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ORIGINAL ARTICLE

A Risk-Reduction Model of Sharing: Role of Social Stimuli and Inequity

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Abstract The present study experimentally investigated human cooperation (sharing) in a laboratory foraging task that simulated environmental variability and resource scarcity (shortfall risk). Specifically, it investigated whether a risk-reduction model of food sharing derived from the energy budget rule could predict human cooperative behavior. Participants responded on a computer task for money and were given the choice between working alone or working with others and pooling earnings. Earnings could be kept only if the sum exceeded an earnings requirement (i.e., a need level). The effects of social variables on sharing were investigated to determine whether they constrained optimal decision making. The experiments investigated choice when participants were told the partner was a computer or a (fictitious) partner (Experiment 1) and when the earnings between the participant and partner were inequitable (Experiment 2). The results showed that social variables had no effect on decision making. Instead, sharing patterns were in accord with predictions of the risk-reduction model. These results provide additional evidence that a risk-reduction model of food sharing derived from risk-sensitive foraging models may be useful for predicting human cooperation for monetary outcomes.

Keywords Sharing · Risk-sensitive foraging · Energy-budget · Cooperation · Risk reduction

Food sharing has been widely observed in human societies (see Winterhalder, Lu, & Tucker, 1999). Sharing may take the form of reciprocal exchange, such as when individuals give to others and the act is later reciprocated (Winterhalder & Smith, 2000), or resource pooling, in which individuals combine their acquisitions with others, and then divide the sum (Winterhalder, 1986). In either case, when sharing involves giving resources to others the behavior is somewhat puzzling because it involves at least some short-term loss for the actor. When food recipients are relatives, an ultimate explanation for the sharing may be kin selection (Hamilton, 1963). However, sharing in humans often occurs with non-relatives (Winterhalder, 1986) and other benefits must explain sharing in those instances.

Several evolutionary-based theories for human food sharing among non-relatives have been proposed, including tolerated theft, trade, and risk reduction (e.g., Bliege Bird & Bird, 1997; Hawkes, 1993). The risk reduction account of food sharing assumes that sharing occurs because it can reduce the risk of an energy (caloric) shortage. When an individual forages independently, instability in food acquisition leads to variation in the rate of energy gains (Winterhalder et al., 1999). If foragers pool and share their food acquisitions, however, then the variability in gains is averaged across individuals, thereby reducing the risk that any one person will experience a shortage. This pooling of resources can be described as a type of reciprocal exchange because an individual may receive shares during each sharing episode, but only contribute intermittently. Sharing may, therefore, be viewed as a type of cooperative behavior, given that it results in mutual benefits for participating individuals (for discussions on definitions of

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cooperation see Marwell & Schmitt, 1975; Nowak, 2006; West, Griffin, & Gardner, 2007).

The risk-reduction model of food sharing is derived from a risk-sensitive optimal foraging model known as the energy-budget rule (Caraco, Martindale, & Whittam, 1980; Stephens, 1981). The energy-budget rule was developed to predict adaptive risk-sensitive foraging choices in an organism who needs to acquire sufficient energy (food) resources in a limited time period to survive. In the simplest scenario, the organism is assumed to be faced with a choice between two food options. Both have the same mean rate of energy gain, but one produces highly variable gains and the other produces more consistent gains. Stephens argued that the chance of starvation is minimized by choosing the low-variance option when the energy budget is positive (i.e., when the mean rate of food gain plus energy reserves exceeds requirements) and choosing the high-variance option when the energy budget is negative (i.e., when the mean rate of food gain plus energy reserves fails to meet requirements). Thus, in times when starvation is more probable (negative budget), organisms should favor high variance resources because it provides the better chance of obtaining enough energy to survive. If foraging independently produces resources with high variability and sharing produces resources with lower variability, then the model would predict that sharing should occur under positive, but not negative energy-budget conditions.

Several anthropological field studies have found that patterns of human food sharing are consistent with the predictions of the risk-reduction account (see Winterhalder et al., 1999). For example, the Aché (Kaplan & Hill, 1985) and the Basarwa (Cashdan, 1985) were found to share unpredictable food acquisitions, such as meat and honey, much more often than other, less variable food options, like vegetation. In a study of the Yanomamö, Hames (1990) found that the amount and frequency of sharing also depended on the predictability of the resource. That is, sharing occurred when resources were unpredictable, likely because it decreased variability in consumption. Although the studies described above found support for the risk-reduction sharing model, they did not directly assess sharing as a function of shortfall risk (i.e., budget condition), thus it is impossible to isolate the effects of shortfall avoidance on sharing apart from other variables. Consequently, laboratory studies may be useful for determining whether risk (variance) reduction itself can generate sharing.

As described above, the risk-reduction model of sharing is based upon the predictions of the energy budget rule. Although studies with nonhumans have found some experimental support for the model, it has had difficulty in accounting for risk preferences in many nonhuman species (see Kacelnik & Bateson, 1996; Kacelnik & El Moudena, 2013; Fantino & Romanowich, 2006). No laboratory study has investigated whether the energy-budget rule can predict risky choice in humans, because of ethical issues of manipulating energy intake. Thus, to test the energy-budget rule with humans some researchers have substituted point/monetary gains and earnings requirements for food intake and energy requirements, i.e., established what may be called an "earnings budget" (Deditius-Island, Szalda-Petree, & Kucera, 2007; Ermer, Cosmides, & Tooby, 2008; Mishra & Fiddick, 2012; Mishra, Gregson, & Lalumiere, 2012; Mishra & Lalumiere, 2010; Pietras & Hackenberg, 2001; Pietras, Locey, & Hackenberg, 2003; Pietras, Searcy, Huitema, & Brandt, 2008; Rode, Cosmides, Hell, & Tooby, 1999; Wang, 2002). Consistent with the description above, earnings budgets are considered positive when mean earnings from low-variance choices will meet the earnings requirement and are considered negative when mean earnings from low-variance choices cannot meet the earnings requirement. The budget is neutral when there is no earnings requirement. These studies have found that, in contrast with many nonhuman studies, human risky choice for points/money is consistent with what the energy- budget rule would predict for food-related choices: preference for the low-variance outcome occurs in positive-budget conditions and preference for the high variance option occurs in negative-budget conditions.

A few laboratory studies have investigated risk-reduction accounts of sharing in humans when choice options involved points or money (e.g. Kameda, Takezawa, Tindale, & Smith, 2002; Kaplan, Schniter, Smith, & Wilson, 2012; Pietras, Cherek, Lane, & Tcheremissine, 2006; Ward, Eastman, & Ninness, 2009). Kameda et al. (2002) and Kaplan et al. (2012) did not directly manipulate earnings budgets, but showed that the probability of sharing depended on the variability associated with resource gains – when resource gains were unpredictable, sharing was more likely. Pietras et al. (2006) and Ward et al. (2009) manipulated earnings budgets by establishing an earnings requirement that participants had to meet to keep earnings. Both studies found that sharing varied in a manner consistent with the energy-budget rule, with participants sharing when doing so reduced the chance of a shortfall.

Behavioral Mechanisms and Constraints on Optimal Decision Making

The energy-budget model predicts risk preferences based on the adaptive advantage of the decision options (i.e., it is a functional explanation), but makes no statements regarding the proximate mechanisms, including the behavioral processes, that underlie foraging choices. Identifying these behavioral processes not only provides a more complete understanding of adaptive behavior, but can also help explain behavior when choice is suboptimal, as departures from optimality may indicate that there are processes that constrain adaptive responding (Nettle, Gibson, Lawson, & Sear, 2013).

Multiple behavioral processes may constrain optimal patterns of sharing (cooperation), either by enhancing cooperation when working alone is optimal, or by disrupting cooperation when cooperation is optimal. For example, an inability to delay gratification, memory limitations, or the inability to detect cheaters may negatively affect cooperation (Declerck, Boone, & Emonds, 2013; Stevens, Cushman, & Hauser, 2005; Stevens & Hauser, 2004). Studies with humans have indicated that social variables, such as familiarity or information about the trustworthiness of sharing partners may enhance cooperation (e.g., Declerck et al., 2013; Declerck et al., 2010; Stevens & Hauser, 2004). Thus, unfamiliarity or lack of information about partners may impede cooperation when cooperation is optimal, or enhance cooperation when cooperation is not optimal. Finally, studies have suggested that inequity in outcomes for individuals in a cooperative relationship can negatively affect cooperation (e.g., Schmitt & Marwell, 1972; Spiga, Cherek, Grabowski, & Bennett, 1992). Thus, inequity may disrupt cooperation when cooperating remains a better option than working independently.

Although the studies cited above suggest that certain social variables may constrain optimal cooperation, it is possible that such variables have little effect on cooperation (sharing) under budget conditions when individuals are motivated to avoid shortfalls. Such an effect would be in accord with results of prior studies that have shown that shortfall-avoidance overrides the effects of other variables related to risky choice. For example, Mishra and Lalumière (2010) demonstrated that, under conditions of varying need, an individual's choices matched the predictions made by risk-sensitive optimal foraging models, regardless of whether an individual was categorized as risk-averse or risk prone by risk-sensitivity questionnaires.

It is also possible that social cues may enhance optimal cooperation. As noted above, cooperation research has shown that social stimuli, such as interactions or communication with partners increases, cooperation (e.g. Marwell & Schmitt, 1975; Rachlin & Jones, 2008). Thus, certain kinds of social stimuli may facilitate optimal responding in situations of shortfall risk when it is optimal to cooperate with others.

The present research had two goals. The first goal was to investigate further the ability of the risk-reduction account of sharing to predict human choice. Thus, some of the conditions in the present study replicated those of Pietras et al. (2006). The second goal was to assess whether two social variables, type of partner (Experiment 1) and inequity in earnings (Experiment 2), affect optimal decision making when the budget condition clearly favors either sharing or working independently. Together these two studies were designed to provide additional information about the predictive utility and generality of the risk-reduction model of sharing.

Experiment 1

In the Pietras et al. (2006) study described above, because choice was strongly influenced by the budget contingencies, it was unclear whether the social context had any influence on responding; participants may have simply responded in ways that maximized earnings. Pietras et al., therefore, investigated preference in a few participants under neutral budget conditions (i.e., no earnings requirements) when an alone option was added that produced the same mean and variability as the sharing option. They found that participants preferred the nonsocial option over the social option. A slight bias away from the social option may have constrained optimal responding in positive budget conditions and enhanced optimal responding in negative budget conditions. A more direct manipulation is needed, however, to evaluate whether social stimuli affect choice in this procedure.

Several cooperation studies have investigated whether social stimuli influence choice by investigating differences in cooperation when partners were people or simulated (computerized) actors. Some have found no effect of partner type (e.g., Fantino & Kennelly, 2009; Kennelly & Fantino, 2007), whereas others have shown differences across partner conditions (e.g., Kiesler, Sproull, & Waters, 1996; Sanfey, Rilling, Aronson, Nystrom, & Cohen, 2003). For example, Sanfey et al. had participants play the Ultimatum Game and found that unfair offers were rejected more frequently when participants were working with another person than when they were working with a computer. Kiesler et al. found that participants were more likely to cooperate with a real person than with a computer on a Prisoner's Dilemma game and that they were more likely to keep commitments made to a person than a computer.

Additional research is needed to understand the conditions under which social variables influence sharing. The "survive" versus "shortfall" outcomes for choices in earnings-budget conditions generate large differences in earnings for optimal and non-optimal choices and across budget conditions there are clear predictions for optimal responding. Therefore, it would be informative to examine the effects of social cues on sharing within the context of budget manipulations to determine if biases or aversions to a social option constrain or facilitate optimal choices. This could have implications for understanding whether social contexts enhance or decrease optimal cooperation outside the laboratory.

Experiment 1 was designed to investigate whether social stimuli (the nature of the partner) influence optimal sharing in the earnings-budget task. Sharing was investigated across three budget conditions (positive, negative, and neutral) when participants were told they were working with a computer program or working with a human partner located at another facility. In actuality, this partner was fictitious. Although the use of a simulated partner limits ecological validity, a simulated partner was used as a starting point in this analysis to standardize and control "partner" interactions experienced by participants.

Method

Participants A power analysis was conducted to determine the number of participants needed to detect a large effect size (d = .8) (Cohen, 1992). Data from a repeated-measures pilot study (n = 10) was used to determine the smallest mean of the difference scores ($M_D = 3.3$) and standard deviation (SD = 4.09). Using $\alpha = .05$ (one-tailed) and 80 % power, a minimum of 11 participants would be needed. Fifteen students, ages 18 years and older were recruited through flyers posted around the campus of Western Michigan University. Participants had to be healthy and not using any drugs or psychoactive medications (as assessed by self-report). Participants ranged in age from 18-39 years (*M* = 21.3 years). The majority were female (80 %), and 80 % identified themselves as Caucasian, 13.33 % as Hispanic, and 6.67 % as Middle Eastern. Informed consent was obtained from all volunteers prior to participation. Participants were compensated for their time by monetary incentives and extra credit in their courses.

Apparatus Participants were seated alone in one of two cubicles measuring 2.2 m × 1.2 m × 1.3 m. Each cubicle contained a desk, a swivel chair, a computer monitor, and computer mouse. A Marsona TSC-330 white-noise generator was used to mask extraneous sound and a video camera was used to observe, but not record, participants. A computer task programmed in Microsoft Visual Basic 6.0® presented all stimuli and recorded all responses.

Procedure All procedures were approved by Western Michigan University's Human Subjects Institutional Review Board. Participants came to the laboratory on two separate days. On one day, participants were told that they were working with a computer (Computer condition) and on the other day participants were told that they were working with another person (Partner condition) at a different university (see Appendix for instructions). Order of exposure to conditions was randomly determined and counterbalanced across participants. Each day participants completed six sessions, two per earnings-budget condition (positive, negative, neutral). Participants were exposed to the three budget conditions under one partner type before being exposed to budget conditions under the second partner type. Sessions lasted 25-30 min and were separated by 5-min breaks. Thus, participation lasted 2.5-3 h each day, for a total of 5-6 h. To assess social deception, participants filled out a survey at the end of each day asking them to report on the number of people they thought they were paired with and to describe their interaction with them.

Participants were given minimal instructions so as not to influence their behavior. Sessions consisted of 18 blocks: eight forced-choice blocks followed by 10 choice blocks. During the eight forced-choice blocks, participants were only exposed to one of two alternatives: work alone or work with others. Each of the two alternatives was presented four times in a random order. Forced-choice blocks allowed participants to experience the outcomes of both alternatives prior to the choice blocks.

At the start of each block, the earnings counter was set at $0.00 and the letter "B" appeared in the center of the screen with the words "Press Now" below it. Participants were required to click the "B" on the screen to initiate the block. Next, participants were presented with two alternatives: a non-social option signaled by the letter "A" and the words "work alone" and a social option signaled by the letter "C" and the words "work with others" (see Fig. 1). Clicking on "A" or "C" turned off the alternative letter, and the selected option remained in effect for the remainder of the block. Each block consisted of five response trials. On each response trial participants were required to click on the selected option ("A" or "C"), which caused the letter to disappear and increased the earnings counter by either $0.00 or $0.12 (*p* = .5). During the reward period, the earnings counter increased in size for 0.5 s and then returned to its normal size for 0.5 s. After a 2-s delay the chosen letter re-appeared and the next response trial began. At the end of five trials then, participants could have earned a total of $0.00-$0.60 in intervals of $0.12. Figure 2 diagrams the events that occurred at the end of a block (five trials) for "work alone" and "work with others" choices. At the end of the block the words "Your Earnings" appeared above the block counter, followed by a 1-20-s delay during which the words "Please Wait" appeared on the screen. This variable

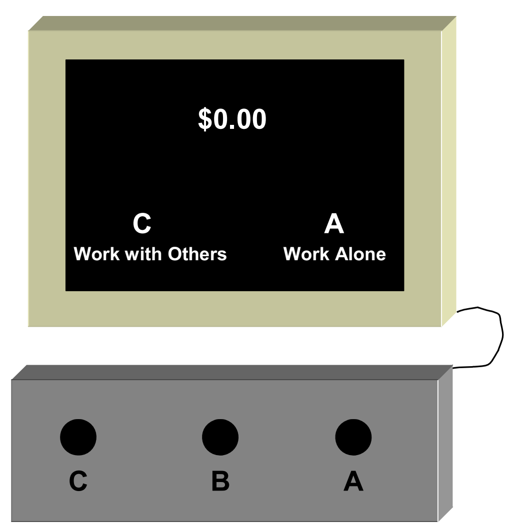

Fig. 1 Diagram of apparatus

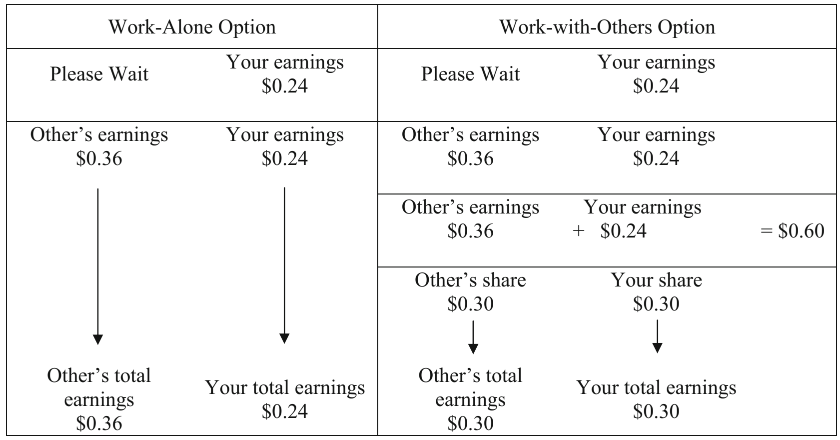

Fig. 2 Illustration of events that occur at the end of the block when participants choose the work-alone and work-with-others options

delay was designed to promote social deception by simulating occasions when the partner took longer than the participant to complete the block. The partner's earnings were negatively correlated with the participants so that the total earnings always equaled $0.60 (i.e., if the participant earned $0.36, the partner earned $0.24). If the "work with others" option was selected, then the participant's and partner's earnings were added together and split equally between them so that they both received $0.30. The words "Your Share" and "Other's Share" appeared on the screen with two counters showing each person's share of the total. Thus, the sharing option produced a constant earnings amount. If the "work alone" option was selected, then the amount that the participant earned during the five trials equaled the amount the participant had earned by the end of the block, which could vary between $0.00 and $0.60, making this a variable option.

At the end of a block the participant's earnings were added to the cumulative counter if they exceeded the requirement, otherwise the block counter was reset to $0.00. The earnings requirement was manipulated across conditions and was $0.00 (i.e., no requirement) in neutral-budget conditions, $0.30 in the positive budget condition, and $0.36 in the negative-budget condition. Thus, in a positive budget, participants could meet the requirement every block if they chose the "work with others" option and on 50 % of the blocks if they chose the "work alone" option. In the negative budget, participants could not meet the requirement if they chose the "work with others" option, but could meet the requirement on 50 % of the blocks if they chose the "work alone" option.

At the start of the block during positive and negative budget conditions, the font of the participant's total earnings counter was colored red, but when the amount met the requirement the font color changed to green and remained green for the remainder of the block. During the neutral budget condition, the font color of the participant's earnings was always green. In all budget conditions, the font color of the partner's earnings was green.

At the end of each day, participants drew from a prize bowl containing 32 slips of paper with monetary values that ranged from $0.00-$1.25, which were paid out to the participants. The distribution of slips was: eight (25 %) stated, "$0.00"; four (12.5 %) stated, "$0.25"; four (12.5 %) stated "$0.50"; four (12.5 %) stated "$0.75"; four (12.5 %) stated, "$1.00"; and eight (25 %) stated "$1.25". For every $2.00 that participants earned during the experimental sessions, they earned one opportunity to draw from the bowl. Daily earnings averaged $7.00. On the last day of participation, participants were partially debriefed (they were not told about the social deception). Once data collection was complete, all participants received an email fully debriefing them.

Results

Of the 15 participants who were recruited, three noted that they did not believe they were working with another person. Data from these participants were subsequently dropped from the analysis, leaving a total of 12 participants.[1] Results from the second exposure to each budget condition are reported.

Figure 3 shows the mean number of work-with-others choices during Computer and Partner conditions across all three budget conditions. A 2 (partner type) × 3 (earnings budget) repeated measures ANOVA test yielded a significant main effect of budget, $F(2, 53) = 14.40$, $p < .001$, $\eta_p^2 = .66$. However, there was no significant main effect of partner type, ($F[1, 53] = .12$, $p = .73$), nor was there a significant interaction between budget and partner type, $F(2, 53) = .84$, $p = .44$. Post hoc tests of the main effect of the earnings budget, using a Bonferroni adjusted alpha of $.05/3 = .017$, showed that there were significant differences between the positive ($M = 5.54$, $SD = 2.90$), neutral ($M = 3.30$, $SD = 3.61$), and negative ($M = 1.35$, $SD = 2.55$) earnings budgets. That is, when participants experienced a positive earnings budget, they preferred

[1] Choices of these participants, however, did not differ in any obvious way from choices of the other participants.

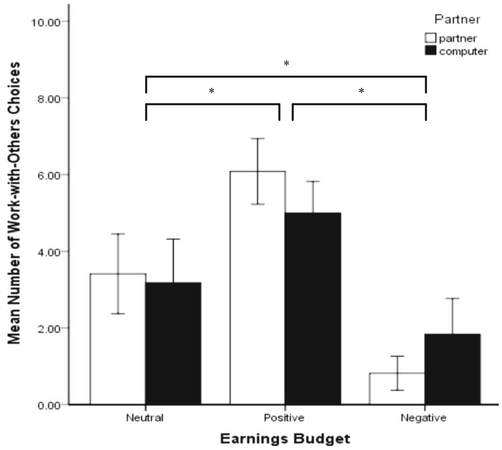

Fig. 3 Mean number of work-with-others choices across three earnings-budget conditions when participants were told they were working with a partner (*white bars*) and computer (*black bars*). *Error bars* show ± 1.0 standard error, and *asterisks* denote statistically significant differences between groups

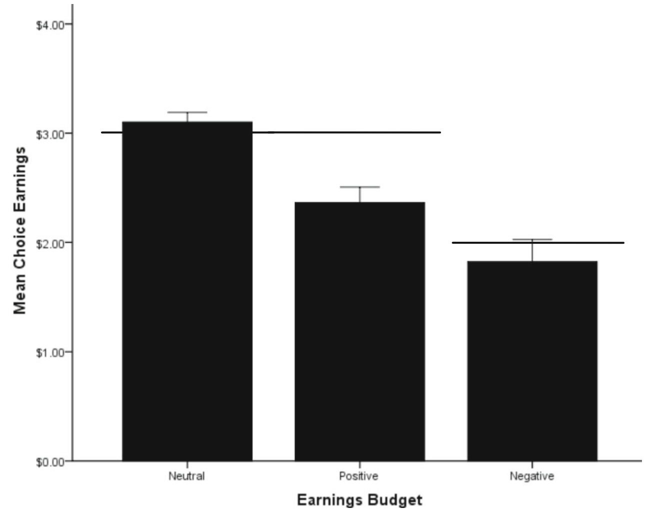

Fig. 4 Mean choice earnings for each of three earnings-budget conditions, with nature of partner collapsed across each condition. The *black horizontal bars* represent the mean programmed earnings for optimal choices across conditions. *Error bars* display 1.0 standard error

the work-with-others option significantly more than when they experienced a neutral ($p = .001$) or negative ($p < .001$) earnings budget. Half of participants preferred the work-with-others option (i.e. chose the sharing option in at least six of 10 blocks) during the positive earnings-budget condition. When participants experienced a negative earnings budget, they preferred the work-alone option significantly more than when they experienced a neutral earnings budget ($p = .017$) and none of the participants preferred the work-with-others option over the work-alone option. Overall, 11 of the 12 participants (92 %) showed more sharing in the positive-budget condition than in the negative-budget condition. Only one participant showed a preference for the sharing option in the neutral budget condition; while eight participants demonstrated a preference for the work-alone option, and three participants did not prefer one option over the other.

Mean earnings during choice trials were slightly above and below the programmed mean for optimal choices in the neutral and negative budget conditions, respectively (see Fig. 4),[2] and were a little below the programmed mean in the positive budget condition. Participants' mean choice earnings were highest in the neutral earnings budget in which there was no earnings requirement. Here, participants mean earnings were $3.10, which slightly exceeded the programmed mean of $3.00. In the positive earnings-budget condition, participants mean choice earnings were $2.37, which was somewhat below the programmed mean earnings of $3.00. In the negative earnings-budget condition, participants mean earnings were $1.79, which was close to the programmed mean of $2.06. If the work-alone option was exclusively preferred in the positive earnings budget, average earnings would have been $2.06, whereas if participants had an exclusive preference for the work-with-others option in the negative earnings budget, average earnings would have been $0.00.

Discussion

Consistent with prior sharing studies (Pietras et al., 2006; Ward et al., 2009) choice was generally congruent with the predictions of the risk-reduction sharing account based upon the energy-budget rule: participants made more work-with-others choices under positive budget conditions than under negative budget conditions. In the neutral earnings-budget condition, participants preferred the work-alone option, but this preference was not as strong as under negative budget conditions. Participants' earnings were close to the programmed maximum, showing that participants responded nearly optimally across conditions. The main exception was in the positive-budget condition. Here, although participant's showed a greater preference for the sharing option than in the negative-budget condition, the preference was only slight. A stronger preference would have yielded greater earnings.

A second goal of Experiment 1 was to investigate the effects of social stimuli on sharing by examining sharing across conditions in which participants were told they were working with a partner or computer. Participants did not show a significant difference in their choices across Partner and Computer conditions. These data, therefore, show that the human vs. computer manipulation of social stimuli did not constrain optimal choice by biasing choice away from the sharing option under positive budget conditions, or by biasing choice towards the sharing option under negative budget conditions. Rather, participants responded in a manner

[2] Because outcomes were random it was possible that participants could get "lucky" or "unlucky" and exceed or fall below the programmed mean earnings.

consistent with optimality. The lack of effect of partner type appears to contrast with the findings of Pietras et al. (2006) who reported what appeared to be a bias away from the sharing option. This negative effect of social stimuli on sharing in that study was likely a result of the instruction that the work-with-others option involved another person. However, the social aversion in that study was observed only in a condition in which an alone option that produced the same constant amount as the sharing option was available (i.e., there was no benefit for sharing). In the present study, it is interesting to note that during neutral-budget conditions, participants showed a slight preference for the work-alone option. This suggests that there may indeed have been a slight bias away from the work-with-others options, regardless of whether the partner was a computer or person, when both choice options produced equal mean outcomes.

Although prior research has shown that social stimuli can enhance cooperation (e.g., Kiesler et al., 1996), being told that the partner was a real person did not increase sharing, even in conditions in which it was optimal to share. Such a finding is consistent with a study by Boone, Declerck, and Suetens (2008) that investigated the effects of social cues on cooperation in an experimental task in which incentives either did or did not favor the development of cooperation. They found that the social cues facilitated cooperation only when incentives favored noncooperation. When cooperation was already very likely, the addition of social cues had a negligible effect.

Possibly, participants did not respond differently across Partner and Computer conditions in positive and neutral budget conditions because they responded to the computer as if it was a person. The Computers Are Social Actors (CASA) paradigm postulates that people respond to humans and computers in a socially equivalent manner (Nass & Moon, 2000). Research in this area has found that people tend to respond politely to computers (Nass, Moon, & Carney, 1999), reciprocate "helpful" acts when a computer initiates a "helpful" act (Fogg & Nass, 1997), and engage in gender stereotyping when presented with male and female voices while working on a computer task (Nass, Moon, & Green, 1997).

Alternatively, it is possible that the differences in social stimuli between the Partner and Computer conditions were insufficient to affect behavior. The only difference in social stimuli between Partner and Computer conditions was the instruction given to participants about who they were working with. The "Partner" behaved the same as the computer, and always shared when the participant selected the work-with-others option. Thus, instructions alone about the nature of the partner may have failed to influence responding.

There also was no other social interaction with the partner. Considerable research has shown that communication between partners can increase cooperation (for reviews see Balliet, 2009; Kollock, 1998; Sally, 1995). Various reasons may account for this effect, such as increased trust (Cohen, Wildschut, & Insko, 2010) or information on partners' intentions (Dawes, McTavish, & Shaklee, 1977). Interestingly, Kiesler et al. (1996) found that people cooperated with computers less than they did with people on a Prisoner's Dilemma task, but that cooperation increased, regardless of partner type, when participants were able to "discuss" choices. Participants in the present study were also given no information about who their partners were (i.e., they were strangers). Prior research also has shown that individuals show greater cooperation with familiar individuals than strangers (e.g., Marwell & Schmitt, 1975; Rachlin & Jones, 2008; Thompson, Kray, & Lind, 1998).

Finally, the procedure was designed so that the partner had no earnings requirement. Participants' choices of the sharing option could reduce variability in the partners' earnings, but could not significantly affect the partner's mean earnings. Shimoff and Matthews (1975) reported that participants sometimes preferred a cooperative option when the main function of such choices was to increase the partner's earnings (i.e., choice was altruistic). In the present study, because sharing did not significantly affect the partner's earnings, there may have been little motivation to share when it did not increase the participant's earnings.

Experiment 2

The manipulation of social stimuli in Experiment 1 through the instructions given to participants about whether the partner was a person or a computer had no effect on choice. Nevertheless, it seemed likely that other social stimuli might affect sharing. Experiment 2, therefore, sought to examine the effect on sharing of a different type of social stimulus: inequity.

Several laboratory studies have shown that when one partner receives greater benefits from cooperating than the other, cooperation may be disrupted (e.g., Aquino, Steisel, & Kay, 1992; Schmitt & Marwell, 1972; Spiga et al., 1992). For example, in a study by Schmitt and Marwell, dyads were able to engage in either an individual task or a cooperative task. The cooperative task produced higher rewards, but during some conditions one participant in the dyad received more than the other. As the magnitude of the inequity increased, cooperation decreased. Although studies have shown that individuals who are both advantaged and disadvantaged by an unequal distribution may respond to avoid or reduce inequity (e.g., Fantino & Kennely, 2009; Shimoff & Matthews, 1975; Marwell & Schmitt, 1975), evidence suggests that individuals respond more negatively to receiving less than others receiving more (e.g., Adams, 1965; Sweeney, 1990). In the Schmitt and Marwell study, for example, cooperation was almost always disrupted by the participant who received less.

Evolutionary biologists have offered several ultimate (i.e., adaptive) explanations for inequity aversion. One possibility is that inequity aversion evolved because individuals who rejected unfair distributions were likely to have greater reproductive fitness than those who did not (Wynne, 2004). Brosnan and de Waal (2003) suggested that preference for equity evolved through social comparisons that allowed organisms to maintain a relative advantage over others. Shaw and Olson (2011) argued that inequity aversion by an individual signals to others that the individual engages in fair and impartial behavior and that engaging in cooperative behavior with the actor will not result in exploitation. Fehr and Gächter (1996) have argued inequity aversion may be adaptive because it avoids exploitation by free-riders in cooperative groups. It also allows individuals to find better cooperative partners (Fehr & Schmidt, 1999). Some researchers have argued that inequity aversion is the result of specific cognitive structures selected within the context of social relations that functioned to avoid inequity (e.g. Brosnan, 2006), whereas others have argued that inequity aversion is the result of more general learning processes related to an organism's ability to discriminate rewards from some reference point (e.g., Chen & Santos, 2006). That some research shows inequity aversion does not necessarily depend on the social context in both children and nonhumans (see McAuliffe, Blake, Kim, Wrangham, & Warneken, 2013), lends some support to this latter interpretation.

In the studies showing disruptive effects of inequity described above (Schmitt & Marwell, 1972; Spiga et al., 1992), participants were guaranteed to earn at least some money for choosing the non-cooperative option. There was no requirement that participants had to meet and, therefore, no chance of experiencing a shortfall in earnings (i.e., $0.00). Individuals may be less sensitive to inequity when there is high motivation to acquire resources, such as under budget constraints. Thus, the purpose of Experiment 2 was to investigate whether inequity would constrain optimal sharing in an earnings-budget procedure involving shortfall risk. Choice was investigated under a range of inequity conditions, all favoring the partner. However, participants could meet the earnings requirement by sharing in all but one inequity condition.

Although Experiment 1 showed little effect on sharing of the nature of the partner (person vs. computer), because prior research has shown that the effects of inequity may be greater when the partner is a person compared to a computer (Sanfey et al., 2003), in all conditions in Experiment 2 participants were told that they were working with another person.

Method

Participants An equal number of males and females ($n = 14$) 18-21 years ($M = 19.08$ years) were recruited to participate (recruitment methods and selection criteria were the same as in Experiment 1). Of these participants, 66.67 % identified themselves as Caucasian, 25 % as African American, 8.33 % as Hispanic, and two participants did not disclose their ethnicity.

Procedure All details of the procedure were the same as Experiment 1's Partner condition except that the division of earnings following choices of the "work-with-others" option was not always equal ($0.30/$0.30). Rather, the division of earnings was varied across four conditions. The conditions were (Participant/Partner): Equity ($0.30/$0.30), Inequity 4 ($0.28/$0.32), Inequity 8 ($0.26/$0.34), and Inequity 12 ($0.24/$0.36). The earnings requirement was $0.25 across all four conditions. Thus, the earnings-budget was positive in all but the last inequity condition (Inequity 12), making sharing optimal in all but the most inequitable condition. Each condition was experienced three times. Order of exposure to conditions was randomly determined and counterbalanced across participants.

Results

Two of the 14 total participants recruited stated that they did not believe they were working with another person. Data from these participants were subsequently dropped from the analysis, leaving a total of 12 participants.[3] The last two exposures to each condition were analyzed. Figure 5 shows the mean number of work-with-others choices across all four conditions. A one-way repeated measures ANOVA test yielded a significant effect of inequity on sharing, $F(3, 33) = 16.23$, $p < .001$, $\eta_p^2 = .596$. Post hoc tests using a Bonferroni adjusted alpha of $.05/6 = .008$ showed that participants chose the work-alone option significantly more in the Inequity 12 condition ($M = .83$, $SD = 1.19$) than in the Equity ($M = 6.21$, $SD = 2.75$, $p < .001$), Inequity 4 ($M = 4.96$, $SD = 2.59$, $p = .001$), or Inequity 8 ($M = 5.79$, $SD = 2.45$, $p < .001$) conditions. There were no significant differences across these latter three conditions. The number of participants who showed a preference of greater than 50 % for the work-with-others option varied across conditions and was 66.67 % (Equity), 41.67 % (Inequity 4), 58.3 % (Inequity 8), and 0.0 % (Inequity 12).

Figure 6 shows mean session earnings from choice blocks from the last two exposures to each condition. As expected, session earnings were highest when block earnings were divided equally and decreased as the inequity in earnings increased. Across all four conditions, participants' mean earnings were near the programmed mean earnings for optimal choices. On average, participants earned $2.62 (programmed mean of $3.00) in the Equity condition. Earnings decreased to $2.50 (programmed mean of $2.80) in the Inequity 4 condition and to $2.33 (programmed mean of $2.60) in the Inequity 8 condition. In both of these inequity conditions, exclusive

[3] Choices from these participants were comparable to participants who did not doubt the social deception.

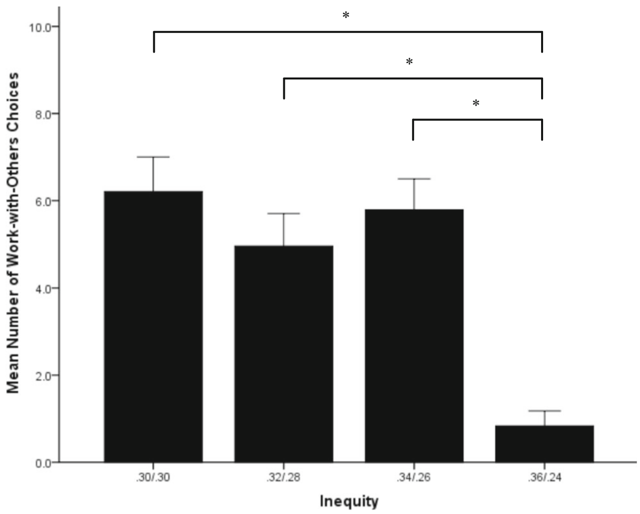

Fig. 5 Mean number of work-with-others choices across four distributions of participant/partner earnings. *Error bars* show 1.0 standard error, and *asterisks* denote statistically significant differences between groups

choice for the work-alone option would have yielded an average of $2.06. Thus, continuing to choose the work-with-others options increased session earnings during choice trials by $0.54 and $0.74. In the last inequity condition (Inequity 12), in which it was optimal for participants to choose the work-alone option, participants earned on average $1.87, which was close to the programmed mean of $2.06.

Discussion

Experiment 2 investigated the effects of inequity in earnings on choice of a work-with-others option within the context of a risk-reduction model of sharing. Consistent with the predictions of the model, participants showed a significantly greater preference for the work-with-others option under positive-budget conditions than under negative-budget conditions. These preferences occurred despite inequity in earnings between the participant and partner, suggesting that inequity did not negatively affect cooperation in this study. Rather, choices tended to maximize earnings.

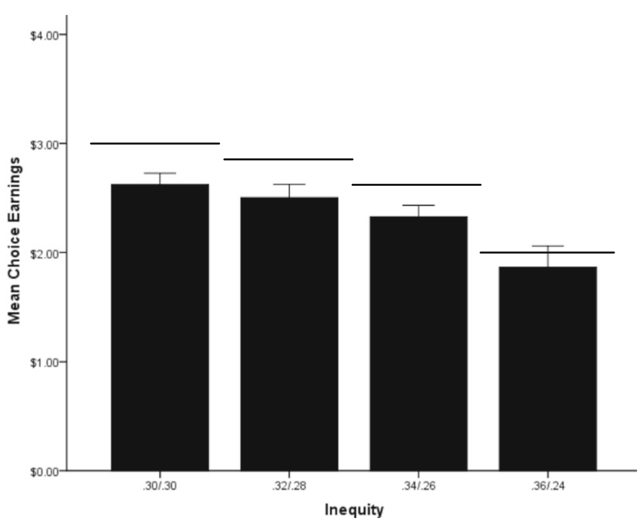

Fig. 6 Mean choice earnings for each of four inequity in earnings conditions. The *black horizontal bars* represent the mean programmed earnings for optimal choices across conditions. *Error bars* show 1.0 standard error

One difference between experiments showing inequity effects on cooperation and the present study is the presence of the earnings requirement that participants needed to meet in order to bank their earnings. In the Spiga et al. (1992) study, working alone did not negatively affect earnings. In the Schmitt and Marwell (1972) study, choosing the work-alone option produced lower earnings than cooperating, but it always produced some amount of money. In the current earnings-budget procedure, preference for the work-alone option led to a shortfall (no money) 50 % of the time. These data suggest, then, that at least within the parameters studied here, earnings-budget requirements make choice less sensitive to inequity. The present results are therefore consistent with several other laboratory studies that have shown that individuals will remain in an inequitable relation when doing so is more profitable than other options (e.g., Burgess & McCarl Nielsen, 1974; Shimoff & Matthews, 1975). This finding is also in accord with research on mini-ultimatum games (in which choice options for the proposer are restricted and known to both members of the dyad) that have shown that a responder's decisions to accept or reject a proposed resource division depends not simply on the absolute size of the proposed share, but also on the size of the proposed share in relation to the other amounts the proposer could have chosen (e.g., Brandts & Solà, 2001). Thus, responders may accept unfair divisions by the proposer if they are better than the alternatives.

Although continuing to share under inequity maximized earnings, there are several other features of the earnings-budget procedure that may have contributed to sharing. One possibility is that budget conditions may have motivated behavior that reduced the chance of losing acquired earnings (by failing to meet the requirement), and this may have overridden the effects of inequity. Loss aversion is commonly observed in risky choice research (Kahneman & Tversky, 1979). For example, studies by Mishra and Fiddick (2012) and Mishra et al. (2012) have found that in high need (i.e. negative budget) conditions, individuals demonstrate loss aversion by significantly increasing their tolerance for risk in comparison to situations framed in terms of gains. Furthermore, switching to the independent option did not restore equity. In social exchanges, withdrawing from the exchange may function to punish inequitable resource distribution (Fehr & Schmidt, 1999). In the present study, however, choosing the work-alone option had no effect on the division of pooled earnings or on the partner's net earnings. There was also no explanation given to participants for the inequity. Research has shown that inequity based on chance is less disruptive than inequity resulting from the partner's decisions (e.g., Bolton, Brandts, & Ockenfels, 2005; Falk, Fehr, & Fischbacher, 2008). Thus, the inequity may have had little effect on choice because participants attributed the inequity to the computer or experimenter. Additional research is needed to evaluate the specific effects of these variables on choice in this procedure.

One could argue that the small magnitude of the inequity was responsible for the persistence of sharing, rather than the shortfall risk of work-alone choices. This explanation seems unlikely given that the differences in self/other earnings under inequity were comparable or greater than those in prior research (e.g. Schmitt & Marwell, 1972). Furthermore, when the sharing option was chosen, the discrepancies in earnings between the participant and the partner would have accumulated across blocks and, on average, totaled $0.67 and $0.87 across the session for Inequity 4 and 8, respectively. In addition, a study by Zin, Escobal, Esteves, and Goyos (2015) used the Sharing Game to investigate whether choice of the sharing option varied as a function of the magnitude of earnings. Here, participants repeatedly choose between an optimal option that maximizes earnings (i.e. participant gets $7.00, partner gets $9.00) or a competitive option (i.e. participant gets $5.00, partner gets $3.00). Zin et al. increased earnings across conditions by a multiplication of 100 and 10,000 (i.e. $7/9 vs. $700/$900 vs. $70,000/$90,000). They found no change in preference when monetary values were increased by a multiplication of 100. When values were multiplied by 10,000, preference did not switch to a different alternative, but did become slightly stronger for the optimal option.

To better determine whether the earnings budget and not small differences between the participants' and partners' earnings for sharing made participants insensitive to inequity, however, it would be necessary to replicate Experiment 2 but include a neutral budget conditions in which there was no earnings requirement. To assess this, five additional participants were exposed to the same four conditions described above, but choice was studied under neutral budget conditions (requirement = $0.00). Participants tended to choose the work-alone option across all conditions, which is not surprising. Participants showed a small preference for the work-alone option under neutral budget conditions in Experiment 1. However, preference for the work-alone option was greater during inequity than equity conditions. The mean number of work-with-others choices across the Equity, Inequity 4, Inequity 8, and Inequity 12 conditions were $M = 3.7$, $M = 2.5$, $M = 2.5$, and $M = 2.4$, respectively. Thus, choice appeared sensitive to the differences in earnings under inequity – sharing decreased by about 35 % under the most inequitable condition. Choice in these pilot participants also maximized session earnings. In the equity condition, mean programmed earnings were $3.00 for both the work-alone and work-with-others options. However, under the inequity conditions, the mean programmed earnings for the work-with-others options decreased to $2.80, $2.60, and $2.40. Although additional research is needed, these data suggest that the budget manipulation, and not simply insensitivity to the small differences in earnings between the participant and partner, was responsible for the persistence of sharing under inequity. Of course it is possible that very large discrepancies in earnings between the participant and partner could disrupt sharing in some participants, even if cooperation was more beneficial. Future research could explore this possibility.

As noted above, many ultimate explanations have been offered to explain the evolution of inequity aversion. The present data do not support any specific account, but provide some additional evidence that inequity does not necessarily disrupt cooperation. Given that persisting in inequitable exchange relations may be beneficial to the disadvantaged partner in some circumstances, evolutionary models of cooperation should also include a specification of the conditions under which it is both adaptive and maladaptive to show inequity aversion (see Bergh, 2008). Situations in which it may be maladaptive to leave an inequitable relation (or maladaptive to try to restore equity through punishment or withdrawal of cooperation) may include: when there are no better alternatives, when resource need is immediate, when the partner will not be encountered again in the future, when the partner is related or can confer other benefits, or when the partner cannot control the distribution.

There are many proximate explanations for why inequality might be aversive and disrupt cooperation. Proximate explanations from social psychologists have often focused on judgments of equity. In social psychological theories of exchange, equality is distinguished from equity (e.g., Greenberg, 1982). Equality refers to equal distributions of resources, whereas equity refers to distributions that are proportional to contributions. Equal/unequal distributions may be considered equitable/inequitable if the effort required of participants is the same. Psychologists and sociologists have argued that inequity aversion may occur in humans because individuals prefer outcomes that are proportional to their contributions (e.g., Adams, 1963; Messick & Sentis, 1979; Walster, Walster, & Berscheid, 1978). Inequitable outcomes produce emotional responses and motivate various behaviors, which may include withdrawing from the cooperative relationship by the disadvantaged participant. Other social scientists have argued that inequity aversion may be a strategy to maximize valued outcomes (e.g., Homans, 1961; Van Avermaet, McCllntock, & Moskowitz, 1978). For example, Van Avermaet et al. argue that preference for equity (and aversion to inequity) would occur when equity increases the likelihood of future benefits, maintains a beneficial cooperative relationship, or produces social approval by others (which leads to other benefits).

The present study was not designed to test specific psychological or social theories of inequity aversion, but the results indicate that even if inequity was aversive, it did not lead participants to stop choosing the sharing option when doing so maximized earnings. These data, therefore, suggest that choice may depend on the relative benefits of the social and independent option. The results support the view of Burgess and McCarl Nielsen (1974) who have argued that equity theory itself is insufficient to explain patterns of cooperation; to explain cooperation it is also important to consider the alternatives available to individuals (also see Thibaut & Kelley, 1959).

General Discussion

The current studies investigated a risk-reduction account of sharing in humans in a laboratory setting using monetary outcomes. Across both studies, participants reduced the risk of an earnings shortfall by sharing when they experienced a positive earnings budget and by working independently when they experienced a negative earnings budget. In addition, the presence of two social variables, the nature of the partner (Experiment 1) and inequity in earnings between the participant and partner (Experiment 2), were examined to ascertain if they constrained optimal responding. Neither variable significantly affected choice. Instead, choice appeared to be primarily influenced by the relative payoffs of the sharing and work-alone options across budget conditions.

Participants' responding was well predicted by the risk-reduction food sharing model, which assumes that sharing should occur when it reduces the variability of resource acquisition and, in turn, reduces the probability of an energy deficit (Winterhalder, 1986). These results are also consistent with several previous laboratory studies that have found that sharing of points/money in humans is consistent with predictions of a risk-reduction model of food sharing (Kaplan et al., 2012; Pietras et al., 2006; Ward et al., 2009) and the energy-budget rule in nonsocial contexts (Deditius-Island et al., 2007; Ermer et al., 2008; Mishra & Lalumiere, 2010; Pietras & Hackenberg, 2001; Pietras et al., 2003; Pietras et al., 2008; Rode et al., 1999; Wang, 2002). The findings also align with the results of Aquino and Reed (1998), who did not manipulate budgets explicitly, but found that when resources were scarce, groups were less likely to cooperate. These findings together show that shortfall avoidance can generate sharing when sharing reduces variability in resource gains, in the absence of any other benefits.

Because all outcomes in this study were monetary, minimizing shortfall risk was equivalent to maximizing earnings, and consequently, participants' earnings were near the programmed mean for optimal responding. The finding that participants' choices were controlled by reinforcement maximization is consistent with previous cooperation studies that have shown that participants' choices to cooperate or work independently depend on which option produces the greatest earnings (e.g., Burgess & McCarl Nielsen, 1974; Marwell & Schmitt, 1975).

Effects of Social Stimuli on Sharing

A second goal of the current research was to investigate the effects of social variables on sharing to determine whether they constrain or facilitate optimal behavior in situations involving shortfall risk. Experiment 1 examined whether participants responded differently when they were told they were working with a computer or a (fictitious) partner, whereas Experiment 2 investigated whether participants' responding was affected by inequity in earnings. In both experiments, the manipulations of social stimuli had no influence on choice. The results of Experiment 1 are consistent with some prior cooperation research showing that humans respond similarly to humans and computers (e.g., Fantino & Kennelly, 2009; Kennelly & Fantino, 2007). Unlike prior studies, however, telling participants that the partner was a real person did not facilitate cooperation either (Kiesler et al., 1996). We suspect that sharing did not decrease under positive budget conditions when the partner was a computer (Computer conditions), or increase under negative budget conditions when the partner was supposedly a real person (Partner conditions) because the instructions were ineffective in generating any social bias (as indicated by the lack of effect in neutral budget conditions), and thus choice simply varied in a pattern that maximized earnings. The finding from Experiment 2 that inequity had no effect on choice contrasts with some studies that have shown that inequity may disrupt cooperation (e.g., Schmitt & Marwell, 1972). We argued that this occurred because (a) sharing was clearly a more profitable option than working independently, despite the inequity, (b) sharing avoided a loss of accumulated earnings, and because (c) working independently did not restore equity. The Experiment 2 outcomes are in accord with other research (e.g., Burgess & McCarl Nielsen, 1974; Molm, 1981) showing that in an unbalanced power relation, a disadvantaged individual may continue to cooperate with a more advantaged partner as long as the relationship produces higher reinforcement than other options.

In the Pietras et al. (2006) study investigating sharing under positive and negative earnings budgets, it was unclear whether social variables influenced choice, or whether participants were simply choosing low-variance options in positive budget conditions and high-variance options in negative budget conditions. The present data provide no compelling evidence that the social nature of the task affected choice of the sharing option. This finding suggests that when payoff contingencies strongly control choice, certain types of social stimuli may have little impact on behavior. Such an interpretation is consistent with studies by Kennelly and Fantino (2007) and Fantino and Kennelly (2009) on the Sharing Game. When earnings were hypothetical, participants responded in a way to equate earnings across the self and partner, but when earnings were real, most participants responded optimally by choosing options that maximized earnings, despite the fact that the option created disadvantageous inequity. Boone et al. (2008) investigated the effects of social cues (prior contact among partners) on cooperation in experimental tasks with individual (short-term) incentives that either did or did not favor the development of cooperation. The social cues facilitated cooperation only when individual payoffs favored noncooperation; when the contingencies favored cooperation, the social cues had no additional effect. It is important to note, however, that only two types of social stimuli, with a limited range of values, were investigated in the present study. It is plausible that other types of variables, or more salient social stimuli (see below), may exert a more powerful effect on sharing under shortfall risk.

Limitations

One limitation of the present research is that participants were only exposed to each condition two or three times and choice was measured only on a few occasions. Thus, there was substantial individual variability in responding. Interestingly, the variability in participants' responding tended to be lower in negative earnings-budget conditions than in positive earnings-budget conditions. The range of responding was most likely higher in positive budget conditions than negative budget conditions because participants could still meet the earnings requirement half the time when they chose the work-alone option in positive budget conditions, whereas participants could never meet the earnings requirement by choosing the work-with-others option during negative budget conditions. This limited experience may explain why participants, on average, only showed a moderate preference for the work-with-others option across positive budget conditions. Despite this individual variability, the effects of condition were significant and apparent when examining the individual data. Thus, longer exposures to conditions probably would not have generated qualitatively different results than those reported here. In addition, although a power analysis indicated that a sample of 11 would produce significant results (see Method in Experiment 1), the sample size was small for a group design. A larger sample size also may have produced less variability.

Another possible limitation was participant fatigue. Sessions lasted an average of 2.5-3 hours and preference may have shifted across time. However, visual inspection of intersession data does not demonstrate any trend across blocks. Participants' choices did not systematically change in one direction or another as the session progressed, suggesting that participant fatigue did not affect choice.

Perhaps the most serious limitation of this research is that various features of the design limit the ecological validity. First, the present procedure did not model all of the contextual variables likely to influence sharing, such as added time, costs, or efforts associated with engaging in a sharing act. These variables are likely to influence relative payoffs of cooperative choices and thus would be useful to model in subsequent manipulations.

Second, in the present study sharing produced a certain outcome. It is unlikely that outside the laboratory, sharing completely eliminates variability in resource acquisitions. Searcy and Pietras (2011) investigated human's choices in positive and negative earnings-budget conditions when all choice options were associated with some variability and found that choice was still consistent with the predictions of the energy-budget rule. However, there were some differences in local choice patterns. It also may be valuable to investigate sharing when sharing reduces but does not completely minimize resource variability.

A third limitation to the ecological validity of the study is the modest incentive structure. Failures to meet the requirement produced only small losses in earnings; greater earnings may have generated clearer preferences. To explore this, it would be necessary to increase the stakes, such as by creating "all or none" payment structures, increasing payment amounts, or by increasing time or effort needed to acquire earnings. Also, as noted above, more substantial differences in earnings between the participant and partner during inequity conditions may be more disruptive of cooperation.

The present procedure also arranged only two options: choose to work alone or work with others (share). Outside the laboratory individuals may have more response options available. Under inequity, for example, individuals may be able to engage in counter-control, such as by engaging in verbal behavior with partners, forming coalitions, or emitting aggressive behavior. Alternatively, individuals may pursue other risk-minimization strategies, such as storage or saving of resources. How the availability of other options impacts social choices is an interesting research direction.

Perhaps the most obvious limitation to ecological validity is that the partner was simulated. Participants said that they believed they were working with others, but the partner always shared when the participant chose that option, thereby removing the risk of failures to reciprocate (share). It would be valuable to investigate sharing under shortfall risk when the partner was a real person. Having participants work with real people would likely affect the benefits of sharing by making the outcomes of choosing the sharing option less predictable (i.e., partners may only probabilistically reciprocate). Future studies could also investigate sharing under shortfall risk when partners delayed their reciprocation, instead of pooling and splitting earnings each block. Delays in reciprocation have been shown to inhibit cooperation (e.g., Komorita, Hilty, & Parks, 1991; Locey & Rachlin, 2012; Parks & Rumble, 2001). In addition, if the other person was real, other social variables that have been shown to influence sharing could be investigated under shortfall risk. One is the familiarity of the partner. Previous research suggests that if an individual were to work with a friend or spouse, cooperation would increase (e.g., Marwell & Schmitt, 1975; Rachlin & Jones, 2008). Future studies could also investigate sharing under budget conditions when participants can see and communicate with a partner. Previous research has indicated that and discussion between partners can increase cooperation (e.g., Declerck et al., 2013; Declerck et al., 2010; Stevens & Hauser, 2004). Tests of these social variables will further assess the generality of the risk-reduction model of sharing, and possibly lead to extensions of the model that incorporate other fitness benefits.

Conclusions

Although cooperation in humans is likely influenced by many factors, the present studies showed that sharing under shortfall risk could be predicted by a relatively simple food-sharing model derived from the energy-budget rule. These data replicate earlier research and, therefore, provide additional evidence that the risk-reduction model can be extended to humans' choice for monetary outcomes. Manipulating the nature of the partner by telling participants that the partner was a real person or a computer and manipulating the inequity in earnings between the participant and (simulated) partner for sharing did not produce sub-optimal choices. Rather, across conditions participants' cooperative choices tended to be consistent with the pattern that minimized shortfalls and maximized earnings. Given the contrived nature of the social interaction and the limited monetary stakes, the scope of these data is necessarily limited. To gain a better understanding of the underlying processes that control human cooperation, it is sometimes necessary to simplify the environment to precisely control variables suspected to influence behavior. Additional variables can then be added to evaluate their effects. In that respect, the present data further show that the risk-reduction sharing model may be a valuable framework for the analysis and construction of more complex models of human cooperation.

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Compliance with Ethical Standards

Funding This study was funded by a Graduate Student Research Fund provided by the Graduate College at Western Michigan University.

Conflict of Interest Dr. Stephanie Jimenez and Dr. Cynthia Pietras both declare that they have no conflicts of interest.

Ethical Approval All procedures were in accordance with the ethical standards of the institutional and/or national committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Informed Consent Informed consent was obtained from all individual participants included in the study.

Appendix

Instructions You will be able to earn points by using a mouse to click letters on a computer screen.

[Today you will be participating with other people in this study. These other people also have response panels and monitors. These other people are located at another facility. When the session starts the computer will connect to the other participant's computer.]

[Today you will be participating in the study by yourself. The computer will simulate other people in the study]

When the session starts, the letter B, the words "Press Now," and a counter will appear on the computer screen. The counter will be at zero. Clicking on the letter B will cause the letter B and the words "Press Now" to go off the screen and will cause other letters to appear. Either the letter A, the letter C, or both letters A and C will appear. The words "Work Alone" will appear beneath the letter A and the words "Work with Others" will appear beneath the letter C. When only one letter is on the computer screen, using the mouse to click on the letter on the screen will add money to the counter. When both letters A and C are on the computer screen, you can click on either letter A or letter C. The letter you have selected will remain on the screen and the other letter will disappear. Clicking on the letter on the screen will add money to the counter. Several counters may appear on the computer screen during the session. The amount of money shown on the counter labeled "Your total earnings" is the amount you have earned during the session. Every $2.00 you earn will be exchangeable for a draw from the prize bowl. Please remain seated. When you see the words "Session Over" appear on the screen you may return to the waiting area.

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