	1.22 (1.50)		3.52 (2.49)	3.98 (3.16)		1.92 (2.18)	1.35 (1.81)		4.20 (3.18)
	HB	3.84 (2.86)	3.30 (2.66)		1.17 (1.61)	2.07 (2.02)		4.17 (3.21)	3.48 (2.96)		1.19 (1.73)	2.33 (2.30)	
Equal PG < unequal PG	LB		1.94 (1.90)	1.64 (1.78)		3.82 (2.85)	4.46 (3.05)		2.14 (2.17)	1.89 (1.98)		3.72 (2.82)	4.28 (2.82)
	IB	2.72 (2.18)		1.78 (1.94)	2.35 (2.17)		4.22 (2.78)	3.04 (2.65)		1.64 (1.75)	2.81 (2.84)		4.94 (3.23)
	HB	2.50 (2.34)	1.75 (2.18)		2.95 (2.72)	4.19 (2.98)		2.56 (2.43)	1.71 (1.97)		3.03 (2.93)	4.53 (3.27)	

Note. PG = public good; LB = low beneficiary; IB = intermediate beneficiary; HB = high beneficiary.
[a] Target positions.

enforcing an equal-earnings norm and high beneficiaries enforcing an equal-contributions norm. Such differences between cooperation norms by uninvolved participants and cooperation behavior by involved participants could be rooted, for instance, in players' expectations and wishful thinking. Other work has revealed that a third party evaluating equality is mainly concerned with fairness, whereas involved individuals can be driven by other motivations such as self-interest, social comparison, and envy (e.g., Gordon-Hecker, Choshen-Hillel, et al., 2017). Asked to dream up an ideal society, third parties chose policies that move all citizens above the poverty line, at the cost of a lower mean income (Mitchell et al., 1993)—thereby prioritizing equality over group efficiency.

To examine potential cooperation norms that are unbiased by personal interest, we performed our final Experiment 5 in which we considered third-party descriptive and injunctive norms, respectively mapping what people think is generally done and what people think should be done (Cialdini et al., 1990). If third party norm patterns mirror players' own expectations, we can rule out the influence of self-interested wishful thinking. If third party norm patterns diverge, expectations in Experiments 1–4 may be self-biased and more aligned with an "opportunism" explanation. Any differences between descriptive and injunctive norms could indicate a (value) conflict, which has been shown to weaken intentions to engage in prosocial behavior (Göckeritz et al., 2010; McDonald et al., 2013; Smith et al., 2012).

Method

Research Ethics, Sample Size, and Participants

We collected data from $N = 120$ participants from the United States of America and the United Kingdom via Prolific ($M_{age} =$ 33.16, $SD = 11.05$; 40.8% women, one nonbinary). The study received ethics approval (2021-03-02-R. Pliskin-V2-2928) and was preregistered along with Experiment 4 (https://aspredicted.org/V3M_32L). Participants read the information letter, indicated their informed consent, and, upon completing the study, received a written debriefing.

Procedure

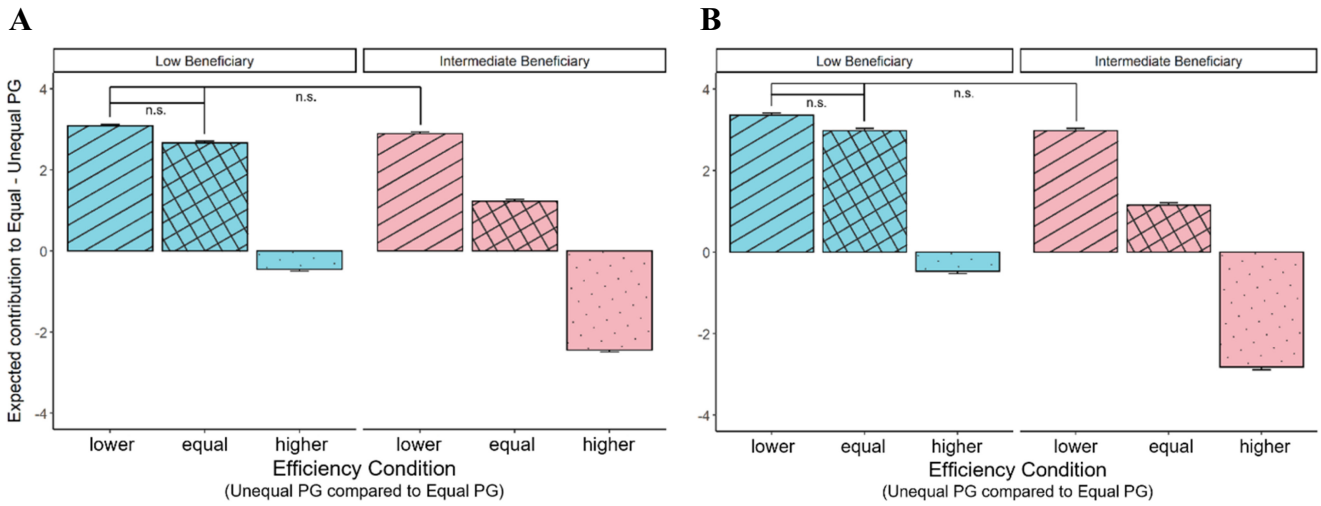
Participants first completed the effort slider task (see Experiment 4) and then were presented with a paraphrased Part 1 of the Krupka–Weber method for eliciting injunctive norms (also see Figure S4 in the online supplemental materials):

> After you read the description of the scenario, you will be asked to indicate which choices available to Members 1, 2, and 3 are the "socially appropriate" ones to make, and "consistent with moral or proper social behavior." By "socially appropriate," we mean behavior that most people agree is the "correct" or "ethical" thing to do. Another way to think about what we mean is that if Members 1, 2, or 3 were to select a socially inappropriate choice, then someone else might be angry at them for doing so. We would like you to answer as truthfully as possible, based on your opinions of what constitutes socially appropriate behavior.

Thereafter, participants were given a detailed description of the multiple-public-goods provision problem, focusing on the situation in which the equal and unequal public good are equally efficient. This focus corresponded to our desire to understand the impact of unequal positions on cooperation, while ensuring that instructions were simple enough for uninvolved participants to follow, especially

Figure 5

High Beneficiaries' Expectations About Cooperation on the Equal-Returns Relative to the Unequal-Returns PG by Low and Intermediate Beneficiaries



Note. Experiment 3 (A) and Experiment 4 (B). Positive (negative) values represent relatively higher cooperation on the equal (unequal) PG. Displayed are means, error bars represent ± 1 standard error. All contrasts differ significantly, except for the ones indicated with "n.s." PG = public good; n.s. = nonsignificant. See the online article for the color version of this figure.

considering they needed to provide norms for all three beneficiary positions. Participants responded to comprehension checks about the rules of the game and proceeded to indicate the injunctive norm and then the descriptive norm for all three beneficiaries.

Injunctive norms were measured by asking participants what contribution they deemed "socially appropriate" for each of the three beneficiaries on a scale from 0 to 10 MUs. Because these norms do not correspond to expectations of actual behavior, we could not incentivize them. Descriptive norms were measured by asking participants to indicate how they expected three group members of different beneficiary positions, on average, to allocate their endowments when confronted with the multiple-public-goods problem. We incentivized correct predictions in descriptive norm responses by comparing them with participants' actual average contributions in Experiment 4, and paid a bonus of 90 cents/pence for each correct prediction, 60 cents/pence for a prediction deviating by up to 1 MU, and 30 cents/pence for deviating by up to 2 MUs. Following the measures of norms, participants responded to demographic questions and were debriefed.

Results

To test for differences in injunctive and descriptive norms for the two public goods, we performed one mixed model for each type of norm, including the equal versus unequal public good and the beneficiary position as predictors, and display the results in Figure 7A and 7B.

Injunctive Norms

Uninvolved third parties considered it more socially appropriate that participants contribute more to the equal than to the unequal public good ($\beta = -2.03$, 95% confidence interval [CI] = [−2.35; −1.70], $p < .001$). Furthermore, uninvolved participants deemed it appropriate for high beneficiaries to cooperate more overall than both low and intermediate beneficiaries, with no difference between the latter two ($\beta_{HL} = -0.68$, 95% CI = [−1.22, −0.13], $p = .016$; $\beta_{IL} = -0.50$, 95% CI = [−1.05, 0.05], $p = .075$).

Main effects were qualified by the public good to which contributions were made (Target Position × Public Good: $\beta_{IL} = 1.34$, 95% CI = [0.56, 2.12], $p < .001$; $\beta_{HL} = 2.51$, 95% CI = [1.73, 3.29], $p < .001$). While participants deemed it socially appropriate for all beneficiaries to contribute more to the equal than to the unequal public good—$t_L(605) = 3.31$, 95% CI = [2.75, 3.86], $p < .001$; $t_I(605) = 1.97$, 95% CI = [1.41, 2.52], $p < .001$; $t_H(605) = 0.80$, $p = .005$, 95% CI = [0.25, 1.35]—the reported difference in social appropriateness appears to be more pronounced for low beneficiaries than for both intermediate and high beneficiaries.

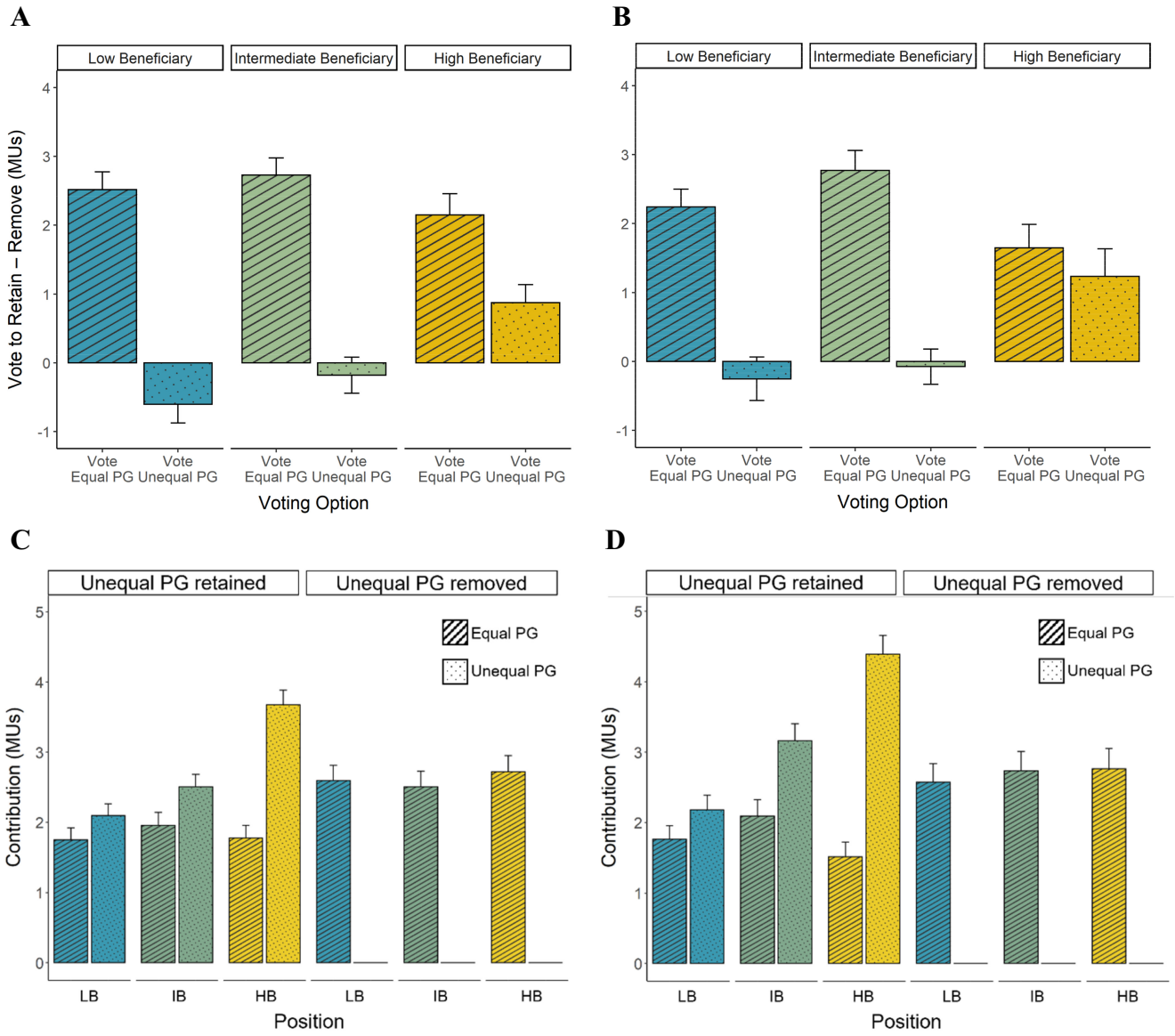
Descriptive Norms

Uninvolved participants expected that participants contribute more to the equal than to the unequal public good ($\beta = -0.59$, 95% CI = [−0.91, −0.27], $p < .001$), in line with their injunctive norms. These participants also expected high beneficiaries to cooperate more overall than intermediate beneficiaries, and intermediate more than low beneficiaries ($\beta_{HL} = 0.63$, 95% CI = [0.24, 1.03], $p = .002$; $\beta_{IL} = 0.43$, 95% CI = [0.03, 0.82], $p = .033$).

Main effects were qualified by the public good to which members contributed (Target Position × Public Good: $\beta_{IL} = 1.98$, 95% CI = [1.29, 2.66], $p < .001$; $\beta_{HL} = 4.88$, 95% CI = [4.20, 5.57], $p < .001$). Specifically, third parties expected low and, to a lesser extent, intermediate beneficiaries to contribute more to the equal than to the unequal-returns public good, $t_L(605) = 2.88$, 95% CI = [2.39, 3.36], $p < .001$; $t_I(605) = 0.90$, 95% CI = [0.41, 1.39], $p < .001$); high beneficiaries were, in contrast, expected to contribute more to the unequal-returns public good, $t_H(605) = -2.01$, 95% CI = [−2.494, −1.52], $p < .001$—in line with the results of Experiments 1–4. In short, descriptive and injunctive norms are applied similarly to low and intermediate beneficiaries, mimicking

Figure 6

Voting to Redesign Multiple-Public-Goods Provision Problems and Subsequent Cooperation



Note. Investments to retain relative to investments to remove a PG from the choice set in Experiment 3 (A) and in Experiment 4 (B). Contributions to the equal PG and the unequal PG when the unequal-returns PG is retained versus removed in Experiment 3 (C) and Experiment 4 (D). Displayed are means, error bars represent ± 1 standard error. PG = public good; LB = low beneficiary; IB = intermediate beneficiary; HB = high beneficiary; MU = monetary unit. See the online article for the color version of this figure.

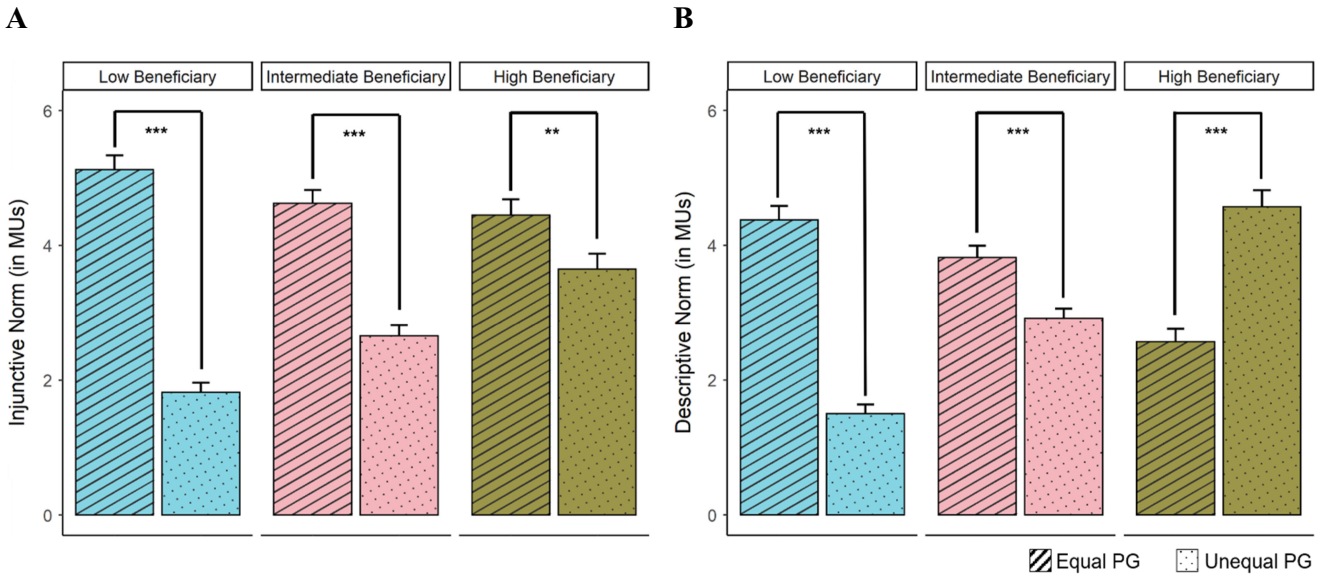
the patterns of contributions we observed Experiments 2–4. For high beneficiaries, descriptive norms align with actual high beneficiaries' observed preference for unequal-returns over equal-returns public goods (per Experiments 2–4), but this preference is not considered socially appropriate.

General Discussion

Notwithstanding the fact that human groups and organizations often present individuals with multiple public goods to cooperate on, theory and research on cooperation has been largely limited to settings in which individuals face only a single public good problem. Here we rectified this gap by investigating cooperative decision making when individuals can contribute to multiple public goods. Across four incentivized experiments, we obtained robust evidence that cooperation operates differently depending on the structural design of the multiple public goods to which individuals can contribute. In a fifth experiment, we find that injunctive norms held by uninvolved individuals mirror the cooperation patterns observed in the multiple-public-goods scenario in Experiment 3, and descriptive norms reflect actual cooperation patterns in Experiments 2 and 4.

Figure 7

Injunctive and Descriptive Norms as a Function of Target Position and (In-)Equality of Returns



Note. Displayed are means, error bars represent ± 1 standard error. MU = monetary unit; PG = public good. See the online article for the color version of this figure.
** $p < .01$. *** $p < .001$.

Implications for Theory on Cooperation and Public Good Provision

By modeling cooperation in multiple-public-goods provision problems, we shed new light on what cooperation is, how it may be perceived by others, and what consequences it can have for individual and group functioning. First, our work offers a novel perspective on free-riding, which is commonly defined as the failure to contribute to public goods and reciprocate the cooperative efforts of others (van Dijk & De Dreu, 2021). In single-public good-provision problems, where individuals choose between cooperating or not and can see who did and did not contribute to the public good, free-riding can be unequivocally identified by other participants. A wealth of research has considered how individuals regulate free-riding within their group through, for example, gossip and peer punishment (Gross & De Dreu, 2019; Yamagishi, 1986; for reviews, see Balliet et al., 2011; van Dijk & De Dreu, 2021). In multiple-public-goods provision problems, not contributing to a public good may not simply reflect a desire to exploit the cooperative tendencies of others, but an attitudinal position on which public good is deserving of cooperation efforts altogether. Furthermore, even when not contributing does reflect free-riding, the fact that individuals may free-ride on some public goods but not on others renders free-riding less easily detectable and more ambiguous. This not only means that it becomes more difficult for third parties, such as leaders in organizations, unit managers, and governmental bodies, to unambiguously identify and treat shirking among employees or citizens, but also that tried-and-true measures against free-riding may lose their effectiveness. Future research on cooperation and public good provision may investigate whether and how individuals identify and regulate free-riding when multiple public goods are available for cooperation.

High and low beneficiaries express different preferences in multiple-public-goods provision problems, voting to keep versus remove the efficient but unequal-returns public good from the mix. Accordingly, how public goods are designed can attract additional cooperation but also, paradoxically, create fault lines between (happy) haves who like the status quo and (unhappy) have-nots who prefer to change the structures of available public goods. In general, fault-lines fragment groups into subcoalitions, reduce overall group cohesion, and create internal conflict (Lau & Murnighan, 1998, 2005) and polarization (Edlund & Lindh, 2015; Gross & De Dreu, 2019; Lau & Murnighan, 1998, 2005; Perrings et al., 2021; Piff et al., 2018; Stewart et al., 2020, 2021; Tanjitpiyanond et al., 2022; Vasconcelos et al., 2021). More specifically, our findings show how cooperation in multiple-public-goods provision problems could thus set the stage for asymmetric conflict between those who prefer the status quo and those seeking change (De Dreu et al., 2021; Kluwer & Mikula, 2003). How such asymmetries in preferences and power emerging from cooperating in multiple-public-goods provision problems impact interpersonal and group relations, as well as future willingness to cooperate, is an important question for future research.

The third contribution to psychological theory on cooperation is our finding that individuals often cooperated in an "opportunistic" way. By and large, our findings were in line with earlier work showing that individuals cooperate more when this creates outcome equality rather than inequality (Bagnoli & McKee, 1991; Buttrick & Oishi, 2017; Côté et al., 2015; Cozzolino, 2011; Fisher et al., 1995; Nikiforakis et al., 2012; Reuben & Riedl, 2009; Sommet et al., 2022) and when (personal) returns on investment are larger rather than smaller in absolute terms (Engelmann & Strobel, 2004; Gunnthorsdottir et al., 2007; Isaac & Walker, 1998; Komorita & Parks, 1995; Lugovskyy et al., 2017; van den Berg et al., 2020; R. Yu et al., 2014; Zelmer, 2003) and relative to fellow group members' returns (Glöckner et al., 2011).

Zelmer (2003) showed in her meta-analysis that heterogeneous MPCRs did not influence group-level cooperation. Our individual-level

findings help illuminate why they did not. We found that individuals trade off equality and efficiency and that such trade-offs are to a large degree opportunistic: Individuals contribute comparatively more to efficient public goods when they benefit more than their fellow group members. These high beneficiaries thus put their money where it (a) maximizes group welfare yet (b) benefits them most in both absolute and relative terms. To illustrate the first point, high beneficiaries cooperated more on whichever public good was the more efficient, regardless of whether it provided equal or unequal returns. For instance, when the equal public good was more efficient for their group than the unequal public good, high beneficiaries chose to cooperate more on the equal than on the unequal public good. Under this condition, both public goods provided the exact same return on investment for high beneficiaries personally, but the unequal public good additionally disadvantaged their fellow group members. High beneficiaries avoided such disadvantage to others when their choice did not affect their personal returns. However, they cooperated most overall when the unequal public good was more efficient than the equal public good. Put differently, high beneficiaries accepted that others would be disadvantaged when their choices benefitted not only themselves, but also overall group welfare.

While high beneficiaries were willing to create disadvantage as long as they themselves and the group as a whole benefitted, low beneficiaries shied away from creating disadvantage altogether. They put their money where it (a) contributed to group welfare yet (b) protected them from diminishing their gains too much—in both absolute and relative terms. In that, they were willing to forgo higher group efficiency for the sake of equal returns, in line with earlier work showing that individuals are willing to restore equity at a cost to themselves by destroying resources that were unjustifiably held by others (C. T. Dawes et al., 2007). Our findings extend earlier work showing that, in a single-public-good game, high beneficiaries who lead by example and cooperate considerably can inspire less privileged group members to follow suit and cooperate (Glöckner et al., 2011). The authors interpret the behavior of the less privileged as reflecting gratitude to the high beneficiaries for sacrificing a considerable part of their endowment. Our novel experimental design allows us to test this empirically, revealing instead that low beneficiaries, when given the chance, shift their cooperation from an unequal to an equal public good. The voting behavior observed in Experiments 3 and 4 provides further support for such opportunism, contrasted with the gratitude motivations posited by Glöckner et al. (2011). Those who stood to earn little from the unequal-returns public good voted it out, whereas those who stood to gain the most from this public good voted to keep it. Accordingly, policy conflicts over what public goods to maintain and develop and which to abolish or reconfigure can thus be understood best in terms of individuals' "enlightened self-interest"—they want (to cooperate on) those public goods that not only efficiently serve the collective but also best serve their personal standing in society.

When looking at motivations of cooperation, one surprising finding in our data were the limited and inconsistent effects of SVO and inequality aversion (Tables S15 and S16 in the online supplemental materials). Earlier work found that prosocial (compared with proself) individuals take fairness and outcome equality into account (e.g., Chirumbolo et al., 2016; Murphy & Ackermann, 2014; Stouten et al., 2005; Van Lange, 1999). In two out of three experiments, we also found that prosocial and inequality averse individuals cooperate more than proself- and joint gain maximization-oriented individuals, respectively, on equal-returns rather than unequal-returns public goods. In some cases, however, these general tendencies were qualified by complex higher-order effects that were inconsistent across experiments and difficult to interpret. Perhaps the complexity of a multiple-public-goods provision problem, alongside the multi-interpretability of noncooperation as free-riding or as selective cooperation may have obscured and complicated what individuals view as the prosocial (proself) decision.

Some earlier work on social dilemmas considered settings similar to the multiple-public-goods problem examined here. For example, in Nested Social Dilemmas (e.g., Aaldering & Böhm, 2020; Aaldering et al., 2018; Gross et al., 2023; Israel et al., 2012; Wit & Kerr, 2002) individuals can contribute to an in-group "club good" that gives returns only to individuals in their own group, and to a universal public good that gives returns to individuals in both their own and in other groups. As noted at the outset, individuals typically contribute more to the in-group club good than to the universal public good, a pattern often taken to reflect parochialism (Aaldering et al., 2018; De Dreu et al., 2020). Our findings suggest an alternative interpretation. Because in these nested social dilemmas the in-group club good is also at least as if not more efficient than the universal public good, preferential cooperation on club rather than public goods may reflect a preference for efficiency rather than parochialism. Relatedly, studies using the Intergroup Prisoner's Dilemma-Maximizing Differences games as a model of intergroup conflict typically find that individuals cooperate on club goods that benefit their in-group without harming the out-group, more than on club goods that benefit the in-group while simultaneously hurting the out-group (for reviews, see De Dreu et al., 2020; Weisel & Zultan, 2021). While this is typically taken as evidence for the hypothesis that "in-group love" is a more important motivation for cooperation than "out-group hate," our findings suggest the alternative possibility that people are inequality adverse and prefer public goods that create little or no inequalities among (groups of) individuals.

Lastly, earlier work has examined third parties' preferences in solving similar decision dilemmas of efficiency and equality, finding them to generally prefer equality over efficiency (e.g., Choshen-Hillel et al., 2015; Gordon-Hecker, Rosensaft-Eshel, et al., 2017; Mitchell et al., 1993; Shaw & Olson, 2012; but see Reuben & Riedl, 2013). The mechanisms proposed for this preference include the (positive) social signaling effect of appearing impartial, but we and others (Choshen-Hillel et al., 2015) observe similar preferences in anonymous settings, suggesting that this partiality aversion is at least in part internalized (Gordon-Hecker, Choshen-Hillel, et al., 2017).

Importantly, uninvolved individuals' injunctive norms in our Experiment 5 findings were misaligned with their descriptive norms, or expectations of actual behavior. Third parties expected high beneficiaries to cooperate more on the unequal public good, and low and intermediate beneficiaries to cooperate more on the equal public good, mirroring the actual group members' decisions and expectations in Experiments 2–4. This implies that self-interest did not bias expectations among involved group members. However, third parties' injunctive norms deviated from their descriptive norms. They deemed it socially appropriate for all beneficiaries to contribute more to equality than to inequality, despite expecting high beneficiaries not to follow this injunctive norm. Yet, they also judged it to be appropriate for high beneficiaries to differentiate

less than the other beneficiaries between equal and unequal public goods. This pattern of norm judgements may be further amplified when also taking into account varying efficiency—an interesting avenue for future research. We found individuals' actual cooperation behavior to match the behavior expectations of both involved and uninvolved others, deviating from injunctive norms. Such normative conflict has been shown to reduce prosocial behavior (intentions) in earlier research (Göckeritz et al., 2010; McDonald et al., 2013; Smith et al., 2012). While we do not find the normative conflict to decrease overall cooperation, it may contribute to the opportunistic behavior observed in the multiple-public-goods game.

Limitations and Avenues for Future Research

Several limitations of the experiments reported above may set the stage for relevant follow-up investigations. First, our conclusions and implications should be considered in light of the fact that low (high) beneficiaries earned less (more) from the unequal public good relative to their group members. Future research may model the low (high) beneficiary to profit more (less) from the unequal than equal public good in absolute terms. Such research can reveal when and under what circumstance groups value efficiency over equality, as we observed across our studies, and in what situations their preference shifts to equality over efficiency.

Second, participants in our experiments were exposed to varying treatments within subjects. This has advantages in terms of statistical power, but may have encouraged participants to change behavior across treatments based on the "demand" of the experimenter (Campbell & Cook, 1979). In our experiments we mitigated demand and carryover effects by presenting both conditions and trials within conditions in randomized order. Moreover, the variations occurred always in the trial-specific MPCRs and were rather subtle. Although we have no strong reason to assume demand and carryover effects account for our results, future research should establish whether the obtained findings replicate in between-subjects designs.

Finally, our experiments were performed online and involved one-shot decisions, without feedback about what other individuals did and without direct access to feedback regarding the consequences of their and group members' decisions for individual and group wealth. Accordingly, conclusions may not extend to situations in which group members interact repeatedly and can adapt to and learn from each other (e.g., Kiyonari & Barclay, 2008; Sefton et al., 2007; Weber & Murnighan, 2008; for a review see, e.g., van Dijk & De Dreu, 2021). Especially when multiple public goods are misaligned in terms of equality in returns and efficiency, group dynamics may shape contribution patterns by high and low beneficiaries, yielding meaningful effects on group welfare and wealth distributions. For instance, the increased cooperation levels observed in high beneficiaries may be interpreted by fellow group members as sacrifice or as merely selfish behavior, leading to differential outcomes for cooperation levels and reciprocity (Glöckner et al., 2011; Reuben & Riedl, 2009). Relatedly, prior work shows that the (mis-)perception of inequality can be an important driver for redistribution preferences (Hauser & Norton, 2017), brought about by psychological processes such as social sampling (Sumaktoyo et al., 2022). On this note, it would be interesting for future research to show how individuals cooperate over time when receiving feedback and how this changes their perceptions of inequality as well as their support for changing the social context, for example, by vote. Furthermore, how social institutions like peer punishment and leadership interact with behavioral preferences in multiple-public-goods provision problems is an important avenue for future research, that may also be best examined through sequential interactions between group members over time. Decisions about efficiency versus equal benefit of public goods may also be made by third parties such as institutions and policy makers, who are not directly affected by the outcomes themselves (Gordon-Hecker, Choshen-Hillel, et al., 2017; Gordon-Hecker, Rosensaft-Eshel, et al., 2017). While our findings about injunctive and descriptive norms allow some insight into third-party preferences, it would be an important future avenue to investigate how such uninvolved individuals make allocation decisions for others.

Constraints on Generality

Our samples consisted of Prolific users residing in the United Kingdom or in the United States of America, potentially raising questions about generalization (Simons et al., 2017). Relying on WEIRD (western, educated, industrialized, rich, and democratic) samples may be nontrivial, as previous work has shown cultural differences in how individuals cooperate and coordinate in mixed-motive games (Henrich et al., 2010; Herrmann et al., 2008), revealing the potential impact of local institutions on social decision making (Enke, 2019). Conversely, a recent meta-analysis found no meaningful cross-cultural variation of cooperation in social dilemmas such as the public goods game (Spadaro et al., 2022), suggesting that we have no reason to believe that the results depend on specific characteristics of the sampled population, yet, future research might uncover such dependencies and thereby help to refine our understanding of the proposed mechanisms.

Practical Implications

Limitations and open questions notwithstanding, our findings can inform policy. Various social contexts entail multiple public goods—from larger-scale communities, organizations, and institutions to small-scale relationships among friends and family members (De Dreu et al., 2023). In theory, our findings apply to individuals in each of these settings, whenever they face choices regarding whether, how much and on what to cooperate. Furthermore, for each of these settings, the structural design of the public goods in terms of their relative efficiency and who benefits more or less matters. To govern the commons well, individuals and their leaders design and revise public goods to make them as efficient possible and, indeed, inequality in returns may appear less important. However, over time such efficient but unequal public goods may also create wealth inequalities that impair social relations and break down groups and societies. Optimal policy should not only invest in making public goods efficient but also mitigating too-strong wealth inequalities that cooperation on efficient public goods sometimes create.

Summary and Conclusion

Individuals within groups often have multiple public goods on which they can choose to cooperate, necessitating decisions on where (not) to invest resources. We have shown here that decisions depend on key design features of public goods—how efficient they are and to what extent they provide equal returns to group members.

We have also shown that how much one benefits from unequal-returns public goods modulates trade-offs that people make when deciding to contribute to equal-returns-but-inefficient and unequal-returns-but-efficient public goods. While these patterns of cooperation may be disconcerting—they could harm the weakest in a group, undermine group cohesion, and seed conflict—we also find something that can be easily overlooked: When group members have multiple public goods that are misaligned in terms of efficiency and equality in returns, overall cooperation is highest. In single-public-good provision problems, individuals choose between selfish keeping and cooperating on group welfare. In multiple-public-goods provision problems, individuals choose which public good to cooperate on. And to quite some degree, individuals cooperate on both, keeping less to themselves.

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