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Can Conformity Bias Transcend Domain Specificity Under Social Dilemma Situations?

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We examined whether conformity bias was observed in social dilemma situations. Cultural group selection theory argues that conformity can establish a cooperative group in a society, which has been theoretically and empirically supported. However, conformity bias has not been examined in most previous studies. Conformity bias refers to the bias that an individual adopts the majority member's behavior (e.g., 60%) with a probability exceeding it (e.g., 80%). Researchers have been theoretically and empirically shown that conformity bias was an adaptive strategy under information-seeking situations. However, there is little empirical evidence to test whether conformity bias can function even in the domain specific to ingroup cooperation. One hundred fifty-nine of crowdsource individuals participated in a vignette experiment wherein they read 14 scenarios that described social dilemma situations in daily life. Participants answered whether they would cooperate with ingroup members when they have informed four patterns of cooperators within an ingroup, 0%, 33.3%, 66.7%, and 100%. The results showed that no conformity bias was observed in all social dilemma situations.

Keywords
conformity bias, cultural group selection, social dilemma, ingroup cooperation, domain specificity

Introduction

Why can humans cooperate with non-kin? Researchers in a variety of fields have investigated this question. One of the examples to elucidate human cooperation is research focusing on a social dilemma situation. A social dilemma is defined by two conflict features: (a) defection is more beneficial for individuals than cooperation, but (b) defection of all members does not excel the benefit of all members' cooperation (Dawes, 1980). In a social dilemma situation, free-riding problems also arise, in which an individual who does not cooperate when the others cooperate gains much profits (Olson, 1965/1996). Researchers have proposed various solutions to the free-riding problem (e.g., punishment systems: Yamagishi, 1986; reciprocity: Panchanathan & Boyd, 2004), but some researchers claimed that these theories were unsatisfactory in explaining the cooperation of human beings in large societies (e.g., Henrich & Muthukrishna, 2021). Therefore, in this study, we focused on cultural group selection theory (Boyd & Richerson, 2005), in which the evolution of cooperation could also be promoted in large groups.

Cultural group selection theory (Boyd & Richerson, 2005) assumes that conformity can work to construct and establish cooperative groups in a society. People tend to conform to others' behavior so that they cooperate when most others do and defect when most others defect in social dilemma situations. The benefit of cooperative groups exceeds one of the defective groups on average, and selection pressure favors cooperative groups. The validity of cultural group selection is theoretically and empirically supported (Nakanishi & Yokota, 2016; Nakanishi et al., 2022; Yokota & Nakanishi, 2012, 2017).

Conformity bias

Cultural group selection theory further argues that conformity includes a bias (Boyd & Richerson, 2005). Biased conformity (conformity bias) is defined as the excessive imitation that an individual adopts the majority member's behavior (e.g., 60%) with a probability (e.g., 80%) of exceeding it (Boyd & Richerson, 1985). Conformity is a continuum from unbiased (non-biased conformists) to strongly biased (biased conformists, Figure 1) in the relationship between their own and others' behavior. The variance of behavior within a group is reduced more quickly by biased conformists than by non-biased conformists. This bias can help individuals seek correct information. Kameda and Nakanishi (2002) theoretically validated the adaptive value of conformity bias under information-seeking situations. While there is debate in the empirical study (e.g., Eriksson & Coultas, 2009), it is supported by much evidence (e.g., Fujikawa et al., 2021, 2022; Muthukrishna et al. 2016).

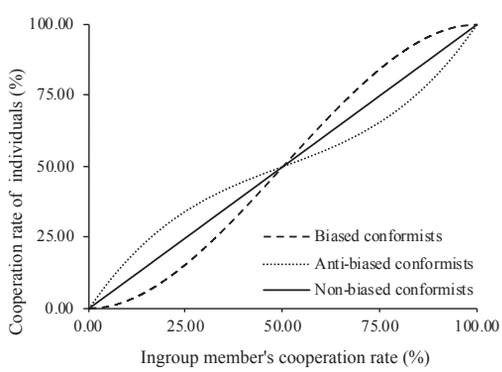

Figure 1. Types of conformity.

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Following cultural group selection theory, the conformity bias should also function in ingroup cooperation situations, such as a social dilemma game, beyond the information-seeking domain. As the adaptive task in group situations is to achieve mutual cooperation, free-riders should be removed from an ingroup. The bias in conformity can make it possible to increase cooperators within a group more rapidly than no bias if cooperation is a majority within a group because the acceleration of reducing the variance of cooperators within a group exceeds the increased speed of free-riders. Thus, conformity bias should be observed even in social dilemma situations.

However, some previous studies showed the limitations of cultural group selection theory. Lehmann and Feldman (2008) conducted evolutionary simulations and showed that non-biased conformity promoted the evolution of cooperation rather than conformity bias. Van den Berg et al. (2015) also suggested no conformity bias in social dilemma situations wherein they demonstrated that cooperators were affected proportionally by the frequency of ingroup members while defectors were not. Their results were replicated in the UK and China (Molleman & Gächter, 2018). These results imply that conformity bias is not necessarily adaptive in social dilemma situations and support the domain-specificity hypothesis (Tooby & Cosmides, 1992) that humans have different psychological tendencies by domains. Thus, conformity bias may be valuable only in the domain specific to information-seeking, but not in the ingroup cooperation domain.

Nevertheless, little empirical data on conformity bias in ingroup cooperation had been reported. Hence, we examined whether conformity bias is observed in social dilemma situations in a vignette experiment. The degree of bias in conformity bias was tested by using the index (D^*) developed by Eriksson and Coultas (2009). Following cultural group selection theory, we hypothesized conformity bias should be observed in social dilemma situations.

Methods

Participants

In the vignette experiment, 161 crowdsourced individuals participated. The two participants who responded inappropriately in DQS (Directed Question Scale; Miura & Kobayashi, 2018) were excluded from the data. Thus, 159 participants (83 females and 76 males, M_{age} = 40.45, SD = 9.13) were used in the following analysis. Each participant received 220 yen as an experimental reward.

Procedure

Participants read and signed an informed consent document. They read 14 scenarios (e.g., fundraising) describing a social dilemma situation in daily life and responded whether they would cooperate or not. Following Eriksson and Coultas's (2009) model (below for details), $p_{neutral}$ was calculated using the 14 answers participants responded with. The scenarios were based on Yamagishi's (1989) classification of social dilemmas, assuming various social dilemma situations.[1] The wording of cooperation and defection was fitted as the story of the scenario, such as "donate" or "not to donate" and "recycle" or "not to recycle."

After completing the 14 scenario questions, four patterns of the number of the other cooperative ingroup members were informed in each of the scenarios. Specifically, participants were asked to imagine a situation in which 0 (0%), 3 (33.3%), 6 (66.7%), or 9 (100%) of randomly selected 9 ingroup members cooperated and answered whether they would cooperate in each pattern (not randomized). Participants then responded to the post-questionnaire, including Conformity Orientation Scale (Yokota & Nakanishi, 2011, a 5-point Likert scale, 1: not disagree – 5: agree) that includes two subscales; normative influence (13 items) and informational influence (10 items). Furthermore, one DQS item (Miura & Kobayashi, 2018) was contained in this scale. The DQS refers to the item to detect the participants who answered unfaithfully, such as "Please choose option '5' in this question." They completed the demographic items (gender and age), read debriefing instructions, and agreed to use their data.

The model of this study

Data analysis was conducted using R ver. 4.2.2 (R Core Team, 2022). Eriksson and Coultas (2009) elaborated the model which Boyd and Richerson (1985) proposed. Eriksson and Coultas's model includes three parameters: the probability that individuals adopt their behavior when there is no social influence ($p_{neutral}$), the probability that individuals decide their behavior when no one chooses it (p_0), and the probability individuals adopt the behavior when everybody selects it (p_1). Furthermore, this is configured to model the probability individuals choose one alternative (the probability participants select cooperation in this study). The model (a cubic equation) is as below.

$$f(s) = p_0 + (p_1 - p_0)s - 2(p_0 + p_1 - 2p_{neutral})s(1 - s) + Ds(1 - s)(2s - 1) \quad (1)$$

For s is the ingroup member's cooperation rate that is 0%, 33.3%, 66.7%, and 100% for each scenario in this study. D is the degree of conformity bias.

Moreover, Eriksson and Coultas (2009) also developed a non-biased conformity model (a quadratic equation) by providing $D = 0$.

$$f_{null}(s) = p_0 + (p_1 - p_0)s - 2(p_0 + p_1 - 2p_{neutral})s(1 - s) \quad (2)$$

[1]The vignette experiment demonstrated in this study is different from the plan described in pre-registration. We conducted a preliminary survey to select appropriate scenarios wherein participants could perceive dilemma situations. However, we employed all of the vignettes in the main experiment because we followed the discussion of Umino (2021). Umino argued that social dilemmas should be defined not by how participants perceive a situation (cognitive level) but by an entity (entity level), such as experimental rewards in empirical research. Following his argument, references to the reward structure in each vignette are significant to examine ingroup cooperation in a vignette study, and all scenarios corresponded to this condition. Therefore, we employed all vignettes in this experiment.

Table 1. Validation for conformity bias.

	Scenario outline (Choice outline: cooperation / defection)	Cooperation rate for each pattern (%)					D^*	95%CI (Bootstrapping)
		$r_{neutral}$	r_0	$r_{1/3}$	$r_{2/3}$	r_1		
Q1	Fundraising (donation / no donation)	59.12	42.14	47.17	61.01	74.21	0.21	[−0.10, 0.54]
Q2	Blood donation (donation / no donation)	31.45	27.04	28.30	32.70	42.77	−0.06	[−0.31, 0.21]
Q3	Beef (1000-yen / 500-yen)	61.01	31.45	45.91	66.04	76.73	0.34	[−0.16, 0.83]
Q4	Picking up trash (pick up / never)	83.02	67.30	79.25	88.05	93.08	0.01	[−0.24, 0.28]
Q5	Bicycle parking (charge / free)	32.08	26.42	28.93	35.22	55.35	−0.23	[−0.61, 0.17]
Q6	Buying-up (no payment / payment)	59.12	41.51	54.09	67.92	73.58	0.21	[−0.17, 0.61]
Q7	Air conditioner (saving / no saving)	74.21	56.60	66.67	78.62	81.13	0.25	[−0.06, 0.58]
Q8	Traffic (bus / car)	59.75	54.72	56.60	59.12	69.81	−0.17	[−0.51, 0.18]
Q9	Best before (short / long)	22.64	25.16	23.27	28.30	46.54	−0.14	[−0.47, 0.18]
Q10	Vote (voting / no voting)	74.21	64.78	70.44	75.47	83.02	−0.07	[−0.31, 0.17]
Q11	Sachets of soy sauce (one / two or more)	76.10	59.75	66.04	74.84	82.39	0.08	[−0.27, 0.45]
Q12	Soy sauce bottle lid (recycle / no recycle)	69.18	57.23	64.78	71.07	81.76	−0.13	[−0.38, 0.14]
Q13	Milk carton (recycle / no recycle)	74.84	61.64	69.81	76.73	86.16	−0.08	[−0.31, 0.16]
Q14	Cleaning up (work hard / cut corners)	85.53	57.86	81.76	90.57	92.45	−0.18	[−0.52, 0.16]
Total		61.59	48.11	55.93	64.69	74.21	0.00	[−0.12, 0.12]

Note: $r_{neutral}$: the cooperation rate when individuals are not influenced by anyone; r_0, $r_{1/3}$, $r_{2/3}$, and r_1: the cooperation rate when ingroup member's cooperation rate is 0%, 33.3%, 66.7%, and 100%, respectively.

D is calculated by the following equation. We have substituted the D value into Equation 1 in this study.

$$D^* = 9/4 \times (r_0 - 3r_{1/3} + 3r_{2/3} - r_1) \quad (3)^2$$

D^* is calculated by Equation 3 based on the responses when four patterns of others ingroup members' cooperation rate. $r_{1/3}$ and $r_{2/3}$ are multiplied by three because it makes D^* zero in non-biased conformity. 9/4 also multiplies cooperation rates. These methods were used to be compatible with D proposed by Boyd and Richerson (1985).

Here, r_0, $r_{1/3}$, $r_{2/3}$, and r_1 is the cooperation rate of participants when ingroup cooperation rate is 0%, 33.3%, 66.7%, and 100%, respectively. Positive values of D^* indicate biased conformists, negative values anti-biased conformists, and 0 does non-biased conformists (see Figure 1).

Results

Table 1 shows participants' responses and D^* in each scenario and all scenarios. The results showed that D^* was small for each scenario and $D^* = 0.00$ in all scenarios.

To test the differences from zero in D^*, a 95% confidence interval was calculated using a bootstrap method (1,000,000 times). The results revealed that the differences from zero in D^* were not significant for each scenario and all scenarios because zero was included within a 95% confidence interval.

As shown as Figure 2, the participants' responses of r_0,

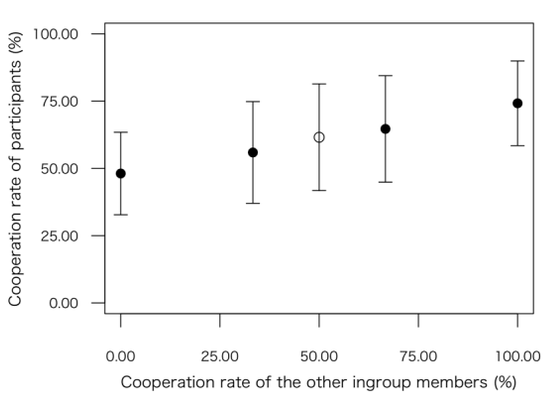

Figure 2. Conformity patterns in social dilemma situations (Total: Q1–14).

Note: The four black circles (●) correspond to r_0, $r_{1/3}$, $r_{2/3}$, and r_1 for all scenarios (Total in Table 1) from left to right. The white circle (○) corresponds to the case of no social information (i.e., $r_{neutral}$). Following Eriksson & Coultas (2009), we assume that the data in the treatment with no social information can be treated as if they were data for $\frac{1}{2}$'. Error bars are the standard deviation of each measured value.

[2]Here are the detailed explanations of the models to help understand Equation 3. First, Equation 2 specifies the parabola, $y = f_{null}(x)$, that passes through three points: $(x, y) = (0, p_0)$, $(\frac{1}{2}, p_{neutral})$, and $(1, p_1)$, which serves as the null model in the absence of biased conformity. Second, Equation 1 specifies the cubic curve, $y = f(x)$, which passes through the same three points as the null model, but also satisfies $f(\frac{2}{3}) - f(\frac{1}{3}) = \frac{1}{3}(p_1 - p_0) + \frac{4}{27}D$, which provides the rationale for Equation 3. Third, by using the observations r_0, r_1, and $r_{2/3} - r_{1/3}$ as estimates of p_0, p_1, and $f(\frac{2}{3}) - f(\frac{1}{3})$, respectively, we can estimate D.

$r_{1/3}$, $r_{2/3}$, and r_1 of all scenarios were approximated to linear. The cooperation rate under no social influence situations ($r_{neutral}$) was 61.59.

Next, following Eriksson and Coultas's (2009) analysis, the polynomial model fitting of the function $f(s)$ using the cubic (Equation 1) and the function $f_{null}(s)$ using the quadratic (Equation 2) equations was performed. If conformity bias is observed, the fitting of Equation 1 will be better than the one of Equation 2. The estimations of p_0, p_1, and $p_{neutral}$ for each cubic and quadratic equation were calculated. The AICs of both models were compared. The results showed that the cubic equation (AIC = −32.49) is better than the quadratic one (AIC = −32.14), however, the difference was small.

Since our data could not determine whether the cubic or quadratic equation is better, we performed the polynomial model fitting of a linear equation and AICs of these three models were compared. The function of the linear equation is below.

$$f_{linear}(s) = as + p_0 \quad (4)$$

a is the slope and p_0 is the intercept (i.e., the cooperation ratio when nobody cooperates in this study). We calculated the estimations of a and p_0, and the AIC of the linear equation. As AIC was −34.11, the linear equation was the best model in our data. These results showed that conformity bias was not necessarily observed in this experiment.

Discussion

We examined whether conformity bias was observed in social dilemma situations. The results of a vignette experiment showed that conformity bias was not observed in any scenarios. The findings in this study are inconsistent with the prediction of cultural group selection theory (Boyd & Richerson, 2005), replicated the findings of previous studies (Lehmann & Feldman, 2008; Molleman & Gächter, 2018), and support the domain-specificity hypothesis (Tooby & Cosmides, 1992). Thus, the function of conformity bias is adaptive only in information-seeking situations (Fujikawa et al., 2021, 2022; Kameda & Nakanishi, 2002) but not in ingroup cooperation situations. Thus, our findings suggest the limitations of the cultural group selection theory.

Three limitations in this study should be noted. First, the situation in which ingroup cooperation was assessed was restricted to one group, such as a single social dilemma situation. Previous studies showed that intergroup conflict situations increase the tendency to conformity (e.g., Yokota & Nakanishi, 2017). Henrich (2004) argued that an ingroup conflict was unnecessary for promoting ingroup cooperation. However, even in intergroup conflict situations, we should examine whether the conformity bias can influence ingroup cooperation or intergroup behavior (e.g., outgroup aggression).

Second, the actual behavior in ingroup cooperation was not measured because of a vignette study. We used scenarios depicting various social dilemma situations in daily life. However, such scenarios include numerous confounding factors, and the situations that participants imagined were not controlled. Therefore, we should conduct replications in laboratory experiments.

Third, individual differences in conformity bias were not examined. Since D^* was calculated based on a group, not an individual, the bias at a micro-level was not analyzed. Van den Berg et al. (2015) found the different effects of the frequency of the other ingroup members on ingroup cooperation between cooperators and defectors. Their findings suggest that the power of bias in conformity could be distinct between cooperators and defectors. When group dynamics in establishing cooperative groups are elucidated, individual differences in the effect of conformity bias should be examined.

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Author contribution

MN analyzed the data, DN and KY supervised this study, DN developed the study concept and design, MN, KY and DN wrote the manuscript.

Ethical statement

This study followed the recommendations of the Ethics Committee of the Faculty of Humanities and Human Science at Hiroshima Shudo University, which also approved the study protocol (No. 2022–17).

Data accessibility & program code

https://osf.io/t2xe4/

Supplementary material

Electronic supplementary materials are available online.

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