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The emergence of conventions in the repeated volunteer's dilemma: The role of social value orientation, payoff asymmetries and focal points[☆]

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ABSTRACT

Conventions are arbitrary rules of behavior that coordinate social interactions. Here we study the effects of individuals' social value orientations (SVO) and situational conditions on the emergence of conventions in the three-person volunteer's dilemma (VOD). The VOD is a step-level collective good game in which only one actor's action is required to produce a benefit for the group. It has been shown that if actors interact in the payoff-symmetric VOD repeatedly, a turn-taking convention emerges, resulting in an equal distribution of payoffs. If the VOD is asymmetric, with one "strong" actor having lower costs of volunteering, a solitary-volunteering convention emerges by which the strong actor volunteers earning less than others. In study 1 we test whether SVO promotes turn-taking and hampers solitary-volunteering. We find that groups with more prosocials engage less in turn-taking and no effect of SVO on the emergence of solitary-volunteering. In study 2 we test whether making one actor focal is sufficient for solitary-volunteering to emerge. We find instead that payoff asymmetry with one strong actor is a necessary precondition. We discuss explanations for our findings and propose directions for future research.

1. Introduction

Every day we face situations in which a single person's effort is necessary and sufficient to produce a benefit for the entire group. Doing the dishes after a flat-share dinner. Getting up to calm the crying baby. Calling the police if a neighbor disturbs everybody's sleep. Vetoing an unpopular motion in a committee meeting. Taking the lead in a new project at work. Abstaining from drinking alcohol to drive everyone home after a night out. Although the person "taking one for the team" benefits from the collective good they produce, they had rather someone else do it. However, if all group members expect someone else to do it, the collective good is not produced or its delayed production reduces everyone's gains. Specifically, these situations are examples of the volunteer's dilemma

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(Diekmann, 1985; Weesie, 1993), a game theoretic model that captures the interdependence of individual decisions in such situations. The volunteer's dilemma (VOD) is a specific type of social dilemma – an interaction situation in which individual and collective interests are at odds (see, e.g., Dawes, 1980; Messick and Brewer, 1983; Kollock, 1998; van Lange et al., 2013; Przepiorka, 2021).

Here we investigate how small groups manage to tacitly coordinate on a single group member to produce the collective good, if the VOD is repeated. Many times we find ourselves in the same recurring situation with the same actors: the flat share having joint dinners every other weekend; a couple having a baby crying every night; an apartment building with one tenant playing loud music on weekdays; a monthly committee meeting; the same work team responsible for repeat customer orders; a bunch of friends going out together on weekends. Although we know from game theory that in repeated social dilemmas (e.g., prisoner's dilemma) cooperation may become a payoff-maximizing course of action (Axelrod, 1984; Fudenberg and Maskin, 1986; Dal Bó, 2005), the conditions under which cooperation can emerge in the repeated VOD is less well understood.

Previous research suggests that asymmetry in payoffs, i.e. when volunteering is less costly for one group member, has a substantial effect on how group members coordinate in the VOD and similar collective goods games. For example, abstaining from drinking alcohol is easier for people that do not like to drink alcohol, the most experienced team member will be less anxious to take the lead in a new project, etcetera. It has been shown that in groups with an asymmetric distribution of payoffs, it is the group member with the lowest costs from volunteering who volunteers most of the time (Cherry et al., 2013; Diekmann and Przepiorka, 2016). By contrast, groups in which payoffs are symmetric (i.e. costs and benefits are the same for all group members) often arrive at a solution by taking turns in volunteering (Bornstein et al., 1997; Diekmann and Przepiorka, 2016; Helbing et al., 2005; Riyanto and Roy, 2019; Sibly and Tisdell, 2018; Winter 2014).

Although previous evidence shows that solitary-volunteering and turn-taking can emerge as efficient solutions in the repeated VOD, solitary-volunteering produces unequal payoffs (with one group member bearing all costs of volunteering), whereas turn-taking leads to (more) equal payoffs (Diekmann and Przepiorka, 2016). Research on social value orientation (SVO, aka social preferences) has shown that individuals differ in their preferences for equality (see, e.g., Kuhlman and Marshello, 1975; Messick and McClintock, 1968; van Lange, 1999). SVO indicates how individuals value their own outcomes relative to others' outcomes in situations of outcome interdependence (Murphy and Ackermann, 2014). The majority of the SVO literature distinguishes the following types: whereas some individuals have a preference for equality and consider the group's payoff (so called *prosocials*), other individuals have a preference for maximizing their own payoff (so called *proselfs*). Hence, in addition to situational characteristics, we investigate the influence of group members' SVO on the emergence of conventions in the repeated VOD.

We call the behavioral regularities that emerge in the repeated VOD conventions (Lewis, 1969; Sugden, 1986; Young, 1993) and distinguish them from social norms (Bicchieri, 2006; Cialdini et al., 1990; Hechter and Opp, 2001). Unlike social norms, conventions lack normativity at first but could become social norms by gaining normativity over time (Guala and Mittone, 2010; Opp, 2004; Wrong, 1994). Our paper offers new insights into how the emergence of conventions is affected by monetary incentives and individuals' social preferences and, with that, paves the way for a better understanding of how norms can emerge from conventions (Bicchieri, 2006; Binmore, 2010; Diekmann and Przepiorka, 2016; Hawkins et al., 2019; Tummolini et al., 2013). Our paper also contributes to the literature that studies the influence of individual and situational factors on the emergence of cooperation in social dilemmas (de Kwaadsteniet et al., 2006, 2008; Roch and Samuelson, 1997; Simpson and Willer, 2015).

We test to what extent the conventions that emerge are determined by characteristics of the group members (i.e., SVO) and/or characteristics of the VOD (i.e., payoff asymmetries and focal points).[1] In our first experiment, we test the hypothesis that SVO promotes coordination on turn-taking in the symmetric VOD and hampers solitary-volunteering by the strong actor in the asymmetric VOD. In our second experiment, we turn our attention to the structural properties of the VOD that promote coordination. Our aim is to disentangle the incentive effect of payoff differences from the "focal point" effect (Schelling, 1960) payoff differences have on singling out one actor (i.e. making one actor salient; for a related study, see Leland and Schneider, 2018). We close our paper with a discussion of possible implications of our findings and directions for future research.

1.1. The repeated volunteer's dilemma

The VOD is a step-level collective goods game with n players (on step-level collective goods games, see also Dijkstra and Bakker, 2017; Ledyard, 1995; van de Kragt et al., 1983). The n players decide simultaneously and independently between the strategies v "volunteer" and ¬v "not volunteer." All n players obtain a benefit U from the collective good if at least one player i chooses v at costs K_i (see Table 1). In the VOD, it is assumed that $U_i - K_i > 0$ for all i. Hence, unlike in the well-known prisoner's dilemma (PD), where defection maximizes a player's payoffs irrespective of what the other players do, choosing ¬v is not a dominant strategy in the VOD. In other words, while in the PD mutual defection is a Nash equilibrium, it is not a Nash equilibrium in the VOD when all players choose ¬v; it is always better to choose v if everyone else chooses ¬v in the VOD.

The VOD has n Nash equilibria in pure strategies, where one player chooses v and $n - 1$ players choose ¬v. Recall that in a Nash equilibrium no player has an incentive to change their strategy unilaterally (see, e.g., Osborne, 2009). Moreover, the pure strategy Nash equilibria are Pareto-optimal in that they produce welfare maximizing outcomes.

[1] Although, technically speaking, payoff asymmetries and focal points can also result from individual differences, it is the observable differences that determine the strategic nature of an interaction situation. SVO is an individual trait that is *a priori* unobservable and therefore cannot have a direct bearing on how the strategic aspects of a situation are perceived by actors. Moreover, there are many examples in which payoff asymmetries and focal points are induced by properties of the situation, such as spatial distance (see, e.g., Przepiorka and Berger, 2016).

Table 1
The volunteer's dilemma game.

Player *i*'s choice	Number of other players choosing v				
	0	1	2	…	$n-1$
Volunteer (v)	$U_i - K_i$	$U_i - K_i$	$U_i - K_i$	$U_i - K_i$	$U_i - K_i$
Not volunteer (¬v)	0	U_i	U_i	U_i	U_i

Unlike the PD, which constitutes a pure cooperation problem, the VOD constitutes a situation in which a coordination problem and a cooperation problem occur at the same time (Przepiorka, 2021). The VOD constitutes a coordination problem because, without communication, deliberate coordination on one of the pure strategy Nash equilibria is not possible. The VOD constitutes a cooperation problem, because a player that chooses v has a lower payoff than a player that chooses ¬v (if at least one player choose v); every player prefers another group member to produce the collective good.[2]

Thus far, our description of the VOD applies to its symmetric version, in which *U* and *K* are the same for all players (Diekmann, 1985). In the asymmetric VOD, *U* and/or *K* differ for at least two group members (Diekmann, 1993; Murnighan et al., 1993).[3] The distinction between the symmetric and the asymmetric VOD constitutes a crucial part of our theoretical argument. Although in both the symmetric and asymmetric VOD with *n* players there are *n* pure strategy equilibria (one player chooses v and all other players choose ¬v), in the symmetric VOD players have no reference point that would allow them to tacitly coordinate on one of the equilibria. However, in the asymmetric VOD with one strongest player (i.e. player with highest net benefits from choosing v), the strongest player constitutes a natural focal point, making it more likely for the group to tacitly coordinate on this player to choose v alone, even in a one-time only encounter (cf. Schelling, 1960). However, a focal solution in the symmetric VOD only comes into existence once the game is played repeatedly among the same group members.

Repeated interactions in social dilemmas consist of two key features that affect the way individuals make decisions, namely past experiences and expected future interactions. These features represent two mechanisms known as 'learning' and 'control' respectively (Axelrod, 1984; Buskens and Raub, 2013; Macy and Flache, 2002). Actors learn from past interactions, form expectations about their partners' future actions, and adjust their behavior as a control mechanism for outcomes in the future. In game theoretic studies, the 'folk theorem' asserts that indefinitely repeated interactions facilitate coordination on Pareto efficient outcomes by inducing agents to adapt conditionally cooperative strategies (Fudenberg and Maskin, 1986).

Diekmann and Przepiorka (2016) observe a clear difference in behavioral regularities that emerge in repeated symmetric and asymmetric volunteer's dilemmas. In the symmetric game, reciprocal turn-taking behavior emerges. That is, over time, coordination on Nash equilibria in which actors volunteer after one another in a sequential manner is more often reached (see also Helbing et al., 2005; Lau and Mui, 2012; Winter 2014). In the asymmetric game with one strong player, solitary volunteering by the strong actor (i.e. the actor with the lowest costs of volunteering) emerges most often. Based on these previous theoretical considerations and empirical observations, we can state our first hypothesis:

H1. Payoff asymmetries foster tacit coordination on solitary-volunteering by the strongest group member rather than turn-taking among all group members.

As just mentioned, our first hypothesis has received consistent support in previous research and we expect to replicate these results. The empirical evidence supporting H1 constitutes the baseline from which the paper at hand departs. In study 1, we investigate to what extent individuals' SVOs affect groups' ability to coordinate on turn-taking and solitary volunteering. In study 2, we investigate to what extent making one actor focal is sufficient for solitary-volunteering to emerge. We expand on our theoretical arguments for the two studies and state our further hypotheses in the corresponding sections.

2. Study 1: the role of SVO

Research shows that asymmetry in the VOD can lead to solitary volunteering by the strongest group member and that the extent to which groups tacitly coordinate on solitary volunteering depends on the degree of asymmetry (Diekmann and Przepiorka, 2016). That is, when asymmetry in terms of payoff differences is large (i.e., the strong player is much stronger than the others), it is more likely that the collective good will be produced by the strong player alone. By contrast, when asymmetry is small, not all groups seem to agree that the strongest player should be the only volunteer, and some of these groups start taking turns instead. This observation instigates the question which factors cause a group to agree on a specific convention (i.e., solitary volunteering or turn-taking), especially when

[2] The VOD also has a mixed strategy equilibrium, in which all players choose v with a certain probability (Diekmann, 1985). The mixed strategy equilibrium implies a monotonically decreasing function of the probability of volunteering with group size. This group size effect is referred to as the "diffusion of responsibility" or "bystander" effect (Darley and Latané, 1968; Krueger, 2019; Przepiorka and Diekmann, 2018).

[3] Alternatively, the VOD can be defined as symmetric if the costs-to-benefits ratio is equal for all players, and otherwise the VOD is asymmetric (Weesie, 1993). We use a stricter definition to make sure that the symmetric and asymmetric models are clearly distinct from one another and to avoid a heuristic problem that could undermine decision making behaviour in social dilemmas (van Dijk et al., 1999). For example, if the payoffs of one player are $U = 10$ and $K = 5$ and another player's payoffs are $U = 4$ and $K = 2$, the first player earns more from choosing C although the game is symmetric in terms of cost-to-benefit ratios.

asymmetry in payoffs is relatively small. We argue that SVO may play an important role in how quickly a group tacitly agrees on a course of action in the repeated VOD.

Compared to proselfs, who primarily care about their own payoffs, prosocials also care about the payoffs of others (Balliet et al., 2009; Bogaert et al., 2008; Murphy et al., 2011). Specifically, prosocials are inclined to incur costs to reduce payoff differences between themselves and other group members. As a consequence, prosocials should be more inclined to coordinate on equilibria that yield a more equal distribution of payoffs than proselfs. Based on this argument, we can state our second hypothesis:

H2. Groups with more prosocial group members are more likely to coordinate on turn-taking among all group members.

On the one hand, payoff asymmetries may provide group members with a monetary incentive to coordinate on the strongest member to volunteer alone (H1). On the other hand, prosocial group members might be more inclined to take turns to avoid inequalities in payoffs that would result from one group member volunteering all the time, also when payoffs are asymmetric (H2). Combining these two predictions results in our third hypothesis:

H3. The extent to which payoff asymmetries foster coordination on solitary-volunteering by the strongest group member will be smaller the more prosocial the group members are.

2.1. Experimental design and procedures

We tested our hypotheses by means of a computerized laboratory experiment. The experiment was conducted in the Experimental Laboratory for Sociology and Economics (ELSE) at Utrecht University and comprised eight experimental sessions with 21–27 participants in each session. The $N = 192$ participants that took part in our experiment were students and non-students from Utrecht, 66.7% were female, and they were 23.7 years old on average (sd = 6.48). Participants were recruited by e-mail with the Online Recruitment System for Economic Experiments (ORSEE) (Greiner, 2015). The experiment was programmed and conducted with the software z-Tree (Fischbacher, 2007).

Upon arrival in the lab participants were randomly assigned to a computer cubicle and received instructions in English on paper. Instructions explained the general procedure and rules of the experiment (see online appendix, Section A). In the instructions, participants were told that the experiment consists of two parts. Part 1 instructions were the same for all participants. Not before Part 1 had ended did participants receive Part 2 instructions. Since part 2 comprised two experimental conditions, participants received condition specific instructions. After reading the instructions, participants took a quiz with comprehension check questions about the decision situations. Questions for which at least one wrong answer was given were read out loud and the correct answer was explained to all participants. Then, the experiment started.

In part 1, we elicited participants' SVO scores by means of the 6-item SVO slider measure (Murphy et al., 2011; Murphy and Ackermann, 2014). This slider measure consists of a series of six allocation games in each of which participants are asked to divide an amount of monetary units between themselves and an anonymous other. We used the z-Tree implementation of the SVO slider measure programmed by Crosetto et al. (2019). The measure produces an SVO score for each individual ranging from −25 to 65. Specifically, values from −25 to −12.04 indicate competitiveness, values from −12.04 to 22.44 indicate individualism, values from 22.45 to 57.15 indicate inequality aversion, and values from 57.15 to 61.39 indicate pure altruism (prosocial). Competitiveness and individualism are attributed to proselfs and inequality aversion and altruism are attributed to prosocials.

In part 2, participants with similar SVO scores were matched in groups of three and assigned to one of two experimental conditions as follows: First, all participants in the same session were sorted in ascending order based on their SVO scores. Second, participants were matched in groups of three starting with the group of three participants with the lowest SVO scores and ending with the group of three participants with the highest SVO scores. We did not inform participants that they were grouped based on their SVO scores to avoid experimenter demand effects (Zizzo, 2010). Third, every other group was assigned to the symmetric or asymmetric VOD condition. Whether the first group was assigned to the symmetric or asymmetric condition was systematically varied across sessions.

In each group, participants were randomly assigned to be person 1, 2 or 3 for the remainder of part 2. In the asymmetric condition person 2 was also assigned the role of the "strong" player, who faced a lower cost for volunteering in every round. To rule out possible end game effects, participants were told that part 2 would last for 30–60 rounds (the actual number of rounds was 48). Then, the decision situation (i.e. VOD) was explained to them. They were told that, in every round, they had to decide independently and simultaneously between volunteering and not volunteering by choosing a button labelled "up" or "down", respectively (see online appendix, Section A, for details). Choosing "up" earned them the benefits of the collective good (U) minus the costs for volunteering (K) with certainty. Choosing "down" earned them U only if another group member chose "up" in the same round. If all group members chose "down", the collective good would not be produced and all group members would earn zero.

After each round, participants were given full information feedback. They were informed about whether the collective good was produced, what their earnings were for the round, and what decisions they and the other group members had made. In both conditions the benefit of the collective good was $U = 80$c. In the symmetric VOD condition the cost for producing the collective good was $K = 50$c for all group members. In the asymmetric condition, the "strong" group member faced a lower cost for choosing "up" of $K = 30$c while the two other ("weak") group members had a cost of $K = 50$c for choosing "up". To make results comparable, these VOD payoffs match the ones Diekmann and Przepiorka (2016) chose in conditions "Symmetric" and "Asymmetric 1" in their first experiment.

After 48 rounds part 2 ended and participants were presented with their earnings in each part and their total earnings. Finally, participants were asked to complete a short questionnaire on basic sociodemographic characteristics and received their earnings in an envelope in private. They were asked to sign a receipt and leave the lab.

2.2. Data analysis strategy

Study 1 data consists of 9216 observations at the participant level (192 participants and 48 rounds) or 3072 observations at the group level (64 groups and 48 rounds). In total there were 64 groups of three, with 32 groups in the asymmetric condition and 32 groups in the symmetric condition.[4] In addition, the dataset consists of participants SVO values and survey data on basic socio-demographic characteristics such as gender and age. Note that hypotheses H1 through H3 are group-level hypotheses, making predictions about how situational factors and group properties affect the emergence of conventions over time. The situational factor is captured by our treatment variable (symmetric vs. asymmetric VOD). The group property we are interested in is the group SVO, which is the mean of the three group members' individual SVOs. Fig. 1 shows the frequency distribution of group SVO in our data. Group SVO has a mean of 19.23 ($SD = 13.70$).[5] Note that the mode (group SVO = 7.82) consists of groups of individuals who chose the option that maximized their own payoff in all six items of the SVO slider measure. In other words, 22% of the groups consisted of purely self-regarding individuals (see also Murphy et al., 2011).

We measure the emergence of conventions in each group with the so-called latent norm index (LNI; Diekmann and Przepiorka, 2016). The $LNI_{h,n}$ captures the proportion of rounds in which a certain behavioral regularity h was observed in a group of size n. For example, if a group of three participants, after having interacted in the VOD for 15 rounds, starts to take turns among the three of them for the remaining 33 rounds, $LNI_{3,3} = 0.69$. Note that the LNI only counts Pareto efficient outcomes in at least n consecutive rounds. To continue with the example, if in rounds 16 and 17 player 1 and player 2 volunteer, respectively, but player 3 abstains from volunteering in round 18 or player 3 and another player both volunteer in round 18, then rounds 16 through 18 are not counted towards the LNI. In this case, the LNI for the 48-round sequence would be $LNI_{3,3} = 0.63$. $LNI_{1,3}$ denotes the proportion of solitary-volunteering and $LNI_{2,3}$ stands for the proportion of turn-taking between the same two of the three group members. A detailed description of the LNI is provided in the online appendix, Section B.

All test statistics are based on regression model estimations. Statistical significance is set at the 5% level (i.e., $\alpha = 0.05$) for two-sided tests, and, where appropriate, we account for the repeated measures obtained on the same groups by estimating cluster-robust standard errors, where every group of three participants forms a cluster. To test the statistical significance of the differences between regression coefficients, we use Wald tests of linear hypotheses. Upon publication, the data and code with which the results of both studies can be reproduced are made available via a public repository.

3. Results

Table 2 provides a summary of $LNI_{h,n}$ values across conditions. Average $LNI_{h,3}$ values listed in this table are calculated based on the interaction sequences shown in Figures C1 through C8 in the online appendix, Section C. Results are in line with our first (baseline) hypothesis (H1) that asymmetric payoffs foster solitary volunteering rather than turn-taking. Solitary volunteering ($LNI_{1,3}$) sequences are significantly more often observed in the asymmetric condition than turn-taking ($LNI_{3,3}$) sequences (30.01 vs 7.10: $t = 2.99$, $p = 0.004$). The opposite is true in the symmetric condition; turn-taking sequences are significantly more often observed than solitary volunteering (34.38 vs 5.86: $t = 3.56$, $p = 0.001$).

Table 3 reports OLS regression models that test our three hypotheses. The first two models use the proportion of solitary-volunteering ($LNI_{1,3}$) as dependent variable whereas models M3 and M4 use the proportion of turn-taking among all three group members ($LNI_{3,3}$) as dependent variable. First, models M1 and M3 corroborate the results reported in Table 2 that solitary-volunteering sequences emerge more often in the asymmetric condition than in the symmetric condition. As expected, in both models the coefficient for the asymmetric condition is substantial and statistically significant albeit positive in M1 (solitary-volunteering) and negative in M3 (turn-taking).

We do not find support for our second hypothesis (H2) that groups with higher SVO are more likely to coordinate on turn-taking. In fact, the results of model M3 are opposite to the prediction: the coefficient of group SVO is negative and statistically significant, indicating that higher SVO makes groups less likely to coordinate on turn-taking. Using the coefficient for group SVO in model M3 ($b = -0.586$), we can say that a group with an SVO of 15 (e.g., a group consisting of mostly proselfs) has on average a turn-taking rate that is 8.8 percentage points (pps) higher than a group with an SVO of 30 (e.g., a group consisting of mostly prosocials).

Model M4 allows us to put the negative effect of group SVO on turn-taking into context. The constant in M4 indicates that a group with an SVO of zero would attain a turn-taking rate of 52% in the symmetric VOD, and the group SVO coefficient in M4 indicates that this turn-taking rate would be reduced by 12.6 pps if the group's SVO was 15 points (around one standard deviation) larger. This reduction in turn-taking is substantial but not as large as the reduction due to the situational factor; in the asymmetric VOD, the turn-taking rate in a group with group SVO of zero would be reduced by 38.3 pps as compared to the symmetric condition.

Finally, our third hypothesis (H3) is not supported by the data. According to H3, we expected groups with a higher SVO to be less

[4] We did not conduct power analysis to determine these numbers because no previous evidence on the effect of SVO on participants' coordination in the repeated VOD exist. Based on previous evidence on the repeated VOD (e.g., Diekmann and Przepiorka, 2016) and the distribution of SVO in typical convenience samples of participants for lab experiments (Murphy and Ackermann, 2014), we guessed that 32 independent observations per condition would create sufficient covariation between the extent to which conventions emerge per group and group average SVO, to identify an effect of the latter on the former if present.

[5] We investigated different centrality measures for group SVO (median and mode). However, the use of mode or median as indicator for a groups' SVO does not yield different results. Therefore, we use the mean for group SVO in our analyses.

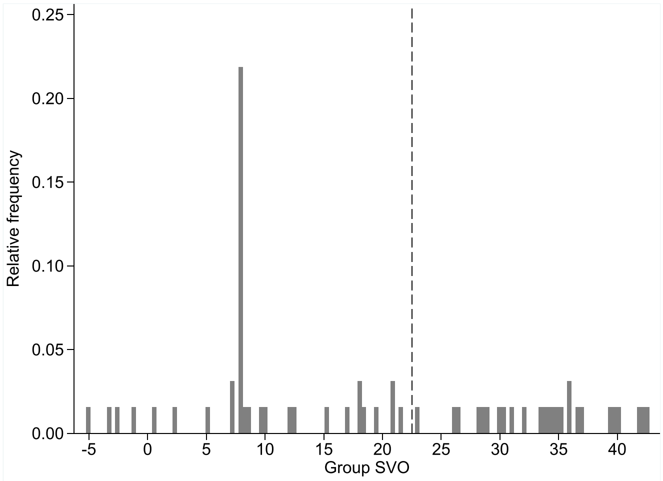

Fig. 1. Frequency distribution of group SVO.

Table 2
Latent norm indices (LNI) across experimental conditions.

	[a] $LNI_{1,3}$	[b] $LNI_{1,3}$	[c] $LNI_{2,3}$	[d] $LNI_{3,3}$
Symmetric	5.86	n/a	3.45	34.38
$n = 32$	(3.04)		(1.35)	(6.45)
Asymmetric	30.21	30.01	6.12	7.10
$n = 32$	(5.84)	(5.87)	(3.26)	(3.30)

Notes: Average $LNI_{h,3}$ values (standard deviations in parentheses) listed in this table are calculated based on interaction sequences shown in Figures C1 through C8 in the online appendix, Section C.
[a] Solitary volunteering by any player.
[b] Solitary volunteering by strong player.
[c] Turn-taking among any two players.
[d] Turn-taking among all three players sequentially.

Table 3
OLS regression models of LNI.

	Solitary-volunteering ($LNI_{1,3}$)		Turn-taking ($LNI_{3,3}$)	
	M1	M2	M3	M4
Const.	12.542*	8.267	46.323***	51.505***
	(6.018)	(5.394)	(8.251)	(10.984)
Symmetric	ref.	ref.	ref.	ref.
Asymmetric	23.594***	31.579*	−28.628***	−38.307**
	(6.473)	(12.228)	(6.973)	(13.399)
Group SVO	−0.328	−0.118	−0.586*	−0.840*
	(0.230)	(0.161)	(0.244)	(0.407)
Asymmetric		−0.415		0.503
× Group SVO		(0.454)		(0.489)
N (groups)	64	64	64	64
adj. R^2	0.18	0.17	0.22	0.22

Notes: The table lists coefficient estimates from OLS regression models and robust standard errors in parentheses (***$p < 0.001$, **$p < 0.01$, *$p < 0.05$, for two-sided tests). The models test the effects of treatment variables and group average SVO on the proportion of conventions that emerge in groups of three. Models M1 and M2 use the proportion of solitary-volunteering by any group member as the dependent variable and models M3 and M4 use the proportion of turn taking among all three group members as dependent variable.

likely to coordinate on solitary-volunteering, especially in the asymmetric condition. The effect of group SVO on solitary-volunteering is negative but statistically insignificant both overall (M1) and in the asymmetric condition only (M2: 0.118–0.415: $t = 1.26$, $p = 0.214$).[6]

3.1. Exploratory analyses

Does SVO have a bearing on what pattern emerges in the repeated VOD? Yes, it does, but in a way that we had not expected. Although the negative effect of SVO on turn-taking is small relative to the treatment effect, it is in need of explanation. This result suggests that groups of proselfs are more likely to coordinate on turn-taking in the repeated symmetric VOD. Perhaps proselfs recognize earlier that embarking on turn-taking would maximize their individual payoffs, whereas prosocials are more concerned with volunteering rather than achieving efficient coordination.

We test these conjectures in a post-hoc analysis. First, if prosocials are indeed more concerned with volunteering than with achieving efficient coordination, we should observe higher rates of *inefficient* collective good provision in groups with higher SVOs. That is, the higher a group's SVO, the more likely will there be more than one volunteer in each round. Second, if proselfs are quicker in recognizing that turn-taking would maximize their individual payoffs, we should observe higher rates of $LNI_{3,3}$ earlier, the lower a group's SVO.

To test the first conjecture, we fit a logistic regression model with the probability of over volunteering as dependent variable. To test the second conjecture, we fit an OLS regression model with the proportion of turn-taking at time t as dependent variable. In both models we use group SVO, time (i.e. round number) and the interaction between the two as independent variables. The results are presented in Table 4.

In line with our first conjecture, the positive and statistically significant coefficient of group SVO in the first model indicates that groups with higher SVOs are more likely to produce the collective good inefficiently (i.e. with more than one volunteer), at least at the start of the interaction sequence. For example, groups with an SVO of 30 have a significantly higher, estimated probability of over-volunteering than groups with an SVO of 15 in period 5 (0.32–0.23 = 0.09, $z = 2.85$, $p = 0.004$). In both these groups, estimated over-volunteering probabilities decrease over time and their difference becomes insignificant eventually (e.g., in period 45: 0.18–0.16 = 0.2, $z = 0.62$, $p = 0.533$). In line with our second conjecture, the positive and statistically significant coefficient of period and the negative and statistically significant coefficient of the interaction between period and group SVO in the second model indicate that the proportion of turn-taking increases over time but this increase is smaller in groups with a larger SVO. For example, groups with an SVO of 15 increase their estimated turn-taking rate from 13.7% to 41.7% between periods 5 and 45, whereas groups with an SVO of 30 increase their estimated turn-taking rate from 13.3% to 28.7% in the same time. The difference in differences in this example is statistically significant (28 pps – 15.4 pps = 12.6 pps, $t = 2.84$, $p = 0.008$).

These findings, although exploratory, corroborate our conjecture that prosocials are more concerned with volunteering than with achieving efficient coordination within their group whereas proselfs are quicker in recognizing that turn-taking is an efficient way to maximize their individual payoffs. But what can we say about our unexpected finding that SVO has no effect on solitary-volunteering in the asymmetric VOD?

Fig. 2 shows diagnostic plots of the OLS regression with the rate of solitary-volunteering as the outcome variable and group SVO as the only explanatory variable. Fig. 2a plots leverages against residuals of every group in the asymmetric VOD condition. The plot allows to identify influential observations, which have both relatively large residual and leverage values (Fox, 1991). The plot shows that there are four potentially influential observations (groups 18, 26, 49 and 56 in the upper right quadrant of Fig. 2a). Fig. 2b shows the scatter plot of solitary-volunteering rates and group SVOs. The lines are fitted to the date with (black solid line) and without the four influential observations (red dashed line). The figure shows that excluding the four cases decreases the slope of the regression line in the expected direction. However, these cases do not have anything in common, which makes it difficult to pinpoint why they are influential. What this exploratory analysis merely shows is that rather competitive individuals may still coordinate on turn-taking and rather altruistic individuals may still coordinate on solitary-volunteering in the asymmetric VOD (see interaction sequence in online appendix, Section C). We therefore conclude that there is no effect of SVO on solitary-volunteering in the asymmetric VOD.

4. Study 2: payoff asymmetries and focal points

The results of Study 1 replicate earlier findings that the payoff structure has a strong effect on the conventions that emerge in the repeated VOD. Whereas payoff asymmetry with one strong player leads to more solitary-volunteering, symmetric payoffs lead to more turn-taking (Diekmann and Przepiorka, 2016). However, hypotheses that the effect of asymmetric payoffs would be moderated by SVO are not supported and results even show an opposite effect on the emergence of turn-taking if payoffs are symmetric. Groups with a lower SVO (i.e., groups consisting of more proselfs) exhibit more turn-taking in the symmetric VOD. Our post-hoc analyses suggest that proselfs are more focused on efficient coordination, whereas prosocials are more focused on volunteering, which more often results in over-volunteering (Krueger, 2019). Moreover, we find a null effect of SVO on the emergence of solitary-volunteering in the asymmetric VOD. Our conjecture is that asymmetric payoffs do not leave much leverage for SVO to matter (Simpson and Willer, 2015). Once solitary-volunteering has emerged, even proselfs might be reluctant to deviate, as deviations could lead to discoordination and cause

6 We performed the same analyses using fractional probit regression models, which are better suited if the dependent variable's range is between 0 and 1. The results do not change substantially based on this approach (see online appendix, Section D).

Table 4
Post hoc analysis.

	Pr. over volunteering		$LNI_{3,3}$ in period t	
	Coef.	SE	Coef.	SE
Const.	−1.616***	0.322	0.091	0.076
Group SVO	0.031**	0.011	0.001	0.003
Period	−0.005	0.014	0.010***	0.002
Group SVO × Period	−0.0004	0.0004	−0.0002**	0.0001
N_1	1536		1536	
N_2	32		32	
pseudo R^2	0.02			
adj. R^2			0.10	

Notes: The table lists coefficient estimates from logistic and OLS regression models and robust standard errors (***$p < 0.001$, **$p < 0.01$, *$p < 0.05$, for two-sided tests). The models test the effects of group SVO and time on the probability of over volunteering and the proportion of turn-taking at time t in the symmetric VOD conditions. N_1 denotes the number of group outcomes and N_2 denotes the number of groups.

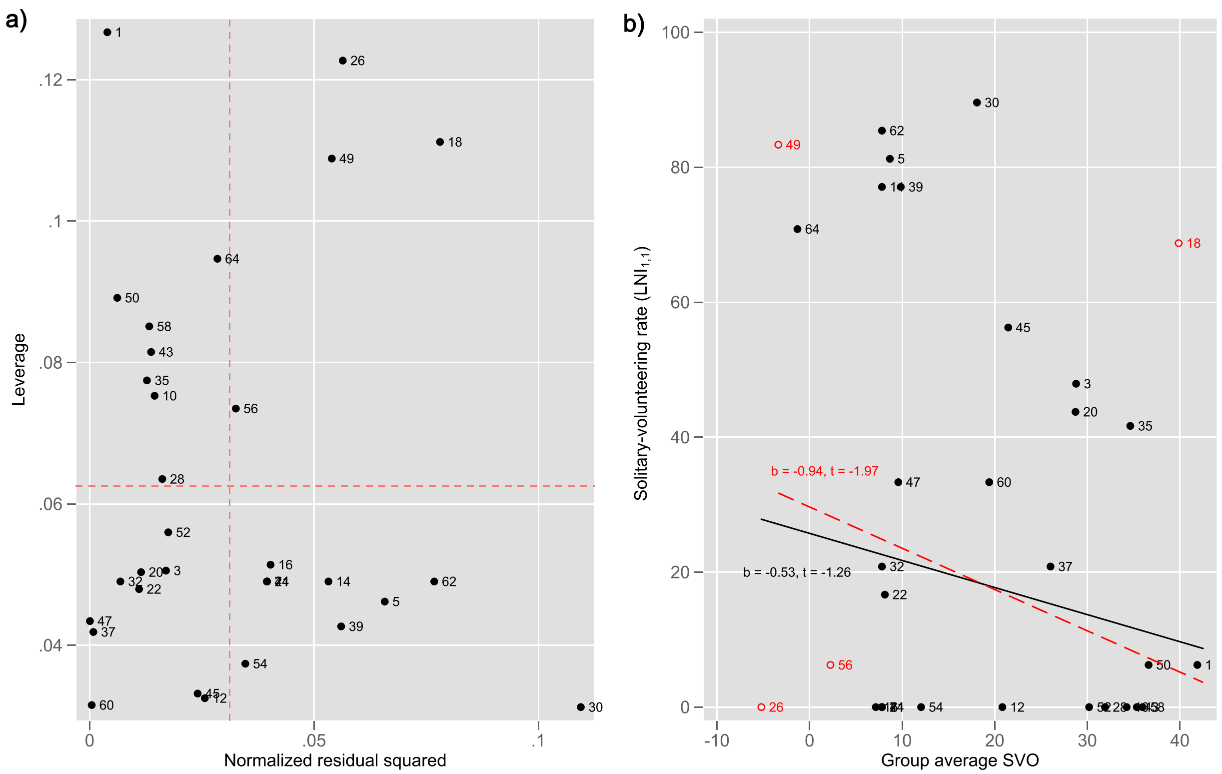

Fig. 2. Diagnostic plots.

more harm than help in sharing the costs of volunteering.

The dominant effect of payoff asymmetries leaves open the question to what extent payoff asymmetries provide an incentive for solitary-volunteering and to what extent the focality of the strong player facilitates coordination on solitary-volunteering (Schelling, 1960). In Study 2 we therefore take a closer look at the structural properties that affect the emergence of solitary-volunteering in the asymmetric VOD.

We know from research on tacit coordination that people often use “focal points” to make decisions when they have to coordinate their decisions with others and without communication. Focal points are choice-options that stand out by being salient, unique or prominent. For instance, as Schelling’s (1960) seminal research showed, when two people had to find each other in New York City, most of them indicated that they would go to Grand Central Station, as this was the most prominent traffic hub at the time, and thus a focal point for coordination (Schelling, 1960). But not only choice-options can be focal, in some cases specific players can become focal too (Chartier, 2013; De Kwaadsteniet and Van Dijk, 2010). For instance, when there is one “strong” player in the VOD, this player does not only have lower costs of volunteering, the payoff asymmetry also makes the strong player stand out from the rest. As such, the strong player can be perceived as a focal social actor, irrespective of the payoff asymmetry (Chartier, 2013). As coordination in the VOD requires only one player to volunteer, social focality might be sufficient to establish successful coordination. If so, and given that

SVO did not affect solitary-volunteering in Study 1, would payoff asymmetries in the other direction (i.e. with one weak player) also induce coordination on solitary-volunteering by the weak player? To address these questions, we vary the types of asymmetry groups of players face in Study 2.

Another important feature of the VOD we used in Study 1 is that participant roles were fixed during all rounds. That is, the group member who was strongest in round 1, remained in that role until the end. Our expectation is that random assignment of roles in each round will facilitate coordination on volunteering by the actor that stands out (i.e., the stronger, focal or weaker actor), not least because such coordination would result in an equal payoff distribution (see also Diekmann and Przepiorka, 2016). Hence, the second factor we vary in Study 2 is whether participant roles are fixed or assigned randomly in every round. Table 5 summarizes the experimental design and the hypotheses we test in Study 2. In what follows, we describe each of the five hypotheses in more detail.

Since hypothesis H1 was corroborated in Study 1 (see also Diekmann and Przepiorka, 2016), we do not implement the asymmetric VOD condition with one strong player and fixed player roles in Study 2. Hypotheses H4 through H8 are new and are put to an empirical test in Study 2.

We expect payoff asymmetry with one strong player to have a stronger effect on solitary-volunteering if player roles are assigned randomly in every round than with fixed player roles. This expectation is based on evidence from Diekmann and Przepiorka (2016), who found higher rates of solitary-volunteering in the asymmetric VOD if groups were disbanded and randomly formed anew after every round. In their experiment, the random matching protocol implied random assignment of player roles in every round. It thus remains to be shown whether random role assignment is sufficient for solitary-volunteering to emerge to a larger extent than in the asymmetric VOD with partner matching and fixed roles.

H4. In the asymmetric VOD with one strong player and random role assignment, solitary-volunteering will emerge more often than in the asymmetric VOD with one strong player and fixed roles.

Diekmann and Przepiorka (2016) conjecture that random role assignment leads to more solitary-volunteering by the strong actor in the asymmetric VOD because it leads to a more equal distribution of payoffs. By the same token, we can expect that in a payoff-symmetric VOD with one focal player (i.e. a player that stands out for reasons other than VOD payoffs) and fixed player roles, groups would mostly engage in turn-taking. However, since with random role assignment, solitary volunteering by the focal actor also leads to an equal distribution, it establishes an alternative, Pareto-optimal equilibrium. We therefore expect to observe this convention more frequently.

H5. In the payoff-symmetric VOD with one focal player and fixed roles, turn-taking among all three players will emerge as the main convention.

H6. In the payoff-symmetric VOD with one focal player and random role assignment, solitary-volunteering by the focal player will emerge as the main convention.

If it is indeed the one player standing out that promotes solitary-volunteering, rather than the incentive to volunteer induced by the payoff asymmetry, players might be even inclined to coordinate on the one weakest player to volunteer, if role assignment is random. However, if role assignment is fixed, solitary-volunteering by the weak player will create a highly unequal payoff distribution and therefore is less likely to emerge. We expect that with fixed roles, it is more likely that the two strong players take turns among themselves and let the weak player freeride.

H7. In the asymmetric VOD with one weak player and fixed roles, turn-taking among the two strong players will emerge as the main convention.

H8. In the asymmetric VOD with one weak player and random role assignment, solitary-volunteering by the weak player will emerge as the main convention.

4.1. *Experimental design and procedures*

We tested our hypotheses by means of a computerized laboratory experiment. The experiment was also conducted at ELSE and comprised ten experimental sessions with $N = 240$ participants in total.[7] Participants were students and non-students from Utrecht, 70.4% were female, and they were 23.7 years old on average (sd = 5.82).[8] Participants that took part in Study 1 were not invited to participate in Study 2. Participants were recruited with ORSEE (Greiner, 2015) and the experiment was programmed and conducted

[7] We first conducted seven sessions with 165 participants in total and 11 independent observations per experimental condition. At a later stage, we decided to conduct another three sessions to increase the number of independent observations per condition to 16. This we did primarily to increase statistical power for the test of hypothesis H4. Note that only H4 requires a statistical test; H5 through H8 state our expectations as to which convention will emerge most frequently. Nevertheless, below we report statistics testing the difference in LNI between the convention that we expected to emerge most frequently and, depending on the result, the convention that emerged second most frequently or most frequently.

[8] The unbalanced sample in terms of gender (66.7% in Study 1) reflects the higher proportion of female students at the Faculty of Social and Behavioural Sciences at Utrecht University Evidence from meta-analyses suggests that female participants are less cooperative in repeated social dilemmas than male participants (Balliet et al., 2011). If anything, this suggests that our results provide a more conservative estimate of the extent to which certain conventions emerge in the repeated VOD than one could expect in a more balanced sample.

Table 5
Experimental design and hypotheses.

	Asymmetric with one strong player $U = 80c$ $K_1 = 30c$ $K_{2,3} = 50c$	Symmetric with one focal player $U = 80c$ $K = 50c$	Asymmetric with one weak player $U = 80c$ $K_1 = 60c$ $K_{2,3} = 50c$
Players' roles are fixed	[Solitary-volunteering by strong player emerges (H1)]	Turn-taking among all three players emerges (H5)	Turn-taking among two strong players emerges (H7)
Players' roles are random	Solitary-volunteering by s. player higher than in fixed (H4)	Solitary-volunteering by focal player emerges (H6)	Solitary-volunteering by weak player emerges (H8)

with z-Tree (Fischbacher, 2007).

Upon arrival in the lab, participants were randomly assigned to one of the computer terminals in the lab and received part 1 instructions on paper. Part 1 instructions were the same as in Study 1 (see above). Participants' SVO scores were measured in the same way as in study 1, but this time, groups were not formed based on these SVO scores.

Before part 2 started, participants were randomly matched in groups of three and each group was randomly assigned to one of the five experimental conditions (recall that the asymmetric VOD condition with one strong actor and fixed roles was already conducted in study 1). Participants received condition-specific part 2 instructions on paper (example instructions are reproduced in the online appendix, Section E). Part 2 instructions explained the decision situation step by step and contained a screenshot of the actual decision screen (see study 1 for details).

In the asymmetric condition with one strong player and the symmetric condition with one focal player, the VOD payoffs were the same as in, respectively, the asymmetric and symmetric conditions in Study 1. In the symmetric payoffs condition with one focal player, the decision field of the focal player appeared in a different color (pink) than the decision fields of the other two participants (blue), and this was explicitly stated in the instructions. In the asymmetric payoffs condition with one weak player, the weak player had a cost of $K = 60c$ for choosing "up" whereas the two strong players had a cost of $K = 50c$ for choosing "up" (see Table 5). Note that the difference in payoffs between the weak and the two strong players ($60c - 50c = 10c$) is smaller than the difference between the strong and the two weak players in Study 1 ($50c - 30c = 20c$). The reason for this is that we anticipated the effect of social focality on the emergence of solitary-volunteering to be weak and did not want to disincentivize coordination on the weak player by a too large difference in payoffs.

In all conditions with random role assignment, participants were informed in the instructions that their role (expressed in terms of costs of choosing "up" or color of decision field) would be randomly determined in every round and that they would learn who was in which role before they got to make their decision in the round. After reading the instructions, participants took a quiz with comprehension questions about the decision situations. Questions for which at least one wrong answer was given were read out loud and the correct answer was explained to all participants. Then, the experiment started. After the experiment, participants filled in a questionnaire, received their payment, filled in and signed a form confirming receipt of the payment, and left the lab.

5. Results

Table 6 lists the latent norm indices (LNIs) across six experimental conditions. Recall that the LNI measures the proportion of

Table 6
Latent norm indices (LNI) across experimental conditions.

	[a] $LNI_{1,3}$	[b] $LNI_{1,3}$	[c] $LNI_{2,3}$	[d] $LNI_{3,3}$
[e] Asym. strong fixed	30.2	30.0	6.1	7.1
n = 32	(5.84)	(5.87)	(3.26)	(3.30)
Asym. strong random	0.7	54.2	4.9	1.0
n = 16	(0.47)	(9.02)	(2.48)	(1.04)
Sym. focal fixed	2.1	0.0	15.7	41.7
n = 16	(1.58)	n/a	(6.93)	(8.76)
Sym. focal random	2.5	17.9	10.6	24.9
n = 16	(1.87)	(6.68)	(5.62)	(9.44)
Asym. weak fixed	6.3	1.0	16.7	31.9
n = 16	(3.92)	(1.04)	(7.38)	(9.36)
Asym. weak random	4.4	2.0	10.9	27.2
n = 16	(2.93)	(1.37)	(2.81)	(8.40)

Notes: Average $LNI_{h,3}$ values (standard deviations in parentheses) listed in this table (except for asym. strong fixed) are calculated based on interaction sequences shown in Figures F1a through F5b in the online appendix.

[a] Solitary volunteering by any player.
[b] Solitary volunteering by strong/weak/focal player (i.e. the one out).
[c] Turn-taking among any two players.
[d] Turn-taking among all three players sequentially.
[e] Data from study 1.

interactions in which a particular behavioral pattern was observed in at least three consecutive rounds (see Study 1 for details). Note moreover that the asym. strong fixed condition is from Study 1 and the numbers are the same as the numbers in the corresponding row in Table 2.

We already know from Study 1 that in the asym. strong fixed condition, solitary-volunteering by the strong player emerges as the main convention. In line with hypothesis H4, the rate of solitary-volunteering by the strong player is significantly higher if player roles are assigned randomly (30.0 vs 54.2: $t = -2.24$, $p = 0.027$). In fact, solitary-volunteering by the strong player is the convention with the highest LNI value in Table 6.

In line with hypothesis H5, singling out one player while keeping VOD payoffs symmetric does not result in solitary-volunteering by the focal player ($LNI_{1,3} = 0$); turn-taking among all three remains the convention that emerges most frequently in condition sym. focal fixed ($LNI_{3,3} = 41.7$). The rate of turn-taking among all three players is also higher than the rate of turn-taking among any two players albeit the difference is statistically insignificant (41.7 vs 15.7: $t = 1.80$, $p = 0.074$). In condition sym. focal random, solitary-volunteering by the focal player reaches an LNI of 17.9. However, turn-taking among all three players reaches a higher LNI of 24.9. Although the two rates are not significantly different from each other (17.9 vs 24.9: $t = -0.56$, $p = 0.576$), this evidence goes against hypothesis H6 that random role assignment in the sym. focal condition would establish an alternative equilibrium to turn-taking.

We do not find support for hypotheses H7 and H8. In condition asym. weak fixed, despite the asymmetry in payoffs, it is turn-taking among all players that emerges as main convention ($LNI_{3,3} = 31.9$). According to H7 we expected turn-taking among the two strong players to emerge as the main convention, but $LNI_{2,3}$ reaches a lower value of only 16.7 (31.9 vs 16.7: $t = 1.06$, $p = 0.292$). Turn-taking among all three is also the main convention that emerges in asym. weak random ($LNI_{3,3} = 27.2$). According to H8, we expected solitary-volunteering by the weak player as the main convention, but this pattern exhibits the lowest LNI value in the asym. weak random condition (27.2 vs 2.0: $t = 3.40$, $p = 0.001$).

The results of Study 2 show which structural properties are necessary for solitary-volunteering to emerge as the main convention in the repeated VOD. Only if payoffs are asymmetric with one strong player does single-volunteering by the strong player emerge as the main convention. All other types of asymmetries instigate the emergence of turn-taking among all three players as the main convention.

5.1. *Exploratory analyses*

There are two other, noteworthy findings in Table 6. Although in the sym. focal and asym. weak conditions turn-taking among all three players emerged as the most common convention, other conventions also emerged relatively frequently. For example, in all four of these conditions, turn-taking among two players has an LNI larger than 10, and in condition sym. focal random, the LNI of solitary-volunteering by the focal player is 17.9. It is as if in these conditions, participants had more difficulties to tacitly agree on one course of action as compared to the asym. strong conditions.

Given that we find turn-taking among all three players to emerge as the main convention in four out of five experimental conditions in Study 2, let us check whether we can replicate the finding from Study 1 that groups with a higher average SVO are less likely to coordinate on turn-taking among all three players. Recall that unlike in Study 1, participants in Study 2 were randomly matched with each other. Still, group SVO has a mean of 19.34 ($SD = 7.48$) and ranges between 0 and 35 (see Figure G1 in online appendix).

The first model in Table 7 tests whether among the 64 groups in the four conditions in which turn-taking emerged as the main convention, group SVO has a negative effect on turn-taking. Although the coefficient estimate of group SVO is negative, it is statistically insignificant.

The second model in Table 7 tests to what extent groups with a higher SVO are more likely to produce the collective good inefficiently (i.e. with more than one volunteer). Here the positive coefficient estimate of group SVO suggests that they do, but the *p*-value of the estimate is 0.069. Moreover, over-time reduction in over volunteering tends to be lower for groups with a higher SVO, but this

Table 7
Post hoc analysis.

	Turn-taking ($LNI_{3,3}$)		Pr. over volunteering		$LNI_{3,3}$ in period t	
	Coef.	SE	Coef.	SE	Coef.	SE
Const.	49.888***	14.150	−2.200***	0.384	0.231*	0.099
Random role (0/1)	−11.496	8.921	0.479*	0.202	−0.067	0.072
Group SVO	−0.684	0.616	0.030	0.016	−0.005	0.004
Period			−0.035**	0.011	0.005*	0.002
Group SVO × Period			0.001	0.001	−0.00002	0.0001
N_1	64		3456		3456	
N_2			64		64	
adj. R^2	0.01				0.07	
pseudo R^2			0.04			

Notes: The table lists coefficient estimates from OLS and logistic regression models and robust standard errors (***$p < 0.001$, **$p < 0.01$, *$p < 0.05$, for two-sided tests). The models test the effects of group SVO and time on the proportion of turn-taking overall, the probability of over volunteering and the proportion of turn-taking at time t in the sym. focal and asym. weak conditions. Variable random role is a dummy variable controlling for whether role assignment was fixed (=0) or random (=1). N_1 denotes the number of group outcomes and N_2 denotes the number of groups.

effect is statistically insignificant ($z = 1.91$, $p = 0.057$).

Finally, the third model tests whether groups with a higher SVO take longer to agree on turn-taking among all group members. Unlike in Study 1, we do not find support for this conjecture; although the interaction effect of group SVO and time is negative, it is statistically insignificant.

We did not analyze the effect of group SVO on solitary-volunteering in Study 2 for the following reasons. In the three treatment conditions with random role assignment, following the random cue would lead to equal payoffs for all group members. Therefore, if anything, SVO should have a positive effect on groups' tacit coordination on following the random cue. Regressing the solitary-volunteering rate on group SVO in condition asym. strong random (where single volunteering occurred by far the most) yields a small and insignificant coefficient estimate ($b = 0.123$, $t = 0.11$, $p = 0.917$). In the two treatment conditions with fixed roles, the single-volunteering rates were very low, making further analyses less meaningful (see Table 6).

6. General discussion

The volunteer's dilemma (VOD) has been studied and applied in many scholarly disciplines (Archetti, 2011; Goeree et al., 2017; Krueger, 2019; Naserian and Tepe, 2009; Schneider et al., 2012; Weesie and Franzen, 1998), and yet the VOD remains a relatively understudied model of social interaction situations (Przepiorka and Diekmann, 2018).

That the VOD is understudied is remarkable, as people face VOD-like situations every day at work, in their families, with friends as well as with strangers. Who takes the lead in a project at work? Who vetoes an unpopular suggestion made by the boss? Who walks the dog? Who calms the crying baby? Who drives and abstains from drinking? Who does the dishes after a joint dinner? Who helps the elderly person who just stumbled on the street? Although people facing such situations would still benefit from "taking one for the team", they had rather someone else do it, especially the more others are around who could volunteer instead.

The VOD has been used to formally describe the diffusion of responsibility effect – the decreasing inclination of actors to volunteer the more other actors are present (Barron and Yechiam, 2002; Diekmann, 1985; Darley and Latané, 1968; Krueger, 2019; Hillenbrandt et al., 2019). It has been shown that observable asymmetries in actors' costs of volunteering can solve the diffusion of responsibility problem, even in one-off encounters (Cramer et al., 1988; Przepiorka and Diekmann, 2018). However, the VOD has other solutions once it is repeated among the same actors. Laboratory experiments have shown that in the repeated VOD, and similar collective goods dilemmas, different conventions can emerge tacitly by which actors coordinate on efficient solutions of the dilemma. Equality preserving turn-taking and inequality-inducing single-volunteering are the most frequently observed conventions that emerge (Bornstein et al., 1997; Cherry et al., 2013; Diekmann and Przepiorka, 2016; Helbing et al., 2005; Sibly and Tisdell, 2018; Winter 2014).

Findings and evidence from other studies (Balliet et al., 2009; Bogaert et al., 2008; Murphy et al., 2011) strongly suggest that next to payoff asymmetries, individuals' social value orientations (SVO) might also play an important role in determining the particular convention that emerges (Simpson and Willer, 2015). With this idea in mind, we set out to study the role of SVO, payoff asymmetries and focal points in the emergence of conventions in the repeated VOD by means of behavioral lab experiments. In Study 1, we tested whether SVO promotes turn-taking and hampers solitary-volunteering. Contrary to our expectations, we found that groups with more prosocial members engaged less in turn-taking, and we did not find an effect of SVO on the emergence of solitary-volunteering. In Study 2, we tested whether making one actor focal by an arbitrary cue is sufficient for solitary-volunteering to emerge. We found this not to be the case; payoff asymmetry with one strong actor was necessary for solitary-volunteering to emerge. Why are groups of prosocials worse at coordinating on efficient solutions than groups of proselfs in the symmetric VOD but not in the asymmetric VOD with one strong player?

The results of Study 1 are difficult to explain, even if one considers that the 6-item SVO measure that we used does not distinguish prosocials that are motivated by inequality aversion from prosocials that are motivated by the maximization of collective gains (Murphy et al., 2011). Note that in the symmetric VOD, turn-taking satisfies both types of prosocials because it leads to equal payoffs *and* maximizes collective gains at the same time. Yet, we find that proselfs are better at coordinating on turn-taking than prosocials. However, we do not find evidence for the hypothesized negative effect of SVO on the emergence of solitary-volunteering in the asymmetric VOD. If anything, this may indicate that the majority of prosocials in Study 1 are motivated by the maximization of collective gains rather than the reduction of inequalities in cumulative payoffs. Although the use of the extended, 9-item SVO measure could shed light on this issue (Murphy et al., 2011), results from our exploratory analyses suggest an alternative explanation.

Our exploratory analyses as well as recent findings suggest that prosocial group members care more about volunteering, which results in over-volunteering and the inefficient production of the collective good (Krueger, 2019; Tham et al., 2019). Prosocials might, at first, (mis)perceive the symmetric VOD as a group effort task in which all group members are expected to take action, and neglect the resulting inefficient outcome. Proselfs, by contrast, are more concerned with what is in for them, and will scrutinize the nature of the interaction situation, quickly realizing that only one volunteer is necessary. However, with one strong actor rendering the situation asymmetric hints even prosocials to realize the payoff structure of the VOD, but not the payoff inequality that would result from the strong actor volunteering all the time. The *over-zealous prosociality* of some of our participants could explain why there is a negative effect of SVO on the emergence of turn-taking in the symmetric VOD, but no effect of SVO on the emergence of solitary-volunteering in the asymmetric VOD.

Future research should therefore pay more attention to the unexpected effects the interplay of individuals' social preferences and social structures (e.g., payoff asymmetries) can have on the emergence of conventions (Bicchieri, 2006; Broere et al., 2019; Centola and Baronchelli, 2015; Hawkins et al., 2019). Key to this line of research will be the incentivized measurement of participants' beliefs about their group members' behaviors and expectations (i.e. second-order beliefs) (see, e.g., Bicchieri, 2017; Murphy and Ackermann, 2015; Otten et al., 2020). Such measurements are also necessary to capture the emergence of social norms; the observation of behavioral regularities alone does not provide sufficient evidence for the normative underpinning of these behavioral regularities (Bicchieri, 2017; Tummolini et al., 2013). One way in which norms can emerge is from actors' repeat encounters in similar interaction situations (Lewis, 1969; Opp, 2004; Wrong, 1994). In the context of our experiments, conventions can be conceived of as preceding the emergence of norms. Hence, to better understand how norms can emerge from conventions, it is important to first establish the conditions under which conventions emerge.

Whereas we replicated the finding that the asymmetric VOD with one strong actor leads to the emergence of single-volunteering in Study 1, we did not find any effects of more fine-grained variations in the degree of asymmetries or other types of asymmetries in Study 2 (see, e.g., Dijkstra and Bakker, 2017). For example, in the VOD with one weak actor, we hypothesized the emergence of turn-taking among the two strong actors to emerge as the main convention, but mostly observed turn-taking among all three actors. Maybe, in this case, the payoff difference was not large enough to induce the former pattern. Moreover, in the condition with symmetric payoffs and one focal actor, random role assignment did not facilitate tacit agreement that the random device should be followed such that the actor with a different color in one round should volunteer alone in that round. It is unclear, however, whether participants were unwilling to follow the random device, or whether the randomness of it was more confusing than helping. The fact that in this condition the most diverse set of conventions emerged (see Table 6), suggests it was the latter. Future research should more systematically vary payoff asymmetries and ways of making one actor focal in the repeated VOD to address this question.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.ssresearch.2020.102488.

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