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Helping Behavior in Rats May Be Facilitated by Social Learning

La Conducta de Ayuda en Ratas Puede Ser Facilitada por el Aprendizaje Social

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Recently, several authors have reported evidence of helping behavior in rats. However, the mechanisms underlying such behavior are unclear. Two experiments with Wistar rats used the task developed by Sato et al. (2015) to assess whether social enhancement affects the helping response. Experiment 1 tested whether rats placed in a dry compartment adjacent to a pool-type compartment (where another rat was trapped) opened a door to allow the trapped wet rat to escape from the water. The behavior of rats was also examined by reversing the roles (wet rats were placed in the dry compartment, while dry rats were placed in the pool-type compartment). The results obtained with 16 rats, using analysis of variance (ANOVA), showed that no rat opened the door to liberate a soaked cagemate; even rats that had previously experienced soaking did not open the door to allow the trapped rat to enter the dry area. In Experiment 2, a pre-training phase was introduced that involved local enhancement (the researchers opened the door). The results obtained with 32 rats and analyzed using an ANOVA showed that, with the pre-training phase, rats learned to help a cagemate, both in the initial and role-reversal sessions. The findings are discussed based on the methodological differences of both studies (such as the housing and strain of rats). The discussion also covers the role of social learning in the modulation of helping behavior in rats, with the desire for social contact being advanced as an alternative explanation for helping behavior.

Keywords: social learning, helping behavior, distress, empathy, rats

Recientemente, varios autores han reportado evidencia de comportamientos de ayuda en ratas. Sin embargo, los mecanismos que subyacen a dichos comportamientos no son claros. Dos experimentos con ratas Wistar emplearon la tarea desarrollada por Sato et al. (2015) para evaluar si el mejoramiento social afecta la respuesta de ayuda. El Experimento 1 evaluó si ratas colocadas en un compartimento seco adyacente a un compartimento tipo piscina (donde otra rata estaba atrapada) abrían una puerta para permitir que la rata mojada escapara del agua. Después, el papel de las ratas se invirtió (las que estaban en la piscina se pasaron al lado seco y las otras se colocaron en la piscina). Los resultados obtenidos con 16 ratas, utilizando análisis de varianza (ANOVA), mostraron que las ratas no abrieron la puerta para liberar a la rata sumergida en agua. Incluso las que fueron sumergidas en el agua previamente fallaron en abrir la puerta a su compañera. En el Experimento 2, se incluyó un pre-entrenamiento que involucró el mejoramiento local (los investigadores abrieron la puerta). Los datos obtenidos con 32 ratas y analizados con un ANOVA indicaron que, con el pre-entrenamiento, las ratas aprendieron a ayudar a su compañera tanto en la sesión inicial como en la inversión de papeles. Los hallazgos se discuten en base a las diferencias metodológicas de ambos estudios (tales como el alojamiento y la cepa de las ratas). También se discute el papel del aprendizaje social en la modulación de la conducta de ayuda en ratas y la explicación alternativa basada en el deseo por el contacto social.

Palabras clave: aprendizaje social, conducta de ayuda, distrés, empatía, ratas

Helping behavior is defined as a voluntary action that benefits a third party and involves an immediate cost to the actor (e.g., Marshall-Pescini et al., 2016; Yamamoto & Takimoto, 2012). For example, Warneken et al. (2007) reported that children did help unfamiliar adults in a situation that involved placing one object (pencil) out of reach for the adult, even when helping was costly (children had to surmount an array of obstacles to get the pencil).

Although in the past helping behavior was considered a hallmark of human animals, nowadays several results indicate that non-human animals like chimpanzees (e.g., Yamamoto et al., 2009), elephants (Plotnik

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et al., 2010), dogs (Bräuer et al., 2013), and ravens (Massen et al., 2015) also show helping behavior. However, the laboratory model to study helping behavior that has received the most attention in the last five years is the rat model (Ben-Ami Bartal et al., 2011; Ben-Ami Bartal et al., 2014; Ben-Ami Bartal et al., 2016; Sato et al., 2015; Schwartz et al., 2017; Silberberg et al., 2014).

For example, Sato et al. (2015) reported an experimental series with rats that demonstrated helping behavior between conspecifics. In Experiment 1, these authors showed that, without explicit training, rats learned to open a door to allow soaked cagemates to escape from a pool of water. Furthermore, given that Sato et al. (2015) observed that switching the rats' roles led to a quicker door opening behavior, they proposed that helping behavior was motivated by empathy. Although accepting the empathic mechanism may seem tempting, it is important to note that the findings were obtained by using a novel experimental task, which raised some concerns about the robustness of the effect (e.g., Silberberg et al., 2014). Since having a solid rodent model to study helping behavior would improve our understanding of the underlying psychological, biological, and evolutionary mechanisms of altruism, it is necessary to continue evaluating the task presented by Sato et al. (2015). In addition, given that in recent years the value of the reproducibility of psychological phenomena has been recognized (Open Science Collaboration, 2015), the main goal of our experiments was to follow up the methods and findings of Sato et al. (2015).

We present the designs in Table 1. We used the same distress situation proposed by Sato et al. (2015; Experiment 1). One rat (R1) was soaked in a pool of water whereas another rat (R2) was placed in an adjacent dry (safe) side. Two phases constituted Experiment 1: door-opening and role-reversal. During the first phase, we evaluated whether R2 helped R1 in a distress situation. Then, we switched R2 and R1's roles and examined whether R1 helped R2. In Experiment 2, the only difference was that we conducted a pre-exposure phase before door-opening.

Experiment 1

In 2015, Sato et al. (2005) developed a low-cost experimental task to study helping behavior in rats. To create a distress situation, researchers soaked a rat in water (the literature on water mazes has shown that an important incentive for rats to solve these mazes is to escape an aversive situation; Hodges, 1996; Morris, 1981; Vorhees & Williams, 2014), while a second rat placed in a ground area had the chance to open the door to liberate the soaked rat. The authors observed that rats helped their cagemate in a distress situation. Given the key role of rodent models in the study of prosocial and empathic behaviors (Meyza et al., 2017), the main goal of our study was to continue evaluating the task proposed by Sato et al. (2015). Thus, we carried out a partial replication of the two main phases of their first experiment: door-opening and role-reversal.

Table 1
Experimental Designs

Experiment	Group	Pre-exposure sessions	Door-opening sessions	Role-reversal sessions
1	Partial replication	------	12 days	3 days
2	NoPre	------	12 days	3 days
	Pre	5 days	12 days	3 days

Note. In Experiment 1, all rats received only door-opening and role-reversal phases. In Experiment 2, two groups of rats were used. Rats in the NoPre group received the same treatment as in Experiment 1, whereas the Pre group experienced 5 days of pre-exposure. Figures indicate the number of sessions conducted in each phase.

Method

Subjects

A group of 16 three-month-old, experimentally naïve female Wistar rats weighing 288 g on average were used (eight pairs). They were housed in groups of four in methracrylate cages (21 x 24 x 46 cm, *height* x *width* x *depth*) inside a room maintained on a 12-12 hours light dark cycle (07:00 onset and 19:00 offset of lights). The temperature of the colony room ranged from 20° to 25°C, while the humidity value was maintained at 45-60%. The rats, provided by the Faculty of Psychology of the Universidad Nacional Autónoma de México, had free access to food and water throughout the experiment.

Apparatus

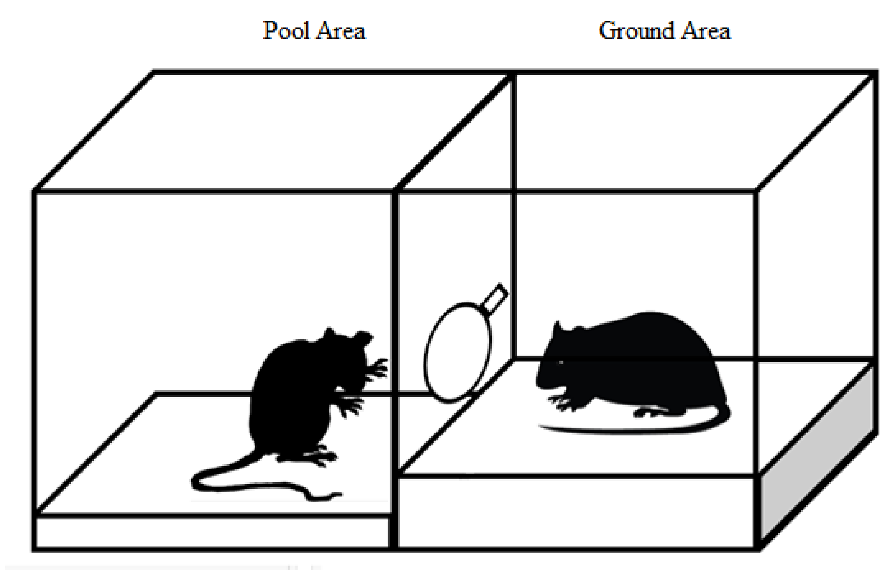
We used two experimental boxes (made of black polyvinyl chloride boards), similar to those employed by Sato et al. (2015) in their Experiment 1 (see Figure 1). Both the pool (45 mm depth of water) and ground areas were 50 x 30 x 30 cm (*height x width x depth*). In addition, the hole (65 mm in diameter) through which rats could pass between areas and the transparent circular door (80 mm diameter) had the same dimensions as in Sato et al.'s Experiment 1. Nevertheless, the circular door from our boxes did not have a handle 30 mm from the center (Sato et al.'s doors did). Note that the door could only be opened by R2 (which could directly roll it open).

Procedure

The experimental protocol was conducted by the experimenter in strict agreement with the guidelines established by the Ethical Committee of the National Autonomous University of Mexico's Faculty of Psychology.

Sessions were conducted on successive days at the same time each day. We used a similar procedure to that reported by Sato et al. (2015) in Experiment 1. Fourteen days before the experimental phases, eight pairs of rats were handled daily for 5 min. On the last day of handling, the rats were randomly classed as R1 or R2. The experiment comprised two phases: door-opening sessions and role-reversal sessions.

Figure 1
Experimental Box



Note. The pool area was filled with water (based on Reynoso-Cruz & Bernal-Gamboa, 2019).

Door-opening sessions. During the next 12 days, the rats were placed in the experimental box. R2 was put in the ground area (the door was closed), while R1 was soaked in water in the pool area (i.e., if the rat stood on its hind legs, about a third of its body was under water). Each session lasted 300 s. One daily session was carried out per pair of rats and could be composed of multiple trials (the session did not end at the first door-opening). For example, if a door-opening occurred, the experimenter waited until R1 entered the ground area and then the rats were again placed in their respective areas (R2 in the ground area; R1 in the pool area). This was repeated throughout the 300 s.

Role-reversal sessions. Over the following three days, the rats' roles were reversed. R1 was placed in the ground area, whereas R2 was soaked in the pool water. One daily session was carried out per pair of rats and could also comprise multiple trials. Each session lasted 300 s.

We show the experimental design in the first row of Table 1.

Statistical Analysis

For all the experiments we present here, it is important to note that, besides using the same dependent variable reported by Sato et al. (2015)—mean latency of the first door-opening—we also implemented a different recording of the door-opening behavior in order to get a more sensitive measure: mean door-opening. Thus, we compared the mean door-opening and the mean latency of door-opening using one-factor and factorial analyses of variance (ANOVA). We also used planned comparisons. We set the rejection criterion at $p < 0.05$ and we reported the effect sizes using partial eta-squared (η_p^2).

Results and Discussion

Figure 2 shows the mean number of door-openings for R2 during the 12 door-opening sessions (black circles) and the three role-reversal sessions for R1 (white circles).

The ANOVA confirmed that the rats did not learn to perform the helping behavior, because there was no difference between the first ($n = 8$, $M = 0.25$, $SD = 0.46$) and the last ($n = 8$, $M = 1.12$, $SD = 1.35$) session of the first phase, $F(1, 14) = 0.23$, $p = 0.770$, or between the first ($n = 8$, $M = 0.62$, $SD = 0.51$) and the last ($n = 8$, $M = 0.75$, $SD = 0.70$) session of the role-reversal phase, $F(1, 14) = 0.15$, $p = 0.984$.

Figure 3 shows the mean door-opening latencies for R2 (door-opening, black circles) and R1 (role-reversal, white circles). An ANOVA showed that the latency for door-opening did not decrease over the course of the experimental sessions, since there was no difference between the first ($n = 8$, $M = 298.12$, $SD = 3.72$) and the last ($n = 8$, $M = 279.87$, $SD = 33.49$) session of both door-opening phases, $F(1, 14) = 0.18$, $p = 0.845$, or between the first ($n = 8$, $M = 293.00$, $SD = 6.21$) and the last ($n = 8$, $M = 282.25$, $SD = 16.99$) session of the role-reversal phase, $F(1, 14) = 0.26$, $p = 0.684$.

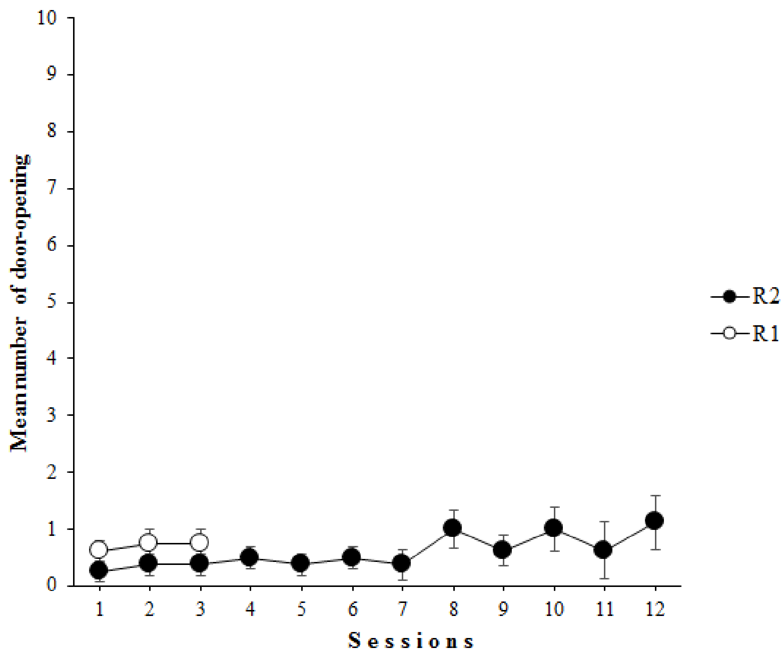
The results show that, under the present conditions, we were unable to replicate the findings of Sato et al. (2015; Experiment 1). In our experiment, the rats did not learn to open the door to liberate their cagemate. Furthermore, rats that had previous experience in the distress situation also failed to show helping behavior.

Experiment 2

Our implementation of Experiment 1 failed to replicate the results of Sato et al. (2015). Before rejecting the adequacy of the present task, we noted a possible methodological issue. Given rats' neophobia, the absence of helping behavior in our previous experiment could be explained by a lack of pre-exposure to the apparatus. In this regard, other rat models for studying helping behavior include a pre-exposure phase (Ben-Ami Bartal et al., 2011; Ben-Ami Bartal et al., 2014). Thus, the main goal of the present experiment was to evaluate whether adding a pre-exposure phase facilitated the helping behavior. Two groups of rats were used: the rats in the NoPre group received the same treatment as those in Experiment 1, whereas the rats in the Pre group experienced five days of pre-exposure to the apparatus.

Figure 2

Experiment 1: Mean Number of Helping Behavior Instances During Door-Opening Sessions (R2) and Role-Reversal Sessions (R1)



Note. The black circles denote door-openings for R2, while the white circles stand for R1 during role-reversal sessions. The bars denote standard errors of the mean.

Method

Subjects

Thirty-two experimentally naïve female Wistar rats weighting 301 g on average were used (16 pairs). All the rats were approximately three months old at the beginning of the experiment. The rats were maintained in the same conditions as in Experiment 1. These rats were also provided by the Faculty of Psychology.

Apparatus

The same experimental boxes as in the previous experiment were used.

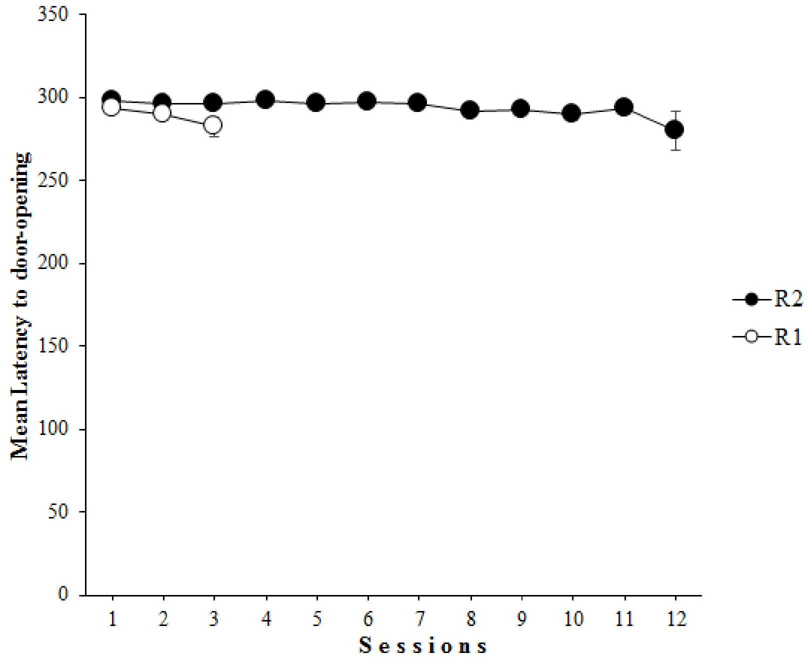
Procedure

Except when noted, we used the same procedure as in Experiment 1. Before the beginning of door-opening, eight pairs of rats (Pre group) received five days of pre-exposure. During the first two days, R1 and R2 were placed together on the ground area with the door closed. The remaining days, only R2 was placed on the ground area. During those days, the researcher opened the door three times a day. All sessions lasted 5 min. Throughout the pre-exposure phase, no water was used in the pool area.

We present the experimental design in the second row of Table 1.

Figure 3

Experiment 1: Mean Latency for Door-Opening and Role-Reversal



Note. The black circles denote the mean latency of the first door-opening for R2 during each door-opening session. The white circles show the mean latencies during each role-reversal session for R1. The bars denote standard errors of the mean.

Results and Discussion

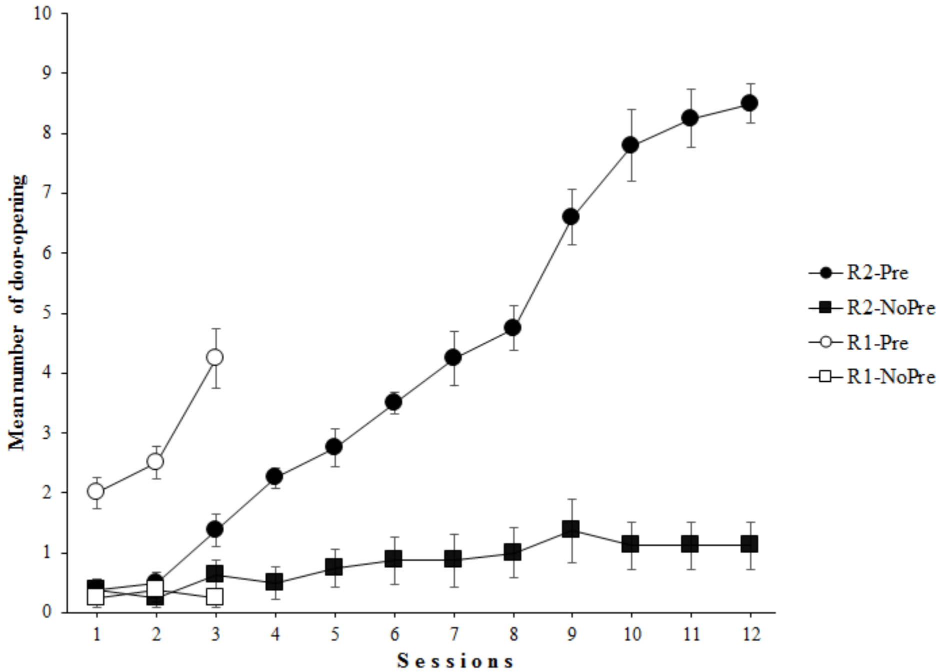
Figure 4 shows the mean number of door-openings during the 12 door-opening sessions (black symbols) and the three role-reversal sessions (white symbols) for the NoPre (squares) and Pre (circles) groups (see Table 2 for additional statistical information).

A 2 (Group) x 12 (Session) factorial ANOVA conducted with the data from the door-opening phase revealed a main effect of Group (the Pre Group showed the highest mean number of door-openings), $F(1, 14) = 100.72$, $p = 0.001$, $\eta_p^2 = 0.87$, 95% CI [0.68, 0.93], and Session (the Pre Group showed the highest increase in door-openings), $F(11, 154) = 67.21$, $p = 0.001$, $\eta_p^2 = 0.83$, 95% CI [0.77, 0.85]. There was also a Group x Session interaction (the Pre Group showed the highest mean number of door-openings as the sessions progressed), $F(11, 154) = 44.13$, $p = 0.001$, $\eta_p^2 = 0.76$, 95% CI [0.68, 0.79]. Subsequent analyses conducted to explore this interaction revealed that the simple effect of Session was significant only in the Pre Group, $F(1, 14) = 86.96$, $p = 0.001$, 95% CI [0.64, 0.92], indicating that the door-opening phase did not proceed similarly for both groups. Planned comparisons showed that the rats in both groups performed similarly during the first two door-opening sessions, largest $F(1, 14) = 4.06$, $p = 0.063$. However, the analyses also showed that, after session 3, only the rats in the Pre Group learned to open the door, smallest $F(1, 14) = 4.06$, $p = 0.043$, 95% CI [0.00, 0.51].

A 2 (Group) x 3 (Session) factorial ANOVA conducted with the data from the role-reversal sessions revealed a main effect of Group (the Pre Group showed the highest mean number of door-openings), $F(1, 14) = 66.30$, $p = 0.001$, $\eta_p^2 = 0.82$, 95% CI [0.56, 0.89]. There was also a main effect of Session (the Pre Group showed the highest increase in door-openings), $F(2, 28) = 16.94$, $p = 0.001$, $\eta_p^2 = 0.54$, 95% CI [0.25, 0.68], and a Group x Session interaction (the Pre Group showed the highest mean number of door-openings as the sessions progressed), $F(2, 28) = 18.25$, $p = 0.001$, $\eta_p^2 = 0.57$, 95% CI [0.27, 0.70]. Subsequent analyses conducted to explore this interaction showed that the simple effect of Session was significant only in the Pre Group, $F(1, 14) = 13.59$, $p = 0.002$, 95% CI [0.09, 0.69], indicating that the groups performed differentially during the Door-opening phase. Planned comparisons showed that, from session 1 onward, the Pre Group did exhibit the helping behavior, smallest $F(1, 14) = 31.18$, $p = 0.001$, 95% CI [0.31, 0.81].

Figure 4

Experiment 2: Mean Number of Helping Behavior Instances for the Pre and NoPre Groups During Door-Opening and Role-Reversal Sessions



Note. The black symbols denote door-openings for the Pre and NoPre groups during door-opening sessions. The white symbols show door-openings for the Pre and NoPre groups during role-reversal sessions. The bars denote standard errors of the mean.

Table 2

Experiment 2: Door-Opening Instances Additional Statistical Information

Group	Door-opening phase (first sessions)	Door-opening phase (last sessions)	Role-reversal phase (first sessions)	Role-reversal phase (last sessions)
Pre	*M* = 0.37	*M* = 8.50	*M* = 2.00	*M* = 4.20
	SD = 0.51	*SD* = 0.92	*SD* = 0.75	*SD* = 1.30
NoPre	*M* = 0.37	*M* = 1.10	*M* = 0.25	*M* = 0.25
	SD = 0.51	*SD* = 1.20	*SD* = 0.46	*SD* = 0.46

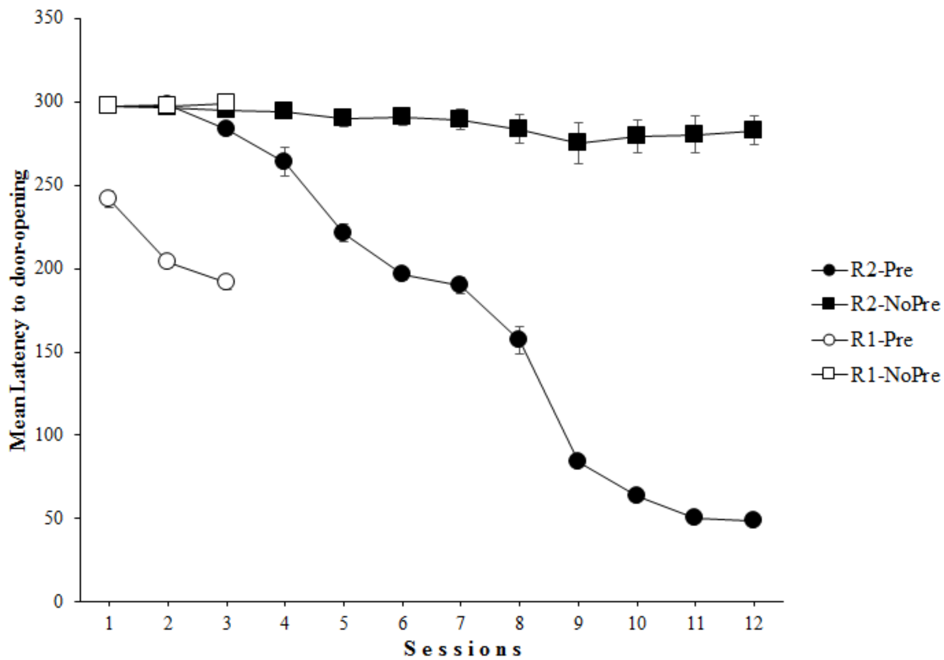
Note. $n = 16$

In order to compare the helping performance of the Pre Group R1 and R2, we conducted a 2 (Role) x 3 (Session) factorial ANOVA. The analyses revealed a main effect of Role (the Pre Group showed the highest mean number of door-openings), $F(1, 14) = 46.39$, $p = 0.001$, $\eta_p^2 = 0.77$, 95% CI [0.45, 0.86], and Session (the Pre Group showed the highest increase in door-openings), $F(2, 28) = 27.19$, $p = 0.001$, $\eta_p^2 = 0.66$, 95% CI [0.39, 0.76]. There was also a Role x Session interaction (the Pre Group showed the highest mean number of door-openings as the sessions progressed), $F(2, 28) = 3.77$, $p = 0.035$, $\eta_p^2 = 0.21$, 95% CI [0.00, 0.41]. Planned comparisons indicated that R1 exhibited a higher number of door-openings during the three role-reversal sessions than R2 during the first three door-opening sessions, smallest $F(1, 14) = 25.17$, $p = 0.001$, 95% CI [0.25, 0.79].

Figure 5 shows the mean door-opening latencies for both groups during the Door-opening phase (black symbols) and the Role-reversal phase (white symbols) for the NoPre (squares) and Pre (circles) groups (see Table 3 for additional statistical information).

Figure 5

Experiment 2: Mean Latency for the Pre and NoPre Groups During Door-Opening and Role-Reversal



Note. The black symbols denote the mean latency for the Pre and NoPre groups during door-opening sessions. The white symbols show the mean latency for the Pre and NoPre groups during role-reversal sessions. The bars denote standard errors of the mean.

Table 3

Experiment 2: Door-Opening Latency Additional Statistical Information

Group	Door-opening phase (first sessions)	Door-opening phase (last sessions)	Role-reversal phase (first sessions)	Role-reversal phase (last sessions)
Pre	M = 297.00	M = 49.00	M = 241.50	M = 191.60
	SD = 5.10	SD = 6.70	SD = 13.90	SD = 11.10
NoPre	M = 297.20	M = 282.80	M = 297.00	M = 298.60
	SD = 3.80	SD = 25.10	SD = 4.30	SD = 2.50

Note. n = 16

A 2 (Group) x 12 (Session) factorial ANOVA conducted with the data from the Door-opening phase indicated a main effect of Group (the Pre Group showed the lowest mean door-opening latency), $F(1, 14) = 295.71$, $p = 0.001$, $\eta_p^2 = 0.95$, 95% CI [0.87, 0.97], and Session (the Pre Group showed the highest decrease in latency), $F(11, 154) = 319.72$, $p = 0.001$, $\eta_p^2 = 0.96$, 95% CI [0.94, 0.96]. There was also a Group x Session interaction (the Pre Group showed the highest decrease in latency as the sessions progressed), $F(11, 154) = 239.82$, $p = 0.001$, $\eta_p^2 = 0.94$, 95% CI [0.92, 0.95]. Subsequent analyses conducted to explore this interaction revealed that the simple effect of Session was significant only to the Pre Group, $F(1, 14) = 272.63$, $p = 0.001$, 95% CI [0.87, 0.97], indicating that the rats in the Pre Group learned the helping behavior faster. Planned comparisons showed that, during the first two sessions, all rats performed similarly, all $F < 1$. The analyses also showed that, after session 3, the rats in the Pre Group opened the door faster, smallest $F(1, 14) = 7.40$, $p = 0.016$, 95% CI [0.01, 0.60].

A 2 (Group) x 3 (Session) ANOVA conducted with the data from the role-reversal sessions revealed a main effect of Group (the Pre Group showed the lowest mean door-opening latency), $F(1, 14) = 737.06$, $p = 0.001$, $\eta_p^2 = 0.98$, 95% CI [0.95, 0.99]. There was also a main effect of Session (the Pre Group showed the highest decrease in latency), $F(2, 28) = 52.18$, $p = 0.001$, $\eta_p^2 = 0.78$, 95% CI [0.60, 0.85], and a Group x Session interaction (the Pre Group showed the highest decrease in latency as the sessions progressed), $F(2, 28) = 57.12$, $p = 0.001$, $\eta_p^2 = 0.80$, 95% CI [0.62, 0.86]. Subsequent analyses conducted to explore this interaction revealed that the simple effect of Session was significant only to the Pre Group, $F(1, 14) = 90.48$, $p = 0.001$, 95% CI [0.65, 0.92], indicating that its performance was faster. Planned comparisons showed that the Pre Group performed the helping action faster during all three sessions, smallest $F(1, 14) = 117.01$, $p = 0.001$, 95% CI [0.72, 0.94].

A 2 (Role) x 3 (Session) ANOVA was conducted to compare the door-opening latency of the Pre group R1 and R2. The analyses revealed a main effect of Role (the Pre Group showed the lowest mean door-opening latency), $F(1, 14) = 597.50$, $p = 0.001$, $\eta_p^2 = 0.97$, 95% CI [0.94, 0.99], and Session (the Pre Group showed the highest decrease in latency), $F(2, 28) = 59.94$, $p = 0.001$, $\eta_p^2 = 0.81$, 95% CI [0.64, 0.87]. There was also a Role x Session interaction (the Pre Group showed the highest decrease in latency as the sessions progressed), $F(2, 28) = 28.13$, $p = 0.001$, $\eta_p^2 = 0.67$, 95% CI [0.41, 0.77]. Planned comparisons showed that R1 were quicker to open the door during the three role-reversal sessions than R2 during the first three door-opening sessions, smallest $F(1, 14) = 112.00$, $p = 0.001$, 95% CI [0.71, 0.93].

General Discussion

The goal of the present experiments was to follow up the study of Sato et al. (2015). Our first experiment was a partial replication of their Experiment 1. Our findings derived from Experiment 1 were inconsistent with the reports of Sato et al., as the rats did not learn to perform the door-opening behavior. The absence of the helping behavior was observed even in the rats that were previously soaked in water. However, since we only performed half as many sessions as Sato et al. (2005), we cannot reject the possibility that extending the role-reversal sessions may be an important factor in observing the behavior. In Experiment 2, we added a pre-exposure phase to familiarize the rats with the apparatus and the task. Here, we found that only the rats that received the pre-exposure quickly learned to open the door to help their cagemates. Moreover, we also observed the helping behavior after transferring the helper role to the soaked rat.

It is important to note the methodological differences between our study and Sato et al.'s (2005), as they might help to explain our findings, particularly those derived from our first experiment. Although we used similar experimental boxes to those employed by Sato et al. (2015) in their Experiment 1, the circular doors were not the same. For instance, the circular doors from our boxes did not have a handle 30 mm from the center (Sato et al.'s doors did). Thus, whereas Sato et al.'s rats could open the door by pushing the handle or directly moving the door, our rats could only open the door by rolling it open. This could have made it more difficult to open the door.

Another methodological distinction is the way the rats were housed. While Sato et al. (2015) housed rats in pairs, in the present experiment all rats were housed in groups of four. Since we did not record the social interaction within the groups, it could be argued that the lack of helping behavior might have been influenced by the establishment of social rank. In this regard, some findings indicate that social rank modulates various social behaviors (e.g., Barker et al., 2017). Although we randomly classed rats as R1 or R2, we cannot completely rule out the possibility that social rank may have played a role in our results.

A third major difference between both studies concerns the rat strains used. Sato et al. (2015) used Sprague-Dawley, whereas in the present experiments we used Wistar. The use of different strains of rats might help to account for the inconsistencies between Sato et al.'s findings and ours. Despite the lack of a direct comparison between strains and their performance in prosocial tasks, it is important to highlight that some studies have reported strain-related differences in animals' learning ability (e.g., Andrews et al., 1995; Kelley et al., 2015).

Although future research should consider the methodological issues mentioned above, our study strongly suggests that the task developed by Sato et al. (2015) is a solid laboratory model to study helping behavior in rats. However, an additional suggestion related to latencies is warranted. In the present study, we took into account the latency of all rats, not only those that opened the door; therefore, subsequent researchers could perform more objective measurements if they only calculate the latency of the animals that did perform the helping behavior.

Beyond the methodological differences noted above, in our study, pre-exposing the rats to the task was observed to favor the helping behavior. Most importantly, given that pre-exposure included door-opening by the experimenter, the present data suggests a key role for social enhancement (e.g., Franz & Matthews, 2010). Social enhancement is a simple form of social learning that changes the observer's behavior through exposure to an actor (Heyes, 1994, 2012). For example, stimulus enhancement increases the likelihood of coming into contact with a specific stimulus by observing another party do so (Warden & Jackson, 1935). Thus, because R2 rats presumably saw the experimenter interacting with the door during some pre-exposure sessions, we can hypothesize that stimulus enhancement modulated their door-opening behavior. Moreover, given that R1 rats presumably witnessed R2 rats (note that R1 rats did not experience the experimenter interacting with the door), directing their behavior to a specific stimulus (i.e., the door) during door-opening sessions, we can hypothesize that R1 rats also opened the door during the role-reversal sessions through stimulus enhancement (despite their shorter pre-exposure phase).

In our view, the differences between the results of Experiment 1 and Experiment 2 might be due to social enhancement. However, it could also be argued that the results differed because the soaked rats of Experiment 1 never experienced getting through the door. As this issue is beyond the scope of the experimental designs employed in the present study, future experiments should examine it in more detail.

Given the relevance of having a robust paradigm for studying altruistic behavior in nonhuman animals, it is important to continue conducting research to understand the underlying mechanisms of helping behavior in rats. These studies would also shed light on the contextual factors (e.g., social interactions, hierarchy, level of distress, strain, species-specific behavior) that might be involved in the performance of helping behavior, prosociality, and empathy in non-human animals (see Cronin, 2012). In addition, as we have stated elsewhere, future research could use this kind of paradigm to study the neural mechanisms involved in social communication and social emotions (Ben-Ami Bartal et al., 2016; Meyza et al., 2017).

It is important to note that our results are not completely inconsistent with the empathic mechanism. If stimulus enhancement alone explained the door-opening behavior, there would be no differences between phases in the Pre group. However, given that all rats performed a faster door-opening behavior during the role-reversal phase, social enhancement might be interacting with empathetic-like feelings toward their distressed cagemate.

Finally, it should be mentioned that there may be an alternative explanation for the present findings. As previously noted, helping behavior is defined as a voluntary action that involves an immediate cost to the actor. In this report, we consider that opening the door is helping, but we did not directly test whether door-opening entails an immediate cost to R2 rats. Moreover, some authors have claimed that door opening could be modulated by the desire for social contact (i.e., door-opening is an instrumental behavior and the soaked rat provides a social reward; see Silberberg et al., 2014). On the other hand, this is not supported by the data reported by Sato et al. (2015; Experiment 2), who showed that rats did not open the door due to the mere presence of a conspecific (a rat was placed in the pool area without water). Rather, the results of Sato et al. (2015) suggest that the door-opening behavior only occurs when the rat is soaked (see also Bernal-Gamboa & Nieto, 2018). Nevertheless, more research needs to be done to clarify the main motivation of rats to perform the door-opening behavior.

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