

Desire for social contact, not empathy, may explain “rescue” behavior in rats

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Abstract Ben-Ami Bartal et al. (Science 334:1427–1430, 2011) showed that a rat in an open space (free rat) would touch the front door of a restraining tube to open its rear door, thereby enabling a rat trapped within (trapped rat) to enter a larger space that was farther away from the free rat. Since opening the rear door distanced the trapped rat from the free rat, Ben-Ami Bartal et al. argued free-rat behavior could not be motivated by the pursuit of social contact. Instead, this rat was empathically motivated, its goal being to reduce the presumed distress of the rat trapped in the restraining tube. In two experiments, we show that (a) a free rat will not learn to touch the front door to open the rear door when it is the first condition of the experiment; (b) over time, a trapped rat will often return to a restraining tube despite its presumed aversiveness; and (c) a free rat experienced in touching the front door will continue to touch it even if touching does not free the trapped rat. We explain these results and Ben-Ami Bartal et al.’s in terms of two processes, neophobia and the pursuit of social contact. When first placed in a restraining tube, neophobia causes the trapped rat to escape the tube when the rear door is opened. Across sessions, neophobia diminishes, permitting the rats’ pursuit of social contact to emerge and dominate free- and trapped-rat behavior.

Keywords Empathy · Social contact · Altruism · Neophobia · Rats

Introduction

A popular research strategy in comparative psychology is to seek evidence of a capacity in nonhuman animals that is similar to a capacity some might imagine as uniquely human. To offer just a few examples, there are studies that claim to show that like humans, other species engage in deception (e.g., Woodruff and Premack 1979), are averse to inequity (Brosnan and de Waal 2003) and loss (Chen et al. 2006), and evidence altruism (e.g., Masserman et al. 1964).

The research community is attentive to claimed demonstrations of human-like cognitive capacities in other animals, a fact that often leads to follow-up studies. Unfortunately, this subsequent work is sometimes empirically discrepant with the original report (for deception, see Povinelli et al. 1998; for inequity aversion, Fontenot et al. 2007; for loss aversion, Silberberg et al. 2008; for altruism, Silk et al. 2005). These failures in reproducing a targeted effect not only suggest the claimed linkages may be empirically labile or too dependent on procedure, but also cast doubt on the relevance of the original, putatively successful linkage because the target phenomenon to be evidenced in a nonhuman can often be robustly demonstrated in humans across a wide range of experimental designs (e.g., see Warneken and Tomasello 2006).

The present report is, itself, a follow-up evaluation, in this case targeting the literature on empathy in nonhumans. By way of definition, Decety et al. (2012, p38) state that “when individuals empathize, they vicariously feel the emotions of others, which not only promote affective communication but depending on the context and social relationships may motivate to behave pro-socially toward other conspecifics.” Thus, empathically motivated behavior (altruism) consists of actions in one animal (the donor)

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to redress the perceived needs of another (the recipient). The rat and nonhuman primate literature addressing this topic has followed one of two general designs. In one, the recipient is stressed by a temporally discrete aversive event such as fear induction or pain. The experimental question is whether the donor will emit a response that provides aid. To illustrate, Rice and Gainer (1962) found that a rat donor would press a lever to lower a squealing, recipient rat suspended by a harness to the ground. In another report, Masserman et al. (1964) found that rhesus monkey donors were less likely to pull a chain that provided them with a food reinforcer if that chain pull also delivered a painful electric shock to a recipient. However, the altruism evidenced in reports such as these is subject to alternative interpretation because the emission of the putatively altruistic response may have been governed by the donor's aversion to hearing the recipient's vocalizations from pain rather than concern about the recipient's well-being (Preobrazhenskaya and Simonov 1974). If so, the donor's response may be better characterized as escape than as altruism.

In this regard, a second design for studying altruism, one in which the recipient may be less likely to give voice in fear or pain, may be preferable. Such work was first done by Wolfe and Wolfe (1939). In their study, a monkey donor could pull a string that delivered a food reinforcer to a recipient in an adjacent cage. They found that monkeys often made this response whether or not the adjacent cage was occupied. This failure to demonstrate altruism was echoed by the subsequent efforts of Colman et al. (1989). In their study, a donor macaque could press a lever that fed only itself or press another lever that fed not only itself, but also its 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 altruism in the absence of fear or pain use a variety of techniques and show, at best, mixed 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 altruism in chimps failed if food was the aid provided to the recipient (Jensen et al. 2006; Silk et al.), but not, if it was an object out of the recipient's reach (Warneken and Tomasello). Burkart et al. provide weak evidence for altruism in marmosets using an adaptation of the Wolfe and Wolfe (1939) procedure. De Waal et al. (2008) show altruism in capuchins, but it is conditional on variables such as donor–recipient familiarity. Lakshminarayanan and Santos also present data they view as consistent with capuchins' altruism; however, based on a comparison of data from their test condition and empty-

chamber control (see their Fig. 2), we view their effect as possibly not statistically significant.

Thus, it appears that when pain or fear is not used, the literature does not identify robust examples of altruism in nonhuman species. Arguably, only Burkart et al. (2007) show a tendency toward altruism not dependent on exceptions (de Waal et al. 2008). But, the effect size that Burkart et al. report is modest. In their report, donors showed high tendencies to respond even when the recipient's cage was empty, and when a recipient was present, donation was only approximately 10 % higher. We entertain that demonstrating statistical significance cannot mask the underlying modesty of the propensity toward altruism in this and in all other studies claiming to show this effect. In our view, even in the absence of experiment, humans would surely produce differences between experimental and control groups that dwarf those reported by Burkart et al., de Waal et al., and Lakshminarayanan and Santos (2008). To our thinking, this fact suggests that such a difference in degree might represent a difference in kind.

However, a demonstration of empathy requires more than a demonstration of altruistic behavior; it requires that such behavior should be motivated by the donor, vicariously feeling the need of the recipient (Decety et al. 2012). Consistent with this interpretation is Nowbahari et al.'s (2009) interpretation of their finding that ants will attempt to rescue trapped relatives snared by a thread. As was the case in some of the studies described above, correspondences can be noted between the rescue behavior seen in this study and that seen in humans when they behave empathetically. But, lacking any evidence of the feelings of the rescuing ants, Nowbahari et al. do not interpret their results in terms of empathy. Unless one views the correspondences between human and ant-rescuing behavior as truly homologous, differences in how each species rescues another become critical to arguing that human empathy is unrelated to the behavior seen in an ant. But, if these differences are used to distinguish between rescue behavior in humans and ants, why should they not serve a similar role in distinguishing human empathy from that seen in rats or nonhuman primates (cf. Vasconcelos et al. 2012)?

An empathy experiment in rats

Recently, Ben-Ami Bartal et al. (2011) addressed some of the concerns discussed above by clearly demonstrating what may be an empathically motivated response in a donor rat toward a recipient rat that arguably was not afraid or in pain. In their study, a recipient rat was trapped in a restraining tube, while a donor rat was free in a larger chamber containing the tube. They found that the free rat would learn to open a door blocking egress from the restraining tube so that the trapped rat could join it in the

larger chamber. Two explanations of this result were considered: (a) It might be due to the pursuit of social contact—a tendency for the free rat to be motivated to be closer to the trapped rat (e.g., see Latané and Glass 1958); or (b) it might be due to empathically motivated “pro-social behavior” (Ben-Ami Bartal et al.)—a tendency for the free rat to respond to reduce the trapped rat’s distress that is presumably caused by being in the restraining tube. To discriminate between these accounts, hereinafter called, respectively, social-contact and empathy accounts, Ben-Ami Bartal et al. used free rats that had previously liberated a trapped companion in a new test. In this test, the door-opening response allowed the trapped rat to escape not to join the free rat, but instead to an empty space farther removed from the free rat. Ben-Ami Bartal et al. theorized that if social contact motivated the door-release response, a distal-chamber accessing response should extinguish because it puts the trapped rat at a greater distance from the free rat. On the other hand, if empathy motivated free-rat behavior, the door-release response should continue because it still reduced distress in the trapped rat by enabling it to be freed into a large space. Ben-Ami Bartal et al. found free-rat responding continued in this condition without diminution for 27 sessions. Since this outcome seems incompatible with a social-contact explanation of the door-release response, they attributed the persistence of responding in the free rat to rat empathy.

This finding has already generated considerable discussion, much (e.g., de Waal 2012; Decety et al. 2012; Panksepp 2011), but not all (Vasconceles et al. 2012) of which is favorable to Ben-Ami Bartal et al.’s (2011) interpretation of it. Our own concern with this paper is driven not by apparent procedural weakness, but by the very fact that its methods are novel. Novel methods raise the concern that a given finding may depend on poorly understood features of experimental design that may lead to misinterpretation of research findings. A popular technique to address such concerns is to test the boundary conditions of a new phenomenon and the procedures that produced it by attempting to reproduce the targeted effect in a different way. This approach is called “systematic replication” (Sidman 1960). Toward this end, we repeated Ben-Ami Bartal et al.’s experiment here in a different way. In the first condition of our experiment, door responses by an experimentally naïve free rat released a trapped rat into a distal chamber rather than into the same chamber as had occurred in Ben-Ami Bartal et al.’s first condition. The critical question was not whether a previously conditioned release response would extinguish as in the Ben-Ami Bartal et al. study, but whether the free rat would learn to respond in the absence of social contact as outcome. Once these data were collected, the arrangement that confounds social-contact and empathy accounts—releasing the trapped rat into the same chamber as the free rat—was tested. Finally,

to complete an ABA design, the final condition returned to the methods of the first test—where occurrences of a door-contact response once again released the trapped rat into the distal chamber.

Experiment 1

Method

Subjects

Twelve female Sprague–Dawley rats aged 3–6 months, the same breed and age of those used in Ben-Ami Bartal et al. (2011), were housed in pairs (one to serve as the free rat and the other as the trapped rat) in six home cages with unrestricted access to food and water. The colony was maintained on a 12-h light, 12-h dark cycle.

Apparatus

The apparatus, illustrated in Fig. 1, consisted of two translucent plastic chambers sized 41 cm wide, 58 cm long, and 30 cm deep. A transparent Plexiglas rat-

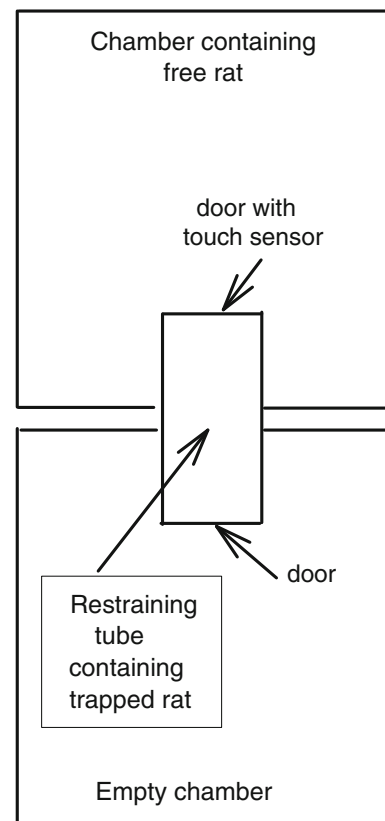


Fig. 1 Apparatus used in the experiments of this report. Drawing is not to scale

restraining tube, containing several slits and holes, and sized 25 by 8.1 cm, length by diameter (Harvard Apparatus, Holliston, MA), connected the two chambers. This tube was the same model as used in Ben-Ami Bartal et al. (2011). The two walls of the plastic chamber that held the restraining tube in place were composed not of translucent plastic, but of transparent Plexiglas. These walls were 1 cm apart. Transparent Plexiglas doors at each end of the restraining tube could be raised by computer-controlled motors. These doors were recessed 2.1 cm within the restraining tube. A vertical metal strip (1.9 by 9.6 cm) on the door of the restraining tube that protruded into the chamber that contained the free rat (front door) sensed free-rat contacts with it. A red light briefly flashed with each sensor contact.

Procedure

After 14 days of the rats living together in pairs in their home cages, the tail of one rat in each home cage was marked in ink to identify it as the free rat, and the rat pairs were then exposed to a regimen of habituation to the experimental apparatus. Each home cage was brought into the testing room. After 10 min in the testing room, each rat was handled by an experimenter for 5, 10, 15, and 15 min over four successive days. After handling, each rat pair was placed in the free-rat chamber and then permitted to roam for 1 h through that chamber. During these adaptation sessions, the restraining-tube doors were removed, and the rats could crawl through the restraining tube into the distal chamber. These procedures duplicate those of Ben-Ami Bartal et al. (2011).

Following habituation, rat pairs began Condition 1 of the experiment. In this condition, the free rat was placed in the free-rat chamber, and the trapped rat was placed in the restraining tube with both doors closed. Any response by the free rat to the sensor on the door proximal to it elevated the back door of the restraining tube, giving the trapped rat access to the empty distal chamber. Each session ended after 30 min. Only one session was conducted per day. Following completion of a session, both rats were placed immediately in their home cages and returned to the animal colony.

After 15 sessions of Condition 1, rat pairs began Condition 2, where free-rat contacts with the front door opened that door, permitting the trapped rat to join the free rat. After 15 sessions in this second condition, rat pairs were returned to the Condition-1 contingencies where free-rat contacts with the front door of the restraining tube once again permitted the trapped rat to enter the empty distal chamber. This third condition ended after 27 sessions, the duration selected to match the number of sessions Ben-Ami Bartal et al. (2011) used in their extinction test.

On occasion, the experimenter watched subject behavior in each of the three experimental conditions. Sessions were typically conducted daily except for weekends. No additional time elapsed between successive conditions of the experiment.

Results

The left panel of Fig. 2 presents the time it took for the free rat to contact the front door, thereby freeing the restrained rat to enter the distal chamber. Each bar is based on 18 outcomes (six free rats \times three sessions). The horizontal line within each bar is the median latency; the ends of the bars define the interquartile range. Latencies increased for all free rats as a function of sessions in this first condition ($P = .03$, two-tailed binomial test).

The center panel of the figure presents the latencies to free-rat, front-door contacts in Condition 2, where responses resulted in the restrained rat entering the chamber containing the free rat. In this condition, latencies diminished for all free rats over sessions. For all free rats, contact latencies were significantly reduced between the last three-session blocks of the first and second conditions (two-tailed binomial test, $P = .03$).

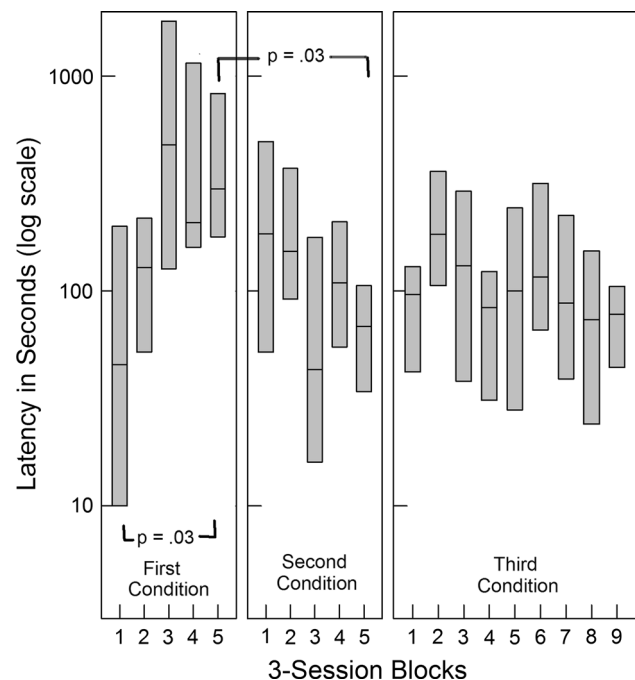


Fig. 2 Time from the start of a session until the first response to the front-door touch sensor by the free rats as a function of three-block sessions in Condition 1 (*left panel*), Condition 2 (*center panel*), and Condition 3 (*right panel*). The line within each bar defines the median time to first response, and the ends of the bars define the interquartile ranges

The right panel of the figure presents the third condition of the experiment—a return to the first-condition procedures where front-door contacts by the free rat opened the rear door of the restraining tube, permitting the trapped rat to egress into the empty distal chamber. During this test, latencies remained short and indistinguishable in duration from those of the Condition 2.

Figure 3 is identical to Fig. 2 except that it records the number of free-rat, front-door contacts rather than latencies to first response. In Condition 1, response rate decreased across sessions for all the free rats. This result was statistically significant ($P = .03$, two-tailed binomial test). No data are presented for the second condition, where the front door opened to permit the trapped rat to join the free rat, because the touch sensor on the door was elevated above the restraining tube after the first free-rat contact with it. In Condition 3, touch-contact frequencies were higher for all rats than in Condition 1 even though the between-condition contingencies were identical in the two conditions. Based on a comparison of the last three-session block of Conditions 1 and 3, this difference was significant for all free rats (two-tailed binomial test, $P = .03$). These data show that in Condition 3, but not Condition 1, free rats responded to the front door with high frequencies even though the trapped rat had already been released from the restraining tube.

Although not quantified, we observed that in Condition 3, trapped rats often re-entered the restraining tube after they had been released into the distal chamber.

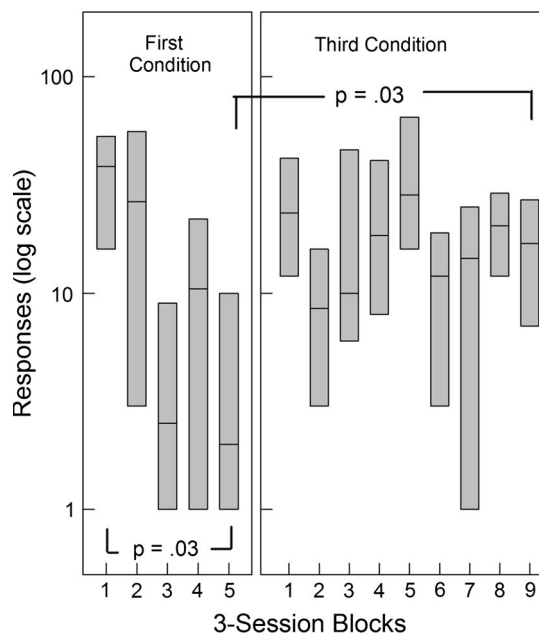


Fig. 3 Number of responses by the free rat to the front-door touch sensor in three-session blocks for Conditions 1 (*left panel*) and 3 (*right panel*). The line through each bar defines the median number of responses, while the ends of each bar define the interquartile ranges

Discussion

In Ben-Ami Bartal et al. (2011), the free rat opened the door to the restraining tube by physically displacing it from the front of the restraining tube. Our procedure was likely simpler for the rat because it only required making contact with a narrow metal strip attached to the restraining door. However, its simplicity may invite concern about whether, in fact, responding was an accidental consequence of free-rat activity.

Virtually all, if not all, responses by the free rat were due to touching her nose to the sensor plate. Because it was recessed 2.1 cm within the restraining tube, only her nose or tail could reach the sensor. While the possibility of sensor operation by the rat's tail remains, it never occurred in any of our observations of subject performances.

Given that nose contacts predominate in responding in our study, the next question to ask is whether these contacts were intentional. This question is answered by comparing the latency data in the first and second conditions of our study. As shown in Fig. 2, latencies increased over sessions when responding caused greater distance between the free and trapped rat (Condition 1) and decreased over sessions when responding decreased distance between them (Condition 2). Such outcome-dependent changes are, of course, the hallmark of operant behavior and, therefore, willful action.

In Condition 1 of the present study, a free-rat, front-door response permitted the trapped rat to enter a space distal to the free rat. Across sessions, free-rat response latencies (Fig. 2) increased and response frequencies decreased (Fig. 3). These results do not support an empathy hypothesis, but are compatible with a social-contact account.

In Condition 2, free-rat responding permitted the trapped rat to join it in the same chamber. As shown in Fig. 2, response latencies decreased in this condition, a result compatible with both an empathy and a social-contact account.

Condition 3 of this study repeated Condition-1 contingencies, but this time to different effect: Response latencies continued to be short and response frequencies high. On first consideration, this outcome may seem incompatible with a social-contact account (the trapped rat is freed into the distal chamber), but compatible with an empathy account (entry into distal chamber reduces presumed trapped-rat distress). However, two features of these data call this interpretation into question. First, except for the first front-door response, which opened the rear door of the restraining tube, subsequent front-door responses were without consequence. Why then did the free rat continue to respond? Second, why, when watching the experiment, did the experimenters often see the trapped rat return to the supposedly aversive restraining tube?

A possible account of these results can be constructed that is also compatible with the findings of Ben-Ami Bartal et al. (2011). Rats can be fearful of novel foods, objects, and places (Cowan 1977; Ennaceur et al. 2009; Mitchell 1976). We speculate that at the beginning (but not the end) of the experiment, the trapped rats responded neophobically to the lifting of the rear door. This reaction did not occur in the free rat because she, unlike the trapped rat, was 25 cm away from the rear door (i.e., the length of the restraining tube) and may not have sensed that it was raised.

Neophobia induction is feasible because during pre-experimental habituation training, both restraining-tube doors were open and did not move. If the trapped rat viewed movement of the rear door as novel, she may have to run from the restraining tube to an area that was familiar from its earlier habituation training, the distal chamber. If the trapped rat was not in the restraining tube due to neophobia, there would be no reason for a free rat motivated for social contact to approach the restraining tube. By this argument, the high rate of free-rat responding to the front door at the beginning of Condition 1 is rationalized (the free rat wished to be proximal to the trapped rat, and the opening of the distal door did not induce neophobia in her); so too is the finding that at condition's end, the free rat responds much less (each response she makes to the tube is punished by her partner escaping the tube). In the second condition, where free-rat responding opened the front door of the tube, a free rat motivated for social contact should approach the front door to be proximal to the trapped rat. Hence, the finding that contact latencies decreased in Condition 2 is explained. Finally, by the third condition, neophobia to rear door openings in the trapped rat is hypothesized to have diminished. In consequence, her natural propensity to pursue social contact was not opposed by her fear of the door opening. Therefore, she got as close as possible to the free rat, an outcome realized by spending much of her session time in the restraining tube. In response to the trapped rat's enduring occupation of the restraining tube, the socially motivated free rat also spent much of her time at the restraining tube, thereby producing frequent door–sensor contacts.

Experiment 2

The thesis advanced above could be best evaluated had we taken video recordings of sessions rather than rely on the comments of our experimenters. Unfortunately, we did not record performances. This deficiency is remedied in part by the next experiment where we continue Condition 3 for one session while the behaviors of rat pairs are video-recorded. A result consistent with our explanation of free-

rat behavior requires that the trapped rat, once released from the restraining tube, return to the tube to be near the free rat. In response to that, it would be expected that the free rat would make frequent contact with the restraining tube in order to be near the trapped rat, and thereby occasionally produce touch-sensor contacts.

Following this single video-recording session, a new experimental test was conducted in which free-rat responses open neither restraining-tube door. In this circumstance, there is no response that frees the trapped rat from the tube. Therefore, if free-rat responding is empathically motivated, her responding should extinguish. However, if free-rat, touch-sensor contacts are due to being motivated by the desire to be proximal to the trapped rat, touch-sensor contacts should continue because the trapped rat's continual presence in the tube reinforces free-rat proximity to the restraining tube and the touch sensor it contains.

Method

Subjects

The rat pairs from the prior experiment served in this experiment.

Apparatus

The apparatus was the same as in Experiment 1 except that a Webcam connected to a laptop computer recorded from above the chamber activity occurring around the restraining tube. Video recording was only done for this session.

Procedure

The procedure consisted of a single session of the experimental contingencies that defined Condition 3 in Experiment 1—that is, free-rat, front-door contacts opened the rear door of the restraining tube. Following this session, the contingencies were changed so that neither door would open. This second arrangement continued for 15 sessions. All other experimental arrangements were unchanged from Experiment 1.

Video scoring

Videos from the one-session continuation of Condition 3 of Experiment 1 were scored in terms of the number and duration of restraining-tube contacts by the free rat, and the number of entrances into and the duration of time spent by the trapped rat in the restraining tube once the rear door was opened. The number of video-tallied contacts by the free rat required that at least one second elapse between successive contacts. Possible successive contacts that were

not interrupted by at least 1 s of no contact with the restraining tube were counted as a single contact. Contact durations were timed in seconds from the beginning of contact with the tube until it ended. Trapped-rat entrances were tallied in a similar way. The trapped rat had to exit the tube completely for at least one second to have its next entrance into the tube be counted as a separate instance of entry. Free-rat snout contacts with the restraining tube were not counted because it was often ambiguous whether the free rat's snout was simply close to the tube or actually in contact with it. For this reason, the contact scores recorded were almost entirely composed of occasions when the free rat placed a paw on the tube or when she sat on top of the tube. Occasionally, the free rat would sit on the tube in a way that blocked determining whether or not the trapped rat was in the tube. During those intervals, trapped-rat location (in the restraining tube or out) was not scored.

Results

Table 1 presents the video-scored response frequency and response duration for the free and trapped rats during the one-session video-recorded continuation of the experimental arrangement used in Condition 3 of Experiment 1. These data were used to compose Fig. 4. The top panel of Fig. 4 presents for each of the free rats, the percentage of session time they were in contact with the restraining tube. The bottom panel presents the percentage of session time the trapped rats were in the restraining tube after the back door had been opened. Three of the six free rats spent the majority of their session time in contact with the restraining tube; four of the six trapped rats spend most of their session time inside the restraining tube after the rear door was opened.

Figure 5 presents the number of times the touch sensor on the front door recorded a response as a function of the

Table 1 Response frequency totals and their durations to the restraining tube for free rats and response entrances and their durations for restrained rats: subject pair (column 1); number and duration in seconds of free-rat contacts with restraining tube (column 2 and 3, respectively); number and duration in seconds of restrained-rat entrances into the restraining tube (columns 4 and 5, respectively)

Subject pair	Free-rat contacts with restraining tube		Restrained-rat entrances into restraining tube	
	Number (2)	Duration (s) (3)	Number (4)	Duration (s) (5)
1	5	1,387	12	347
2	15	774	18	981
3	2	374	16	1,774
4	14	508	18	1,281
5	15	1,179	25	290
6	24	919	27	173

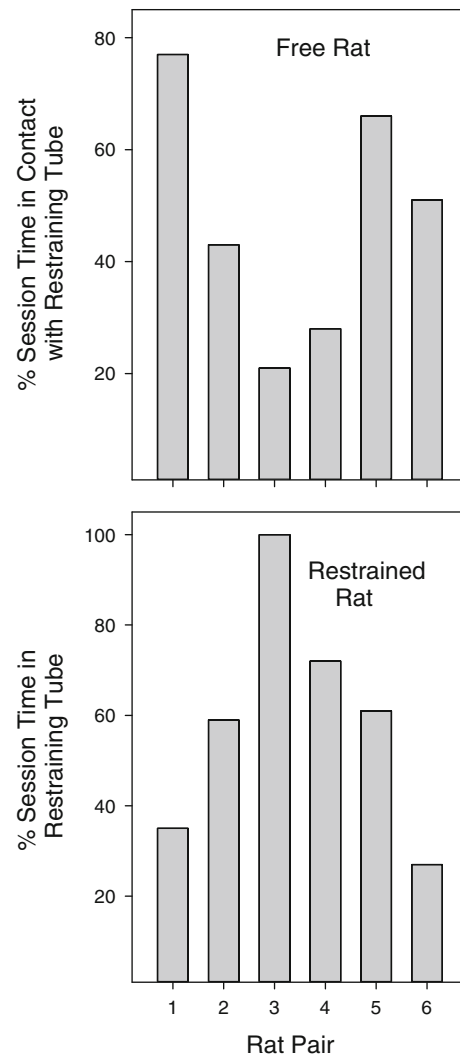


Fig. 4 The *top panel* presents for each of the six free rats the percent of session time it spent in contact with the restraining tube in a single-session test when its first response opened the back door of the restraining tube. The *bottom panel* presents for each of six trapped rats the percent of session time she spent in the restraining tube after the rear door had been opened. These data are from video recordings of a single session based on the experimental contingencies in Condition 3 of Experiment 1

number of times the free rat made contact with any part of the restraining tube as recorded by the scorer viewing the video recording of the session. As the figure makes clear, the number of touch-sensor responses to the front door recorded by the computer was significantly correlated with the scorer's video-based frequency counts of touching the restraining tube.

The left and right panels of Fig. 6 present, respectively, the latency to first response and the number of responses to the touch sensor for free rats in three-session blocks when the trapped rats were denied egress from the restraining tube. As with prior figures, the line within each bar presents the median value of each measure, and the ends of the bar

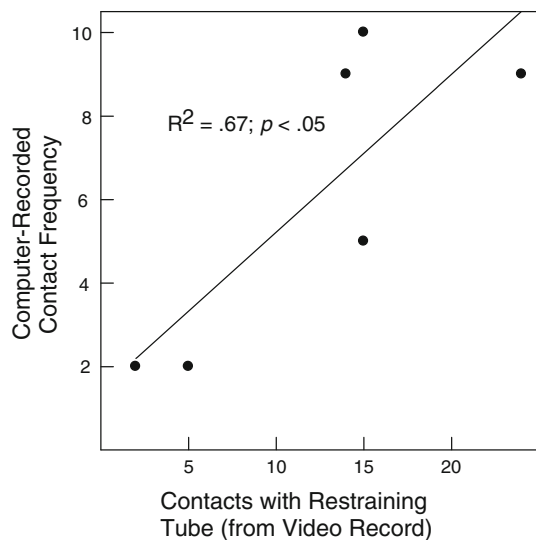


Fig. 5 Free-rat, front-door contact frequencies are recorded by computer as a function of free-rat, restraining-tube contacts as scored from video records. Each *point* is based on a single free-rat performance

define the interquartile ranges. The dashed line through each panel defines the median response latency (left panel) and the number of responses in a session (right panel) from the last three-session block of Condition 3 of Experiment 1. As is apparent, free-rat response latencies and frequencies to the touch sensor were approximately the same as in Condition 3 of Experiment 1.

Discussion

Ben-Ami Bartal et al. (2011) attempted to resolve whether free-rat responding was motivated by empathy or by social contact by having free-rat responding open the rear door of the restraining tube so that a trapped rat could enter a distal chamber. However, the adequacy of that test is called into question by the results of Experiment 2. In our video-based evaluation, most previously restrained rats returned for substantial periods of time to the restraining tube, presumably to be next to the free rats, which also spent much of their time in contact with the restraining tube, presumably to be near the trapped rat (see Fig. 4). If, in fact, the free rat maintained its contact with the restraining tube to be near to the previously trapped rat during those intervals when that rat returned to the restraining tube, and if free-rat proximity to the restraining tube resulted in additional contacts with the touch sensor on the front door—a notion consistent with the results shown in Fig. 5—our findings endorse social contact as motivating free-rat responding during the distal-chamber condition (Condition 3 of Experiment 1) and suggest the same interpretation may be appropriate for the findings in Ben-Ami Bartal et al.

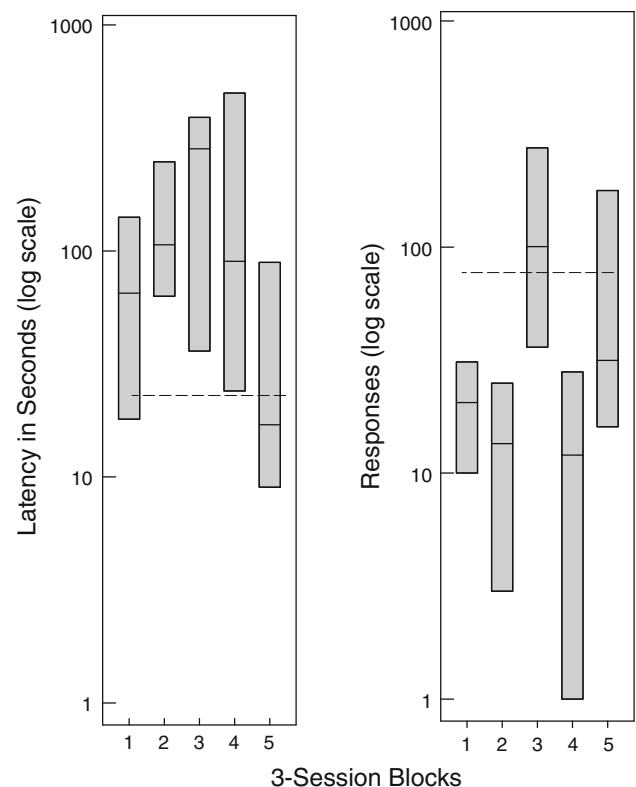


Fig. 6 The *left panel* presents over three-session blocks the time in a session to the first free-rat, front-door contact when free-rat responses did not liberate the trapped rat from the restraining tube. The *dashed line* through the panel defines the median level attained for this measure in the final three-session block of Condition 3, Experiment 1. The *right-hand panel* is identical to the *left-hand panel* except that it measures response frequencies to the front sensor by free rats. The *dashed line* through the figure is the median outcome from the last three-session block of Condition 3, Experiment 1 for this measure

The second part of Experiment 2, where free-rat responding could not open either door of the restraining tube, presents results compatible with the interpretation offered above. With this arrangement, free-rat contacts with the touch sensor had no consequences; hence, they would be expected to extinguish if, in fact, they were reinforced by freeing the trapped rat into the distal chamber. However, if the free rat remained near the restraining tube in order to be proximal to the trapped rat, and if touch contacts occurred as a consequence of this proximity, there would, according to the social-contact hypothesis, be no reason to anticipate a decrease in touch-sensor contacts from the levels seen in Condition 3 of Experiment 1. As Fig. 6 shows, this is the result that obtained—a finding consistent with a social-contact interpretation of free-rat behavior. An empathy account, on the other hand, cannot explain this result because free-rat responding did not liberate the trapped rat from the restraining tube. Therefore, this account predicts that responding should extinguish.

General discussion

In Experiment 1, both the empathy and social-contact hypotheses failed to account for free-rat latency responding across all conditions. The results of Condition 1, where the trapped rat was released into a distal chamber, were compatible with a social-contact thesis, but not an empathy account. The results of Condition 2, where trapped rats were released into the same chamber as the free rats, were compatible with both accounts. Finally, the results of Condition 3, where trapped rats were again released into the distal chamber, were now compatible with an empathy account, but not a social-contact account.

We rationalized these results in a fashion compatible with the social-contact hypothesis by postulating that during Condition 1, trapped rats responded fearfully to the new experiences of being locked in the restraining tube and having the back door of the tube raised by free-rat responding. Such neophobically induced fear is hypothesized to have dissipated over sessions. By Condition 3, the fear might have been eliminated, ending trapped rats' need to avoid the restraining tube, and enabling their motivation to engage in social contact to become apparent when they and their paired companions congregated at the restraining tube. This neophobia-plus-social-contact account organizes all of the results of Ben-Ami Bartal et al. (2011) and the present report.

Vasconcelos et al. (2012) recently listed criteria for inferring empathic intent in an actor. One of those criteria is showing that an actor's rescue behavior is outcome-dependent. As applied to the present study, it should occur when rescue can be successful, but not when rescue is not needed or fails. It is this criterion that Ben-Ami Bartal et al.'s (2011) empathy account does not pass when applied to our data. As regards occurrence when it can be successful, free rats responded with lower vigor as Condition 1 of Experiment 1 progressed. Regarding the required nonoccurrence of responding when it is unneeded or cannot be successful, free rats continued to respond in Condition 3 of Experiment 1 even though the trapped rats already had free access to the distal chamber, and in Experiment 2, free rats responded even though all responses failed to free the trapped rat. These predictive failures of an empathy account require an alternative interpretation of the data. In our view, this goal is realized by the neophobia-plus-social-contact account presented in this report.

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