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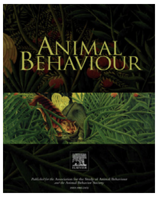

Female squirrel monkeys' (*Saimiri boliviensis*) responses to inequity in a group context; testing a link between cooperation and inequity responses

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Primates of several species respond negatively to receiving less preferred rewards than a partner for completing the same task (inequity responses), either rejecting rewards or refusing to participate in the task when disadvantaged. This has been linked to cooperation, with species that cooperate frequently refusing to participate in inequity tasks (the 'cooperation hypothesis'). However, inequity is a social response, and previous research has involved dyads, precluding studying the effects of additional social partners. While dyads allow for tighter control in experimental settings, dyadic interactions in nature do not take place in a social vacuum, so understanding the role of the social context is needed to verify that the pattern of results supports the cooperation hypothesis. Here we focus on Bolivian squirrel monkeys, *Saimiri boliviensis*, a highly social species that does not generally cooperate and has not responded to inequity in previous dyadic research, although they do respond to receiving a lower reward than they expected. In the current study, we provide a more nuanced test by studying female Bolivian squirrel monkeys, the demographic most likely to cooperate in both field and laboratory contexts, in a more socially relevant group setting. For some reward values, females responded in both the inequity condition, rejecting less preferred rewards when they were disadvantaged relative to their social group, and a contrast condition, wherein all animals received a lower reward than they expected, making it difficult to disentangle contrast from inequity. As in capuchin monkeys, refusals increased when monkeys were to receive low-value rewards compared to medium-value rewards. These results suggest that the relationship between cooperation and inequity responses may be more nuanced than previously suggested, with demographic, social context and reward value potentially influencing outcomes even within species.

Some animals compare their outcomes to those of others (Brosnan & de Waal, 2014), even when they cannot change their own outcomes, reacting when they receive a different outcome than their partner. Rats (Oberliessen et al., 2016), dogs (Essler et al., 2017), capuchins and rhesus monkeys, *Macaca mulatta* (Brosnan & de Waal, 2003; Hopper et al., 2013), chimpanzees, *Pan troglodytes* (Brosnan et al., 2005, 2010; Brosnan et al., 2015; but see Bräuer, Call & Tomasello, 2006, 2009; Engelmann et al., 2017 for opposing evidence) and some corvids (Massen et al., 2015; Wascher & Bugnyar, 2013) respond to inequity in at least some contexts (although there is variability in some species; reviewed in Brosnan & de Waal, 2014; McGetrick & Range, 2018), while others species, even within the same taxa, have not been documented to respond to inequity (e.g. squirrel and owl monkeys, New Caledonian crows, *Corvus moneduloides*, keas, *Nestor notabilis*: Freeman et al., 2013; Heaney et al., 2017; Jelbert et al., 2015).

In both humans and other species, this response, part of what economists call inequity aversion, has been tied to cooperation (Fehr & Schmidt, 1999). The 'cooperation hypothesis' (Brosnan, 2011) posits that cooperation with nonkin and responses to inequity coevolved, with responses to inequity serving as a mechanism to evaluate the spoils of partnerships, enabling animals to drop

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particularly disadvantageous relationships, which, in the long run, can support cooperation through individuals finding different, and potentially more equitable, individuals to partner with (Brosnan, 2011). This assumes that individuals have some mechanism for recognizing the value of their cooperative partners by comparing their outcomes and, if their partner's payoffs are consistently better than their own, they may benefit from discontinuing cooperation with that partner and trying someone new. This may be the case even if individuals choose their next partner at random (i.e. a 'walk away' heuristic; Darden et al., 2020). Previous work has generally supported this hypothesis; many studies find that individuals from species that routinely cooperate with nonkin also respond negatively to inequity in experimental tasks, whereas individuals from species that do not routinely cooperate do not respond to inequity (summarized in Brosnan & de Waal, 2014).

There are (at least) two aspects of the cooperation hypothesis that require more exploration. First, it is common in experimental work to test subjects in dyads, rather than a larger group, both to increase experimental control (i.e. the number of trials, who has access to which outcome) and to minimize the distractions that are inherent with other group members' presence. For group-living species, this is not how such interactions occur in the animals' day-to-day interactions; even in a dyadic interaction, such as mating, other individuals are present and their behaviour, or mere presence, may influence the focal dyad's choices and actions. This raises the possibility that the dyadic context of previous work, also common in human studies (Camerer, 2011), has influenced our understanding of animals' responses to inequitable outcomes. For instance, individuals may be more sensitive to how their actions appear to others when there is an audience, or there may be an additive effect, such that the more individuals they see receive a more preferred outcome, the more likely they are to respond negatively to inequitable situations.

Second, most work to date has focused on species differences, and while species is a convenient and important marker, there are variations in demographics and individual differences in responses to inequity. For instance, for those who do show responses to being disadvantaged, whether they respond is apparently influenced by rank (chimpanzees: Brosnan et al., 2010), personality (chimpanzees: Brosnan et al., 2015), inhibitory control measures (dogs: Brucks et al., 2017) and social status (rats: Oberliessen et al., 2016), making it clear that responding to inequity is highly context dependent. Thus, we postulate that differences in ecology across subspecies, or even across the range within the same taxon, might also influence responses.

For the current study, our goal was to test these two nuances to the cooperation hypothesis, specifically testing whether the presence of other individuals influences responses to inequity using a specific demographic of squirrel monkey, female Bolivian squirrel monkeys, *Saimiri boliviensis*. Two previous studies of squirrel monkeys in dyadic settings found no evidence of a response to inequity; that is, they did not refuse to work for or accept lower value rewards than their partners received for the same effort, despite a combined sample size of nearly 40 individuals (Freeman et al., 2013; Talbot et al., 2011). However, male (but not female) squirrel monkeys showed sensitivity to variability in reward outcomes; when males were initially shown a preferred reward, but then received one of lower value after performing the task, they often refused it, a behaviour called a 'contrast effect' (Tinklepaugh, 1928). This suggests that they do notice and care about relative rewards, albeit not in the context of what their partner received. This is also consistent with the cooperation hypothesis, because squirrel monkeys generally do not cooperate.

However, one demographic, the female Bolivian squirrel monkey, shows some evidence of cooperation in both field and laboratory studies. For instance, in the wild, females form alliances or coalitions to defend resources (Boinski & Cropp, 1999; Boinski et al., 2002; Mitchell et al., 1991), and in captive settings, they coordinate to some degree in the assurance game (Vale et al., 2019). In addition, female common squirrel monkeys, *Saimiri sciureus*, show sensitivity to inequities with outgroup, but not ingroup, female partners in a different methodology than has been used previously (Bucher et al., 2020), also suggesting some tendency towards an inequity response in females. This makes squirrel monkeys, and in particular, females and/or female Bolivian squirrel monkeys, important for a stronger test of the cooperation hypothesis. Thus, for the current study, we tested female Bolivian squirrel monkeys' responses to inequity in a group setting (i.e. to explore the effect of other social partners' presence), using the exchange paradigm that was used previously. We predicted that testing in a group setting would increase the likelihood that subjects would refuse to participate and/or refuse to accept rewards compared to earlier studies involving just dyads. While this would not be conclusive, evidence of an enhanced response to inequity or contrast in this study would suggest that the broader social context influenced their tendency to respond.

Subjects participated in an exchange task in small, all-female social groups in which they (1) got the same rewards as their groupmates (equity controls; upon exchange, the exchanging individual received a reward that was the same as what others received for their exchanges), (2) received a less preferred reward than the other members of their group (i.e. upon exchange, the focal subject received a reward that was lower in value than what their group members received for their own exchanges) or (3) received a more preferred reward than the other members of their group (i.e. upon exchange, the focal subject received a reward that was higher in value than what their group members received for their own exchanges). We also tested contrast effects in a condition in which subjects were all shown a more (or less) preferred reward but received the less (or more) preferred one. This allowed for a test of frustration effects that can occur from seeing one reward but gaining a different one (Roma et al., 2006). In contrast to previous work involving dyads, wherein interactions are tightly controlled such that partners alternate in trading for food, in the present study, participants were free to approach the experimenter in any order.

Given that previous studies with squirrel monkeys, including some Bolivian female squirrel monkeys, found no evidence of females responding to inequity or contrast (Freeman et al., 2013; Talbot et al., 2011), our null hypothesis was that our female squirrel monkeys would also show no response to inequity or contrast. However, we predicted that, if demographic is relevant, then these female *S. boliviensis* should show a response to disadvantageous inequity due to their heightened tendency to cooperate. In addition, since previous work included some female *S. boliviensis* pairs that did not respond, in an otherwise similar task, finding a response in these monkeys tested in a group would suggest that the social context, and in particular, the presence of other members of the group, is key in eliciting a response to inequity. Thus, our study was designed to determine the importance of social context, but it did not allow us to tease apart potential underlying mechanisms (i.e. audience effects, the additive effect of seeing additional individuals advantaged, etc.). Finally, we did not predict a response to advantageous inequity, which has not been seen in any primates except humans and, to some degree, chimpanzees (Brosnan et al., 2010).

METHODS

Participants

We tested two groups of six female Bolivian squirrel monkeys, aged 3–9 years old at the time of study (mean age = 5 years old; see Appendix, Table A1, for demographic information, including participant rearing history, weight and ages). We formed all-female subgroups to test our specific hypothesis regarding female Bolivian squirrel monkeys, appropriate for our question because in the wild, the two sexes naturally segregate during the nonbreeding season (e.g. Williams & Abee, 1988) due to male exclusion from the troop by females (Boinski & Cropp, 1999). Individuals of similar ages were subgrouped by their regular care staff. As noted, we chose to test the females rather than males because females show more evidence of longer-term relationships and cooperation in both field (Boinski, 1999; Mitchell et al., 1991) and laboratory (Vale et al., 2019; see detailed discussion, in Introduction) settings, making for a stronger test of the cooperation hypothesis. Participants were housed at the Michale E. Keeling Center for Comparative Medicine and Research, UT MD Anderson Cancer Center, U.S.A. (KCCMR). The KCCMR is fully accredited by AAALAC-I. This study was approved by the Institutional Animal Care and Use Committee of The University of Texas MD Anderson Cancer Center (IACUC approval number: 00000149-RN03). Animal protocols followed the Guidelines for the treatment of animals recommended by the ASAB/ABS (2019).

Squirrel monkeys were never deprived of water or food for this study and the test rewards were in addition to their regular daily diet. Water and commercial monkey chow were available ad libitum, including during testing. The socially housed squirrel monkeys retained access to their enriched enclosures at all times during the study and continued to receive their regularly scheduled enrichment. Subjects participated voluntarily by (1) choosing to enter the test enclosure attached to their home enclosure, (2) collecting tokens from either of two dispensers and (3) bringing the tokens to the experimenter. Although all subjects were trained to exchange and, therefore, knew how to do the task, two females from the same group (Group 1) chose not to participate in this study, only exchanging one or two tokens across the two studies, even though they entered the testing area of the enclosure with the rest of their group. Groups were tested on consecutive working days, up to twice daily, but at the very end of the study (the last week), a small number of sessions were run three times in a day due to constraints on access to the animals. Veterinary procedures took precedence over testing.

Procedures and Materials

Food preferences

To determine the study rewards, participants were presented with forced-choice discriminations of paired food items. All food preference tests took place in a group setting to provide the same social conditions in which testing occurred (Finestone et al., 2014). Tests were performed to identify three foods: a high-value reward, preferred by all monkeys in the group over a medium-value reward, which was preferred over a low-value reward. To determine preferences, subjects were given daily sessions of 10 trials per monkey in which they made dichotomous choices between the foods. Every subject, in their group setting, had to select one reward over the other on at least 80% of trials on two consecutive sessions to count as a preference for this study. Subsequent to preference testing, to ensure that the squirrel monkeys would consume the low-value reward, every monkey also had to consume 10 consecutively presented pieces of the reward on two sessions on different days for it to be used in the study.

Token training

We used an exchange paradigm that has previously been successfully employed to study inequity responses in squirrel monkeys (Freeman et al., 2013; Talbot et al., 2011) and other primates (e.g. Brosnan et al., 2005; Hopper et al., 2014). We first trained our participants to return inedible tokens (clear polycarbonate rods, length: ca. 10 cm, diameter: 1 cm) to the experimenter. We trained this behaviour using shaping and positive reinforcement training techniques, initially using a clicker as a conditioned reinforcer and always using food as the primary reinforcer, again in a group setting, until each monkey was successful in completing 10 exchanges across each of two sessions (clickers were not used in testing). Specifically, monkeys were first rewarded for simply touching tokens. The rewarded target behaviour was then shaped to the acts of picking up, holding and moving a token. Once the monkeys were manipulating tokens, they were rewarded for pushing the tokens out of their test enclosure towards the experimenter's hand. To ensure that the exchange was an intentional act, and to slow the response rate sufficiently to enable the experimenter to track who had exchanged and in proximity to whom, we placed tokens in two adjacent open-top dispensers (22.5 × 17.8 and 7.6 cm high) located in the centre of the test enclosure (Figs 1, 2). This required monkeys to collect tokens and travel at least 52 cm before they could visit the experimenter to exchange them. Once monkeys exchanged, they had to walk back around the mesh barrier (an area inaccessible due to mesh partitions; see Fig. 2) to collect a new token from one of the dispensers. This process was repeated as often as the monkeys chose to do so throughout each 1 h session. When the monkeys dropped or pushed the token through the enclosure mesh in the 'exchange area', it was counted as an exchange and the experimenter delivered a reward to them. Exchanges anywhere outside this area were not rewarded. We introduced this exchange area to ensure that we were not counting random token drops as a trade.

Experimental conditions and procedure

Monkeys were tested in social groups, in the large mesh test enclosure, attached to their home enclosure (see Figs 1, 2). This gave them a designated spot to interact with the experimenter, although they could freely come and go from their home enclosure at any point during testing. Subjects participated in two studies (disadvantageous inequity and advantageous inequity; see Table 1 and below). We counterbalanced study presentation such that Group 1 participated in the disadvantageous inequity study first and Group 2 participated in the advantageous inequity study first. Each group completed one entire study before moving on to the other one.

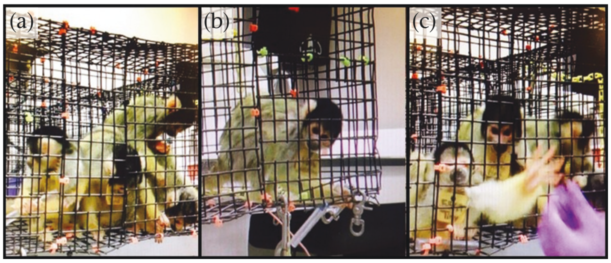

Figure 1. Monkeys in the exchange area of the test enclosure (a) holding a token, (b) pushing a token through the mesh in exchange for a reward and (c) reaching for a reward in front of groupmates following an exchange. The test enclosure was attached to the subject's home enclosure (not shown) and was always accessible to the monkeys during testing. Note: all six monkeys had access to the exchange area at all times and were free to exchange tokens in the exchange area, such that multiple exchanges could occur simultaneously or in close temporal order. In addition, because monkeys could come and go at will, sometimes exchanges took place with no other monkeys in close proximity (as in b). See Fig. 2 for a schematic of the test enclosure.

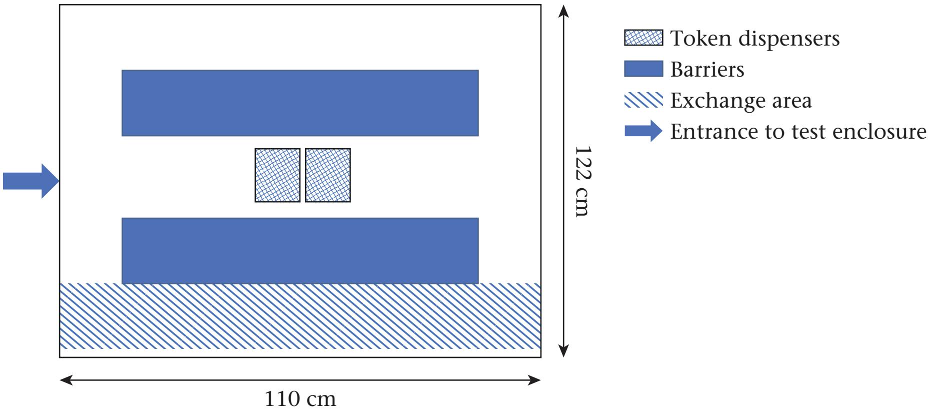

Figure 2. Schematic of a bird's eye view of the test enclosure. Note that the exchange area, indicated by the hatched lines, is the front area of the test enclosure in which the monkeys are standing in Fig. 1. Their attached home enclosure is not shown here, but they could freely access it at any point during testing.

Table 1
Study, condition terminology and descriptions

Study	Condition	Description
Disadvantageous inequity	Inequity	Subject receives a less preferred reward than their social group
	Equity control	All monkeys receive the same reward
	Contrast	All monkeys in the social group receive a lower-value reward than what they were first shown
Advantageous inequity	Inequity	Subject receives a more preferred reward than their social group
	Equity control	All monkeys receive the same reward
	Equity	All monkeys in the social group receive a higher-value reward than what they were first shown

Within each study, the order of conditions was pseudorandomized such that a condition did not occur more than three consecutive times.

Following completion of the first study, we noticed what appeared to be an effect of exposure to rewards, with a few monkeys rejecting specific rewards or failing to participate when those rewards were available. Thus, we repeated the entire set of food preference tests, detailed above, including the low-value food consumption test, prior to the second phase of testing for both groups (see Table 2 for each groups' specific rewards).

For the basic procedure, 30 tokens were split between the two adjacent dispensers in the group's test enclosure. We used two dispensers to avoid dominance interactions blocking some individuals from participating, but the tokens available in each dispenser were identical and there was no difference in using one dispenser over the other. Tokens were replenished as they were depleted. Each token was the same, but rewards to individuals varied depending on the condition (see below and Table 2 for details). All participants could return a token to the experimenter as often as they wanted and at any time during each 60 min session. If they exchanged, they could either accept or reject the food offered to them. They could also choose not to participate (as two subjects did). Throughout tests, participants could freely move between their home enclosure and the test enclosure. As a result, they were never restricted and could choose at any time whether or not to approach the experimenter or to participate.

As mentioned above, subjects participated in two studies (disadvantageous inequity and advantageous inequity), each consisting of the three conditions (equity, inequity, contrast). The key condition was the inequity condition, in which the focal subject received a different reward than the rest of their group. In the disadvantageous inequity study, the focal subject received a reward of lesser value (a low- or medium-value reward) than their groupmates (who received a medium- or high-value reward), whereas in the advantageous inequity study, the focal subject received a more preferred reward (medium- or high-value reward) than their groupmates in the inequity condition (who received a medium- or low-value reward). Each focal subject participated twice for each reward and test condition, for each study. For example, in the disadvantageous inequity study, each participant received (1) a low-value reward during two 1 h sessions during which her groupmates received the medium-value reward for their exchanges ('LowMed' reward condition, denoting the focal's reward (low-value) relative to her groupmates' reward (medium-value)), (2) a low-value reward during two sessions while her groupmates received a high-value reward for their exchanges ('LowHigh' reward condition) and (3) a medium-value reward during two sessions while her groupmates received a high-value reward for their exchanges ('MedHigh' reward condition).

Both studies also included two control conditions, the equity control condition and the contrast condition. In the equity control condition, all individuals in a group received the same reward (disadvantageous inequity study: two sessions in which all participants received the low-value reward and two sessions in which all participants received the medium-value reward; advantageous inequity study: two sessions in which all participants received the medium-value reward and two sessions in which all participants received the high-value reward). In the contrast condition, individuals in a group were shown a reward of higher value than

Table 2
Rewards used for each group and study (disadvantageous inequity, 'DI'; advantageous inequity, 'AI')

Group	Study	Reward value		
		Low	Medium	High
1	DI	Sunflower seed	Cereal	Marshmallow
1	AI	Sunflower seed	Sweetcorn	Marshmallow
2	DI	Sunflower seed	Raisin	Marshmallow
2	AI	Sweetcorn	Raisin	Marshmallow

what they received after completing the exchange. Again, there were two sessions for each of the relevant reward conditions: disadvantageous inequity: (1) all participants received a low-value reward after seeing a medium-value reward; (2) all participants received a medium-value reward after seeing a high-value reward; advantageous inequity: (1) all participants received a medium-value reward after seeing a low-value reward; (2) all participants received a high-value reward after seeing a low-value reward. The three foods were visible during all sessions, including control conditions in which only one food type was ever used, to control for the presence of both lower- and higher-value foods.

We coded from video recordings both the number of tokens exchanged and how often monkeys refused to take or eat the food offered to them within 10 s. Rejections included monkeys dropping the food (before taking a bite of it) or not taking the food from the experimenter. The number of exchanges and food rejections were coded by the experimenter, with 24 h of the data recoded by a second observer to test for inter-rater reliability. Concordance was high for both the number of exchanges ($r = 0.99$) and the number of rejections ($r = 0.99$) made by participants.

Statistical Analysis

Models were run using the 'Bayesian Rethinking' R package (McElreath, 2016, 2020). All models were multilevel with varying intercepts (a 'random effect') fitted for individual identity. The models generated posterior estimates using the Hamiltonian Monte Carlo algorithm available in the 'rstan' package (Stan Development Team, 2018). We assessed chain convergence by visual inspection of traceplots and 'Rhat' values, which should equal 1 when convergence occurs (McElreath, 2016). Where necessary, chain convergence was facilitated by increasing the 'adapt_delta' value closer to 1. For analyses of condition effects on resource rejections, models were constructed using a binomial distribution (and logit link) appropriate for binary responses (monkeys could either reject or accept rewards). The number of exchanges made by monkeys constituted the number of trials in the models. All priors were centred on zero and were weakly informative. For our second response variable, token exchanges, models were constructed using a Poisson distribution and log link. We had to construct separate models for each study because the rewards were inconsistent across the two studies. Predictors included treatment (index variable for reward value (LowMed/LowHigh/MedHigh) and condition (equity/contrast/inequity) combinations) and test number (test 1/test 2), and we compared these 'full' models to 'null' models with the same structure but excluded these predictors. Due to experimenter error we were missing test 2 for the medium-value reward in the advantageous inequity test for Group 2. Because we saw no effect of test number on our results (see Results), as refusals were all clustered around zero in the equity controls, we used the data from test 1 for test 2 as well.

We used the Watanabe–Akaike information criterion (WAIC) to compare models' out-of-sample deviances, and we report posterior mean, standard deviation and highest posterior density interval (89% HDPI) for predictors on a log scale (exchanges) or log odds (rejections). When our 'full' model outperformed 'null' models, we performed contrast tests for each condition pairing, with condition effects assumed when their posterior interval (89% HDPI) did not cross zero. Model fit was also visually compared to the raw data using the 'postcheck' function (Rethinking package). We also report frequentist nonparametric analyses in the Appendix that enable more direct comparisons to previous papers using this approach, although a note of caution is required when interpreting nonsignificant results with our small sample size. The condition effects from each approach were very similar.

To better examine the role of context on inequity responses, we also re-analysed the dyadic inequity tests previously conducted with 10 Bolivian, female squirrel monkeys (i.e. data from Talbot et al., 2011) using the same approach outlined above (previous statistics were based on nonparametric Friedman's tests). Models (full/null) were run with rejections as the response variable, with the number of exchanges constituting the number of trials. Reward condition was not included as a treatment variable as monkeys participated in the MedHigh condition only (C. F. Talbot, personal communication; Talbot et al., 2011). Thus, predictors included test number (test 1/test 2) and condition only (equity control/contrast/inequity). Because these are a re-analysis, results are included in the Appendix and outlined in the Discussion.

RESULTS

Study 1: Disadvantageous Inequity

Overall, subjects exchanged 3408 tokens in the disadvantageous inequity study and rejected 340 rewards (see Figs 3, 4 for reward rejections according to reward condition: LowMed/LowHigh/MedHigh). Breaking this down by condition, but not by reward value, monkeys exchanged 922 tokens in the equity condition and rejected 5 rewards (0.5% reject rate), exchanged 1165 tokens in the contrast condition and rejected 111 rewards (9.5% reject rate) and exchanged 1321 tokens in the inequity condition and rejected 224 rewards that were lower in value than the rewards given to their groupmates (17% reject rate).

Disadvantageous inequity rejections

When considering the effect of condition on reward rejections in the disadvantageous inequity condition, our full model (WAIC = 670.2) improved the out-of-sample deviance relative to our null model (WAIC = 1162.0.1; see Table 3). Interpreting our full model, we saw no effect of test number (test 1 or 2). There were few food rejections in any equity condition (LowMed; LowHigh; MedHigh; Table 3) indicating that when all monkeys received the same food, they rarely rejected it.

Reward rejections did however differ across conditions. In the LowMed reward condition, reward rejection was more likely in the contrast condition than in the equity control condition and the inequity condition (Tables 3, 4). Conversely, reward rejections in the LowHigh reward condition were higher in the inequity condition than in the contrast condition and the equity control condition. Finally, there was some evidence that rejections in the MedHigh condition were higher in the inequity condition than in the equity control condition, but there was little difference between the inequity condition and the contrast condition (Tables 3, 4).

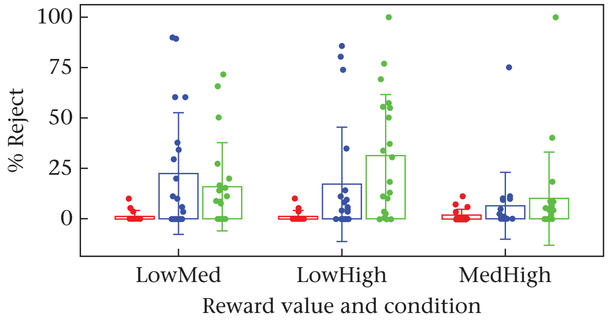

Figure 3. Study 1 (disadvantageous inequity) resource rejections according to reward value (LowMed; LowHigh; MedHigh) and condition (red symbols = equity; blue symbols = contrast; green symbols = inequity). Bars show mean rejections ± SE.

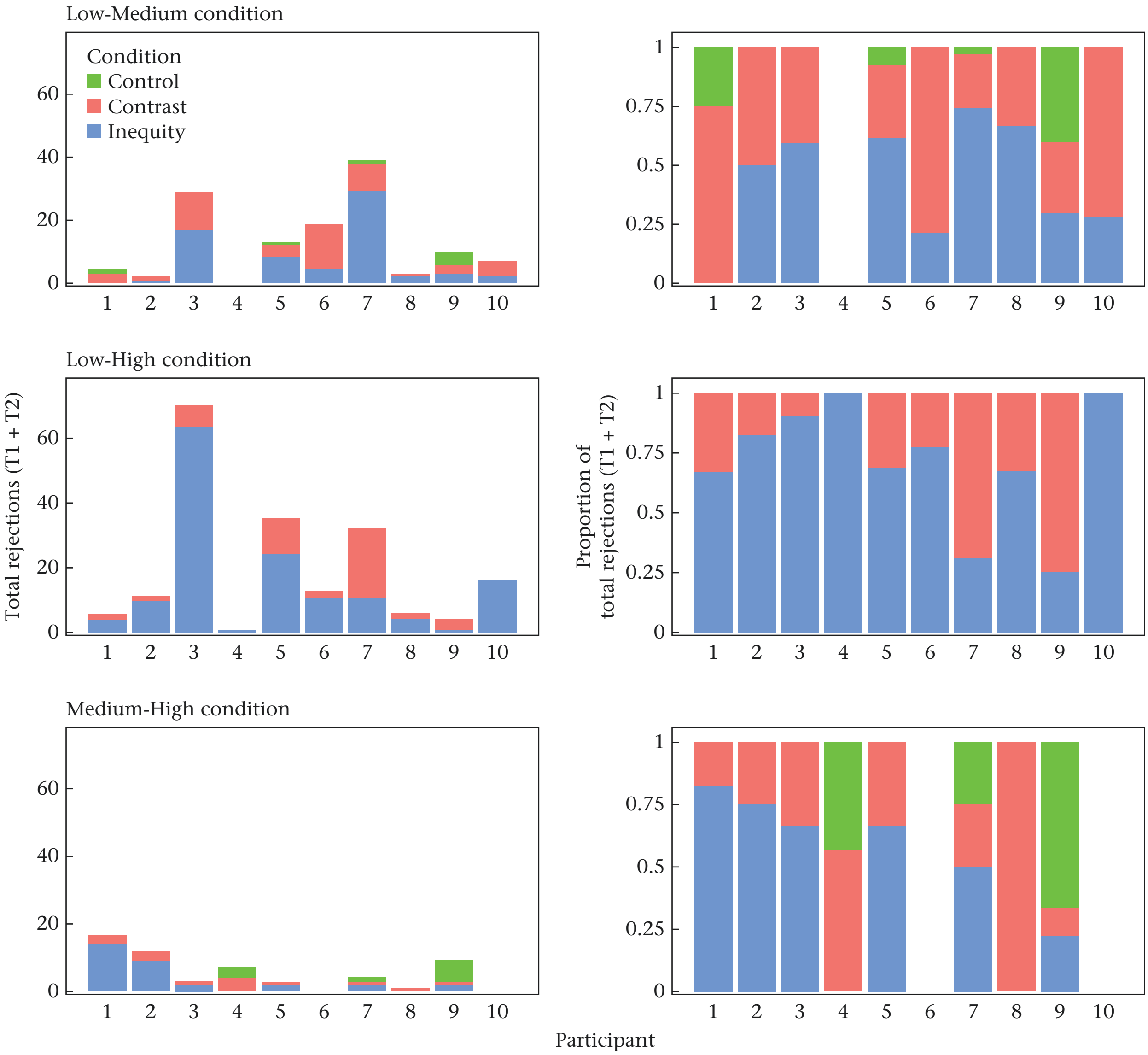

Figure 4. Individual variation in the number and proportion of food rejections (rejections/exchanges) during tests 1 and 2 (T1, T2) in each reward condition.

Disadvantageous inequity exchanges

Next, we considered the effects of condition, reward and test on the number of tokens squirrel monkeys chose to exchange (subjects had free access to the token bins and so, unlike in dyadic contexts with limited trial counts, the number of times they chose to exchange could vary and was an important measure of participation). Our full model including all of these conditions improved the out-of-sample deviance (WAIC = 2103.4) compared to our null model that excluded all conditions (WAIC = 2163.9). There was individual variation in the number of exchanges made (mean ± SD = 2.83 ± 1.92, HDPI = −0.21, 5.63) and high uncertainty around the mean (wide posterior intervals; Table 3). Although contrast tests revealed some condition effects (Table 4), estimated mean differences across conditions were less than two tokens per session.

Study 2: Advantageous Inequity

In study 2, we investigated squirrel monkeys' rejection and exchange rates when receiving rewards that were higher in value than those of their conspecifics. Overall, subjects exchanged 4432 tokens and rejected 28 rewards. Breaking this down by condition, monkeys exchanged 985 tokens in the equity condition and rejected 2 rewards (0.2% rejection rate); they exchanged 1286 tokens in the contrast condition and rejected 11 rewards (0.9% rejection rate); they exchanged 2161 tokens in the inequity test and rejected 15 rewards that were higher in value than the rewards given to their groupmates (0.7% rejection rate). Despite the low refusal rate in any condition, we repeated the analysis for advantageous inequity to ensure that there was not a pattern within this low refusal rate.

Advantageous inequity rejections

For reward rejections, our null model (WAIC = 273.6) returned similar out-of-sample predictions to our full model (WAIC = 273.8), indicating that both models performed similarly with or without treatment and test number as predictors. Monkeys rarely rejected rewards, regardless of the condition and the rewards they received (which were medium- or high-value rewards relative to their partners' low- or medium-value rewards in the advantageous inequity condition).

Table 3
Model estimates (posterior means and 89% highest posterior density intervals (HDPIs) for treatment ($N = 9$) effects on the probability that monkeys rejected resources (log odds displayed) and the number of exchanges (log scale)

Condition	Reward condition	Mean	SD	HDPI	
				5.5%	94.5%
DI rejections					
EC	Low	−1.51	0.34	−2.07	−0.98
	Med	−1.27	0.30	−1.76	−0.80
CC	LowMed	1.45	0.24	1.07	1.83
	LowHigh	0.98	0.23	0.61	1.34
	MedHigh	−0.83	0.28	−1.30	−0.39
IC	LowMed	0.77	0.22	0.41	1.12
	LowHigh	2.02	0.21	1.68	2.36
	MedHigh	−0.36	0.26	−0.78	0.05
Test 1		−0.20	0.35	−0.76	0.36
Test 2		−0.10	0.35	−0.66	0.45
DI exchanges					
EC	Low	−0.09	0.84	−1.42	1.26
	Med	0.30	0.84	−1.04	1.65
CC	LowMed	−0.39	0.84	−1.72	0.97
	LowHigh	0.00	0.84	−1.33	1.36
	MedHigh	0.17	0.84	−1.16	1.52
IC	LowMed	0.00	0.84	−1.32	1.36
	LowHigh	0.10	0.84	−1.23	1.46
	MedHigh	0.13	0.84	−1.19	1.48
Test 1		0.17	0.17	1.76	−2.71
Test 2		0.03	1.76	−2.86	2.88
AI rejections					
EC	Low	−0.31	0.37	−0.91	0.27
	Med	−0.51	0.37	−1.11	0.08
CC	LowMed	0.11	0.41	−0.56	0.75
	LowHigh	−0.06	0.35	−0.64	0.50
	MedHigh	−0.01	0.33	−0.54	0.50
IC	LowMed	0.26	0.30	−0.24	0.74
	LowHigh	0.12	0.31	−0.38	0.61
	MedHigh	0.46	0.29	−0.01	0.91
Test 1		−0.06	0.36	−0.63	0.51
Test 2		−0.41	0.36	−0.98	0.17
AI exchanges					
EC	Low	−0.09	0.83	−1.42	1.25
	Med	−0.01	0.83	−1.34	1.32
CC	LowMed	−0.91	0.84	−2.25	1.23
	LowHigh	−0.10	0.83	−1.43	1.12
	MedHigh	0.16	0.83	−1.16	1.49
IC	LowMed	0.26	0.83	−1.07	1.58
	LowHigh	0.29	0.83	−1.03	1.62
	MedHigh	0.43	0.83	−0.90	1.76
Test 1		0.02	1.76	−2.85	2.81
Test 2		0.20	1.76	−2.85	2.99

DI = disadvantageous inequity study; AI = advantageous inequity study; EC = equity condition; CC = contrast condition; IC = inequity condition.

Advantageous inequity exchanges

Concerning the number of tokens exchanged, our full model (WAIC = 2104.4) performed better than our null model (WAIC = 3788.6). Interpreting our full model, there was again no effect of test (test 1 and 2, as subjects were tested twice for each condition) on the number of exchanges made; however, there was individual variation (mean ± SD = 3.05 ± 1.93, HDPI = −0.01, 6.22) and high uncertainty in the model estimates for the number of tokens monkeys exchanged (Table 3). Contrast tests revealed variation across conditions, but again, the difference in the estimated number of exchanges in the model was small (under 4 tokens per session; Table 5).

DISCUSSION

We explored female Bolivian squirrel monkeys' responses to inequity when other members of their group were present, as compared to previous work looking solely at dyadic interactions. We considered two types of inequity: disadvantageous inequity, in which monkeys received a less preferred reward than the other members of the group, and advantageous inequity, in which monkeys received a more preferred reward than the other members of their group for trading a token with an experimenter. Monkeys in the disadvantageous inequity study, who were disadvantaged relative to their group (inequity) or were shown a better reward than the one they subsequently received (contrast), rejected more rewards than when all of the individuals received the same rewards (equity). Neither inequity responses nor contrast effects, however, were seen in earlier dyadic studies with female Bolivian squirrel monkeys, suggesting that something about the current study's context and the presence of other monkeys increased refusals. Moreover, as with previous work on capuchin monkeys (Talbot et al., 2018), rejections were more likely when the monkeys received the least preferred reward than when they received the medium-value reward, irrespective of their partner receiving a reward of higher value. This suggests that the monkeys were more motivated to refuse to participate when they received a relatively unpreferred reward, although we do not know whether this was because they only cared about reward discrepancies when they received foods of low value or because they were unwilling to give up a more preferred food reward. Finally, monkeys that were advantaged relative to their group showed no variation among these three conditions. Overall, these results suggest that squirrel monkeys noticed when they received less than expected, either in comparison to what they were led to expect (contrast) or in comparison to what others received (inequity), and they were more likely to refuse low-value rewards. Moreover, they were not averse to being advantaged in either of these contexts.

Our previous work using this paradigm in dyads of squirrel monkeys found no evidence of an elevated refusal rate in the inequity condition, relative to the equity condition, in males or females (Freeman et al., 2013; Talbot et al., 2011), suggesting that these social responses are indeed more common in a larger social group context. However, we also observed an increase in contrast effects. In all previous work with nonhuman primates, it has been considered essential to include a control to rule out contrast effects as a potential explanation in order to demonstrate an inequity effect (although this has not been the case in many human studies; e.g. LoBue et al., 2011). In most cases in which primates respond at all, they respond more strongly to inequity than to contrast, except, interestingly, among squirrel monkeys, in which males respond to contrast but not to inequity (and females respond to neither; Freeman et al., 2013; Talbot et al., 2011). In the current data, we found a higher rate of response in the inequity conditions than in the contrast conditions when subjects received a low-value reward and their group received a high-value reward. However, rejections were more likely in the contrast condition than in the inequity condition when the subjects received a low-value reward and their group received a medium-value reward. This suggests that the same mechanism, presumably frustration, caused the response in both conditions (Brosnan, 2013). Interestingly, contrast is not typically thought of as a social response, which may suggest that a nonsocial mechanism (i.e. increased attention to rewards) was driving the increase in response in the females, but we cannot rule out that there may be elements of both contrast and inequity.

It is interesting to consider why the females showed increased refusals in the inequity condition in this experiment but not in Talbot et al.'s (2011) study. We see several (nonexclusive) possibilities. First, we used a different statistical approach in the current study that we thought was more nuanced. To ensure that our results were as comparable as possible, we performed a post hoc reanalysis of both studies using our approach on Talbot et al.'s (2011) data and Talbot et al.'s statistical approach on our data. Reanalysing the dyadic data from Talbot et al. (2011) using the same

Table 4
Contrast tests showing average difference across treatments in the disadvantageous inequity (DI) study

Paired contrasts	Mean difference (log odds)	SD	HDPI 5.5%	HDPI 94.5%	Mean difference (probability reject)
DI rejections					
EC Low/CC LowMed	**2.96**	**0.38**	**3.57**	**2.36**	**0.62**
IC LowMed/CC LowMed	**−0.68**	**−0.22**	**−1.03**	**−0.32**	**0.13**
EC Low/IC LowMed	**2.28**	**0.36**	**1.71**	**2.87**	**0.50**
EC Low/CC LowHigh	**2.50**	**0.36**	**1.93**	**3.08**	**0.54**
IC LowHigh/CC LowHigh	**1.04**	**0.19**	**0.74**	**1.35**	**0.16**
EC Low/IC LowHigh	**3.54**	**0.35**	**3.00**	**4.10**	**0.70**
EC Med/CC MedLow	0.45	0.37	−0.15	1.04	0.08
IC MedHigh/CC MedHigh	0.47	0.33	−0.05	1.00	0.11
EC Med/IC MedHigh	**0.92**	**0.34**	**0.37**	**1.47**	**0.19**
DI exchanges	*Mean difference (log scale)*	*SD*	*HDPI 5.5%*	*HDPI 94.5%*	*Mean difference (token exchanges)*
EC Low/CC LowMed	**−0.30**	**0.08**	**−0.43**	**−0.17**	**1.35**
IC LowMed/CC LowMed	**0.39**	**0.08**	**0.26**	**0.51**	**1.45**
EC Low/IC LowMed	0.09	0.07	−0.02	0.20	1.09
EC Low/CC LowHigh	0.09	0.07	−0.02	0.21	1.09
IC LowHigh/CC LowHigh	0.10	0.07	−0.01	0.21	1.11
EC Low/IC LowHigh	**0.19**	**0.07**	**0.08**	**0.30**	**1.21**
EC Med/CC MedHigh	**−0.13**	**0.06**	**−0.22**	**0.02**	**1.14**
IC MedHigh/CC MedHigh	−0.04	0.06	−0.14	0.06	1.04
EC Med/IC MedHigh	**−0.16**	**0.06**	**−0.26**	**−0.06**	**1.17**

EC = equity condition; CC = contrast condition; IC = inequity condition. Contrasts with 89% highest posterior density intervals (HDPIs) excluding zero are shown in bold.

Table 5
Contrast tests showing average difference across treatments in the advantageous inequity (AI) study

AI exchanges	Mean difference (log scale)	SD	HDPI 5.5%	94.5%	Mean difference (token exchanges)
EC Low/CC LowMed	**−0.83**	**0.08**	**−0.96**	**−0.7**	**2.29**
IC LowMed/CC LowMed	**1.17**	**0.08**	**1.07**	**1.3**	**3.22**
EC Low/IC LowMed	**0.34**	**0.06**	**0.25**	**0.06**	**1.40**
EC Low/CC LowHigh	−0.09	0.06	−0.19	0.02	1.09
IC LowHigh/CC LowHigh	**0.39**	**0.06**	**0.3**	**0.49**	**1.48**
EC Low/IC LowHigh	**0.31**	**0.06**	**0.21**	**0.4**	**1.36**
EC Med/CC MedLow	**0.18**	**0.06**	**0.08**	**0.28**	**1.18**
IC MedHigh/CC MedHigh	**0.27**	**0.05**	**0.18**	**0.35**	**1.20**
EC Med/IC MedHigh	**0.44**	**0.06**	**0.35**	**0.54**	**1.55**

EC = equity condition; CC = contrast condition; IC = inequity condition. Contrasts with 89% highest posterior density intervals (HDPIs) excluding zero are shown in bold.

statistical (Bayesian) approach as in this paper revealed little difference in squirrel monkeys' food refusal rates between the equity control condition and the contrast condition. Similar to what we found in the MedHigh reward condition, there was some evidence that rejections were higher in the inequity condition than in the equity control condition, but with no difference between the inequity condition and the contrast condition. Re-analysing our own data using the nonparametric Friedman's tests employed by Talbot et al. (2011) confirmed that our group-tested monkeys rejected significantly more rewards in the inequity and contrast controls than in the equity condition in the LowMed and LowHigh reward conditions but not in the MedHigh condition (results of these analyses are reported in the Appendix). Thus, we think that, while the Bayesian regression models may be slightly more sensitive in detecting condition effects, statistical approach is unlikely to be influencing our study conclusions.

The second possibility is that the food rewards used by Talbot et al. (2011) were simply too good to refuse. The rewards used by Talbot et al. were akin to those in our medium-high reward (MedHigh) condition (C. F. Talbot, personal communication). Not only was this the condition in which our females also showed no meaningful response to either inequity or contrast (rejections were only slightly more likely in the inequity condition than in the equity control condition, but again there was no difference between the inequity condition and the contrast condition, nor between the equity control condition and the contrast condition), but previous work with capuchin monkeys found that they, too, only refused in inequity conditions in which they received the least preferred foods (equivalent to our low value; Talbot et al., 2018). Moreover, results of a recent study suggest that the value of the reward is relevant in other cooperative contexts too; capuchin monkeys participating in a coordination task (the assurance game) in which one monkey got more food rewards than the other for coordinating on the higher-value option (they got the same outcome if they coordinated on the lower-value option) were less likely to choose the high-value, but unequal, option when the food rewards were the less preferred banana flavoured pellets but not when they were working for the more preferred cheerios. Interpreting these results is made more challenging by the fact that the monkeys also refused to complete the entire study for the pellets (but did so for the cheerios; Robinson et al., 2021), but the overall picture nevertheless suggests that the value of the food reward strongly impacts the decisions that monkeys make, possibly because they are unwilling to give up food that is highly preferred, even if they are unhappy with the context. Indeed, subjects may refuse to participate at all for lower-value foods (Robinson et al., 2021), biasing our studies towards higher-value rewards with the result that we are not seeing the full spectrum of subjects' responses. This reiterates the need for caution when interpreting the results of food-based experimental tasks. Indeed, responses to inequity appear to also be sensitive to monkeys' feeding regimen, with increased willingness to refuse in capuchin monkeys who have unrestricted access to food (Schweinfurth & Call, 2021).

Finally, it may also be that the group context is simply more likely to elicit responses to both inequity and contrast (again, this is not mutually exclusive; an inequity response to what a partner receives builds upon noticing and caring that rewards differ). We know that even subtle procedural changes, such as where resources are located, can influence learning (Wood & Whiten, 2017), and that the social context of testing can affect an individual's consumption of food (Finestone et al., 2014). If this is the case in the context of inequity, we see several potential mechanisms, none of which are mutually exclusive. First, in the present study, because the group context meant that more conspecifics were participating, monkeys saw greater numbers of higher-value rewards that they themselves were not receiving than in previous work involving dyads, resulting in overall more exposure to the high-value rewards. It is critical not to overlook such low-level explanations that may have great explanatory power, especially when considering organisms that have advanced cognitive abilities, such as nonhuman primates and humans. Second, not only did the monkeys see more rewards, but they also saw more individuals receiving higher-value rewards (by definition, in a dyad, they saw at most only one other individual get a more preferred outcome); this may have made the higher-value reward more salient. Moreover, if there is a social component related to social dynamics or the relationships among the participants, it would have increased the chances of seeing socially relevant individuals receive the preferred reward. Thus far, testing the role of social relationships in inequity responses has been hampered by small sample sizes and the fact that, at least among primates, all subjects participate voluntarily, and therefore, by definition, with individuals with whom they have a good relationship (Brosnan et al., 2015). In this group context, we increased the chances of them at least observing the interactions of individuals with whom they do not have as good of a relationship.

It is curious that squirrel monkeys rejected rewards that they had already earned through trading, an energetically expensive behaviour, instead of flexibly adjusting their participation (i.e. the number of tokens exchanged) across conditions. This contrasts with previous primate studies of inequity in which subjects frequently refused to trade, but more rarely refused rewards once the trade was complete (Brosnan et al., 2010; Talbot et al., 2011; although see Brosnan et al., 2005). We see several possible explanations that are, again, not mutually exclusive. One is that the squirrel monkeys were highly motivated to exchange irrespective of food rewards, for instance because they were overtrained in the behaviour or because exchange behaviour itself was intrinsically rewarding for them (Harlow et al., 1950). Afterwards, however, when they received lower-value rewards, they may have been inclined not to accept them. Another possibility is social (or response) facilitation, in which the mere presence of others, or their performance of an act, increases the probability of onlookers performing an act. Thus, others being present and exchanging tokens may have elicited the same response in the subjects, again irrespective of the rewards (Hoppitt et al., 2007; Møller, 1992; Zajonc, 1965). However, by this explanation, others eating rewards should similarly facilitate the consumption of rewards as well. A third possibility is that the presence of higher-value food was such a strong motivator that subjects could not inhibit their exchange response, leading to high participation in all conditions, even though they then refused the rewards (see Range et al., 2012). Finally, it is possible that the squirrel monkeys did not understand that their rewards did not change within a session and thus kept exchanging based on the expectation of receiving the better reward, only to refuse it when they received the lower-value one. Future work should help untangle these possibilities.

There was individual variation in squirrel monkeys' responses. Reward rejections were driven by six participants, and there was variability in whether subjects responded more strongly to inequity or contrast, or treated them similarly (Fig. 4). Similar interindividual variability has been documented in rats, dogs and other primates (Brosnan et al., 2010; Brucks et al., 2017; Oberliessen et al., 2016), based on factors as diverse as dominance rank, inhibitory control, sex, personality, and, possibly, relationships between participants (Brosnan et al., 2005, 2010, 2015; Brucks et al., 2017; Oberliessen et al., 2016). While we can rule out gender effects, as our sample was all-female, we performed unplanned exploratory analyses (see Appendix) to assess any effect on rejection rates of three factors to which we had access: age, weight and rearing history (nursery- or mother-reared). We found a modest effect of rearing (see also Bard & Hopkins, 2018; French & Carp, 2016) on the total number of rejections monkeys made in the disadvantageous inequity study, with ~2.5 more rejections made on average by mother-reared monkeys compared to those that were nursery-reared (the model included age, but not weight, due to strong collinearity). This could be an experience effect, as nursery-reared animals relied upon humans for their dietary needs during early infancy, and accordingly, they may have been more accepting of rewards offered to them. It could also be due to different social exposure between the two groups during development. Unfortunately, the small sample sizes of these studies have made it difficult to determine any impact of these different demographic- and experience-based factors.

The cooperation hypothesis (Brosnan, 2011) predicts that species that do not routinely cooperate will show less response to inequity than species that do routinely cooperate. Squirrel monkeys are an interesting case study; in previous work, no squirrel monkeys responded to inequity in any context (but males did respond to contrast, suggesting they were sensitive to reward variation), which supports the cooperation hypothesis. In the current study, we tested female Bolivian squirrel monkeys as they show some evidence for cooperation, albeit not as strongly, nor in as many contexts, as capuchin monkeys, a confamilial Neotropical primate that cooperates across multiple contexts and shows a robust inequity response (Brosnan, 2011; Brosnan & de Waal, 2003). Our hypothesis was that, in this socially and ecologically relevant situation, female Bolivian squirrel monkeys might show a response to inequity given their increased tendency to cooperate. Indeed, they did show an increased response to being disadvantaged in both the inequity condition and the contrast condition as compared to the equity controls. Although these results leave questions, it is important to note that by changing the context to a more ecologically relevant group situation in which additional social partners were present and adjusting the value of the rewards, our results differed from those in previous work that focused on dyads receiving highly preferred rewards. Not only, then, do these results add to our knowledge of how squirrel monkeys react to frustration, but they emphasize the need to add social validity to captive studies and to be sensitive to the impact of our reward choices on our study subjects' behaviour.

Author Contributions

S.F.B. developed the idea, S.F.B., G.L.V. and L.E.W. conceived the study. G.L.V. conducted the study with logistical support from L.E.W. G.L.V., S.F.B. and L.E.W. analysed the data. S.N.W. recoded a portion of the data for inter-rater reliability. G.L.V. and S.F.B. wrote the paper. All authors reviewed and approved the final draft.

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Declaration of Interest

None.

Data Availability

Data will be made available on request.

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Appendix

Study 1

Exploratory analyses

As there was individual variation, we ran an exploratory analysis to examine whether subject age, weight and/or rearing history influenced monkeys' resource rejections. Due to collinearity, we dropped weight from our full model, which then included age and rearing history (mother/nursery) and rejections as the response variable. The full model returned better out-of-sample predictions (WAIC = 296.1) than our null model (WAIC = 345.1). We found an effect of rearing (mean difference ± SD = 0.67 ± 0.13, 89% HDPI = 0.47, 0.88), equating to mother-reared subjects rejecting, on average, 2.46 more resources than their nursery-reared counterparts.

Nonparametric analyses

For comparison, we also ran nonparametric analyses (Friedman and Wilcoxon signed rank-tests, using SPSS) equivalent to those employed in previous studies examining squirrel monkey's responses to inequity (Talbot et al., 2011), but with Bonferroni-corrected alpha values to control for multiple comparisons. To account for variation in exchanges, we calculated the proportion of the resources offered to monkeys that were rejected by dividing the number of rejections by the number of exchanges made. We found no significant differences in the number of exchanges made by monkeys across conditions (equity control/contrast/inequity; Table A2). Overall, rejections did significantly differ across conditions (Table A2). Post hoc analyses revealed a significant difference in the proportion of rejections made in the equity control condition and in the inequity condition, but no significant difference between the inequity condition and the contrast condition. Focusing on each reward comparison separately, we found an effect of condition (equity control/contrast/inequity) in the LowMed and LowHigh reward contrasts only. As documented in Table A2, monkeys rejected a greater proportion of low-value rewards in the inequity condition than they did in the equity condition, but there were again no significant differences between the contrast and inequity conditions.

Table A1
Participant information, including rearing history, weight and age at the time of study onset and participation in the studies

Subject number	Rearing	Weight (g)	Age (years)	Participated
1	Nursery	790	4.01	Yes
2	Mother	717	4.88	Yes
3	Mother	689	4.97	Yes
4	Nursery	671	5.03	Yes
5	Mother	635	3.76	Yes
6	Nursery	740	6.95	Yes
7	Mother	824	8.85	Yes
8	Mother	694	3.98	Yes
9	Mother	708	4.95	Yes
10	Nursery	759	4.94	Yes
11	Mother	765	3.91	No
12	Mother	651	3.82	No

Re-analysis of Talbot et al. (2011)

For comparison, we also re-analysed the dyadic inequity tests previously conducted with 10 Bolivian squirrel monkeys (i.e. using data from Talbot et al., 2011, females only), using the same Bayesian approach used to analyse the group-tested monkeys (this study). We ran models (full/null) with the number of rejections as the response variable and the number of exchanges as the number of trials. We constructed models with a binomial distribution (logit link), and, for the full model, entered condition (equity/contrast/inequity) and test number as predictors. Unlike in the current study, reward condition was not entered as a predictor variable as these dyadic-tested monkeys only participated in the MedHigh reward condition (C. F. Talbot, personal communication). Our full model, including condition and test number as predictors (WAIC = 76.9), outperformed our null model (WAIC = 87.4). However, we saw no clear effect of test number or condition on participants' rejection rates (Table A3), although paired comparisons revealed a difference in the equity and inequity conditions. These findings mirror those in our group-tested monkeys.

Table A2
Nonparametric analyses equivalent to previous inequity studies with squirrel monkeys

Disadvantageous inequity	Condition	Mean rank	Friedman's test	*df*	*N*	*P*	Contrast	Repeated measures Wilcoxon signed -rank test *P*	Bonferroni corrected *P* (<0.017)
Exchanges LowMed	Control	2.1	2.6	2	10	0.273			
	Contrast	1.6							
	Inequity	2.3							
Exchanges LowHigh	Control	1.7	2.6	2	10	0.273			
	Contrast	1.9							
	Inequity	2.4							
Exchanges MedHigh	Control	2.35	3.081	2	10	0.214			
	Contrast	1.6							
	Inequity	2.05							
LowMed proportion reject (LowMed all rejections/exchanges)	Control	1.25	**10.606**	**2**	**10**	**0.005**	Control-Contrast	−2.366	0.018
	Contrast	2.5					**Control-Inequity**	**−2.521**	**0.012**
	Inequity	2.25					Contrast-Inequity	−1.599	0.11
LowHigh proportion reject (LowHigh all rejections/exchanges)	**Control**	**1.1**	**14.1**	**2**	**10**	**0.001**	**Control-Contrast**	**−2.51**	**0.012**
	Contrast	2.2					**Control-Inequity**	**−2.803**	**0.005**
	Inequity	2.7					Contrast-Inequity	−1.478	0.139
MedHigh proportion reject (MedHigh all rejections/exchanges)	Control	1.8	1.032	2	10	0.597			
	Contrast	2.2							
	Inequity	2							
Overall proportion reject (all rejections/exchanges)	Control	1.3	**7.8**	**2**	**10**	**0.02**	Control-Contrast	−2.191	0.028
	Contrast	2.2					**Control-Inequity**	**−2.599**	**0.009**
	Inequity	2.5					Contrast-Inequity	−0.968	0.333

Note that with such a small *N* we lacked statistical power. Significant *P* values are shown in bold.

Table A3
Model estimates (posterior means and 89% highest posterior density intervals, HDPIs) for study condition and test number effects on dyadic-tested monkeys' rejections (log odds displayed)

Condition	Reward condition	Mean	SD	HDPI 5.5%	HDPI 94.5%
EC	MedHigh	−1.80	0.89	−3.22	−0.39
CC	MedHigh	−0.74	0.83	−2.07	0.59
IC	MedHigh	−0.37	0.82	−1.67	0.92
Test 1		0.43	0.41	−0.22	1.09
Test 2		−0.77	0.41	−1.43	−0.12
Paired contrast	*Mean difference (log odds)*	*SD*	*HDPI 5.5%*	*HDPI 94.5%*	*Mean difference (probability reject)*
EC/CC	0.36	0.53	−0.47	1.23	0.07
IC/CC	1.07	0.13	−0.01	0.39	0.17
EC/IC	**1.42**	**0.68**	**0.39**	**2.56**	**0.24**

EC = equity condition; CC = contrast condition; IC = inequity condition. Condition effects indicated in bold.