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ORIGINAL PAPER

Does a rat release a soaked conspecific due to empathy?

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Abstract In Experiment 1, rats choosing in an E maze preferred to release a rat standing in a pool of water to dry ground over a rat already standing on dry ground. Five additional experiments showed that the choosing rat's preference for releasing the wet rat was maintained by two separable outcomes: (1) the social contact offered by the released rat and (2) the reinforcing value of proximity to a pool of water. These results call into question Sato et al.'s (Anim Cogn 18:1039–1047, 2015) claim to have demonstrated that a rat's releasing of a wet rat to dry ground is empathically motivated.

Keywords Empathy · Social contact · Water · Rats

Introduction

Empathic action—aiding a recipient despite cost to a donor—is so pervasive a human attribute that its absence is often diagnostic of maladies such as autism, sociopathy, social avoidance and social phobia (Belzung et al. 2005; Lukas et al. 2011; Preston et al. 2007). Because of the clinical importance of addressing cases where human empathy is absent, researchers have sought animal models of human empathy so they can elucidate the substrate motivating empathic action. Some elements of empathy—for example, emotional contagion (e.g., one baby cries, other babies cry as well)—have been convincingly demonstrated in rodents (e.g., Langford et al. 2006). Moreover, higher-order, multi-component models have been constructed that include emotional contagion and other processes (e.g., perspective taking and consolation) as building blocks of a perception–action theory of empathy (de Waal 2008).

Even though the elaboration of the possible mechanisms of empathy has been ongoing for years now (e.g., de Waal 2008; Panksepp and Lahvis 2011; Panksepp and Panksepp 2013), the number of reports that can claim to test for empathy is few. This claim may surprise readers if they have conflated pro-sociality, which has been frequently demonstrated (e.g., Hernandez-Lallement et al. 2015; Márquez et al. 2015), with empathy (Vasconcelos et al. 2012). Pro-sociality only indicates donor interest in social interaction with a recipient. While this may be a precursor to empathic action, it does not imply empathy. Interactions only become empathetic if: (1) the donor's actions are at personal cost; and (2) the donor perceives the recipient as benefiting from this interaction.

Of course, there are studies that have tested for empathy without the risk of conflation with pro-sociality. However, these studies have encountered other problems. For example, Masserman et al. (1964) found that rhesus monkey donors were less likely to pull a chain for food if that chain pull also delivered an electric shock to a recipient. This outcome is unlikely to be due to pro-sociality. Nevertheless, there is the risk that donor responding represents donor aversion to hearing the recipient's pain-induced vocalizations. If so, the donor's response may be better characterized as escape than as empathic action.

Other nonhuman primate evaluations fare no better. In Wolfle and Wolfle (1939), a monkey donor could pull a string that delivered a food reinforcer to a hungry recipient in an adjacent cage. They found that monkeys often made this response whether or not the adjacent cage was

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occupied. Colman et al. (1989) arranged it so that a donor macaque could press a lever that fed only itself or press another lever that fed not only itself, but also an adjacent recipient. Of the two donors showing a consistent preference across manipulations, one chose altruistically while the other chose spitefully. The two remaining subjects seemed indifferent to the consequences of their preferences for recipients.

Subsequent attempts at demonstrating pro-sociality or empathic action in nonhuman primates use a variety of techniques (see Jensen 2016) and show weak or contradictory results (Burkart et al. 2007; de Waal et al. 2008; Jensen et al. 2006; Lakshminarayanan and Santos 2008; Silk et al. 2005; Warneken and Tomasello 2006). Demonstrations of pro-sociality (Silk et al. 2005) or empathic action (Jensen et al. 2006) failed if food was the aid provided to the recipient, but not if it was an object out of the recipient's reach (Warneken and Tomasello 2006). While Warneken and Tomasello found empathic action, their chimps failed in five other empathic tasks given in their report. Burkart et al. (2007) found marmosets had a weak preference (0.55) for empathic action. De Waal et al. (2008) show pro-social (but not empathic) action in capuchins. However, even pro-sociality was conditional on variables such as donor-recipient familiarity. Finally, Lakshminarayanan and Santos (2008) present data they view as consistent with capuchin empathic action; however, they compared their test and empty-chamber control data to chance performances, and not to each other. Inspection of their Fig. 2 raises the possibility that had their comparison been between test and control, and their previously significant finding would not reach statistical significance.

We view the evidence of empathic action in nonhuman primates as unconvincing. This view extends to the rat literature as well even though there are two studies that report robust effects that are admittedly compatible with empathic action. Silberberg et al. (2014) have already reclassified one of these studies (Ben-Ami Bartal et al. 2011), attributing the results obtained to pro-sociality, not empathy. The second rat study that of Sato et al. (2015) is the target article for the present work. We discuss both experiments below.

Rat studies that putatively demonstrate empathic action

Ben-Ami Bartal et al. (2011) found that a rat free to move about in a chamber would learn to push aside a door to a restraining tube that contained a trapped rat, permitting the trapped rat to join the free rat. Two explanations of this outcome are apparent. First, the free rat may have released the trapped rat so that the free rat could make social contact with the trapped rat. Second, the free rat's releasing response may have been empathically motivated—that is, if the free rat viewed the trapped rat as being in distress, and it also found reducing the distress in another rat rewarding, it should be motivated to free the trapped rat.

To disentangle these interpretations, Ben-Ami Bartal et al. (2011) permitted free rats that had previously learned to release a trapped rat into its chamber to now release the trapped rat into a more distant chamber. Ben-Ami Bartal et al. reasoned that if the free rat continued to free the trapped rat, it could not be due to pursuit of social contact because the freeing response puts the trapped rat at a greater distance from the free rat. They found that the freeing response continued to be emitted over many sessions even though it reduced social contact. Absent evidence that social contact was required to maintain the freeing response, they labeled the freeing rat's door-opening response as empathic action maintained by relieving the trapped rat of distress caused by its enclosure in a restraining tube. In a systematic replication (Sidman 1960), a targeted procedure is modified in ways that should not impact manifestation of a psychological phenomenon. Such a replication tests possible boundary conditions to a phenomenon and establishes whether that phenomenon is robust. Silberberg et al. (2014) conducted such a test of Ben-Ami Bartal et al.'s (2011) procedure and found: (1) Free rats do not learn to release a trapped rat to a distal chamber when the releasing response has not been previously trained; (2) trapped rats often return to the putatively aversive restraint tube once they have been released; and (3) free rats that have previously learned to free a trapped rat continue to make the rat-freeing response even when that response no longer works. They interpreted these findings as incompatible with an empathy account of Ben-Ami Bartal et al.'s findings. Instead, they explained their data and those of Ben-Ami Bartal et al. in terms of neophobia and pursuit of social contact.

An important test of these opposed explanations has been conducted by Sato et al. (2015). In their first experiment, a rat ("free" rat) was free to open a circular door covering a hole that was 65 mm in diameter. When opened, this hole permitted a rat soaked in a pool of water to join the free rat in a dry chamber. Over 12 sessions, nine out of ten free rats opened the door permitting the wet rat to join it in its chamber. In addition, they demonstrated that the free rat opened the door more rapidly when the door blocked egress of a soaked rat than when (1) no rat was present in the pool of water, (2) neither rat nor water was in the pool chamber and (3) a toy rat was present in the dry pool chamber.

Sato et al.'s (2015) first experiment did not resolve whether door opening represents empathic action or the

pursuit of social contact. One possibility is that the free rat opened the door more rapidly when a rat was in the pool than when the pool was empty or contained a toy rat because the free rat wanted company, and neither an empty pool nor a toy rat provided company (pro-sociality). Alternatively, the free rat may have opened the door more rapidly because it felt sorry for the wet rat, but this empathic reaction was absent when the second chamber did not contain a wet rat.

To tease these accounts apart, Sato et al. (2015) built a new apparatus. Unlike the first apparatus, which contained adjacent wet and dry chambers separated by a single door, the new apparatus consisted of three adjacent chambers connected by two doors, each 85 mm in diameter. A wet chamber was on one side of the free rat's chamber, and a dry chamber was on the opposite side. The wet chamber was not used in Experiment 2. Instead, naïve free rats were given the opportunity to open the door to the dry chamber containing a trapped rat that was presumably not distressed because it was not in a pool of water. Sato et al. found that only one of eight free rats opened the door to free the dry rat from its dry chamber during this 12-session condition. Given that nine of ten free rats opened the door to free a soaked rat in Experiment 1, but only one out of eight did so to free a dry rat in Experiment 2, Sato et al. concluded that the door opening should be interpreted as empathic action and not as the pursuit of social contact.

We find Sato et al.'s (2015) claimed demonstration of empathic action in rats unconvincing because door sizes differ in Experiments 1 and 2 (diameters of 65 and 85 mm, respectively). Assuming these doors were made of the same material in both apparatuses, those in the second apparatus should be more than 70% heavier than those in the first apparatus (using the equation for the area of a circle, $\pi 42.5^2/\pi 32.5^2 = 1.71$). A free rat in Experiment 2 might have failed to release the dry rat as often as the wet rat was released in Experiment 1 not because the wet chamber in Experiment 1 evoked empathy, whereas the dry chamber of Experiment 2 did not, but rather because the door in Experiment 2 was heavier than in Experiment 1. This interpretation is supported by the fact that for one group of free rats that used the second apparatus (Experiment 3), it took 19.6 sessions on average to meet the training criterion of opening the door to the pool chamber to free a soaked rat. Applying the same criterion to the data in the first apparatus (Experiment 1), it took no more than ten sessions to get reliable door opening to free the wet rat. We attribute this difference to the possibility that it was easier to open the door in the apparatus of Experiment 1 than in the apparatus of Experiment 2.

The interpretative problems that we find with Sato et al. (2015) led us to propose a systematic replication of their work. Toward this end, we constructed an E maze. In Experiment 1, a free rat could choose to free either a rat standing in a pool of water or a rat standing in a dry chamber.

Experiment 1

Method

Subjects

Six female and six male Sprague–Dawley rats (Harlan Laboratories, USA) aged approximately 15 weeks at the start of the experiment served as subjects. The rats were housed as same-sex triplets in four home cages with unrestricted access to food and water. The colony was maintained on a 12-h light, 12-h dark cycle, lights on at 8 AM.

Apparatus

Figure 1 illustrates the design of the E maze used in this experiment. The maze was constructed from polyvinyl chloride, with a Plexiglas ceiling. Each maze arm was 84 cm long, 12 cm wide and 11 cm high. Each goal box was 21 cm by 18 cm by 11 cm. A bin made of 6-mm-thick polyvinyl chloride and measuring 18 cm by 16 cm by 5 cm could be placed in either goal box and filled with water. Two polyvinyl chloride panels (Door A in Fig. 1) could block movement through the alley when lowered through a slit in the Plexiglas ceiling that covered the entire maze. A second pair of sliding Plexiglas panels (Door B in Fig. 1) could block movement into and out of each goal box.

Procedure

After 2 weeks' acclimation in their home cages, each rat in a given cage was randomly assigned the role of "free," "wet" or "dry" rat. There were a total of four of each kind

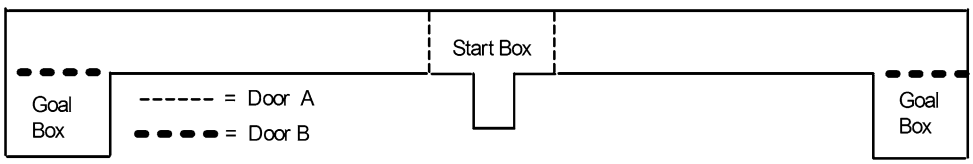

Fig. 1 Design of the E maze. Drawing is not to scale

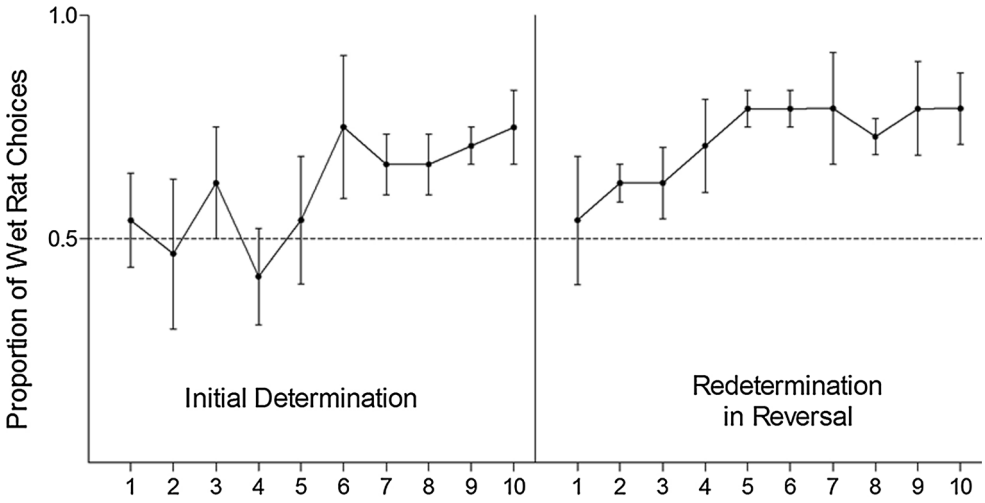

Fig. 2 Mean proportion of choices of the rat in the wet goal box as a function of sessions. The *left panel* is from the initial condition, and the *right panel* is from the redetermination with goal boxes reversed. *Bars* through data points present the range (+1/−1) of the standard error of the mean. The *dotted line* presents indifference in choice

of rat. The free rats were tested with their cage mates in the wet and dry goal boxes. For half of the free rats, the wet and dry rats were, respectively, in the left and right goal boxes of the maze. For the other half, this arrangement was reversed.

Each session began with forced-choice trials, the order of which was randomized with the constraint that the free rat was required to go to the wet and dry rats an equal number of times. With the designated wet and dry rats in their respective goal boxes, trials began by removing the free rat from its home cage located near the E maze and placing it in the start box. When the free rat moved through an already-open door A (the other door A was closed), defined as having the base of its tail pass the open door, that door was closed behind the rat. If the free rat did not go past door A within 3 min, the trial was terminated and the free rat was returned to its home cage for 1 min to await the next trial. When the free rat made the criterion response by passing door A, the Plexiglas door separating it from the goal box was removed once the free rat's nose was within approximately 3 cm of door B. Once door B was removed, the free and wet or dry rats were permitted to mingle for 1 min. Thereafter, the free rat and wet or dry rat were returned to their home cage and goal box. After a 1-min intertrial interval, the next trial began with the reintroduction of the free rat to its start box. After six forced-choice trials, the free-choice trials began.

The six free-choice trials were the same as the forced trials except that both A doors were already open, permitting the free rat to choose either goal box. In all other ways, free-choice trials were the same as forced-choice trials.

Sessions were conducted 5 days per week. The first condition continued for ten sessions, and then the positions of the wet and dry goal boxes were reversed in the second condition for an additional ten sessions. All statistical analyses here and in subsequent experiments are based only on free-choice trials.

Results and discussion

As shown in Fig. 2, free rats preferred mingling with the wet rat over the dry rat in both the initial and reversal conditions. A one-sample t test of the first two sessions indicated rats did not significantly differ from chance performance in the initial ($t_3 = .042$, *NS*) or reversal ($t_3 = .925$, *NS*) conditions; however, when applied to the last two sessions, this test indicated that rats were preforming significantly above chance levels for the initial ($t_3 = 4.32$, $P < .05$) and reversal ($t_3 = 4.041$, $P < .05$) conditions.

Preferences were calculated over the last five sessions across subjects. In the initial and reversal conditions, respectively, these proportions were 0.71 and 0.78. Each result was significant (one-sample t tests, $t_3 = 3.673$, $P < .05$; $t_3 = 4.664$, $P < .05$). The experimenters observed that on those occasions when the wet box was chosen, some free rats frequently, but not always, stepped into the open water goal box; others never did. Moreover, all free rats would sometimes, but not always, lick the wet sides of the goal box, if they entered it, or of the dry alley where the wet rat was present. Finally, free rats typically made physical contact with the wet rat in the alley leading to the goal box and also seemed to peer over the water pool.

At least two explanations of these results can be offered. First, it may be the case that free rats preferred wet rats over dry rats because they wished to enable wet rats to get out of the water. This interpretation is compatible with the empathy account offered by Sato et al. (2015). Alternatively, it may be the case that free rats prefer the wet goal box over the dry goal box per se. Since each goal box

contains a rat, there should be no preference between them in terms of social contact; however, a preference for the wet goal box might emerge if a free rat prefers a wet goal box to a dry one.

Experiment 2

In the prior experiment, door B, once removed, was not closed until the trial ended. Therefore, regardless of choice, the free rat could make contact with both the liberated rat and the goal box where the liberated rat resided. The present experiment is identical to the initial condition of Experiment 1 except for a single procedural change: After a wet or dry rat left its goal box, its door B was immediately closed, preventing either the liberated or free rat from entering the goal box.

Method

Subjects

The subjects used in the prior experiment were used in the present study. Their roles as free, wet or dry rats were not changed between experiments.

Apparatus

The apparatus was the same as in the prior experiment.

Procedure

The procedure was the same as in the initial condition of Experiment 1 save for one change: Once a trapped rat left its goal box, leaving defined as having the base of its tail just past the slit containing door B and the rest of its body standing in the alley, the door was immediately closed part way until the rat's tail passed completely by the door. At that point, the door was lowered completely.

Results and discussion

A one-sample t test on the first two sessions indicated rats did not significantly differ from chance performance ($t_3 = 1.732$, *NS*) whereas this test of the last two sessions indicated that rats were preforming significantly above chance levels ($t_3 = 4.251$, $P < .05$).

As shown in Fig. 3, free rats chose on free-choice trials the goal box containing the wet rat on 0.66 of the trials on average during the last five sessions. This outcome was significantly above chance expectations (one-sample t test, $t_3 = 3.217$, $P < .05$). From this we conclude that the wet rat is somehow reinforcing. One possibility is empathy, but another could be the opportunity to access the water on the wet rat, or water that washes onto the side of the alley when the wet rat is freed. Might preference be controlled by the water itself?

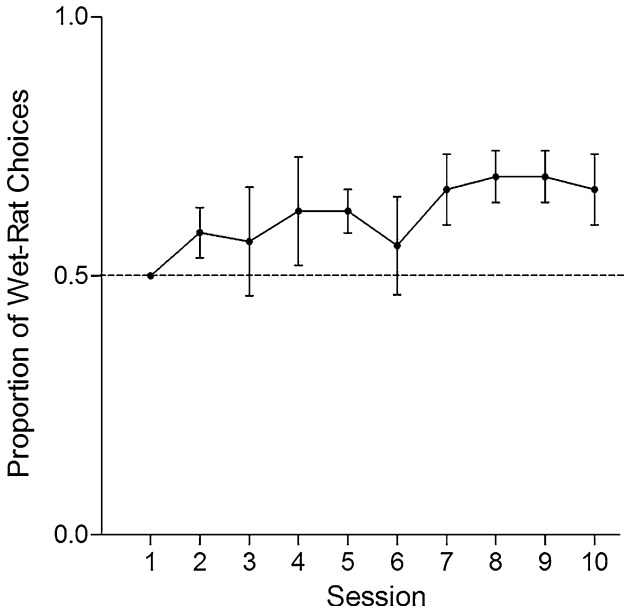

Fig. 3 Mean proportion of choices of the rat in the wet goal box as a function of sessions. *Bars* through data points present the range (+1/−1) of the standard error of the mean. The *dotted line* presents indifference in choice

There is a simple test that can be made that addresses this question. The next experiment repeats the redetermination condition of Experiment 1. The only difference between this reversal condition and the reversal condition of Experiment 1 is that there are now no rats in either goal box. If access to the water box or licking a goal box wall is reinforcing for the free rat, even though some free rats seldom step into it, a water-box preference should emerge.

Experiment 3

Method

Subjects

Only the free rats used in the prior experiment were used in the present study.

Apparatus

The apparatus was the same as in the prior experiment.

Procedure

The procedure was the same as in the reversal condition of Experiment 1 except that neither goal box contained a restrained rat.

Results and discussion

A one-sample t test indicated rats significantly differed from chance in the first two sessions ($t_3 = 7.039$, $P < .01$) and last two sessions ($t_3 = 4.817$, $P < .05$). Figure 4 presents the proportion of free-rat choices of the wet box across sessions. On average, these rats chose the wet box on .78 of the free-choice trials over the ten sessions. By a one-sample t test, this result is significant ($t_3 = 5.291$, $P = .01$). These results indicate that the rats had a significant preference for the wet box even though no rat was present in that goal box or its alternative. This suggests that an open water bin is reinforcing. As had been true in earlier experiments, this outcome may have been reinforced by peering over the water pool, licking the sides of the wet goal box or both.

If our interpretation of these results is correct, repeating Experiment 2 with no rats in the goal box should reduce preferences to the minimum levels. We predict that such a procedure would largely remove all sources of reinforcement for choice because access to the wet goal box is obstructed by not removing door B when a choice is made, there is no possibility of licking the walls of the wet goal box, and there is no rat in either goal box to reinforce choice by social contact. The next experiment makes this test.

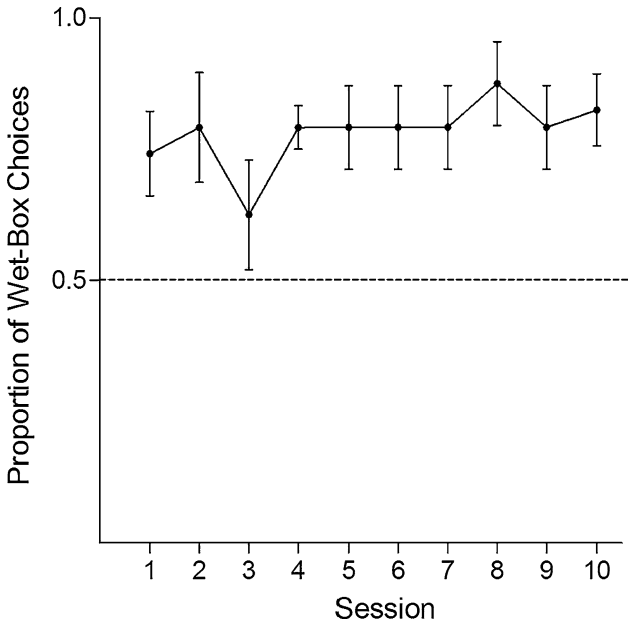

Fig. 4 Mean proportion of choices of the wet goal box as a function of sessions. *Bars* through data points present the range (+1/−1) of the standard error of the mean. The *dotted line* presents indifference in choice

Experiment 4

Method

Subjects

The free-rat subjects used in the prior experiment were used in the present study. Their role as a free rat was not changed between experiments.

Apparatus

The apparatus was the same as in the prior experiment.

Procedure

The procedure was the same as in the initial condition of Experiment 1 except that neither goal box contained a restrained rat, and both B doors were in place prohibiting access by a free rat to the wet and dry goal boxes at any point during a trial.

Results and discussion

A one-sample t test indicated rats did not significantly from chance levels on the first two sessions ($t_3 = .192$, *NS*) or last two sessions ($t_3 = 0$, *NS*). Figure 5 presents the proportion of wet box choices. A one-sample t test on all data did not differ significantly from chance levels ($t_3 = 1.040$, *NS*).

If, as hypothesized, this experiment has reduced the reinforcing efficacy of free-rat choice by removing two sources of reinforcement—the opportunity to peer over water/lick goal box walls and the opportunity to make social contact with a cage mate—and it might be expected that sometimes the free rat would not even bother to make a choice. To remind the reader, across all experiments, free rats had to choose within 3 min from trial initiation, otherwise the trial was terminated.

To make this evaluation, we present in Fig. 6 the proportion of trials in which free rats made a choice across all experiments of this report. As is apparent, free rats chose in virtually all conditions of Experiments 1, 2 and 3; however, as hypothesized, they chose less in Experiment 4. A one-way ANOVA indicated that these conditions were significantly different ($F_{4,15} = 15.4$, $P < .001$). Post hoc comparisons using Tukey's HSD test indicated that the mean number of choices in Experiment 4 was significantly lower than the mean choices in any other experiment ($P < .001$). There were no significant differences in the average number of choices among any of the other experiments.

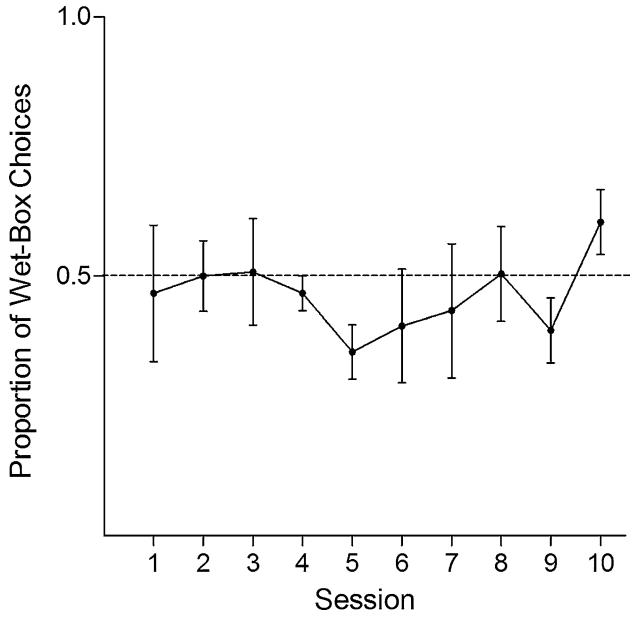

Fig. 5 Mean proportion of choices of the wet goal box as a function of sessions. *Bars* through data points present the range (+1/−1) of the standard error of the mean. The *dotted line* presents indifference in choice

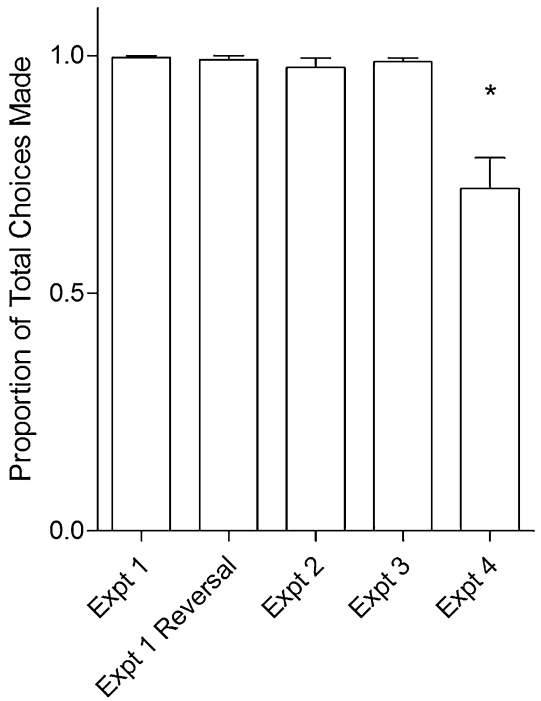

Fig. 6 Mean proportion of trials in a session in which the free rat made a response in Experiments 1 through 4. The "T" shape atop *each bar* defines one standard error of the mean. The *asterisk* indicates a *bar* the mean value of which differs significantly from the others

Experiment 5

Experiment 3 showed that free rats used in prior experiments preferred an empty, but open, wet goal box over one that was dry; and Experiment 4 showed that closing these goal boxes with their Plexiglas barriers resulted in indifference in choice. Taken together, the results are most easily explained by positing that among the manipulations evaluated, only access to an open wet goal box is reinforcing.

Two questions have not been addressed heretofore. First, did some feature of the history of accessing trapped rats carry over from Experiment 1 to other experiments, causing it to appear that an open wet goal box, by itself, is reinforcing when, in fact, it was not? This possibility is supported by the finding that the first two sessions of Experiment 3 were significantly above chance, whereas the previous experiments did not show this effect. Second, was the open wet goal box itself reinforcing or was it the opportunity to lick alley walls moistened by wet rats that caused free rats to choose their alley?

Experiment 5 addresses both of these questions by repeating Experiment 3 with naïve free rats. Thus, choice is between two open goal boxes, one leading to the water pool and the other leading to a dry goal box. By virtue of their naiveté, there can be no carryover of reinforcement effects across experiments to influence preference. Further, arguments for the reinforcing effects of licking wet walls would be muted because the alley walls proximal to the pool are to be dry. If the wet pool per se is reinforcing, preferences for it should now emerge. If not, no orderly preferences should emerge in this study.

Method

Subjects

Six male and three female experimentally naive Sprague-Dawley rats (Harlan Laboratories, USA) aged approximately 15 weeks at the start of the experiment served as subjects. They were housed as same-sex triplets in three home cages with unrestricted access to food and water. The colony was maintained on a 12-h light, 12-h dark cycle, lights on at 8 AM. After 2 weeks' acclimation in their home cages, the experiment began.

Apparatus

The apparatus was the same as in the prior experiment.

Procedure

The procedure was the same as in Experiment 3.

Results and discussion

Figure 7 presents the proportion of free-rat choices of the wet box as a function of sessions. A one-sample t test on the first two sessions indicated rats did not significantly differ from chance performance ($t_8 = .992$, *NS*); however, when applied to the last two sessions, this test indicated that rats were preforming significantly above chance levels ($t_8 = 18.66$, $P < .001$).

On average, these rats chose the wet box on 0.72 of the free-choice trials over the last five sessions. This result is statistically significant (one-sample t test, $t_8 = 3.796$, $P = .005$). On trials when the free rats chose the wet goal box, they sometimes, but not always, also stepped into the water; however, they did not drink from the water pool. No records were kept on the frequency of pool entries. These results suggest that free-rat access to an open pool of water is reinforcing per se.

Experiment 6

We have demonstrated that rats prefer the proximity of another rat plus water over another rat without water (Experiments 1 and 2). We also found that proximity to water even in the absence of social contact with another rat is sufficient to guide choice in its direction (Experiment 3). We found that without proximity to another rat or unrestricted access to proximity to water, rats find moving about in the E maze largely unrewarding (Experiment 4). Finally, we showed that experimentally naïve rats prefer access to a water pool over a dry goal box (Experiment 5), a result showing that a water pool per se is reinforcing. Experiment 6 addresses a remaining question: Will social contact alone serve as a reinforcer in an E maze?

This question can be answered directly by giving a free rat a choice between a dry rat and no rat. Based on Silberberg et al. (2014), where the social-contact hypothesis account was first presented, we expect free rats to prefer social contact.

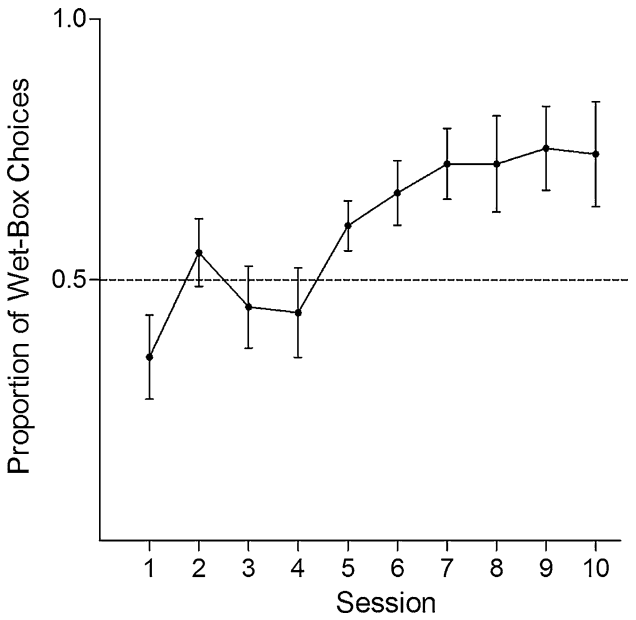

Fig. 7 Mean proportion of choices of the wet goal box as a function of sessions. *Bars* through data points present the range (+1/−1) of the standard error of the mean. The *dotted line* presents indifference in choice

Method

Subjects

Two groups of rats were used in this experiment. The first group was composed of four 10-month-old male Sprague-Dawley rats that participated previously in a radial-arm-maze study where rat memory was evaluated. They were experimentally naïve to the E maze used in this experiment. Each rat was housed with another rat that did not participate in this experiment. One rat served as the trapped rat for the other three free rats. A second group of rats consisted of four naive 10-week-old male Sprague Dawley rats. One rat served as the trapped rat for the other three free rats. The free rats were housed together, while the trapped rat was housed separately. All rats had unrestricted access to food and water.

Apparatus

The apparatus was the same as in the prior experiment.

Procedure

The procedure differed from that in Experiment 1 in four ways: (1) There were eight forced trials instead of six; (2) forced trials strictly alternated between goal boxes instead of the goal boxes being randomly selected with the constraint of an equal number of forced trials to each; (3) all analyses are based on all sessions, and the number of sessions in the initial and reversal conditions was limited to five; and (4) a dry rat occupied one goal box, whereas the other goal box was dry and empty.

Results and discussion

The average number of choices of the goal box containing a trapped rat did not differ between the two groups of rats

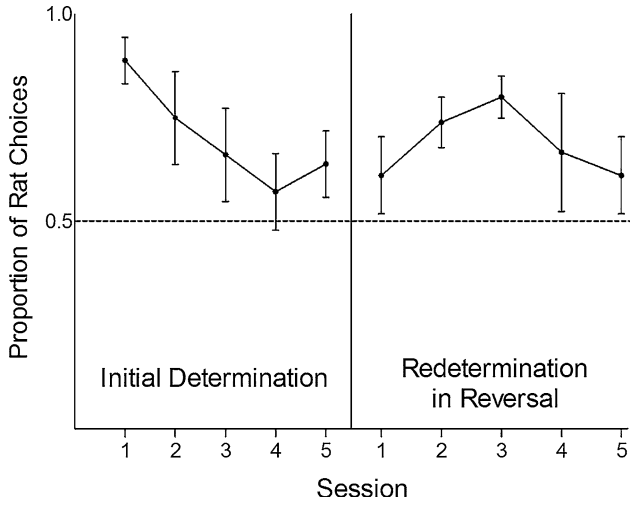

Fig. 8 Mean proportion of choices of the dry rat in a goal box as a function of sessions. The *left panel* is from the initial condition, and the *right panel* is from the redetermination with goal boxes reversed. *Bars* through data points present the range (+1/−1) of the standard error of the mean

in this study (between-group t test, $t_4 = -1.43$, $P = .29$). Based on this outcome, we pooled the data.

Figure 8 presents free-rat preferences during choice trials for the dry trapped rats when the other goal box was empty and dry. The initial presentation of these alternatives is presented in the left panel, and the redetermination when goal boxes were reversed is in the right panel. Since this experiment was only conducted for five sessions, our statistical analysis was conducted on all sessions in the initial and reversal conditions. Rats chose the box containing the trapped rat on 0.70 of the free-choice trials in the initial condition and on 0.69 free-choice trials in the reversal condition. A one-sample t test determined that the free rat significantly preferred the trapped rat over the empty goal box in the initial ($t_5 = 2.901$, $P < .05$) and reversal ($t_5 = 3.124$, $P < .05$) conditions. These results show that going to a trapped rat was more rewarding to a free rat than going to an empty dry goal box. These results are consistent with the social-contact hypothesis advanced by Silberberg et al. (2014).

General discussion

In six experiments, we have shown that proximity to a rat and to a body of water is each reinforcing to a free rat. These results are compatible with those from Sato et al. (2015). In their first experiment, they showed a free rat opened a door more rapidly to liberate a soaked rat than to be proximal to a water pool without a rat, a dry chamber or one with a toy inside. Given our view that proximity to water or a rat, wet or dry is reinforcing, these results are consonant with ours. In their second experiment, they showed in a different apparatus that free rats tend not to open a door to liberate a dry rat. However, as noted earlier, the door may have been heavier in this apparatus than in the prior one. Heavier or not, Sato et al. did not demonstrate in this apparatus that free rats would liberate a wet rat with higher likelihood within the 12-session criterion used with dry rats. Moreover, even if they had conducted this comparison, and the wet rats were liberated more rapidly than the dry rats, these results would still be compatible with our thesis because proximity to a pool of water and a rat should be more reinforcing than proximity to a rat alone. In their final experiment, Sato et al. demonstrated that under certain conditions, a free rat will liberate a wet rat before it will open a door that gives it access to a highly palatable food. While this result is interesting, it is not relevant to addressing an empathy account. From our perspective, this result only means that under certain conditions, a free rat prefers proximity to water with a rat, to palatable food.

Accepting the interpretations, we lend our data and Sato et al.'s (2015) does not disprove their empathy account. To speak colloquially, it could be the case that rats not only prefer proximity to water and another rat, but also feel sorry for the rat trapped in the water. Unfortunately though, none of the data in our report and Sato et al.'s (2015) require empathic action to accommodate any data set. If the reader accepts our view that action motivated by the pursuit of social contact is inherently less complex than action motivated by empathy, then by Morgan's Canon our account is to be preferred. On the other hand, if the reader does not share our view that a social-contact hypothesis is more parsimonious than an empathy account, the results of the present report support that view that in the Sato et al., these two accounts are confounded.

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