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Social sharing and risk reduction
Exploring a computational algorithm for the psychology of windfall gains

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Abstract

Sharing important resources widely beyond direct kin group members is one of the core features characterizing human societies. Moreover, generalized exchange involving many community members (e.g., meat sharing in bands) seems to be a uniquely human practice. This paper explores a computational algorithm for the psychology of social sharing that may underlie such practices, based on the risk-reduction hypothesis in food sharing of Kaplan and Hill [Curr. Anthropol. 26 (1985) 223]. We predicted that, independent of the amount of effort actually invested, uncertainty involved in resource acquisition is a key factor that triggers the psychology of social sharing for both acquirers and nonacquirers of a resource. It was also predicted that the "windfall effect" is independent of individual preferences as to modern distributive ideologies. Four multisample/multimethod studies, using Japanese and American participants, and laboratory as well as vignette experiments, supported these predictions: although the identical fungible resource (money) was under consideration, different psychological processes were triggered, depending on the degree of uncertainty involved in the money acquisition. Implications of the windfall effect for egalitarianism in resource sharing, observed not only in

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hunter–gatherer bands but also in highly industrialized societies, are discussed.

Keywords: Resource sharing; Risk reduction; Computational algorithm; Egalitarianism

1. Introduction

Sharing important resources, such as food, widely beyond direct kin is one of the core features characterizing human societies. Although a primitive form of food sharing is known in several primates, including chimpanzees, bonobos, and capuchin monkeys (see de Waal, 1996, for a comprehensive review), no primates other than humans have a broad social sharing system. Food sharing in primates is a complex phenomenon, and its adaptive origins are most likely manifold (cf. Flack & de Waal, 2000). Nevertheless, as discussed below, one of the key functions of social sharing may be collective risk reduction against variability in resource supply. Based on this risk-reduction notion, this paper aims to shed some light on the "computational algorithm" (Cosmides & Tooby, 1992) underlying the psychology of resource sharing. More specifically, by a series of experiments, we test a hypothesis that *uncertainty* involved in resource acquisition triggers the psychology of sharing for both acquirers and nonacquirers, independent of the amount of effort actually invested and the individual modern ideologies about desirable distribution.

1.1. Individual and collective solutions to the problem of variability in food supply

Reducing uncertainty in food acquisition to secure a stable supply has been one of the most central and universal adaptive problems for many species. In the animal kingdom, one common strategy to cope with environmental variability in food supply is *storage*. For example, small birds such as great tits store fat as body reserves against unpredictable temperatures and variable feeding day length (Bednekoff, Biebach, & Krebs, 1994; Bednekoff & Krebs, 1995). Many animals also store food reserves in the environment. Nutcrackers and jays, for instance, store pine and oak seeds in the autumn and retrieve them in the following spring to feed themselves and/or their offspring (cf. VanderWall, 1990).

For some types of food resources, however, storage may not be the best way to cope with environmental variability. Some group-living species have evolved collective solutions to this problem—*social exchange and sharing* of precious foods within a group. A well-known example is the blood sharing observed in vampire bats. Wilkinson (1984) observed that these animals quite often fail to obtain a blood meal during the night and subsequently beg for blood from other individuals in the daytime roosts. Such a practice takes the form of reciprocal altruism (Trivers, 1971), providing a *social* mechanism by which the variability in the food supply at the individual level is reduced.

1.2. Food sharing among the Ache foragers

As in the vampire bat example, most resource sharing beyond direct kin in the animal kingdom takes the form of reciprocal altruism, viz., enduring exchanges conducted within *particular pairs*. Using the language of sociology, this is a *restricted exchange* (Ekeh, 1974) where resources flow essentially in a pairwise manner over time. (Of course, a single individual can engage in restricted exchanges with many individuals; individuals can have bundles of exchange partners.)

However, human social exchanges are not necessarily limited to such pairwise, restricted exchanges. A particularly illustrative example was provided by Kaplan and Hill's (1985) and Kaplan, Hill, and Hurtado's (1990) observation of the Ache foragers living in lowland subtropical eastern Paraguay. These researchers found that food transfers among the Ache show markedly different patterns between hunted games (e.g., peccary, monkey, deer) and collected resources (e.g., vegetables, fruits). Hunted game, especially when large in package sizes, tends to be shared widely across many community members beyond the acquirer's family. While a substantial portion of collected resources is still given to nonfamily members, hunted game is much more likely to be the target of communal sharing, in terms of both "depth" (the *proportion* of the food given away to nonfamily members) and "breadth" of sharing (the *number* of nonfamily members who receive the share: cf. Gurven, in preparation). Related findings have also been obtained for other hunter–gatherer societies (cf. Cashdan, 1989; Gibson, 1988; Woodburn, 1982). These observations suggest that the properties of the resources affect deeply how they may be transferred among community members. While the principle of kin sharing essentially operates for collected resources, sharing across the entire community is often observed for hunted game. Notice that the latter type of sharing not only involves nonkin as recipients, but also seems to signify a *generalized exchange* (Ekeh, 1974) or a *generalized reciprocity* (Sahlins, 1974) involving many community members simultaneously, rather than a series of pairwise, restricted exchanges (cf. Hawkes, O'Connell, & Blurton Jones, 2001).

Why, then, do these markedly contrasting sharing rules operate for different resources? Kaplan and Hill (1985) explained the difference in terms of the degree of uncertainty involved in resource acquisition. While provision of collected resources (e.g., vegetables, fruits) is relatively stable, acquisition of meat is a highly variable, uncertain prospect. On average, there is a 40% chance that an Ache hunter will come back empty-handed (Kaplan et al., 1990). It is thus essential for them to manage the variance associated with meat acquisition, securing a stable supply of the resource. Storage by freezing is an obvious individual solution to reduce the uncertainty, but such a technique is not readily available in hunter–gatherer societies. Other storage methods such as drying and smoking meat may result in nutrient loss. Kaplan and Hill argued that, instead, the sharing system functions as a collective risk-reduction device. By including more individuals in the risk-pooling group, the variance in food supply decreases exponentially. Once established and maintained, the *generalized exchange system* (Ekeh, 1974; Sahlins, 1974) that includes many hunters can buffer the variance in the resource supply collectively.

1.3. Exploring a "computational algorithm" for the psychology of sharing based on the risk-reduction notion

Food sharing in hunter–gatherer societies is currently the topic of a vigorous debate, and is unlikely to be explained by any single mechanism (e.g., Gurven, Allen-Arave, Hill, & Hurtado, 2000; Hawkes et al., 2001; Smith & Bliege Bird, 2000; Sosis, 2000; see Winterhalder, 1997, for review). Yet, the risk-reduction notion that focuses on the benefits of a generalized exchange system is logically straightforward and produces a set of interesting hypotheses about the psychology of social sharing. That is, if coping with high variance in resource acquisition has been a recurrent adaptive problem in hominid evolution as implied by the risk-reduction notion, then our minds may have been shaped to respond to variance information quite sensitively. In the following, we explore such a "computational algorithm" (Cosmides & Tooby, 1992) that potentially underlies the psychology of social sharing, based on this risk-reduction notion.

1.3.1. Uncertainty as a key factor for triggering the psychology of social sharing

Casual observation of our everyday behavior suggests that we tend to use windfall money (obtained by winning lotteries, etc.), more often than money acquired by hard labor, for social purposes such as treating friends or donations to charities. Although the identical fungible resource (money) is under consideration in both cases, different psychological processes seem to be triggered almost automatically, depending on how the resource is acquired.

Of course, such a tendency may simply reflect a modern ideology of labor theory of value ("money earned without making effort has little value"). However, the risk-reduction perspective suggests another possibility. The key factor that triggers such a sharing tendency may be the *uncertainty* associated with the acquisition of money per se, rather than the absence of effort. As Cosmides and Tooby (1992) argued, it may be the case that "information about variance in foraging success should activate different modes of operation of these (computational) algorithms, with high variance due to chance triggering a psychology of sharing" (p. 213, parentheses added). We live in modern societies where uncertainty in resource acquisition is reduced by various social systems (e.g., production technologies), yet our minds may still be quite sensitive to variance information, as suggested by the risk-reduction notion.

1.3.2. Bidirectionality of the windfall effect

Second, for the social sharing system to work as a collective risk-reduction device, the aforementioned "windfall psychology" must be *bidirectional*. That is, uncertainty in resource acquisition should trigger the windfall psychology not only for *acquirers* of a resource but also for *nonacquirers*.

Bearing on this point, we recently developed an evolutionary game model about the emergence of a communal sharing system under uncertainty (Kameda, Takezawa, & Hastie, submitted). This is an n person game model and views social interaction over acquired resource as a process of *demand sharing* (Hawkes et al., 2001; Peterson, 1993) or

Table 1
Four behavioral strategies in the evolutionary game model of the emergence of a communal sharing system under uncertainty (Kameda et al., submitted)

	When in the nonacquirer role	
When in the acquirer role	Demanding communal sharing	Granting another acquirer's ownership
Provisioning as a common property	communal sharer	saint
Claiming private ownership	egoist	bourgeois

tolerated theft (Bliege Bird & Bird, 1997; Blurton Jones, 1987)—a process where nonacquirers essentially scrounge the resource. As shown in Table 1, the model assumed four behavioral strategies specifying (a) how to behave when an individual happens to be an acquirer of resource in a group and (b) how to behave when the individual happens to be a nonacquirer. The four behavioral strategies differ in their underlying "ideology" about what to do with the resource (to be privatized or to be shared) when in the acquirer role and when in the nonacquirer role, respectively (thus $2 \times 2 = 4$).

For example, "communal sharers" (see Table 1) are the purest endorsers of the windfall psychology; they provision the windfall gain as a common property when in the acquirer role, and demand sharing when in the nonacquirer role. On the other hand, "egoists" and "saints" (cf. Table 1) are *unidirectional*. Their windfall psychology is triggered only when in the nonacquirer role (egoists) or when in the acquirer role (saints), but not in both times. ("Bourgeois" in Table 1 are totally free from the windfall psychology.) The evolutionary game analysis revealed that, when resource acquisition is uncertain, the "communal sharing" strategy is a unique Evolutionarily Stable Strategy under a wide range of parameters, overcoming various free-rider problems in enforcement of the sharing norm (see Kameda et al., submitted, for details). In other words, in terms of individual fitness, the windfall effect is predicted to be bidirectional—individuals should be susceptible to the windfall psychology when in the *nonacquirer* role as well as in the *acquirer* role.

1.3.3. Independence from modern distributive ideologies

Third, if uncertainty in resource acquisition is indeed the key factor that triggers the psychology of social sharing, the aforementioned windfall effect should function independently of modern distributive ideologies. We have already argued that a modern ideology of labor theory of value ("money earned without making effort has little value") will not mediate this effect. The same argument goes for other modern distributive ideologies. For example, the social psychological literature has repeatedly shown individual differences as to "fair" distributive principles (e.g., Deutsch, 1985; Mellers & Baron, 1993). Some people endorse an equality rule as the fairest principle, while others endorse an equity rule, which demands a balance between individual inputs and outcomes, as their prime distributive justice system. However, as in the labor value ideology, we argue that such individual differences will not mediate the windfall effect. We predict that both equality rule endorsers and equity rule endorsers will be equally

susceptible to the windfall psychology under conditions where uncertainty in resource acquisition is high.

1.4. Previous studies and the present research

There are several empirical studies in the decision-making literature that are relevant to the argument we have made thus far (Arkes et al., 1994; Henderson & Peterson, 1992; McLean Parks et al., 1996). Among them, the Arkes et al. (1994) study is particularly pertinent to the present study. By a series of questionnaire surveys and experiments, these researchers showed that windfall gains were spent more readily than other types of assets. Arkes et al. argued that, because of their unanticipated nature, windfall gains are likely to be placed in a different "mental account" (Thaler, 1990) than other types of predictable income (e.g., monthly salary). For example, the windfall money may go into a "fun money" account that the individual has a much higher "marginal propensity to consume" (Keynes, 1936). Although Arkes et al. did not distinguish potentially different usage of windfall money conceptually (for personal fun or for social sharing), their argument that a defining characteristic of a windfall gain is its unanticipa-ted status is close to our theoretical perspective focusing on uncertainty in resource acquisition.

The present research recasts such a windfall effect more systematically from an evolutionary viewpoint. With the risk-reduction notion as a theoretical guide, we focus on uncertainty as a critical factor for triggering the psychology of social sharing. In this paper, we report four studies to test the computational algorithm that should characterize the psychology of sharing, viz., (a) variance information being a key that triggers the communal sharing psychology, (b) bidirectionality of the windfall effect, and (c) independence of the windfall effect from modern distributive ideologies. Studies 1 and 2 are scenario experiments in which we manipulated the degree of uncertainty involved in resource acquisition, independent of the amount of effort actually invested. Study 3 aims to replicate and extend results of Studies 1 and 2 using American as well as Japanese samples. Study 4 is a laboratory experiment in which we attempted a different manipulation of uncertainty and also assessed participants' actual (not imaginary) sharing behaviors directly. Thus, as a package, the four studies constitute a multisample/multimethod examination of the windfall effect from an evolutionary perspective.

2. Studies 1 and 2

Studies 1 and 2 were vignette experiments in which the uncertainty (outcome variance) associated with resource (money) acquisition and the amount of effort actually invested were independently manipulated. Participants received a booklet containing a series of hypothetical scenarios concerning various resource acquisition situations, and for each of the situations, stated their willingness to share (WTS) when in the acquirer role (Study 1) or their willingness to demand sharing when in the nonacquirer role (Study 2).

2.1. Method

2.1.1. Participants

Participants in Study 1 were 91 (34 male and 57 female) undergraduate students enrolled in an introductory psychology class at Sapporo Gakuin University, Japan. Participants in Study 2 were 70 (23 male and 47 female) undergraduate students enrolled in an introductory social psychology class at Shukutoku University, Japan.

2.1.2. Experimental design

We used a within-subject design with three conditions regarding resource acquisition mode. Participants were provided with hypothetical scenarios in which they (Study 1) or a friend (Study 2) obtained some money, either (a) contingent on investing substantial effort; (b) unexpectedly (i.e., high-outcome variance due to low contingency between effort and outcome) but after investing substantial effort; or (c) unexpectedly with almost no effort. These conditions are referred to as (a) certain/high-effort, (b) uncertain/high-effort, and (c) uncertain/low-effort conditions, respectively. As implied by the risk-reduction perspective, our main theoretical focus is with the comparison of participants' sharing tendencies between the certain/high-effort and the uncertain/high-effort conditions. Example scenarios for these conditions are provided in Table 2.

To control for potentially confounding thematic effects in scenario use, we initially prepared six prototype situations (like the "prize giveaway" situation in the above example). We first picked two of these prototype situations randomly for each of the three conditions and added the necessary modifications (i.e., degree of effort and uncertainty) to the texts. Then, using a Latin Square design (Winer, 1971), we permutated the assignment order. This procedure yielded six different variations in combinations of the prototype situations to the conditions. A booklet with one of the six variations was assigned to each participant randomly. (Notice that each prototype situation appeared only once in a single booklet; each participant saw, for example, the "prize giveaway" situation only once under one of the conditions in the booklet.)

Table 2
Example scenarios ("prize giveaway") used in Study 1

Certain/high-effort condition
An acquaintance requested you to fill out application forms for a prize giveaway. It was a tedious job to fill out the form. You completed 50 forms in total. Your acquaintance paid you US$100 for this service.
Uncertain/high-effort condition
You decided to apply for a prize giveaway. Although it was a tedious job to fill out the application forms, you completed 50 of them to increase the chance to win. Later, you found that you won a prize of US$100.
Uncertain/low-effort condition
You decided to apply for a prize giveaway and submitted one application form. Later, you found that you won a prize of US$100.

Thus, the confounding thematic effects that might accrue from particular combinations of conditions and situations were controlled experimentally.

2.1.3. Procedure

The studies were run in large classrooms. Participants received a booklet containing the six hypothetical scenarios. For each scenario, participants were asked to rate their WTS the money with a friend (Study 1) or the extent to which they would demand some share from a friend (Study 2) on three 7-point scales. The items used in Study 1 asked: (a) how likely it was that they would buy their friend something with the money; (b) how reluctant they would be to treat their friend with the money if asked to do so (reversed item); and (c) how obliged they would feel toward buying their friend something with the money. These questions were modified accordingly in Study 2.

At the end of the booklet, participants were asked to answer additional questions that identified their primary distributive principles (e.g., equality, equity) through a series of choices about various allocation schemes (Ohtsubo, Kameda, & Kimura, 1996).

2.1.4. Experimental hypotheses

Our experimental hypotheses were as follows.

Hypothesis 1: Independent of the amount of effort invested, money obtained unexpectedly in a high-outcome variance situation will be more likely to be shared with others than money obtained in a low-outcome variance situation (Study 1).

Hypothesis 2: Independent of the amount of effort invested, money that another obtained in a high-outcome variance situation will be more likely to be demanded for social sharing than money that another obtained in a low-outcome variance situation (Study 2).

Hypothesis 3: These "windfall effects" will be obtained even if we statistically control for participants' individual attitudes toward distributive rules (Studies 1 and 2).

2.2. Results

2.2.1. Social sharing as a function of uncertainty

Hypotheses 1 and 2 predict that social sharing should be facilitated by the uncertainty involved in money acquisition, even though the amount of effort invested is identical. If these hypotheses are correct, then there should be a significant difference in the sharing tendency between the certain/high-effort and the uncertain/high-effort conditions.

Figs. 1 and 2 display mean sharing tendencies in the three conditions in Study 1 (WTS) and in Study 2 (willingness to advocate sharing, WTAS), respectively. For these means, each participant's responses to the two scenarios in each condition were averaged to yield his/her sharing tendency in the condition. Also, since the three response scales to measure the sharing tendency were correlated with each other (average Cronbach's $\alpha = .76$ in Study 1 and .70 in Study 2), we aggregated them into a composite score. Means in the figures are based on these composite scores. A higher score indicates

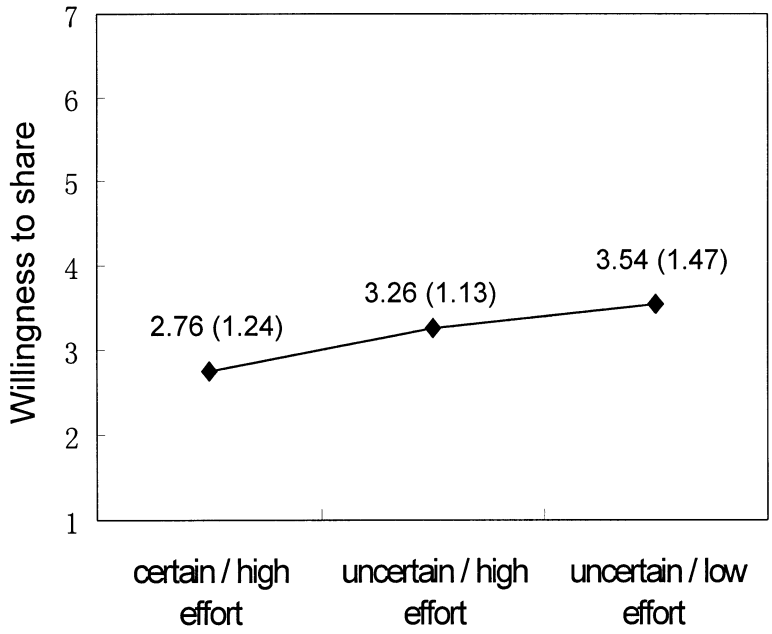

Fig. 1. Participants' mean WTS (with standard deviations in parentheses) as a function of uncertainty involved in the acquisition of money and the amount of effort actually invested (Study 1).

greater sharing tendency. (Since no effects involving participant's sex were obtained, the data were collapsed across sex in the figures.)

A repeated-measure analysis of variance (ANOVA) yielded a highly significant main effect for the resource acquisition mode [$F(2,178) = 14.77$, $P < .001$, in Study 1 and $F(2,138) = 34.71$, $P < .001$, in Study 2]. Furthermore, Scheffé post hoc test revealed that the main effect was mainly due to the difference in sharing tendency between the uncertain/high-effort and the certain/high-effort conditions [$F(2,178) = 7.81$, $P < .01$, in Study 1 and $F(2,138) = 8.01$, $P < .01$, in Study 2]. The difference between the uncertain/high-effort and the uncertain/low-effort conditions was marginally significant in Study 1 [$F(2,178) = 2.45$, $P = .09$] and significant in Study 2 [$F(2,138) = 5.26$, $P < .01$].

To summarize, even though the effort invested was identical, money obtained unexpectedly in a high-outcome variance situation was more likely to be shared (Study 1) and more likely to be demanded for sharing (Study 2) than money obtained in a low-outcome variance situation. Thus, Hypotheses 1 and 2 were supported.

2.2.2. Independence of the windfall effect from modern distributive ideologies

Although these results support our argument that uncertainty involved in resource acquisition triggers the psychology of social sharing, it might be argued that this effect is qualified by one's ideology about resource distribution. The social psychological literature on distributive justice has repeatedly shown that people's attitudes toward distributive rules

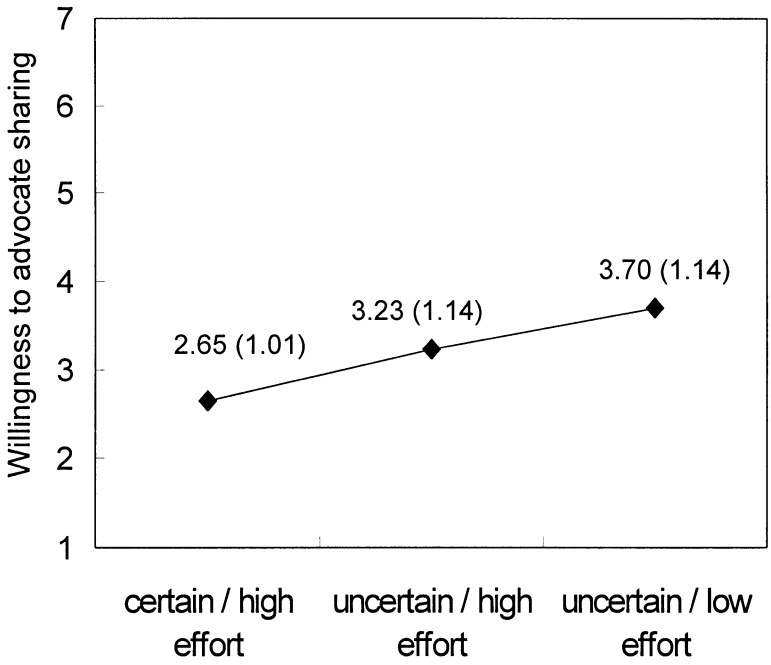

Fig. 2. Participants' mean WTAS (with standard deviations in parentheses) as a function of uncertainty involved in the acquisition of money and the amount of effort actually invested (Study 2).

differ substantially from each other (see Deutsch, 1985; Mellers & Baron, 1993, for a comprehensive review). Some people prefer the equity rule emphasizing a balance between individual inputs and distributive outcomes, whereas others prefer the equality rule as their prime distributive justice system.

To see if such individual differences in distributive ideologies may qualify the windfall effect, we classified participants into equity rule endorsers or equality rule endorsers based on their choice patterns about desirable distributions (Ohtsubo et al., 1996), and then added this ideology factor to the original ANOVA.

A 2 (Distributive Ideology) × 3 (Resource Acquisition Mode) ANOVA with the second factor as repeated measures again revealed a main effect for the resource acquisition mode [$F(2,166) = 9.40$, $P < .01$, in Study 1 and $F(2,124) = 27.00$, $P < .001$, in Study 2]. A main effect for the distributive ideology was also significant in Study 1 [$F(1,83) = 4.94$, $P < .05$], indicating that equality rule endorsers were more willing to share (mean = 3.19) than equity rule endorsers (mean = 2.56), but this effect failed to reach significance in Study 2 [$F(1,62) = 1.79$, ns]. However, most important to our concern here, no interaction effect was obtained in either study [$F(2,166) = 1.90$, ns, in Study 1 and $F(2,124) = 0.03$, ns, in Study 2]. Responses to uncertainty on the part of equality rule endorsers were indistinguishable from those of equity rule endorsers, as predicted by Hypothesis 3.

2.3. Discussion

The results of Studies 1 and 2 supported all three hypotheses about uncertainty and resource sharing. Even though the amount of effort invested was identical, obtaining money in a high-outcome variance situation was more likely to trigger a "psychology of social sharing" than obtaining it in a low-variance situation, with an essentially isomorphic pattern of results for both the acquirer (Study 1) and nonacquirer (Study 2) roles. Furthermore, this windfall effect was observed even after statistically controlling for modern distributive ideologies.

Although these results are consistent with our reasoning, several methodological limitations should be considered. First, these were vignette studies using imaginary scenarios and did not assess participants' actual sharing behavior directly. Second, although we attempted to control confounding thematic effects in scenario use experimentally (by creating different stimulus patterns via Latin Square design), some uncontrolled features might have biased the results. We will address these two problems that essentially accrue from scenario use in Study 4.

Thirdly, the social psychological literature on distributive justice has reported cross-cultural differences in preferred distributive principles (e.g., Bond, Leung, & Wan, 1982; Kashima, Siegal, Tanaka, & Isaka, 1988; Siegal & Shwalb, 1985). For example, Bond et al. (1982) showed that Chinese preferred equality in reward allocation to a larger extent than did Americans; Kashima et al. (1988) and Siegal and Shwalb (1985) reported a corresponding difference between Japanese and Australians. Given such cross-cultural differences, the focal windfall effect may also be culture- or society-specific. Thus, in Study 3, we conducted a cross-cultural validation of the windfall effect, using Japanese and American samples.

3. Study 3

The purpose of Study 3 was twofold. First, we aimed to replicate the previous two studies using a different (but again Japanese) sample. Second, we also administered the same questionnaire to an American sample to see if there were cross-cultural/societal differences in the sharing tendencies under uncertainty. Our experimental hypotheses were identical to Hypotheses 1–3 in Studies 1 and 2. If the Japanese and American samples in Study 3 show a conceptually converging pattern with each other and also replicate the results of Studies 1 and 2, then our confidence in the robustness of the windfall effect will be heightened substantially.

3.1. Method

3.1.1. Participants

Japanese participants were 88 (70 male and 18 female) undergraduate students enrolled in an introductory social psychology class at Mie University. American participants were 162

(49 male and 113 female) undergraduate students enrolled in introductory psychology classes at Loyola University-Chicago and Grand Valley State University.

3.1.2. Experimental design and procedure

Experimental design and procedure were identical to Studies 1 and 2 except that participants experienced both the acquirer and nonacquirer roles in the same questionnaire. Again to control for potentially confounding thematic effects in scenario use, we used a Latin Square design in assigning six prototype situations to six conditions, i.e., 3 (Resource Acquisition Mode) × 2 (Acquirer or Nonacquirer), and added necessary modifications to the texts. This procedure yielded six different variations in combinations of the prototype situations to the conditions.

Another minor modification from Studies 1 and 2 was that, in addition to the distributive ideologies, we also assessed participants' attitudes concerning labor values at the end of the questionnaire. Participants responded to three attitudinal items on labor values: "money earned without making effort has little value," "hard work is honorable," and "the value of a thing is determined by how much effort you have made to obtain it."

The questionnaire for the American sample was translated by one of the authors from Japanese to English and then back-translated into Japanese by an independent person who was ignorant of the research purpose. We then checked the final version against the original and found them to be identical in meaning. Comparability of the Japanese questionnaire and the American questionnaire was thus assured.

3.2. Results

Again, no effects involving participant's sex were obtained. Thus, responses were collapsed across sex in the following analyses.

3.2.1. Social sharing as a function of uncertainty

3.2.1.1. Willingness to share. Fig. 3 displays mean "WTS" scores when in the *acquirer* role in the Japanese and American samples. A 2 (Country) × 3 (Resource Acquisition Mode) ANOVA with the second factor as repeated measures yielded a significant main effect for country [$F(1,244) = 5.80$, $P < .05$]. As can be seen from the figure, the Japanese sample tended to be more "generous" than the American sample, essentially replicating the previous finding that Japanese prefer equal distributions more than Americans (cf. Bond et al., 1982). More important to our concern here, a main effect for the resource acquisition mode was highly significant [$F(2,488) = 29.33$, $P < .001$]. The interaction effect was also significant [$F(2,488) = 10.54$, $P < .001$], reflecting a greater differential impact of resource acquisition mode in the Japanese sample than in the American sample. However, planned contrasts separately conducted for each sample revealed that American participants' mean WTS was significantly higher in the uncertain/high-effort condition than in the certain/high-effort condition [$F(1,314) = 4.10$, $P < .05$]. This comparison was also significant in the Japanese

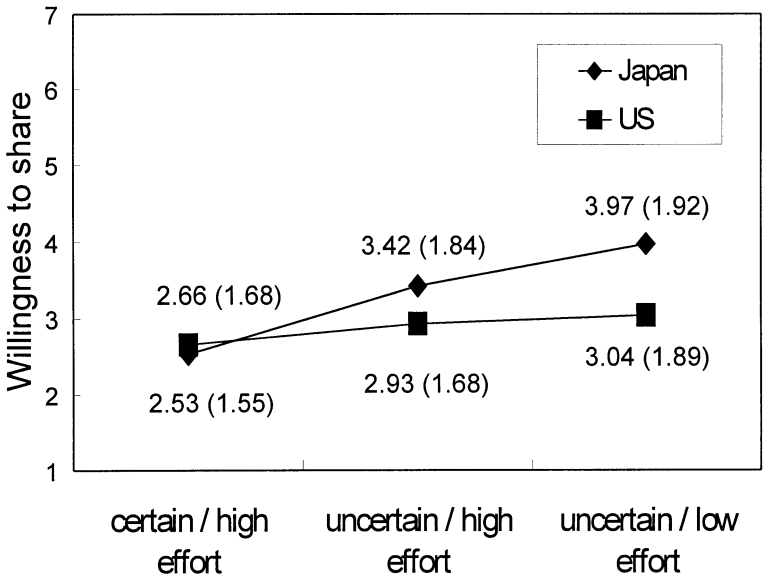

Fig. 3. Japanese and American participants' mean WTS (with standard deviations in parentheses) when in the acquirer role (Study 3).

sample [$F(1,174) = 22.76$, $P < .001$]. Therefore, our Hypothesis 1 was supported for both Japanese and American samples.

3.2.1.2. Willingness to advocate sharing. Fig. 4 displays mean "WTAS" scores when in the *nonacquirer* role in the Japanese and American samples. A 2 (Country) × 3 (Resource Acquisition Mode) ANOVA with the second factor as repeated measures yielded a significant main effect for country [$F(1,248) = 19.67$, $P < .001$]. The Japanese sample tended to be more "demanding" than the American sample—a mirror image of their greater "WTS" tendencies.[1] More importantly, a main effect for the resource acquisition mode was highly significant [$F(2,496) = 39.28$, $P < .001$]. Although the interaction effect was significant [$F(2,496) = 14.06$, $P < .001$], planned contrasts separately conducted for each sample again revealed that American participants' mean WTAS was higher in the uncertain/high-effort condition than in the certain/high-effort

[1] The editors pointed out that the difference in sample structure about sex (predominance of males in the Japanese sample and females in the American sample) might be responsible for the observed cross-national differences. To assess this possibility, we reanalyzed data separately for each sex. The separate analyses again yielded significant cross-national differences. Collapsed across the resource acquisition mode, Japanese males were more willing to share (mean = 3.29) and more willing to advocate sharing (mean = 3.08) than American males [mean = 2.87, $F(1,114) = 3.32$, $P = .07$; mean = 2.31, $F(1,117) = 6.46$, $P < .02$]. Likewise, Japanese females were more willing to share (mean = 3.37) and more willing to advocate sharing (mean = 3.17) than American females [mean = 2.88, $F(1,127) = 3.31$, $P = .07$; mean = 2.22, $F(1,128) = 11.84$, $P < .001$]. Thus, the cross-national differences in the overall sharing tendencies between the Japanese and American samples held for each sex.

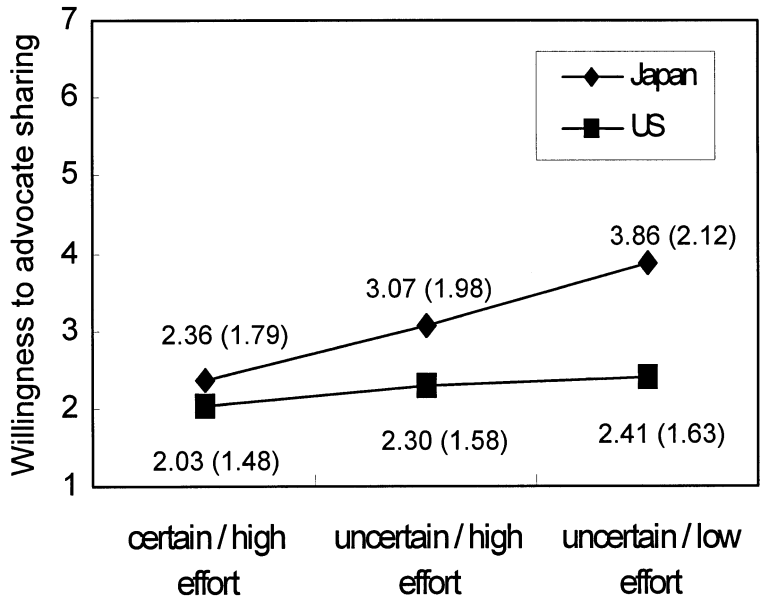

Fig. 4. Japanese and American participants' mean WTAS (with standard deviations in parentheses) when in the nonacquirer role (Study 3).

condition [$F(1,322) = 5.19$, $P < .05$]. This comparison was also significant in the Japanese sample [$F(1,174) = 16.80$, $P < .001$]. These results support our Hypothesis 2.

3.2.2. Independence of the windfall effect from modern distributive/labor ideologies

3.2.2.1. Distributive ideologies. As in Studies 1 and 2, we categorized participants into "equality rule endorsers" or "equity rule endorsers" based on their choices about desirable distributions (Ohtsubo et al., 1996), and added the ideology factor to the original ANOVAs. Separate 2 (Country) × 2 (Distributive Ideology) × 3 (Resource Acquisition Mode) mixed ANOVAs on the "WTS" and "WTAS" scores replicated the results of the earlier ANOVAs. The main effects for the resource acquisition mode [$F(2,436) = 16.36$, $P < .001$, for WTS and $F(2,444) = 23.33$, $P < .001$, for WTAS] and the Country × Resource Acquisition Mode interaction [$F(2,436) = 3.76$, $P < .05$, for WTS and $F(2,444) = 5.68$, $P < .01$, for WTAS] were significant. However, more important to our concern here, no interaction effect was observed involving distributive ideology and the resource acquisition mode [$F(2,436) = 0.16$, ns, for WTS and $F(2,444) = 0.66$, ns, for WTAS]. As predicted by Hypothesis 3, the sharing pattern in response to the uncertainty level was indistinguishable between the equality rule endorsers and equity rule endorsers.

3.2.2.2. Labor values. A similar analysis was also conducted with the data on attitudes toward labor values. For the Japanese and American samples separately, participants were split into categories with relatively positive or negative attitudes toward the labor value

ideology (50 percentile in each sample was used as a cutoff point). Separate 2 (Country) × 2 (Labor Value Ideology) × 3 (Resource Acquisition Mode) mixed ANOVAs on the "WTS" and "WTAS" scores again yielded the main effect for the resource acquisition mode [$F(2,484) = 19.33$, $P < .001$, for WTS and $F(2,492) = 25.15$, $P < .001$, for WTAS] and the Country × Resource Acquisition Mode interaction [$F(2,436) = 7.78$, $P < .01$, for WTS and $F(2,492) = 10.90$, $P < .001$, for WTAS]. However, no interaction effect involving labor value ideology, and the resource acquisition mode was significant [$F(2,484) = 0.77$, ns, for WTS and $F(2,492) = 1.16$, ns, for WTAS]. In conjunction with the absence of interaction effect with the distributive ideology just mentioned, these patterns support our Hypothesis 3 that the windfall effect is independent of modern sharing ideologies.

3.3. Discussion

On both the "WTS" and the "WTAS" scores, the Japanese sample showed a greater sharing tendency than the American sample, which may reflect cultural/societal differences on the value of equality as observed in the previous studies (e.g., Bond et al., 1982). This implies that socialization in different cultures indeed has sizable and perhaps prime impacts on people's actual sharing behaviors. However, besides the cultural/societal differences, it should be noted that the identical manipulations about the degree of uncertainty involved in resource acquisition had the same directional impacts across the two countries. In both countries, money obtained unexpectedly in a high-outcome variance situation was more likely to be shared and more likely to be demanded for sharing than money obtained in a low-outcome variance situation. This suggests that the windfall effect, albeit subtler than the cross-cultural/societal effects, may indeed be a universal psychological or behavioral phenomenon. Furthermore, the results indicate that such a windfall effect was not qualified by modern distributive ideologies or labor values.

The converging results of the three studies certainly heighten our confidence about the robustness of the windfall effect, yet another methodological problem, as outlined earlier, still remains. That is, the three studies reported so far all used hypothetical scenarios and did not directly assess participants' actual sharing behavior. Moreover, the use of scenarios, in principle, can never be free from the possibility of confounding thematic effects, even though we tried to control them experimentally via a Latin Square design (see Lanza, 1990, for a methodological discussion about how to enhance the ecological validity of vignette experiments). Thus, in Study 4, we attempted to replicate the results of Studies 1 through 3 conceptually using a laboratory experiment that did not rely on hypothetical scenarios.

4. Study 4

In Study 4, we tested Hypotheses 1 and 3 (sharing behavior when in the acquirer role), with a laboratory experiment using a Japanese sample. If a conceptually parallel pattern was obtained in the laboratory experiment as well, our concern that the windfall effect may be an

artifact arising from some thematic or other confounding factors associated with scenario use would be reduced.

4.1. Methods

4.1.1. Participants

Participants in Study 4 were 65 (41 male and 24 female) undergraduate students enrolled in introductory psychology classes at Hokkaido University, Japan.

4.1.2. Experimental design

There were two conditions in which participants received a fixed amount of money either in a deterministic manner (''certain condition'') or in a stochastic manner where high variance was associated with the money acquisition (''uncertain condition'' hereafter). The amount of effort invested to obtain the money was kept identical across the two conditions. Participants were assigned to one of the conditions randomly.

4.1.3. Procedure

Upon arrival, each participant was seated in a private booth and received further instructions *individually* via a computer. Participants were told that the purpose of the experiment was to investigate the effects of monetary reward on cognitive performance, and that they would be asked to work on 30 arithmetic problems individually. Before they actually started working, the reward for solving one problem correctly was decided either in a deterministic manner (certain condition) or in a stochastic manner (uncertain condition).

In the certain condition, participants were told, ''as a unit reward per problem, we have five conditions ranging from ¥5 to ¥25. You have been assigned to the ¥25 per problem condition.'' In the uncertain condition, participant's unit reward was determined by ''using a roulette wheel of fortune'' with five slots ranging from ¥5 to ¥25; however, in actuality, the roulette was preset to always stop at the ¥25 slot. Thus, these two conditions differed with respect to how the participants acquired their entitlement to the advantageous ¥25-unit reward, either assigned by the experimenter or by pure chance. Notice that the modern notion of property rights makes no distinction about the legitimacy of the entitled ownership between these two conditions. However, if our minds are sensitive to variance information associated with resource acquisition, then participant's *subjective* legitimacy of monopolizing the money should be weakened, leading to more social sharing in the uncertain condition.

After the unit reward was determined this way, participants started working on the 30 arithmetic problems on the computer. They were instructed that their performance speed would be timed and that they could not proceed to the next problem until they had answered the current problem correctly. Thus, all participants received an identical amount (¥750 = US$7) at the end as a total reward. The average working time required for solving 30 problems correctly was 18.7 min (S.D. = 4.8 min).

After completing the calculation task, participants were told that their experimental reward would be ¥750. While waiting for others to finish, each participant received a

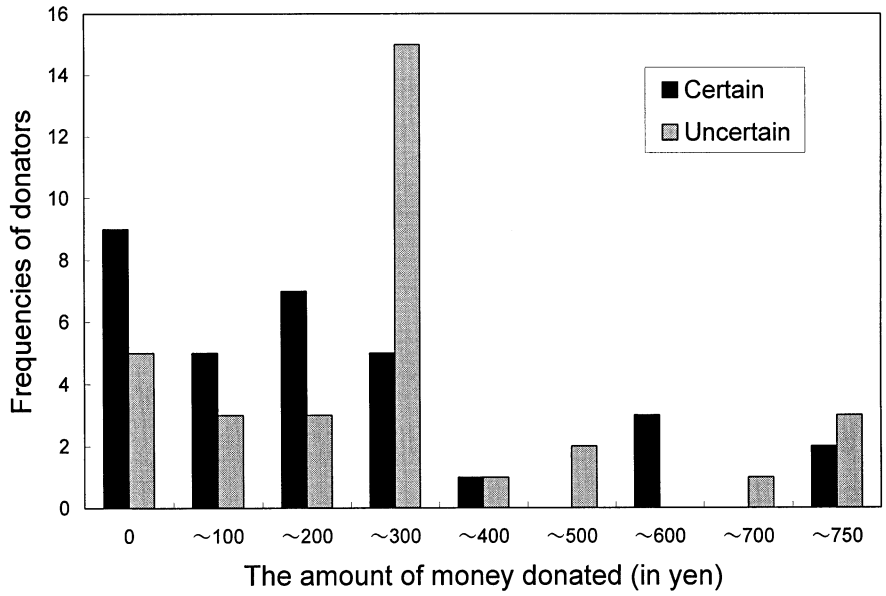

Fig. 5. Distributions of individual donations as a function of uncertainty involved in the acquisition of money (Study 4).

message from the experimenter soliciting a donation of some money from the reward "to help participants in another, unrelated experiment." Notice that this request was made to help individuals who had no prior histories of repeated interaction with the participant. Except that those individuals were also undergraduate students of Hokkaido University (a common in-group), no enduring pairwise relations with the participant (e.g., friendship), such as those found in restricted exchange, existed. Thus, the experimental situation featured core elements of *generalized exchange*, in terms of both the number of recipients and the absence of enduring pairwise relations.[2] The solicitation for a donation was made through a chat window on the computer screen, and a participant was able to input a figure from ¥0 to ¥750 that he/she thought was appropriate for this request. The amount of the donation that a participant made served as an index of the sharing tendency in the respective conditions. A couple of minutes after the solicitation, participants received a postsession questionnaire concerning their distributive ideologies and attitudes toward labor values. Participants were then debriefed, paid, and dismissed.

[2] In the preceding three studies, participants were asked about their sharing tendencies toward a "friend." As the reviewers pointed out, this procedure caused some mismatch between our theoretical argument and the experiments: the sharing context in Studies 1 through 3 featured a restricted exchange with a single individual having a history of repeated interaction, rather than a generalized exchange. Study 4 addressed this criticism by testing whether the windfall effect observed in the preceding three studies could be replicated in a sharing context that incorporated core features of generalized exchange.

4.2. Results and discussion

4.2.1. Social sharing as a function of uncertainty

Fig. 5 displays distributions of individual donations in the two conditions. Participants in the uncertain condition shared more than those in the certain condition. A Mann–Whitney U test (the distributions in Fig. 5 were skewed and the usual normality assumption was not met) revealed that the difference was significant, $z = 1.81$, $P < .05$ (one-tailed).

Since participants in both conditions worked on the identical calculation task, there is no reason to believe that they invested different amounts of effort across conditions. Indeed, there was no sizable difference in mean working time, mean = 19.5 min in the certain condition and mean = 18.0 min in the uncertain condition, $t(63) = 1.31$, ns. Furthermore, a logistic regression of the amount of donation[3] revealed only a significant effect of the resource acquisition mode [$\chi^2(1, n = 63) = 6.98$, $P < .01$]. The working time had no effect [$\chi^2(1, n = 63) = 1.83$, ns].

Thus, our Hypothesis 1 was supported in a laboratory experiment as well; independent of the amount of effort invested, uncertainty involved in resource acquisition facilitated the psychology of social sharing.

4.2.2. Relation to modern sharing ideologies

4.2.2.1. Distributive ideologies. As in previous studies, we categorized participants into "equality rule endorsers" or "equity rule endorsers" based on their choices about desirable distributions. A 2 (Distributive Ideology) × 2 (Resource Acquisition Mode) hierarchical log-linear analysis of the amount of donation (treated as a binary variable; see footnote 3) revealed only a main effect of the acquisition mode [$\chi^2(1, n = 59) = 3.97$, $P < .05$]. The interaction effect was not significant [$\chi^2(1, n = 59) = 0.06$, ns], implying that the sharing pattern in response to uncertainty was not qualified by participant's distributive ideology, as predicted by Hypothesis 3.

4.2.2.2. Labor values. Similarly, a 2 (Labor Value Ideology) × 2 (Resource Acquisition Mode) hierarchical log-linear analysis revealed only a main effect of the acquisition mode [$\chi^2(1, n = 65) = 6.41$, $P < .05$]. The interaction effect was once again not significant [$\chi^2(1, n = 65) = 1.32$, ns]. Taken together, these patterns support our Hypothesis 3 that the windfall effect is not qualified by modern sharing ideologies.

5. General discussion

This paper has explored a computational algorithm (Cosmides & Tooby, 1992) that underlies the psychology of social sharing by empirically focusing on the "windfall effect"

[3] Since the amounts of donation were distributed in a skewed manner (see Fig. 5), we transformed the amounts into upper or lower 50 percentile, and treated them as binary in the following analyses.

(e.g., Arkes et al., 1994). Based on a risk-reduction notion (Kaplan & Hill, 1985; Kaplan et al., 1990), we hypothesized that a key factor for triggering the psychology of social sharing is the degree of uncertainty associated with resource acquisition. It was predicted that, independent of the amount of effort actually invested, high-variance information (i.e., high uncertainty) should facilitate the sharing mode for both acquirers and nonacquirers of the resource, and that such a windfall psychology should operate independently of individual preferences for various modern distributive ideologies. Four multisample/multimethod studies, using Japanese and American participants and laboratory as well as vignette experiments, under the identical conceptual framework consistently supported these predictions. These results, of course, do not imply that other factors such as invested efforts, modern distributive ideologies, different cultural/societal values, etc., are irrelevant to social sharing. (Indeed, in our experiments, these variables did affect people's actual sharing behaviors.) Nor do these results mean that high-variance information is the strongest predictor of sharing breadth and depth (cf. Gurven, in preparation). What we have demonstrated is that, *even controlling for these factors*, our minds are still sensitive to variance information associated with resource acquisition; high-variance information is an essential ingredient of a computational algorithm that underlies social sharing, as envisioned by Cosmides and Tooby (1992).

Given the successful demonstration of such a windfall algorithm, we now turn to its broader theoretical implications for human resource sharing. Specifically, we speculate about potential relevance that the windfall effect may have for the egalitarian ideology. The windfall effect we have examined in this paper was people's increased WTS and increased demand to be shared with, as a function of uncertainty involved in resource acquisition. It is thus important to remember that this paper did *not* demonstrate an increased tendency towards *egalitarian sharing* ("divide by *n*" rule) per se. Nevertheless, we believe that the theme of uncertainty may also have some relevance to "egalitarianism" observed not only in hunter–gatherer bands (cf. Boehm, 1993; Cashdan, 1989) but also in highly industrialized societies broadly.

5.1. Egalitarian resource sharing and windfall psychology

5.1.1. Equality as a social decision heuristic

Resource sharing involving two or more individuals has been a major research concern not only in anthropology but in social psychology as well. Recent social psychological research on group decision-making suggests that, when people have to decide on which sharing rules are appropriate, one decision rule, *egalitarian division*, often emerges as a prominent solution (e.g., Allison, McQueen, & Schaerfl, 1992; De Vries & Wilke, 1992; Ohtsubo & Kameda, 1998). To summarize these empirical findings, Messick (1993, 1995) argued that "share equally" serves as a *social decision heuristic* in many complex decision-making situations. Messick proposed that equality is qualified as a social decision heuristic due to the following three characteristics. First, it is simple and easily understood. Second, equality is effective in the sense that its use usually leads to an unambiguous choice or allocation. Third, the use of equality is relatively easy to justify to those people affected by the social decision.

The first two characteristics that Messick (1993, 1995) ascribed to equality are essentially features often attributed to various cognitive heuristics in the decision-making literature: cognitive simplicity and frugality along with reliability of outcomes (e.g., Gigerenzer, Todd, & the ABC Research Group, 1999; Kahneman, Slovic, & Tversky, 1982). However, notice that the third characteristic that he ascribed to equality is *not* cognitive: "share equally" is *socially* justifiable. Then, an important question surfaces: why and under what conditions is equal sharing regarded as *the* just rule? We believe that the windfall psychology may provide one answer to this question.

An ultimatum bargaining game study by Polzer, Neale, and Glenn (1993) is particularly informative on this point. Ultimatum bargaining is a two-person game in which Player 1 divides a resource and Player 2 then decides to either reject or accept the division. If Player 2 declines the division, both players receive nothing (Güth, Schmittberger, & Schwarze, 1982). Polzer et al. (1993) demonstrated that Player 1's offers were influenced critically by *justifications* for being permitted to divide first. When participants *earned* the Player 1 position by scoring high in a preceding task, the mean offer was 80% of what Player 1 proposed to retain for him or herself. However, when participants were *assigned randomly* to the Player 1 position, the mean offer rose to 97% of the sum retained. Samuelson and Allsion (1994), who investigated people's sequential harvesting behavior from a common resource pool, reported a parallel finding. For example, when participants were assigned their early position because "their birthday was nearest to a date selected *at random* earlier by the experimenter," they harvested much less (i.e., requested shares closer to equal division) from the common pool, than when they had superior "justifications."

These differences have often been explained by somewhat coarse notions like justifiability or entitlement. However, notice that in both studies, *uncertainty* (i.e., high variance) involved in the assignment of the advantageous, early positions played a key role in determining why such an "entitlement" operated strongly in one setting and not in another. Our Study 4, which manipulated uncertainty in assigning participants to the advantageous reward condition, yielded conceptually parallel results. Taken together, these results suggest that high-variance information involved in resource or resource status acquisition plays a critical role for an egalitarian division to be perceived as the "just" rule in social sharing. In other words, adaptive advantage of variance reduction by resource pooling may provide an ultimate reason why people feel less entitled (i.e., that it is less legitimate) to monopolize unexpected gains.

5.1.2. Is equal sharing under uncertainty always conducted willingly?

The "just" view of egalitarian sharing may seem to imply that this rule is internalized as a basic moral value that binds us, unconditionally, under uncertainty. However, we feel that this is perhaps an overstatement. For example, in the aforementioned Polzer et al. (1993) and Samuelson and Allsion (1994) studies, participants' *mean* sharing behavior under uncertainty was close to egalitarian sharing, but the distribution was positively skewed with some deviant individuals favoring more "selfish" divisions. Similarly, as an acquirer of resources (e.g., Player 1 in the ultimatum game), participants were highly sensitive to nuances of justifications provided for their early positions, often interpreting the justifications toward their

personal advantage. In other words, it seems that an acquirer of a resource under uncertainty shows some egalitarian tendency behaviorally, but not always "willingly." One interesting study illustrates this point. Eckblad and von der Lippe (1995) investigated 261 lottery winners of prizes of 1 million Norwegian krone (= US$150,000). Those winners were asked about various psychological reactions after winning the prizes. One of the most frequent reactions among those respondents was a wish for anonymity, together with fear of envy from others!

These observations seem to suggest that social sharing under uncertainty essentially may be characterized as a "vigilant sharing" (Erdal & Whiten, 1994), in which sharing is conducted because of vigilant and envious eyes of nonacquirers who are immediate beneficiaries of sharing. In other words, nonacquirers may play a more active, initiative role in social sharing, implicitly or explicitly, than the acquirer of the resource (cf. Bliege Bird & Bird, 1997; Blurton Jones, 1987; Hawkes et al., 2001; Peterson, 1993). Notice that this view is not contradictory to the risk-reduction perspective, since those who face the *immediate* risk of resource shortage are nonacquirers and not the acquirer of the resource. (See Kameda et al., submitted, for an evolutionary game model of resource sharing under uncertainty based on these "demand sharing" notions.) In any event, this reasoning suggests that there may be some asymmetry between acquirers and nonacquirers, with the psychology of windfalls being more easily and/or more vigorously activated among nonacquirers. Given that the modern notion of property rights should operate in exactly the opposite way (i.e., sharing is at the acquirer's discretion), this poses an intriguing possibility awaiting future investigations.

As often pointed out by various theorists, human resource sharing, including food sharing, is a complex phenomenon, and its adaptive origins are most likely manifold. Given this complexity, a multidisciplinary approach seems to be essential to better understand the phenomenon. We followed such a path in this paper, by linking social psychological experimentation to anthropological findings to shed some light on the psychology of social sharing. Much remains to be done, but we believe that a multidisciplinary approach under the evolutionary perspective will eventually clarify the computational algorithm underlying social sharing in a rigorous manner.

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