Organizational Behavior and Human Decision Processes 123 (2014) 9–22

Contents lists available at ScienceDirect

Organizational Behavior and Human Decision Processes

journal homepage: www.elsevier.com/locate/obhdp

Effect of inequality on cooperation: Heterogeneity and hegemony in public goods dilemma

Jane M.Y. Fung, Wing-tung Au *

The Chinese University of Hong Kong, Hong Kong Special Administrative Region

ARTICLE INFO

Article history:
Received 29 November 2010
Accepted 15 October 2013
Available online 26 November 2013
Accepted by Madan Pillutla

Keywords:
Public good
Heterogeneity
Hegemony
Inequality
Self-efficacy

ABSTRACT

We conducted two studies to explain inconsistent findings on the effect of resource inequality based on two properties of heterogeneity: (a) level of inequality and (b) asymmetry of resource distribution. We confirmed that symmetrically heterogeneous groups cooperated less than homogeneous groups did. We also found that larger resource inequality led to less cooperation. More importantly, the effect of inequality was different among groups with different distributions of resources – cooperation declined in groups with a symmetrical distribution of resources but did not decline in groups with a hegemonic distribution. Hegemonic distribution also affected psychological states as resource inequality changed. High endowment members reported higher self-efficacy when distribution was hegemonic than symmetric. However, they also reported more fear of being a sucker in hegemonic groups.

Introduction

Theoretical models and experimental studies that examine the impact of unequal resources on public goods dilemma (PGD) are aplenty. Nevertheless, their findings do not converge. Some researchers found that heterogeneous groups, in which members have endowments that are different from each other, cooperate less than homogeneous groups, in which members have equal amounts of endowment (e.g., Aquino, Steisel, & Kay, 1992; Cherry, Kroll, & Shogren, 2005). Others argue the opposite and state that heterogeneity fosters cooperation (e.g., Bergstrom, Blume, & Varian, 1986; Chan, Mestelman, Moir, & Muller, 1996). Yet, some suggest that cooperation is invariant across different levels of inequality (e.g., Levati, Sutter, & Van Der Heijden, 2007; Warr, 1983). In this study, we propose that endowment inequality alone is not enough to explain or predict cooperation. Asymmetry of endowment distribution is another property that drives cooperation. In two experiments, we examine the effects of endowment inequality and asymmetry of distribution on cooperation in PGD and discuss the underlying psychological processes.

Homogeneity vs. heterogeneity

PGD studies typically focused on homogeneous groups in which endowments are equally distributed (Van Lange, Liebrand, Messick, & Wilke, 1992; Yamagishi & Sato, 1986). In these homogenous groups, every member in a group has (a) the same amount of endowment, (b) the same impact on the PG for each unit of endowment they contribute, and (c) they are rewarded by the same payoff function. In recent years there has been an increasing focus on heterogeneous groups that endowments are different among members (e.g., Buckley & Croson, 2006; Cress & Kimmerle, 2008; Isaac & Walker, 1988; Marwell & Ames, 1979; Rapoport, 1988; Rapoport, Bornstein, & Erev, 1989; Van Dijk & Grodzka, 1992; Van Dijk & Wilke, 1994; Wit, Wilke, & Oppewal, 1992). In these heterogeneous groups, group members could differ in terms of their endowments (endowment asymmetry) or their rewards (interest asymmetry) (Van Dijik, Wilke, & Metman, 1999). In this study we focus on endowment asymmetry and compare among homogeneous groups and different types of heterogeneous groups. Marwell and Ames (1979, 1980) were the first to suggest that people cooperate less when resources are not equally distributed. Some economic theories, however, predict that inequality should either not affect cooperation (Warr, 1983) or foster cooperation (Bergstrom et al., 1986). In general, empirical findings do show that endowment heterogeneity affects cooperation. Social dilemma studies usually explain this effect by differences in self-efficacy, sense of responsibility, as well as fear and greed (see Kerr, 1983; Van Dijk & Grodzka, 1992; Van Dijk & Wilke, 1995; Wit et al., 1992).

Social identity of members in homogeneous and heterogeneous groups

Differences in cooperation between homogeneous groups and heterogeneous groups could also be explained by members'

* Corresponding author. Address: Department of Psychology, The Chinese University of Hong Kong, Shatin, N.T., Hong Kong Special Administrative Region. Fax: +852 2603 5019.
E-mail address: wintonau@cuhk.edu.hk (W.-t. Au).

0749-5978/$ - see front matter © 2013 Elsevier Inc. All rights reserved.
http://dx.doi.org/10.1016/j.obhdp.2013.10.010

identification with the group. The group engagement model proposed by Tyler and Blader (2003) compares the resource-based social exchange model (Thibaut & Kelley, 1959) and the identity-based social identity model (Hogg & Abrams, 1988) to understand why people engage and cooperate in groups. The resource-based model predicts that members' cooperation behaviors are shaped by material resources they receive from and the sanctioning risk they face in the group; the identity-based model argues that members' motivation to cooperate come from their identification with the group. The identity-based model is supported by empirical findings in work settings that employees with higher identification with their groups were found to be more willing to work on behalf of their groups and to follow rules and policies (Tyler & Blader, 2001). Similar evidence was also found in the society that taxpayers with greater identification with the nation were more likely to feel commitment to the tax system (Wenzel, 2007).

The process that drives the formation of social identity is developed through valence-sensitive social comparisons, in which people look for intragroup similarities and intergroup differences (Hogg, 2003). In particular, Hogg and Terry (2000) found that demographic homogeneity could strengthen organizational ingroup prototype, social attraction and identification. Along the same line, homogeneity of endowment among group members could accentuate perceived similarity among group members. They are then more likely to self-categorize themselves as in group members. Individuals with high group identity are more group-interest oriented and cooperate more (Tyler & Blader, 2003; Wenzel, 2007). This is consistent with the predictions and empirical findings of previous studies that homogeneous groups have higher cooperation rates than heterogeneous groups (Aquino et al., 1992; Cherry et al., 2005; Marwell & Ames, 1979, 1980).

Interestingly, there is evidence showing that heterogeneity does not necessarily decrease group contribution (Levati et al., 2007; Warr, 1983). Some studies even found an increase of cooperation (Bergstrom et al., 1986; Chan et al., 1996). With reference to the social identity theory, the inconsistent findings could be due to the different types of heterogeneous resource distribution in these studies that affect the self-categorization process of group members and as a result also affect their group identities. Specifically, we argue that there are two properties of heterogeneity: (1) level of inequality and (2) asymmetry of resource distribution. Both properties influence members' psychological factors such as self-efficacy and fear and cooperation behavior.

In the following sections, we will first analyze the inconsistent findings in previous studies from the perspectives of level of inequality and asymmetry of resource distribution. We will explain how they influence group cooperation and psychological factors of individual members. Then, we will present two studies to show differences in cooperation between the two types of heterogeneous group and the psychological differences among members of these groups.

Heterogeneity and asymmetry of resource distribution

Heterogeneity was not consistently defined or operationalized in past studies. Heterogeneous groups were sometimes manipulated by endowment inequality and sometimes by endowment distribution asymmetry. Here we define heterogeneity based on two properties as illustrated in Fig. 1, i.e., (a) level of inequality and (b) asymmetry of endowment distribution. These two properties help us understand mixed findings on heterogeneity in past studies.

Level of Inequality

Level of inequality is the variability of endowments in a group. When every member gets the same endowment, there is no endowment variability; the group is a homogeneous group (the top-most level in Fig. 1). We use the Gini Coefficient (GC), a summary statistic for describing the distribution of income and wealth (Atkinson, 1975), to represent the variability of endowments owned by group members. It is a zero-to-one index that is comparable across groups of any size with magnitude of resources measured in any scale.[1] A larger GC represents a larger inequality in the group. As shown in Fig. 1, GC is always zero for homogeneous groups, while GC ranges from anything larger than zero to one for heterogeneous groups.

In general, previous studies showed that large inequality undermined cooperation. According to Table 1 that describes the findings of these studies, cooperation rates of homogeneous groups were higher than those of heterogeneous groups that had relatively high levels of inequality represented by high GCs.[2] Specifically, heterogeneous groups in Cherry et al. (2005), i.e., [10, 20, 30, 40] (GC = .25), cooperated less than homogeneous groups (i.e., [10, 10, 10, 10], [20, 20, 20, 20], [30, 30, 30, 30], and [40, 40, 40, 40]). Along the same line, Aquino et al. (1992) showed that in a step-level PGD, high inequality groups, e.g., [70,000, 66,000, 14,000, 10,000] (GC = .36), cooperated less than low inequality groups, e.g., [41,000, 40,000, 40,000, 39,000] (GC = .01). They explained that in high inequality groups, high-endowment positions contributed less because they were deterred by being a sucker whereas low-endowment positions also contributed less because of their desire to free ride. These two studies gave strong support to Marwell and Ames's (1979) suggestion as well as our analyses on perceived group membership based on the identity-based social identity model (Hogg & Abrams, 1988) that heterogeneity undermines cooperation.

There were also empirical findings supporting Warr (1983) "no difference" prediction that heterogeneity did not affect cooperation. For example, the group cooperation rate of the heterogeneous groups in Levati et al. (2007), [20, 20, 30, 30] (GC = .07) and that of its corresponding homogeneous groups, [25, 25, 25, 25], were negligibly different. Similarly, Chan et al. (1996) also found that the contributions of their heterogeneous groups with relatively low inequality, [18, 18, 24] (GC = .07), did not deviate from their homogeneous groups (i.e., [20, 20, 20]). These findings illustrated that cooperation rates of heterogeneous groups with lower GCs did not differ significantly from those of homogeneous groups.

Interestingly, heterogeneous groups with relatively high inequality in Chan et al. (1996), [12, 12, 36] (GC = .27) and [9, 9, 42] (GC = .37), did not contribute less than homogeneous groups. Instead, heterogeneous groups contributed more, which concurred with Bergstrom et al.'s (1986) BBV model, but contradicted with the findings of Aquino et al. and Cherry et al. We reason that the contradiction could be due to the asymmetry of endowment distribution in Chan et al.'s study.

Asymmetry of resource distribution

Inequality can be distributed symmetrically or asymmetrically (as depicted in the second level in Fig. 1). We use skewness to measure asymmetry. The skewness of a symmetrically heterogeneous group is zero, which means that the shape of the distribution is symmetric, e.g., [15, 30, 45] or [25, 30, 35]. The skewness of an

[1] There are many choices of summary statistics that can describe resource distribution of a group. Some other popular ones are range, variance, and logarithmic variance. Range is only sensitive to the two most extreme values of a distribution as it measures the distance between them and ignore what are in between. Variance and logarithmic variance measure the average distance between the mean and individuals' endowments. Variance has an obvious drawback of being scale dependent. Although logarithmic variance overcomes this problem, both variance measures are not sensitive to resource transfer from the rich to the poor (Cowell, 1995). We chose GC because it does not have the mentioned drawbacks.

[2] GC values are calculated with Wessa's (2010) online Gini Coefficient calculator.

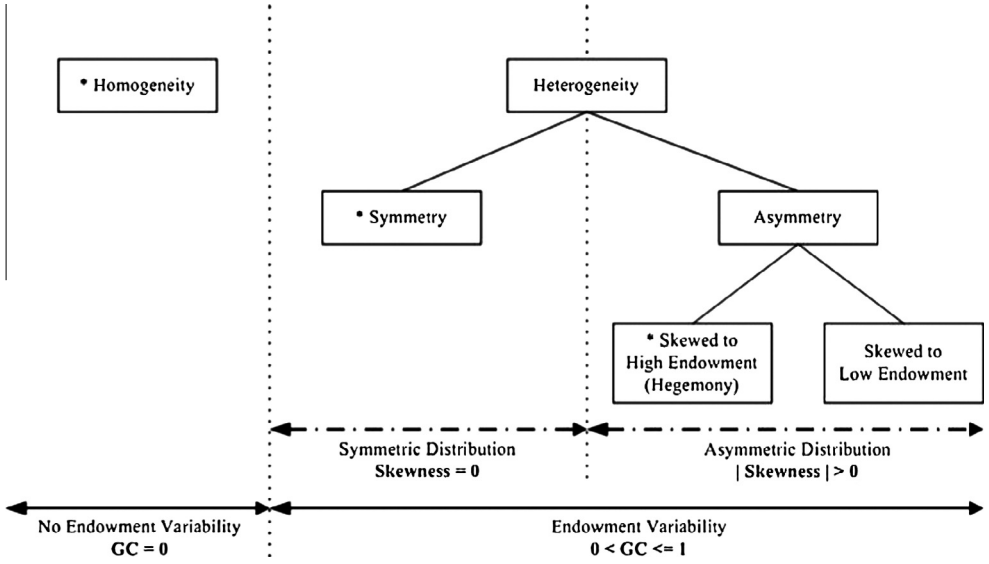

Fig. 1. Relations among homogeneity, symmetrically heterogeneity and hegemony. Names with asterisk (*) are the conditions we examine in this study.

asymmetrically heterogeneous group has an absolute value greater than zero, e.g., [20, 20, 50] and [10, 10, 70]. Both groups have two small and one large endowments. They have the same skewness of 0.81 but their levels of inequality are different. Group [10, 10, 70] (GC = .44) is more unequal than [20, 20, 50] (GC = .22). Thus, groups can have the same level of skewness but different levels of inequality. It is also possible that groups have the same level of inequality but they have different types of distribution asymmetry. For example, [20, 20, 50] and [15, 30, 45] have the same inequality level (i.e., GC = .22) but the former is asymmetric while the latter is symmetric. In other words, the level of inequality and asymmetry may vary independently. In this study, we focus only on asymmetric groups that are positively skewed and we name this type of distributions as "hegemony". Hegemony is defined as "preponderant influence or authority over others", or "the social... or economic influence exerted by a dominant group" (Hegemony, 2010). We focus on hegemonic distributions because heterogeneous groups in Chan et al. are all hegemonically distributed, e.g., [12, 12, 36] (GC = .27) and [9, 9, 42] (GC = .37), while their skewness are both 0.81. These hegemonic groups with high inequality cooperated more than their homogeneous counterparts. We see that cooperation rates of these hegemonic groups actually went in an opposite direction to those of symmetric heterogeneous groups. Although the levels of inequality of these two hegemonic groups were as high as the two symmetrically heterogeneous groups in Aquino et al. (i.e., [70,000, 66,000, 14,000, 10,000] (GC = .36)) and Cherry et al. (i.e., [10, 20, 30, 40] (GC = .25)), these hegemonic groups fostered cooperation whereas the symmetrically heterogeneous groups undermined cooperation.

Two properties of heterogeneity

A review of previous findings shows that two properties of heterogeneity affect cooperation. The first property is the level of inequality that is defined by endowment variability in a group. We use GC to assess inequality in this study. The second property is symmetry vs. asymmetry in endowment distribution. In this study we focus on asymmetry in the form of hegemony that there is a uniquely large endowment. Based on past findings we speculate that symmetric and hegemonic distributions of endowments with similar levels of inequality could lead to different cooperation behaviors.

We conducted two studies to examine the effects of these two properties on cooperation on both a group level and an individual level. The purpose of the first study was to examine the two properties of heterogeneity by replicating findings of different patterns of cooperation behaviors among homogeneous groups, symmetric heterogeneous groups and hegemonic groups. In Study 2, we further examined the underlying psychological processes that drove the different patterns of cooperation behaviors between the two types of heterogeneous groups.

Study 1

We test the two properties of heterogeneity by first demonstrating the phenomenon that cooperation behaviors are different not only between homogeneous groups and heterogeneous groups, but also between heterogeneous groups with a symmetric distribution and those with a hegemonic distribution.

Past findings in general showed that groups with homogeneous resources cooperate more than those with heterogeneous resources. In fact, these evidences are consistent with psychological processes from a resource-based social exchange perspective such as cost-and-benefit ratio and fairness that work in the two situations. Ledyard (1995) listed five experimental papers in his review showing that heterogeneity of resources tended to decrease contributions, supporting Marwell and Ames' arguments. Along the same line, Rapoport et al. (1989) found that people with more resources were less likely to contribute than those with fewer resources in a step-level PG game with all-or-none contribution and step-level payoff. They suggested that this was an evidence of the cost-to-benefit ratio dominating the effect of criticality (Rapoport, 1988). The sense of unfairness could be another reason that heterogeneous groups contribute less in PGD. It is not only the fairness perception of own contribution that affects cooperation, the fairness perception of the reward allocation rule in heterogeneous PGD is also proposed as an explanation that influences one's contribution. Aquino et al. (1992) argued that the heterogeneous distribution of resources led to a perception of unfairness on the equal distribution of rewards in PGD. The reason being that equal division of rewards deviated from the principle of equity (Adams, 1963) as

Table 1
Experimental conditions and resulting comparisons on cooperation rates in previous studies.

		Aquino et al. (1992)		Chan et al. (1996)					Cherry et al. (2005)					Levati et al. (2007)	
		High Asymm-etry (HA)	Low Asymm-etry (LA)	Symm-etry (SYM)	Low Asymm-etry (LA)	Medium Asymm-etry (MA)	High Asymm-etry (HA)	Very High Asymm-etry (VHA)	Symmetry				Asy-mme-try	Symm-etry (SYM)	Asymm-etry (ASYM)
Endowment	A	70,000	41,000	20	18	15	12	9	10	20	30	40	10	35	30
	B	66,000	40,000	20	18	15	12	9	10	20	30	40	20	35	30
	C	14,000	40,000	20	24	30	36	42	10	20	30	40	30	35	40
	D	10,000	39,000						10	20	30	40	40	35	40
Group			endowment		160000	160,000	60	60	60	60	60	40	100	120	160
100	140	140													
Mean			endowment	40000	40,000	20	20	20	20	20	10	20	30	40	25
35	35														
SD of			endowment		32413.9	816.5	0	3.5	8.7			13.9	19.1	0	0
0	0	12.9	0	5.8											
Gini			Coefficient	0.36	0.01	0	0.07	0.17				0.27	0.37	0	0
0	0	0.25	0	0.07											
Skewness	0	0	–	1.7321	1.7321	1.7321	1.7321	–	–	–	–	0	–	0	
Group			contribution		HA < LA										
			SYM = LA = MA < HA < VHA					No group comparison						SYM = ASYM	
Individual			contribution	No				individual comparison		No				individual comparison	
			Average contribution smaller in asymmetry condition						No					individual comparison	

Gini Coefficient $= 1 - \frac{\sum_{i=1}^{n}\sum_{j=1}^{n}|x_i - x_j|}{2n^2\mu}$; x = individual value; n = sample size; μ = sample mean.
Skewness $= \frac{\sum(x-\mu)^3}{(N-1)\sigma^3}$; x = individual value; n = sample size; μ = sample mean.

inequality of resources increased. The unfair feeling then resulted in a decrease of contributions among high endowed group members. In fact, they found a negative correlation between resource inequality and fairness of allocation rule. Therefore, our first hypothesis states that:

H1. Homogeneous groups cooperate more than both the symmetrically and the hegemonic heterogeneous groups.

From the overview of past studies on heterogeneity, we speculate that cooperation behaviors would be different between symmetrically heterogeneous groups and hegemonic groups. This difference is especially prominent when endowment inequality among group members becomes larger. This speculation is consistent with the identity-based social identity model (Hogg & Abrams, 1988; Tyler & Blader, 2003); members of symmetrically heterogeneous groups are more likely to define themselves with a personal identity than with a group identity as endowment inequality increases due to increasing differentiation among group members. Members of hegemonic groups, however, will be less likely to experience diminishing group identity. It is because the majority of the group (i.e., the low endowment members) always has an equal amount of endowment despite the change of endowment inequality at a group-level. Furthermore, motivations and behaviors of individuals with personal identities are self-interest oriented while those with group identities are more group-interest oriented (Haslam, Powell, & Turner, 2000). Based on the empirical evidence from past studies and the theoretical ground of social identity model, we predict that cooperation will decline more rapidly in symmetric heterogeneous groups than in hegemonic groups as endowment inequality increases. Therefore, our second hypothesis states that:

H2. Group cooperation rate will decline as endowment inequality increases, but this decline is larger for symmetrically heterogeneous groups than hegemonic groups.

We further reason that the difference in contribution between these two groups is mainly driven by contributions of high endowment members. This is because high endowment members in both hegemonic and symmetrically heterogeneous groups own a large proportion of group resources. Their contributions have a great impact on groups' payoffs. There have been robust findings that the absolute amount contributed by higher endowed positions is larger than lower endowed positions (Van Dijk & Wilke, 1994, 1995; Van Dijk et al., 1999; Wit et al., 1992). Thus, consistent with the pattern of group cooperation stated in H2, our third hypothesis states that:

H3. As inequality increases, the cooperation rate of high endowment members in hegemonic groups declines less than that in symmetrically heterogeneous groups.

Method

Group configuration design

We examined three types of group in this study: (a) homogeneous groups with equal endowments, (b) heterogeneous groups with symmetrically distribution of high, medium and low endowments, and (c) groups with hegemonic distribution of high and low endowments. All conditions are listed in Table 2.

The PG paradigm was a multiple-trial game with continuous contribution and a linear payoff function for a group of three people. The game was framed as an investment game. Participants decided simultaneously and anonymously the amounts to contribute to their groups for buying snacks that were to be shared among all group members on each trial. There were altogether 10 trials. Each trial represented one of the conditions described in Table 2. The conditions of heterogeneous type and hegemonic type were separately randomized with the Latin Square technique. The order of heterogeneous and hegemonic group configurations was counterbalanced. Each trial was made independent by assigning players

Table 2
Study 1: Experimental conditions and mean contributions (and standard deviations).

	Condition									
Endowment	A	30	25	20	15	10	5	25	20	15	10
	B	30	30	30	30	30	30	25	20	15	10
	C	30	35	40	45	50	55	40	50	60	70
Mean (SD) of group contribution		16.05 (2.57)	15.52 (3.48)	15.72 (3.17)	14.34 (4.08)	13.87 (3.45)[a]	13.18 (3.17)[a,b,c]	14.32 (3.37)[a]	14.53 (4.07)	13.94 (2.74)[a,b]	13.64 (5.61)
SD of endowment		0	5	10	15	20	25	8.7	17.3	26.0	34.6
Gini Coefficient		0	0.0741	0.1481	0.2222	0.2963	0.3704	0.1111	0.2222	0.3333	0.4444
Skewness		N/A	0	0	0	0	0	0.8124	0.8124	0.8124	0.8124
Condition type		HOMO	VLOW HETER	LOW HETER	MED HETER	HIGH HETER	VHIGH HETER	LOW HEG	MED HEG	HIGH HEG	VHIGH HEG

Note: HOMO = homogeneous endowment distribution; HETER = heterogeneous endowment distribution; HEG = hegemonic endowment distribution.
VHIGH = very high; HIGH = high; MED = medium; LOW = low; VLOW = very low.
Group endowments are all equal to 90; contributions appeared only once in each condition.
[a] Significantly different from homogeneous group [30, 30, 30].
[b] Significantly different from heterogeneous group [25, 30, 35].
[c] Significantly different from heterogeneous group [20, 30, 40].

with different group members and different amounts of endowment on each trial. Manipulation check questions regarding perceived heterogeneity and hegemony in the group were asked right after the contribution decision was made. These questions were presented to participants on the first, the sixth and the last trials.

Homogeneous conditions

There was only one homogeneous condition. All three members in the homogeneous group got an endowment of $30. This condition acted as a baseline condition for comparing across different levels of heterogeneity and hegemony.

Symmetrically heterogeneous conditions

There were five endowment inequality conditions, from [25, 30, 35] on the left of Table 2 to [5, 30, 55] in the middle. They represented different levels of inequality measured by the GC with higher GC indicating greater inequality of the group. All groups had the same endowment total of $90; the medium level endowment in the group was always $30. We manipulated the magnitude of endowment variability across these conditions to get different GCs; but we kept the type of distribution (i.e., symmetrically heterogeneous or hegemonic distribution) the same across conditions. For example, in condition [5, 30, 55], the differences between the lowest and the medium and between the highest and the medium endowments were both 25. This configuration had a GC of 0.37 and a skewness of zero. When we reduced the magnitude differences between the lowest and the medium and between the highest and the medium, such as our [25, 30, 35] condition, the inequality represented by GC was also reduced to 0.07. However, both distributions were still symmetric as the values of skewness of the configurations were zero. Thus, by changing endowment variability, we have different levels of inequality but the same type of distribution. Our manipulations should be strong enough as benchmarked to previous studies. Our "very high" GC condition [5, 30, 55] had a GC of 0.37, which was similar to Aquino et al.'s (1992) asymmetry condition. Also, our "high" GC condition [10, 30, 45] had a GC of 0.30, which was close to Cherry et al.'s (2005) heterogeneous condition.

Hegemonic distribution conditions

The group configuration conditions for manipulating the level of inequality in groups with a hegemonic distribution were [25, 25, 40], [20, 20, 50], [15, 15, 60], and [10, 10, 70]. In these hegemonic conditions, group sizes were the same and total endowments within a group were also the same as those in the heterogeneous conditions. The hegemonic and heterogeneous conditions were all comparable to each other. We constructed hegemonic distributions by putting a uniquely large endowment in the group and making the rest of the endowments equal. This was the same design as Chan et al. (1996). The level of inequality represented by the GC of the groups increased as the high and low endowments became more extreme. For example, condition [10, 10, 70], which had the largest GC of 0.44 among the hegemonic distribution conditions, had a high endowment seven times larger than the low endowments. The GCs of our hegemonic distribution conditions were comparable to those of our symmetrically heterogeneous conditions. For instance, GC of the hegemonic condition [20, 20, 50] and that of the heterogeneous condition [15, 30, 45] were both 0.22. Similarly, GC of the hegemonic condition [25, 25, 40] and the heterogeneous condition were both close to 0.1; GC of [15, 15, 60] and [10, 30, 50] were both close to 0.3. By comparing the GC of our conditions with those used in past studies, we expected that our manipulation of endowment distributions should be able to create enough inequality to study the phenomenon effectively. For example, the GC of our highest hegemonic condition [10, 10, 70] was 0.44, which was higher than the highest variability condition of Chan et al.'s study.

Participants and design

The experiment was a 3×3 within-subject incomplete-factorial design with three levels of endowment status (high vs. medium vs. low) and three types of distribution (homogeneous vs. heterogeneous vs. hegemonic). The levels of inequality in the heterogeneous and the hegemonic distribution conditions varied. Specifically, we had five levels of inequality in the heterogeneous distribution and four levels of inequality in the hegemonic distribution. There was only one level for homogeneous distribution, i.e., all three endowments were the same. There were altogether 10 group configurations with three endowments in each of these groups as listed in Table 2.

Participants were 96 college students. They participated in the experiment that took approximately an hour at an hourly rate of HKD50 (~USD6.42). There were 24 participants in each session. Half of them were assigned to play all the symmetrically heterogeneous and homogeneous conditions first, while the other half played all the hegemonic distribution conditions first. On each trial, the 12 participants in each half were randomly assigned into groups of three participants. The two halves of participants were never assigned to play in the same group such that the order of

participants playing in the two conditions of distribution types was counterbalanced.

Procedure

After participants read and signed the informed consent form, the experimenter described the rundown of the experiment, and explained the PG game with examples similar to the actual experimental conditions. Participants then took a quiz to make sure that they understood the calculations involved. Finally, the experimenter demonstrated the computer PG game by going through its screenshots. The PG game was a computer program implemented with *z*-Tree (Fischbacher, 2007) that allowed participants to play PG games over a computer network.

Participants were told that they were going to play 10–20 trials of investment games. Participants actually played 10 trials to avoid the end game effect (Andreoni, 1988). On each trial, they formed groups with randomly selected participants over a computer network. On each investment trial, they were given an amount of endowment based on the group configuration on that trial. Participants were aware that their endowments could be any amounts from a minimum of $10 to a maximum of $40 that were assigned to them randomly on every trial. Participants were also informed of the endowments assigned to each of their group members. On some of the trials, participants were prompted to answer manipulation check questions. On all trials, they were told that each trial was an independent contribution game, and were asked to decide without discussing with others how much they wanted to contribute to the pool of snacks in a room shared by three players (i.e., to contribute to the PG) and how much they wanted to keep for themselves. Participants were informed that the final amount of snacks in the pool would be multiplied by a factor of 2.2 and this product would then be equally divided among the three group members on that trial. At the end of each trial, players were informed of: (a) own endowment, (b) group endowment, (c) total group investment in public account, (d) own investment, (e) total group payoff, and (f) own payoff. Afterwards, they were assigned to another group with other randomly selected participants and played the next trial.

In order to encourage participants to make investment decisions seriously, there was a lucky draw at the end of the experiment in which one of the 24 participants in each session would receive monetary rewards equivalent to the amounts of the payoff they had earned in one of the trials. The average reward was HKD64.5 (∼USD8.31). At the end of the experiments all participants were debriefed, paid and thanked.

Results

Group level analyses

We focused on group contributions in this study. Participants played the games in three-person groups. These groups, however, were not independent to each other because their members were reassigned from the same set of 12 participants across different trials. Therefore, a statistically independent unit involved all 12 participants in four groups. This 12-person independent unit went through 10 types of group configurations represented by the 10 trials. Among the 96 participants in the experiment we had eight independent units. Our "group"-level analyses were based on these eight data points.

Generalized estimating equations

Because all eight group-level statistical units went through every level of inequality represented by the Gini Coefficient (GC), we used Generalized Estimating Equations (GEE) analysis to account for the dependency of our observations in which GC was an independent (continuous) variable. GEE is an extension of the general linear model that is capable of analyzing non-independent data. It supports regression model with time series or correlated data (Garson, 2010). The correlation among observations of an individual across conditions was specified by using the "exchangeable correlation" matrix for the estimation of regression parameters (Hardin & Hilbe, 2003).

Manipulation check

We manipulated perceived inequality as indexed by GC in the 10 group configuration conditions. This was checked by the question, "On this trial, how much is your endowment different from others in your group?" Participants responded on a seven-point scale to indicate that they had "much less than others" = 1 to "much more than others" = 7. Although the exact endowment values were different in different group configuration conditions, we classified endowments within each group into three categories of "high", "medium" and "low" endowments. We expected and also found a GC × endowment status interaction effect, Wald χ^2 (2, $N = 39$) = 28.53, $p < .001$. The post hoc simple slope analysis (Aiken & West, 1991) showed that "low" endowment positions reported having less than others as inequality got larger (as indexed by GC), $\beta = -8.01$, s.e. = 1.91, $p < .001$; while "high" endowment positions reported having more than others as inequality became larger, $\beta = 4.61$, s.e. = 1.32, $p = .001$. No significant change due to inequality was anticipated or revealed for the "medium" endowment positions, $\beta = .40$, s.e. = .81, *n.s.*. Our participants were able to perceive different levels of inequality as represented by the GC.

For hegemonic conditions, we manipulated the differences between the highest and the lowest endowments of a group. The level of inequality of these hegemonic conditions was again represented by the GC. Participants were asked to indicate their agreement that "on this trial, there is one person in my group, including myself, possessing an extremely large amount of endowment relative to others" on a seven-point scale ranging from "strongly disagree" = 1 to "strongly agree" = 7. We expected and also found a main effect of GC that the larger the GC, the more they perceived that there was a member in their groups with a particularly large endowment, Wald χ^2 (1, $N = 16$) = 35.84, $p < .001$. The insignificant GC × endowment status interaction indicated that the perception of hegemonic distribution did not differ among members with small and large endowments, Wald χ^2 (1, $N = 16$) = .94, *n.s.*

Homogeneous vs. symmetric heterogeneity and hegemony

The first hypothesis states that both the symmetrically heterogeneous and the hegemonic heterogeneous groups contributed less than homogeneous groups. Repeated measure analysis showed that homogeneous groups contributed more than heterogeneous groups and hegemonic groups. $F(2, 14) = 7.69$, $p = .006$, $\eta_p^2 = .52$. Within-subject contrasts further showed that homogeneous groups contributed significantly more than symmetrically heterogeneous groups, $F(1, 7) = 25.72$, $p = .001$, $\eta^2 = .79$, and hegemonic groups ($M_{homo} = 16.05$, $SD = 0.91$ vs. $M_{heter} = 14.53$, $SD = 1.04$ vs. $M_{hege} = 14.11$, $SD = 1.22$), $F(1, 7) = 9.95$, $p = .016$, $\eta_p^2 = .59$.

Decline of cooperation in heterogeneous and hegemonic groups

In the second hypothesis, we hypothesized that, as endowment inequality increased, group cooperation of symmetric heterogeneous groups declined to a larger extend than hegemonic groups. We conducted a GEE analysis to test whether cooperation rate changed as inequality (i.e., GC) of symmetrically heterogeneous groups increased and whether this change was different from that of hegemonic groups. As expected, both a main effect of inequality, Wald χ^2 (1, $N = 72$) = 3.71, $p = .05$, and an interaction effect of heterogeneous configuration × inequality, Wald χ^2 (1, $N = 72$) = 3.70, $p = .05$, were significant. Thus, groups with greater inequality of

endowment distribution contributed less than those with smaller inequality (see Fig. 2).[3] Simple slope analyses showed that cooperation of hegemonic groups did not change with endowment inequality, β = -2.39, s.e. = 3.07, *n.s.*., while cooperation of symmetrically heterogeneous groups declined, $\beta = -8.83$, s.e. = 3.63, $p < .05$. The results are consistent with our expectation that cooperation behaviors between heterogeneous groups with symmetric distribution were different from those with hegemonic distribution. Specifically, cooperation rates of symmetrically heterogeneous groups declined as inequality increased, while cooperation rates of hegemonic groups remained unchanged across different levels of inequality.

Change of group cooperation driven by high-endowment members

We have shown that increase in inequality undermined cooperation at a faster rate for symmetric heterogeneous groups than hegemonic groups. We hypothesized in our third hypothesis that this was a result of high endowment members reducing their contribution more in heterogeneous groups than in hegemonic groups as inequality increased. This expectation was confirmed by a GEE analysis that examined the effect of distribution type $\times$ inequality on the proportion of endowment contributed from high-endowment members only. Fig. 3 presents this significant distribution type $\times$ inequality interaction effect, Wald χ^2 (1, $N = 72$) = 4.72, $p < .05$. Simple slope analysis of high-endowment members showed that their percentage of contribution dropped as inequality increased for symmetrically heterogeneous groups, $\beta = -.71$, s.e. = .18, $p < .001$, while it did not change for hegemonic groups, $\beta = -.16$, s.e. = .16, *n.s.*

Discussion

In this experiment we replicated findings from previous studies that heterogeneity undermined overall cooperation in groups. Moreover, we confirmed that inequality was only one of the factors that determined cooperation behaviors. It was critical to also consider the asymmetry of the distribution. We defined two types of distribution. They were the symmetrically heterogeneous distribution and the hegemonic distribution. We used the Gini Coefficient (GC) to describe the level of inequality. Consistent with our expectation, the effect of inequality on cooperation in a group with hegemonic distribution was different from that in a group with symmetrically heterogeneous distribution. Our data showed that inequality undermined cooperation only in symmetrically heterogeneous groups. At least in the GC range that we examined, cooperation remained quite stable for hegemonic groups even if inequality increased. We reasoned that differences in group cooperation between symmetrically heterogeneous groups and hegemonic groups were due to the different behaviors of high endowment members under the respective distributions. While high endowment members' relative contributions dropped significantly in heterogeneous groups as resources got distributed more unequally, their relative contribution did not change in hegemonic groups.

Study 2

In Study 1, we demonstrated how different types of heterogeneity affected cooperation behaviors. Because we controlled the total endowment amount of a group, individual endowment amounts could not be systematically varied. Without comparable individual endowment values limited our examination of psychological processes precisely. In order to analyze psychological processes in Study 2, we systematically varied individual endowment values while relaxing the total endowment of a group. Although we had a different experimental design, we also expected to replicate our findings of the effects of inequality and asymmetry of distribution on group cooperation. Thus, we hypothesize that:

H4. The cooperation rate of symmetrically heterogeneous groups decline as the level of endowment inequality increases. But this decline is less prominent when endowment distribution is hegemonic.

Self-efficacy

People with high endowments generally have stronger self-efficacy. Kerr (1992) argued that increasing the impact of contribution to the public good fostered one's self-efficacy and led to a larger contribution. He also suggested that perceived self-efficacy of contribution is higher for members with high endowments relative to other group members. We argue further that members in heterogeneous groups with symmetric distributions will have a weaker self-efficacy than those in hegemonic groups. The fact that all members in symmetrically heterogeneous groups have endowments different from each other reduces the intragroup to intergroup difference (Doise & Sinclair, 1973). When inequality is large, high endowment members, although having higher self-efficacy than low endowment members, do not feel much more efficacious when within-group inequality becomes larger. It is because the intragroup to intragroup difference is not salient. The feeling that their endowments are different from their ingroup members is similar to the feeling that their endowments are different from outgroup individuals who could possess endowments higher or lower than theirs.

In hegemonic groups, however, the only high endowment member will see the salient difference between his/her resources and the rest of the group who have the same endowment. Thus, the high endowment member will self-categorize himself/herself as a unique individual instead of a member of the group. He/she will then feel more self-efficacious as the endowment inequality increases and the difference between himself/herself and the "subgroup" also becomes more salient.

In addition, high endowment members in hegemonic groups are expected to feel more socially responsible for the welfare of the group when other group members are perceived to have rather less resources (De Cremer & Van Dijk, 2002; Van Dijk & Grodzka, 1992). It is only fair for them to help those in need according to distributive justice (Adams, 1965; Deutsch, 1975). In general, the larger the difference between the high and low endowment members in a hegemonic group, i.e., the larger the inequality in the group, the more the high endowment members feel self-efficacious for the group outcome. Therefore, we hypothesize that:

H5. High endowment members in hegemonic groups have a larger increase of self-efficacy as endowment inequality increases when compared with those in symmetrically heterogeneous groups.

Similar to Study 1, since high endowment members possess a large proportion of endowment in a group, we expect that the pattern of individual level cooperation for high endowment members is similar to that at the group level because their high endowment could play a major role in the resulting group contribution. Hence, we hypothesize that:

H6. Contributions by high endowment members in heterogeneous groups decline as the level of endowment inequality increases in symmetric heterogeneous groups, but the decline will be less significant in hegemonic groups.

[3] Individual contributions are aggregated as independent units. These independent units are depicted as "Group-level individual contribution" on the y-axis in Fig. 2.

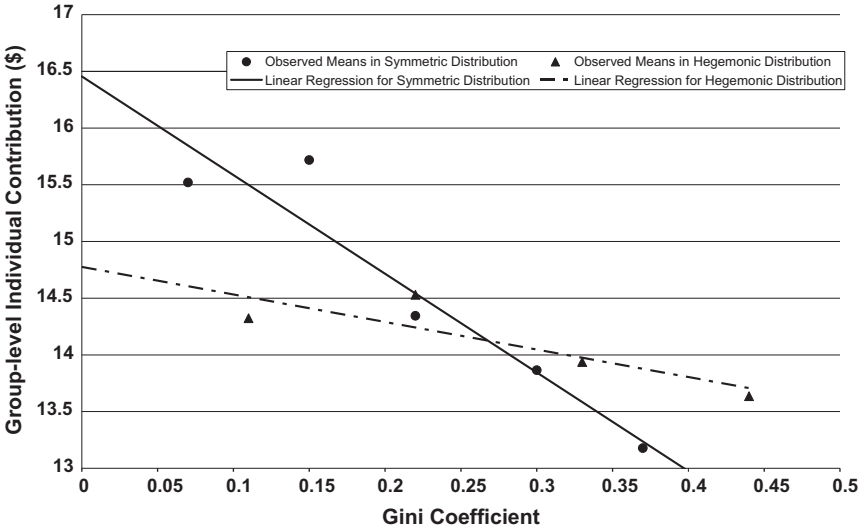

Fig. 2. Study 1: GEE predicted mean individual contributions as a function of level of inequality represented by Gini Coefficient and asymmetry of resource distribution.

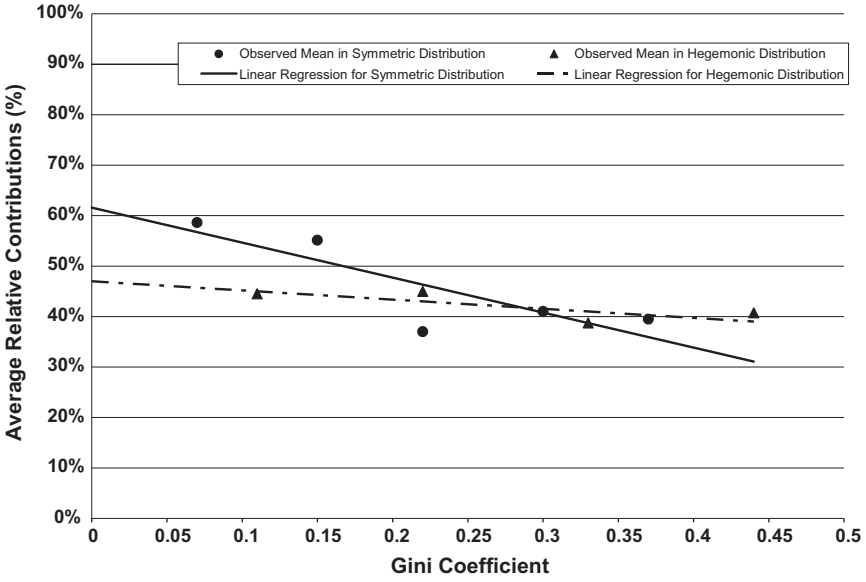

Fig. 3. Study 1: GEE predicted mean percentages of contribution of high-endowment member as a function of level of inequality represented by Gini Coefficient and asymmetry of resource distribution.

Method

Overall design

The experiment was a 2 (high vs. low GC) × 2 (symmetric vs. hegemonic distribution) × 2 (high vs. low endowment) mixed design with endowment being the between-subject factor. There were altogether eight group endowment configurations. All of them were three-person groups. They are shown in Table 3. Four of the endowment configurations had the highest endowments being 100; these belonged to the high endowment condition. The other four endowment configurations had the lowest endowments being 10; these belonged to the low endowment condition. We fixed the values of high and low endowments such that we could accurately measure the effects of endowment inequality and distribution asymmetry on these two endowment values while everything else was being controlled. Under each endowment condition, there were two endowment configurations with high endowment inequality (i.e., GC $\sim$ = 0.35 for the high endowment condition and GC $\sim$ = 0.40 for the low endowment condition) and two with low endowment inequality (i.e., GC $\sim$ = 0.05 for the high endowment condition and GC $\sim$ = 0.25 for the low endowment condition). Half of the endowment configurations had a symmetric distribution (skewness = 0) and the other half had a hegemonic distribution (skewness = 1.73).

Although there were three values of endowment in each group configuration, the values that we were concerned with the most was 100 for the high endowment conditions and 10 for the low endowment conditions. In the following discussions we will refer to these two endowments as "experimental endowments" while the other endowments in a group are considered as "other

endowments". In order to minimize boredom and to speed up the pace of the PG game, psychological measures and manipulation check items were presented only on trials when participants were in the experimental endowment positions.[4]

In the experiment, the set of endowment inequality × distribution conditions for high endowment condition (i.e., A, B, C, D conditions in Table 3) and that for low endowment condition (i.e., E, F, G, H conditions in Table 3) were repeated three times for the purpose of counterbalancing such that there were some participants getting the "experimental endowments" on the first four trials and some getting them on the middle four trials and others getting them on the last four trials. Each participant experienced each endowment x inequality x distribution exactly once. For example, when a participant was assigned to the first counterbalanced order in the high endowment condition, s/he would have 100 units of endowment in the first four trials when going though condition A, B, C and D. After the first four trials, this participant would be randomly assigned to the other two endowments for the rest of eight trials.

Participants and procedure

Participants were 144 college students. Similar to Study 1, they participated in a 1 h experiment at a rate of HKD50 (∼USD6.42) per hour. There were 24 participants in each session. Half of them were randomly assigned to the high endowment condition and the other half were assigned to the low endowment condition.

Participants signed the informed consent form and then the experimenter explained the procedure and the concept of the PG game with examples. The PG game was framed as a contribution to a pool of snacks shared among three roommates in a dormitory. The participants also completed a quiz on sample PG games to make sure that they understood the calculation of payoff in the game. The payoff factor for the games in this experiment was 2.5. All participants in each session played 12 trials of PG game in the same room over a computer network. In each trial, participants were either assigned to an "experimental endowment" position with a high endowment (100 units) or a low endowment (10 units) depending on the endowment condition they were in, or they were assigned to an "other endowment" position in which they had an endowment of other values. When participants were in an "experimental endowment" position, they would be prompted to respond to two manipulation check and three psychological measure items regarding their greed, fear and self-efficacy towards the contribution they were to be made. Afterwards, they were asked to enter the amount, within the range of their endowments that they decided to contribute to the group. When participants were in an "other endowment" position, they would not be prompted to respond to any psychological processes items but to proceed directly to enter the amount of contribution. Unlike Study 1, participants in this experiment did not get feedback about the PG game after each trial in order to minimize the carry-over effect. In order to encourage serious decisions in the games, all participants entered a lucky draw, in which two participants were randomly drawn to receive a cash bonus corresponding to one of the randomly selected trials that they played in the game. The average amount of cash bonus given out was HKD215.5 (USD27.75).

[4] Because there were three players in a group, apart from the participant who was in the "experimental endowment condition", we also needed two more participants to play with this "experimental" participant on this trial. Therefore, participants would be given endowments besides the 10 units or 100 units when they were in the "other endowment" condition. These individual contribution data from the "other endowment" positions were not used in the individual-level analyses, but they were aggregated as group contribution for the group-level analyses.

Results

Manipulation check

In order to assess the manipulation of inequality, we asked participants the extent to which "there is a wealth difference among roommates on this trial" on a seven-point scale from 1 = "no wealth difference" to 7 = "large wealth difference". Repeated measure analysis of inequality × distribution × endowment with endowment being entered as a between-subject factor was run on the inequality manipulation check item. A main effect on inequality showed that a larger wealth gap was perceived when inequality was larger, $M_{GC=small} = 3.97$, $SD = .11$ vs. $M_{GC=large} = 6.13$, $SD = .09$, $F(1, 142) = 269.95$, $p < .001$.

Manipulation of hegemony was assessed by the item "There is one person, including myself, in this dormitory, possessing an extremely large amount of endowment relative to others." Participants responded on a seven-point scale from 1 = "strongly disagree" to 7 = "strongly agree". A repeated measure analysis of inequality × endowment showed a significant main effect on inequality, $F(1, 142) = 188.70$, $p < .001$, which meant that it was more obvious to the players that there was one member in the group holding an extremely high endowment as inequality increased.

Symmetrically heterogeneity vs. hegemony

Group cooperation. Hypothesis 4 stated that the change of group cooperation in symmetrically heterogeneous groups across different levels of endowment inequality was different from that in hegemonic groups. We tested this hypothesis as in Study 1 by conducting a group-level analysis with 12 participants in one session as an independent unit. It is because participants in three-person groups were randomly rotated among the same set of 12 participants in a session. Among the 144 participants in the experiment we had 12 independent units. Each unit was comprised of 48 pieces of group contribution data obtained from the three-person groups that were formed across the 12 trials in a session (i.e., four groups were formed on each trial). To aggregate group contribution data for an independent unit, we took an average of group contributions for each experimental condition. We then conducted the group-level analysis based on these 12 independent unit data points.

An inequality × distribution × endowment repeated measure analysis on group contribution revealed a significant inequality × distribution two-way interaction, $F(1, 10) = 34.51$, $p < .001$. Simple effect analyses showed that the differences between the two inequality levels for both symmetrically heterogeneous and hegemonic distributions were significant. For symmetrically heterogeneous distribution, group cooperation dropped from low inequality conditions to high inequality conditions, M's = 26.4% & 21.4%; SD's = 1.2% & 1.1%, $F(1, 10) = 71.22$, $p < .001$. The drop of cooperation was less severe for hegemonic distributions; cooperation decreased from 29.8% ($SD = 1.2\%$) to 27.8% ($SD = 1.5\%$) when inequality increased, $F(1, 10) = 7.38$, $p < .05$.

Self-efficacy of high endowment members. Hypothesis 5 stated that high endowment members in hegemonic groups had a larger increase of self-efficacy as endowment inequality in the group increased compared with those in symmetrically heterogeneous groups. Confirming this hypothesis, repeated measure analysis on self-efficacy revealed an inequality × distribution × endowment three-way interaction, $F(1, 142) = 4.96$, $p < .05$. Simple effect analyses showed that among high endowment members in hegemonic groups, self-efficacy increased from 5.39 ($SD = .16$) to 6.03 ($SD = .22$) as inequality in the group increased, $F(1, 142) = 10.55$, $p < .01$. However, there was no a significant change in self-efficacy

Table 3
Study 2: Experimental conditions and mean percentage of contributions (and standard deviations).

	Condition							
Endowment	Low endowment				High endowment			
Endowment inequality	Low inequality		High inequality		Low inequality		High inequality	
Asymmetry of distribution	Symmetric	Hegemony	Symmetric	Hegemony	Symmetric	Hegemony	Symmetric	Hegemony
	A	B	C	D	E	F	G	H
	10	10	10	10	100	100	100	100
	20	10	50	10	90	80	60	20
	30	30	90	90	80	80	20	20
Mean% (SD) of group contribution	28.9% (2.5%)[a]	35.4% (2.9%)[a]	12.0% (1.0%)[a]	16.1% (1.5%)[a]	23.8% (5.2%)[b]	24.2% (5.4%)[b]	30.8% (5.2%)[c]	39.4% (7.2%)[c]
SD of endowment	10	11.54701	40	46.18802	10	11.54701	40	46.18802
Gini Coefficient	0.22	0.27	0.36	0.48	0.05	0.05	0.3	0.38
Skewness	0	1.732051	0	1.732051	0	1.732051	0	1.732051
Condition type	LOW ENDOW LOW HETER	LOW ENDOW LOW HEG	LOW ENDOW HIGH HETER	LOW ENDOW HIGH HEG	HIGH ENDOW LOW HETER	HIGH ENDOW LOW HEG	HIGH ENDOW HIGH HETER	HIGH ENDOW HIGH HEG

Note: HETER = heterogeneous endowment distribution; HEG = hegemonic endowment distribution.
HIGH = high; LOW = low.
Endowment is a between-subject variable; Endowment inequality and asymmetry of distribution are within-subject variables.
[a] Significantly different from all groups under the Low Endowment condition.
[b] Significantly different from both High Inequality groups under the High Endowment condition.
[c] Significantly different from all groups under the High Endowment condition.

among high endowment members in symmetrically heterogeneous groups, $F(1, 142) = 1.59$, *n.s.*, $\eta_p^2 = .011$ (see Table 4).

Individual cooperation. Hypothesis 6 stated that the decline of contributions by high endowment members in hegemonic groups was less significant than that in symmetrically heterogeneous groups as endowment inequality increased. A repeated measure analysis was conducted to test the effect of individual contribution percentage. Contrary to our prediction, the patterns of cooperation in the two types of heterogeneous group did not differ as shown by an insignificant inequality × distribution × endowment effect, $F(1, 142) = 1.98$, *n.s.*, $\eta_p^2 = .014$. There was, however, a significant inequality × endowment two-way interaction effect. Simple effect analysis showed that high endowment members contributed significantly more when inequality was low than when inequality was high, $M_{GC=high} = 50.7\%$, $SD = 4.2\%$ vs. $M_{GC=low} = 42.4\%$, $SD = 4.4\%$, $F(1, 142) = 10.02$, $p < .01$ (see Table 5).

Discussion

In two experiments we found converging evidence that not only did group cooperation rates change as endowment inequality in the group changed, but this change in cooperation rate was also affected by the asymmetry of endowment distribution. When endowments in the group became more unequal, symmetrically heterogeneous groups cooperated less. This change in cooperation could not be found in hegemonic groups. We confirmed that magnitude of inequality was only one of the factors that determined cooperation behaviors. Another factor that was also critical to consider was the asymmetry of the distribution. These two properties of heterogeneity affected not only the behaviors, but also the psychological states of the players. Group members felt differently about their self-efficacies in the group when the distribution of endowments was different. When the distribution was hegemonic, high endowment members felt that they were more efficacious as endowment inequality became greater; when the distribution was symmetric, however, their self-efficacies did not change significantly. A symmetric heterogeneous distribution also induced a higher temptation to free ride than a hegemonic distribution.

High endowment members and their fears

We anticipated the effect of distribution asymmetry on individual-level contributions of high endowment members. Specifically, we anticipated a decline of contribution by high endowment members in a symmetrically heterogeneous distribution and negligible changes of contribution in a hegemonic distribution. In order to explore why the results were not aligned with our predictions, we scrutinized the behaviors of these high endowment players by looking at their psychological changes in the game. We noticed from our results that their self-efficacies did increase more significantly in hegemonic groups which should foster contributions. Fear, as suggested by Brubaker (1975), accounted for most of the defection behaviors. Thus, we speculated that fear could be a factor that overshadowed the effect of self-efficacy. The decline of contribution by high endowment members in both distributions could be due to their increase of fear as endowment inequality increased. We examined the changes of fear of the high endowment members in both distributions.

Repeated measure analysis on the self-report fear item found an inequality × endowment interaction effect, $F(1, 142) = 11.65$, $p < .01$. The simple effect of inequality showed that high endowment members reported more fear as endowment inequality became higher ($M_{GC=high} = 5.22$, $SD = .19$ vs. $M_{GC=low} = 4.43$, $SD = .18$), $F(1, 142) = 17.65$, $p < .001$. Moreover, both the inequality × distribution × endowment three-way interaction, $F(1, 142) = .90$, *n.s.*, $\eta_p^2 = .006$, and the inequality × distribution two-way interaction, $F(1, 142) = .278$, *n.s.*, $\eta_p^2 = .002$, were not significant. This result shows that high endowment members had a significant increase of fear in general as the level of inequality increased, and the increase of fear does not differ between the two types of distribution (see Table 6).

This post hoc analysis of fear provides a plausible explanation as to why high endowment members in Study 2 behaved differently as those in Study 1 that they contributed less as inequality increased only when distribution was symmetrically heterogeneous.

Table 4
Study 2: Self-efficacy score (and standard deviations) on a 7-point scale of the High, Low and Medium endowment positions in heterogeneous group conditions.

Endowment position	Overall			High endowment			Low endowment		
Endowment inequality	Low (l)	High (h)	Mean diff. (l – h)	Low (l)	High (h)	Mean diff. (l – h)	Low (l)	High (h)	Mean diff. (l – h)
Self-efficacy score (SD) on a 7-point scale									
Symmetric	5.15 (.12)	4.90 (.14)	.25	5.47 (.17)	5.72 (.20)	−.25	4.83 (.17)	4.07 (.20)	.76***
Hegemony	5.14 (.11)	4.95 (.16)	.19	5.39 (.16)	6.03 (.22)	−.64**	4.89 (.16)	3.88 (.22)	1.01***
Overall	5.15 (.10)	4.92 (.14)	.23	5.43 (.14)	5.88 (.20)	−.45	4.45 (.16)	4.38 (.17)	.07

Note: statistical significance indicated in the table are simple effect comparisons.
** $p < .01$.
*** $p < .001$.

Table 5
Study 2: Mean percentage of contributions (and standard deviations) of the High, Low and Medium endowment positions in heterogeneous group conditions.

Endowment position	Overall			High endowment			Low endowment			Medium endowment		
Endowment inequality	Low (l)	High (h)	Mean diff. (l – h)	Low (l)	High (h)	Mean diff. (l – h)	Low (l)	High (h)	Mean diff. (l – h)	Low (l)	High (h)	Mean diff. (l – h)
Mean% of contribution (SD)												
Symmetric	26.4% (1.2%)	21.4% (1.1%)	5%***	51.4% (4.6%)	42.5% (4.5%)	8.9%	43.2% (4.6%)	49.4% (4.5%)	−6.2%	51.5% (2.8%)	40.4% (2.7%)	11.1%**
Hegemony	29.8% (1.2%)	27.8% (1.5%)	2%*	50.0% (4.4%)	42.2% (4.6%)	7.8%	47.1% (4.4%)	47.2% (4.6%)	−0.1%	48.3% (3.3%)	49.9% (3.6%)	−1.6%
Overall	28.1% (1.2%)	24.6% (1.3%)	3.5%***	50.7% (4.2%)	42.4% (4.4%)	8.3%**	45.1% (4.2%)	48.3% (4.4%)	−3.2%	49.9% (2.3%)	45.1% (2.2%)	4.8%

Note: statistical significance indicated in the table are simple effect comparisons.
* $p < .05$.
** $p < .01$.
*** $p < .001$.

Cooperation behaviors of our participants in Study 2 were driven mostly by fear. Specifically, their actual behaviors seemed to be more consistent with their feeling of fear; their fears increased as endowment in the group became more unequal which led to a decline of contribution.

Effect of hegemonic distribution on medium endowment members

Although we did not offer predictions on the behaviors of the medium endowment members, we were curious to explore which types of players, if not the high endowment members, actually cooperated in a way consistent with the group-level cooperation. Repeated measure analysis showed that only medium endowment members behaved differently in symmetrically heterogeneous and hegemonic groups as endowment inequality increased, $F(1, 142) = 4.09$, $p < .05$. Simple effect analysis showed that in symmetrically heterogeneous groups, cooperation rate dropped from 51.5% ($SD = 2.8\%$) with low inequality to 40.4% ($SD = 2.7\%$) with high inequality, $F(1, 142) = 8.21$, $p < .01$. However, cooperation rates did not change when the distribution of endowment was hegemonic, $F(1, 142) = .13$, *n.s.*, $\eta_p^2 = .001$. Therefore, unlike Study 1, we found that group cooperation rate was not driven by high endowment members, but probably by medium endowment members (see Table 4).

General discussion

We identified two properties of heterogeneity that have not been investigated together in previous studies: (a) level of inequality and (b) asymmetry of resource distribution. The same degree of change of endowment inequality in heterogeneous groups with different types of distribution could end up with different cooperation results. Both of our studies found consistent results that group cooperation rate declines more rapidly when the distribution is symmetric than when it is hegemonic. The effect of distribution can be found not only on a group level, but also on an individual level. High endowment members in Study 1 and medium endowment members in Study 2 cooperated less as inequality increased in a symmetrically heterogeneous group, but they did not show this decline of cooperation in hegemonic groups. Moreover, distribution asymmetry affects one's psychological state as inequality changes. The larger the inequality in hegemonic groups, the more self-efficacious are the high endowment members. Nevertheless, self-efficacy did not change significantly for high endowment members in symmetric heterogeneous groups.

We are now able to explain the inconsistent findings from previous studies by examining the level of inequality and the type of distribution simultaneously. As summarized in Table 1, most heterogeneous conditions in previous studies were symmetrically distributed, except those in Chan et al. (1996). This difference in distribution explains why they found a pattern of inequality effect that was different from all other studies. That is, most studies revealed that when inequality was large, cooperation declined, but Chan et al. found that cooperation increased in his inequality conditions. It was probably because the endowment distributions in their condition were asymmetric. We believe that the two properties of heterogeneity (i.e., level of inequality and asymmetry of endowment distribution) are essential in understanding cooperative behaviors of heterogeneous groups in public goods dilemma.

Implication

The property of distribution asymmetry is important but has often been neglected in previous social dilemma studies. Today, the growing popularity of online collaboration among strangers of diverse backgrounds is a strong indication that we should not rely on getting a team of more or less homogeneous members to get a large group output. Instead, we should look into strategies by managing the distribution asymmetry of a group of heterogeneous members to increase output. An example of applying the effect of the asymmetry property is on crowdfunding campaigns, which has recently emerged as a popular fundraising channel for startup

Table 6
Study 2: Fear score (and standard deviations) on a 7-point scale of the High, Low and Medium endowment positions in heterogeneous group conditions.

Endowment position	Overall			High endowment			Low endowment		
Endowment inequality	Low (l)	High (h)	Mean diff. (l – h)	Low (l)	High (h)	Mean diff. (l – h)	Low (l)	High (h)	Mean diff. (l – h)
Fear score (SD) on a 7-point scale									
Symmetric	4.47 (.14)	4.75 (.15)	−.28	4.42 (.19)	5.25 (.22)	−.83*	4.51 (.19)	4.25 (.22)	.26
Hegemony	4.35 (.14)	4.74 (.16)	−.39	4.44 (.20)	5.19 (.23)	−.75*	4.26 (.20)	4.29 (.23)	−.03
Overall	4.41 (.13)	4.75 (.14)	−.34*	4.43 (.18)	5.22 (.19)	−.79*	4.39 (.18)	4.27 (.19)	.12

Note: statistical significance indicated in the table are simple effect comparisons.
* $p < .05$.

businesses, innovative and artistic projects, non-profit events, etc. (Mollick, 2014). Crowdfunding is under the umbrella of crowdsourcing activities that make use of collective effort of the general public (i.e., the crowd) to accomplish tasks (Kleemann, Voß, & Rieder, 2008). The collective effort in crowdfunding refers to monetary contributions and investments (Belleflamme, Lambert, & Schwienbacher, 2010), and they usually take place on electronic fundraising platform on the Internet, such as Kickstarter and IndieGoGo. Crowdfunding is a public goods dilemma for funders because all of them will get rewarded if the project succeeds regardless of the amount being contributed; and the rewards they get are non-rival. The differentiation between crowdfunding and traditional charity donations is that group members who are involved in crowdfunding can usually get information about the group (e.g., group size) and other funders (e.g., whether they are individuals or companies; the number of projects they had funded). These characteristics allow the funders to make contribution decisions not only based on their interests on the project, but also their evaluations of other funders. This experience is very similar to that of our participants: they have knowledge the endowment of each group member. Moreover, crowdfunding funders are ad hoc groups; they come together only to contribute for a particular project. This is another circumstance that matches the paradigms of our study. More importantly, our finding that an increase of endowment heterogeneity in groups with hegemonic distribution has minimal negative impact on group contribution offers insight on funder recruitment strategy for crowdfunding campaigns. The background and the capital that crowdfunding funders have are diverse by definition. They could be friends and family of the project founders (Cunningham, 2012; Mollick, 2014); they could also be any individuals or venture capitalists from the general public (Zhang, 2012). More often than not the group of funders has a heterogeneous distribution of endowments. According to our findings, if funders perceive a rather symmetric heterogeneous distribution without any particularly high endowed peer funder, their contributions would probably be much more conservative. The founder should, therefore, try to invite a funder who is apparently much wealthier than an average funder. An example of this wealthy funder could be a company which is usually being perceived as much more capable in making a large contribution than an average individual could. The founder should also emphasize to this hegemonic funder the huge difference that its potential financial contribution is going to make to the project in order to enhance the funder's perceived efficacy. Although fear of being suckered is shown to be a factor in our post hoc analysis that could overshadow the effect of self-efficacy, its effect in crowdfunding context should be minimal. This is because the ultimate success of these projects does not depend only on the funding being raised in the campaigns but also the interests of the general public. Having more individual funders from the general public actually reflects a larger potential for success of the project. Therefore, getting an extremely wealthy funder in the group should work better than getting several above average funders.

Not only can our results be applied in contemporary forms of collective tasks like crowdfunding, but in traditional work settings as well. Understanding the effects of different types of distribution allows us to make the most efficient groups out of limited human resources. Recently, a meta-analysis on the effect of demographic diversity on team performance has carefully analyzed the effect of team diversity from the perspectives of separation, variety and disparity (Bell, Villado, Lukasik, Belau, & Briggs, 2011). Demographic disparity (e.g., difference in level of education) in their study is similar to endowment inequality in ours. Although they find negligible performance difference between homogeneous teams and teams with disparity, they acknowledge that previous findings on the effect of team diversity have been quite mixed as there are theories suggesting that diversity could results in low team performance (Milliken & Martins, 1996) as homogeneous teams are more efficient in communication (Wiersema & Bantel, 1992), but demographics diversity also means greater diversity of knowledge which fosters creativity and innovation (Cox & Blake, 1991; Williams & O'Reilly, 1998). These studies illustrate that inconsistent theories and findings regarding how group heterogeneity affect performance is not only a topic of research in the laboratory, it is also an important issue that concerns teams and groups in real-world organizational settings. It is inevitable that people are different from each other in terms of their abilities such as wealth, skills and experiences. This study shows that even people with high disparity of ability could still make very efficient groups in terms of cooperativeness with careful grouping of these people. Our findings show that heterogeneity of some distribution (e.g., hegemonic distribution) might turn out to be as efficient as homogeneous groups. Although it would be difficult to examine all possible types of distribution and identify the most efficient ones, it is feasible that we derive an efficient distribution based on its effect on different psychological processes, e.g., self-efficacy as the level and the distribution of heterogeneity change.

Limitation and further study

One limitation of our study was that we investigated distribution asymmetry qualitatively by comparing symmetric (skewness = 0) and hegemonic (absolute skewness >0) distributions only. We shall also explore how the pattern of cooperation of hegemonic groups would change when the magnitude of skewness changes and when the distribution is skewed to low endowments. We speculate that the pattern of cooperation of hegemonic groups shall be closer to symmetrically heterogeneous groups when the distribution is less skewed because the distributions of endowments of the two types of group are closer to each other in this case. It becomes more interesting when the skewness of distribution changes direction towards low endowments. First, low-endowment members become the minority and, therefore, they might be perceived as people in need instead of people who are responsible for contributing to the group. Second, as there are multiple high-endowment members in a group, coordination of contribu-

tion among them could be less efficient (McCarter, Budescu & Schreffran, 2011). Therefore, it is possible that skewness is also a factor that affects the pattern of cooperation.

Moreover, future studies could explore the effects of different types of endowment distribution on group identity, which in turn affect work motivation and performance. Because the self is context sensitive that the way we define ourselves changes depending on who we compare ourselves with and depending on contexts (Haslam, Oakes, Turner, & McGarty, 1996; Haslam & Turner, 1992), different distribution of heterogeneous resources could lead to different ways of self-categorizations by group members. For instance, the uniquely high endowment member in a group with a hegemonic distribution may categorize himself/herself as a unique individual in the group who may focus on individual needs and worry about being a sucker; the rest of the group with an equal amount of small endowment may categorize themselves as a subgroup who may focus on the benefits of the group and have less temptation to free ride. Indeed, work motivation and performance are very much influenced by one's social identity and self-categorization (Haslam, 2004; Haslam et al., 2000; Tyler & Blader, 2003; Wenzel, 2007). People who identify themselves as members of an organization show more organizational citizenship behaviors (Tyler, 1999) and other positive organizational outcomes (Smith & Tyler, 1997; van Knippenberg & van Schie, 2000). Therefore, it could be a new direction for organizations to enhance group identity and motivation of employees by strategically changing distributions of resources in groups.

Conclusion

We examined two properties of heterogeneity in this study: (a) level of inequality and (b) asymmetry of resource distribution. Our results show that group cooperation, as well as individual players' contributions are affected by the interaction of both of these properties. Not only does the asymmetry of resource distribution affect the change of cooperation behavior in different levels of inequality, but it also changes how group members feel about their self-efficacies under these circumstances. Taking together the two properties of heterogeneity, we can explain inconsistent findings of endowment heterogeneity in previous studies. Distribution asymmetry is an important dimension that cannot be neglected in future research of endowment heterogeneity.

Acknowledgments

The work described in this paper was fully supported by a grant from the General Research Fund of the Hong Kong Special Administrative Region, China (Project No. CUHK 440109). The authors thank David V. Budescu, Darius K.-S. Chan, Takeshi Hamamura, and Lin Tao for their comments on earlier drafts of this paper.

References

Adams, J. S. (1963). Toward an understanding of inequity. *Journal of Abnormal and Social Psychologg, 67*, 422–436.
Adams, J. S. (1965). Inequaity in social exchange. In L. Berkowitz (Ed.). *Advances in experimental social psychology* (Vol. 2, pp. 267–299). New York: Academic Press.
Aiken, L. S., & West, S. G. (1991). *Multiple regression: Testing and interpreting interactions*. Newbury Park, CA: Sage.
Andreoni, J. (1988). Why free ride? Strategies and learning in public goods experiments. *Journal of Public Economics, 37*, 291–304.
Aquino, K., Steisel, K., & Kay, A. (1992). The effects of resource distribution, voice, and decision framing on the provision of public goods. *Journal of Conflict Resolution, 36*, 665–687.
Atkinson, A. B. (1975). *The economics of inequality*. Oxford: Clarendon Press.
Bell, S. T., Villado, A. J., Lukasik, M. A., Belau, L., & Briggs, A. L. (2011). Getting specific about demographic diversity variable and team performance relationships: A meta-analysis. *Journal of Management, 37*, 709–743.
Belleflamme, P., Lambert, T., & Schwienbacher, A. (2010). *Crowdfunding: Tapping the Right Crowd*. <http://ssrn.com/abstract=1578175>.
Bergstrom, T., Blume, L., & Varian, H. (1986). On the private provision of public goods. *Journal of Public Economics, 29*, 25–49.
Buckley, E., & Croson, R. (2006). Income and wealth heterogeneity in the voluntary provision of linear public goods. *Journal of Public Economics, 90*, 935–955.
Chan, K. S., Mestelman, S., Moir, R., & Muller, R. A. (1996). The voluntary provision of public goods under varying income distributions. *Canadian Journal of Economics, 29*, 54–69.
Cherry, T. L., Kroll, S., & Shogren, J. F. (2005). The impact of endowment heterogeneity and origin on public good contributions: Evidence from the lab. *Journal of Economic Behavior and Organization, 57*, 357–365.
Cowell, F. A. (1995). *Measuring inequality*. New York: Prentice Hall.
Cox, T., & Blake, S. (1991). Managing cultural diversity: Implications for organizational competitiveness. *Academy of Management Executive, 5*, 45–46.
Cress, U., & Kimmerle, J. (2008). Endowment heterogeneity and identifiability in the information-exchange dilemma. *Computers in Human Behavior, 24*, 862–874.
Cunningham, W. M. (2012). Crowdfunding. In *A Jobs Act* (pp. 61–81). APress.
De Cremer, D., & Van Dijk, E. (2002). Perceived criticality and contributions in public good dilemmas: A matter of feeling responsible to all? *Group Processes and Intergroup Relations, 5*, 319–332.
Deutsch, M. (1975). Eqquity, equality and need: What determines which value will be used as a basis of distributive justice? *Journal of Social Issues, 31*, 137–149.
Doise, W., & Sinclair, A. (1973). The categorization process in intergroup relations. *European Journal of Social Psychology, 3*, 145–157.
Fischbacher, U. (2007). Z-Tree: Zurich toolbox for readymade economic experiments. *Experimental Economics, 10*, 171–178.
Garson, D. (2010). In *Generalized linear models and generalized estimating equations*. <http://faculty.chass.ncsu.edu/garson/PA765/gzlm_gee.htm> Retrieved 30.05.10.
Hardin, J. W., & Hilbe, J. M. (2003). *Generalized estimating equations*. Coca Raton, FL: Chapman & Hall.
Haslam, S. A. (2004). *Psychology in organizations: The social identity approach*. London: Sage.
Haslam, S. A., Oakes, P. J., Turner, J. C., & McGarty, C. (1996). Social identity, self-categorization and the perceived homogeneity of ingroups and outgroups: The interaction between social motivation and cognition. In R. M. Sorrentino & E. T. Higgins (Eds.), *Handbook of motivation and cognition* (pp. 182–222). New York: Guilford.
Haslam, S. A., Powell, C., & Turner, J. C. (2000). Social identity, self-categorization, and work motivation: Rethinking the contribution of the group to positive and sustainable organizational outcomes. *Applied Psychology: An International Review, 49*, 319–339.
Haslam, S. A., & Turner, J. C. (1992). Context-dependent variation in social stereotyping 2: The relationship between frame of reference, self-categorization and accentuation. *European Journal of Social Psychology, 22*, 251–278.
Hegemony. (2010). In *Merriam-webster online dictionary*. <http://www.merriam-webster.com/dictionary/hegemony> Retrieved 30.05.10.
Hogg, M. A., & Abrams, D. (1988). *Social identifications*. London: Routledge.
Hogg, M. A. (2003). Social identity. In M. R. Leary & J. P. Tangney (Eds.), *Handbook of self and identity*. New York: The Guilford Press.
Hogg, M. A., & Terry, D. J. (2000). Social identity and self- categorization processes in organizational contexts. *Academy of Management Review, 25*, 121–140.
Isaac, R. M., & Walker, J. M. (1988). Group size effects in public goods provision: The voluntary contributions mechanism. *Quarterly Journal of Economics, 103*, 179–199.
Kerr, N. L. (1983). Motivational losses in small groups: A social dilemma analysis. *Journal of Personality and Social Psychology, 45*, 819–828.
Kerr, N. L. (1992). Efficacy as a causal and moderating variable in social dilemmas. In W. Liebrand, D. Messick, & H. Wilke (Eds.), *A social psychological approach to social dilemmas* (pp. 59–80). New York: Pergamon.
Kleemann, F., Voß, G. G., & Rieder, K. (2008). Un(der)paid Innovators: The commercial utilization of consumer work through crowdsourcing. *Science, Technology and Innovation Studies, 4*, 5–26.
Levati, M. V., Sutter, M., & Van Der Heijden, E. (2007). Leading by example in a public goods experiment with heterogeneity and incomplete information. *Journal of Conflict Resolution, 51*, 793–818.
Marwell, G., & Ames, R. E. (1979). Experiments on the provision of public goods. 1. Resources, interest, group size, and the free-rider problem. *American Journal of Sociology, 84*, 1335–1360.
Marwell, G., & Ames, R. E. (1980). Experiments on the provision of public goods. 2. Provision points, stakes, experience, and the free rider problem. *American Journal of Sociology, 85*, 926–936.
McCarter, M. W., Budescu, V., & Schreffran, J. (2011). The give-or-take-some dilemma: An empirical investigation of a hybrid social dilemma. *Organizational Behavior and Human Decision Processes, 116*, 83–95.
Milliken, F. J., & Martins, L. L. (1996). Searching for common threads: Understanding the multiple effects of diversity in organizations work groups. *Academy of Management Review, 21*, 402–433.
Mollick, E. (2014). The dynamics of crowdfunding: An exploratory study. *Journal of Business Venturing, 29*, 1–16.
Rapoport, A. (1988). Provision of step-level public goods: Effects of inequality in resources. *Journal of Personality and Social Psychology, 54*, 432–440.

Rapoport, A., Bornstein, G., & Erev, I. (1989). Intergroup competition for public goods: Effects of unequal resources and relative group size. *Journal of Personality and Social Psychology, 56*, 748–756.

Smith, H. J., & Tyler, T. R. (1997). Choosing the right pond: The impact of group membership on self-esteeem and group-oriented behavior. *Experimental Social Psychology, 33*, 146–170.

Thibaut, J., & Kelley, H. H. (1959). *The social psychology of groups*. New York: Wiley.

Tyler, T. R., & Blader, S. L. (2001). Identity and cooperative behavior in groups. *Group Processes and Intergroup Relations, 4*, 207–226.

Tyler, T. R., & Blader, S. L. (2003). The group engagement model: Procedural justice, social identity, and cooperative behaviour. *Personality and Social Psychology Review, 7*, 349–361.

Tyler, T. R. (1999). Why people cooperate with organizations: An identity-based perspective. In R. I. Sutton & B. M. Staw (Eds.), *Research in organizational behavior* (pp. 201–247). Greenwich, CT: JAI Press.

Van Dijik, E., Wilke, H., & Metman, L. (1999). What information do we use in social dilemmas? Environmental uncertainty and the employment of coordination rules. *Journal of Experimental Social Psychology, 35*, 109–135.

Van Dijk, E., & Grodzka, M. (1992). The influence of endowments asymmetry and information level on the contribution to a public step good. *Journal of Economic Psychology, 13*, 329–342.

Van Dijk, E., & Wilke, H. (1994). Asymmetry of wealth and public good provision. *Social Psychology Quarterly, 57*, 352–359.

Van Dijk, E., & Wilke, H. (1995). Coordination rules in asymmetric social dilemmas: A comparison between public good dilemmas and resource dilemmas. *Journal of Experimental Social Psychology, 31*, 1–27.

van Knippenberg, D., & van Schie, E. C. M. (2000). Foci and correlates of organisational identification. *Journal of Occupational and Organisational Psychology, 73*, 137–147.

Van Lange, P. A. M., Liebrand, W. B. G., Messick, D. M., & Wilke, H. A. M. (1992). Introduction and literature review. In W. B. G. Liebrand, D. M. Messick, & H. A. M. Wilke (Eds.), *Social dilemmas: Theoretical issues and research findings* (pp. 3–28). Oxford: Pergamon Press.

Warr, P. G. (1983). The private provision of a public good is independent of the distribution of income. *Economics Letters, 13*, 207–211.

Wenzel, M. (2007). The multiplicity of taxpayer identities and their implications for tax ethics. *Law and Policy, 29*, 31–50.

Wessa, P. (2010). Free statistics software. *Office for Research Development and Education*, version 1.1.23-r6, <http://www.wessa.net/>.

Wiersema, M. F., & Bantel, K. A. (1992). Top management team demography and corporate strategic change. *Academy of Management Journal, 35*, 91–121.

Williams, K., & O'Reilly, C. (1998). The complexity of diversity: A review of forty years of research. In B. Staw & R. Sutton (Eds.). *Research in organizational behavior* (Vol. 21, pp. 77–140). Greenwich, CT: JAI Press.

Wit, A. P., Wilke, H. A. M., & Oppewal, H. (1992). Fairness in asymmetric social dilemmas. In W. Liebrand, D. Messick, & H. Wilke (Eds.), *Social dilemmas: Theoretical issues and research findings* (pp. 183–197). New York: Pergamon Press.

Yamagishi, T., & Sato, K. (1986). Motivational bases of the public goods problem. *Journal of Personality and Social Psychology, 50*, 67–73.

Zhang, Y. (2012). An Empirical Study into the Field of Crowdfunding. *Economic Policy, 34*, 231–269.