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El comportamiento de apertura de puerta en ratas motivado por el deseo de contacto social

Door-Opening Behavior in Rats Motivated by Desire for Social Contact

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Resumen

Varios autores han utilizado a los roedores como modelo para estudiar fenómenos de aprendizaje social. Particularmente, algunos investigadores han propuesto a los roedores como un modelo adecuado para estudiar los mecanismos que subyacen al comportamiento pro-social. Hallazgos recientes sugieren que la empatía juega un papel clave en la conducta de ayuda. Sin embargo, también se ha propuesto como explicación alternativa el deseo por el contacto social. Por lo tanto, el principal objetivo del presente experimento fue contrastar ambas explicaciones en un mismo experimento. Se emplearon dos grupos de ratas en una tarea que involucró evaluar a las ratas en parejas. Específicamente, el estudio evaluó si la presencia de una rata compañera era suficiente para evocar la conducta de ayuda (aperturas de puerta), o si, por el contrario, era necesario que el conespecífico estuviera en una situación aversiva (sumergido en agua). Los resultados mostraron que las ratas aprendieron a rápidamente a ejecutar la conducta de ayuda únicamente hacia un conespecífico en la situación aversiva. Sugerimos que un mecanismo empático subyace a los resultados observados.

Palabras Clave: Altruismo, Conducta de Ayuda, Contacto Social, Empatía, Ratas.

Abstract

Several authors have used rodents to model social learning phenomena. In particular, some researchers have proposed rodents as a model for studying the underlying mechanisms of pro-social behavior. Recent findings suggest that empathy plays a key role in helping behavior. However, desire for social contact has also been proposed as an alternative explanation. Thus, the main goal of the present experiment was to contrast both accounts within the same experiment. Two groups of rats were used in a task that involves testing rats in pairs. Particularly, the study evaluated whether the mere presence of a cage mate was sufficient to evoke helping behavior (door openings), or if the presence of a conspecific in an aversive situation is necessary (soaked in water). The results showed that rats quickly learned to perform the helping behavior only towards a distressed cage-mate. We suggested that a mechanism of empathy is responsible for the reported results.

Key Words: Altruism, Empathy, Helping Behavior, Rats, Social Contact

Introducción

Altruism (or helping behavior) is a voluntary action performed to benefit another while involving an immediate cost to the actor (e. g., Silk, 2007). For animals that live in groups, the performance of these behaviors might favor survival of the whole group (e. g., Mason,

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2014; Preston & de Waal, 2002). There are several studies that reported altruism in humans (Hay, Castle, Davies, Demetriou & Stimson, 1999; Svetlova, Nichols & Brownell, 2010; Warneken & Tomasello, 2007) and nonhuman primates (e. g., Barnes, Hill, Langer, Martinez & Santos, 2008; Warneken, Hare, Melis, Hanus & Tomasello, 2007; Yamamoto, Humle & Tanaka, 2009). However, due to several factors such as the complexity of the experimental task and mixed results in literature, the underlying mechanisms of altruism are not clear as of yet (e. g., Marshall-Pescini, Dale, Quervel-Chaumette & Range, 2016; Silberberg, Allouch, Sandfort, Kearns, Karpel & Slotnick, 2014).

However, in recent years some researchers have developed new experimental paradigms with rats (Ben-Ami Bartal, Decety & Mason, 2011; see also Rice & Gainer, 1962). For example, Sato, Tan, Tate and Okada (2015) reported an experimental task in which a rat is soaked in water (pool area) while in an adjacent side another rat is placed in a dry floor (ground area). These authors reported that as sessions progressed (and without explicit reinforcement) the rat in the dry side learned to open a door allowing the soaked rat to cross to the dry (and safe) side of the experimental box (see also, Bernal-Gamboa, Hernández, Reynoso-Cruz & Nieto, 2018).

Sato et al. (2015) argued that their results might be explained by an empathic mechanism. Thus, they proposed that the door-opening behavior was motivated by the rat's ability to share the aversive emotional state of the soaked rat (e. g., Decety, 2011). In order to support their proposal, Sato et al. conducted a second experiment to deal with an alternative explanation based on the desire for social contact (i. e., rat opened the door to interact with the soaked rat; see Silberberg et al., 2014). A new group of rats experienced a situation similar to Experiment 1, however, no water was used (pool area was empty). If door-opening behavior is motivated by desire for social contact, rats would have performed that behavior (just to engage in some form of contact with the other rat). On the other hand, if a motivational component of empathy underlies door-opening behavior, then no such behavior would be observed given that no distress would be shown by the rat. The data reported by Sato et al. was consistent with the mechanism of empathy.

Before accepting that a motivational component of empathy underlies the door-opening behavior, it is important to note that Sato et al. (2015) support their argument by comparing data between different subjects in different experiments (Experiment 1 vs Experiment 2). In addition, Schwartz, Silberberg, Casey, Kearns y Slotnick (2017), noted that the experimental boxes were different in each experiment. For example, the size of the door used in Experiment 1 was 65 mm in diameter whereas in Experiment 2 it had a diameter of 85 mm, making those doors heavier for the rats. Thus, Schwartz et al. argued that the data reported by Sato et al. (2015), Experiment 2, not door-opening observed) could be explained by the size of the doors and not by the mechanism of empathy. Thus, the main goal of the present experiment was to evaluate whether the door-opening behavior in rats is empathetically motivated. We contrasted in a single experiment three accounts: desire for social contact, door size and empathy. Throughout the experiment the same experimental box was used (the door was the same size for all rats). Rats in the Group Water received twelve sessions in which a conspecific experienced an aversive situation (i. e., soaked in water in the pool area), while for rats in the Group NoWater both rats were placed in the experimental box (one rat in each side) but both areas were dry (no rats were soaked in water). If a motivational component of empathy underlies the door-opening behavior, then only rats in Group Water would learn to execute the helping behavior rapidly and consistently.

Method

Subjects

A group of 16 three-month-old experimentally naïve female Wistar rats weighing in average 275g (Group Water) and 274g (Group NoWater) were used (8 pairs). Rats 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 hr light dark cycle (07:00 onset and 19:00 offset of lights). Temperature of the colony room ranged between 20 - 25°C, while the humidity value was maintained at 45-60 %. They had free access to food and water throughout the experiment.

Apparatus

We used an experimental box similar to those employed by Sato et al. (2015) in their Experiment 1 (see Figure 1). In the middle of the box, there was a transparent partition that divided the inside of the box into pool area and ground area. In the ground area the floor was raised 50 mm whereas the pool area was filled with 45 mm of water (just for one group). The partition had a hole (65 mm in diameter) through which rats could pass between areas. In addition, a transparent circular door (80 mm in diameter) was placed in front of the hole. The rat could directly move the door to roll it open. It is important to note that the door could be opened only from the ground area

Procedure

The Ethics Committee of the Faculty of Psychology of the National University of Mexico approved the present experimental protocol.

Figure 1

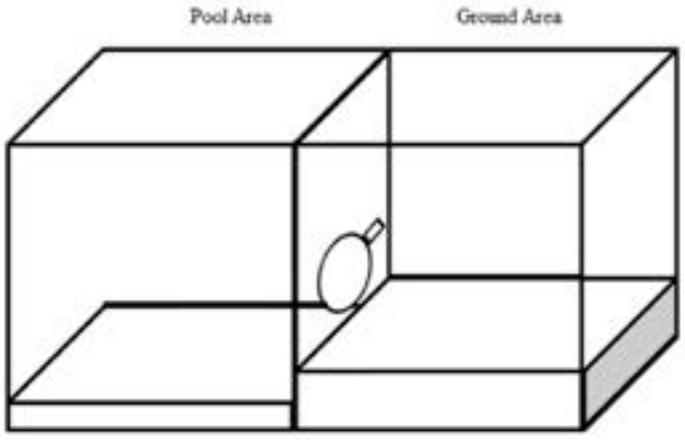

Figure1. Experimental apparatus. Only for rats in the Water Group was the pool area filled with water. See text for details.

Sessions were conducted on successive days, at the same time each day (12:00). We used a procedure similar to the one reported by Sato et al., in Experiment 1 (see also, Bernal-Gamboa et al., 2018). Fourteen days before experimental phases, 8 pairs of rats were handled daily for 5 min. In the last day of handling, rats were randomly assigned as R1 or R2. The experiment consisted on two phases: pre-exposure sessions and door-opening sessions.

Pre-exposure sessions. During the first two days, R1 and R2 were placed together on the ground area with the door closed. The remaining three 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 pre-exposure, no water was used in the pool area.

Door-opening sessions. During the next twelve days, rats were placed in the experimental box. For both groups, R2 was placed in the ground area; however, for rats in the Group Water, R1 was soaked in water in the pool area, while in the Group NoWater, R1 was placed in an empty pool area. Each session lasted 300 s.

Table1
Experimental Design

Groups	Pre-exposure Sessions	Door-opening Sessions
Water	5 days	*12 days
NoWater	5 days	12 days

Note: Two groups of rats were used. All rats received the same treatment during the Pre-exposure Sessions. (*) indicated that the pool area was filled with 45 mm of water only for the Water Group. Numbers indicate the amount of sessions conducted in each phase. See text for details.

Dependent Variable and Statistical Analysis

Mean door-opening and mean latency for door-opening were compared using a mixed analysis of variance (ANOVA, 2W-Repeated Measures). The rejection criterion was set at $p<.05$, and effect sizes were reported using partial eta-squared ($np2$).

Results and Discussion

Figure 2 shows the mean number of door-openings during the twelve Door-opening sessions for Water (black circles) and NoWater (white circles) groups. During the first day, the number of door-openings for rats in the Water Group was .5 (.18) and 1 (.26) in the Group NoWater (standard errors are presented within brackets). On the twelfth day, the number of door-openings for rats in the Water Group was 9.1 (.28) and .87 (.30) in the Group NoWater. A 2 (Group) x 12 (Session) ANOVA conducted with the data from the Door-opening phase found a significant main effect of Group, $F(1, 14) = 1219.35$, $p= .001$, $np2 = .98$. The main effect of Session, $F(11, 154) = 73.91$, $p= .001$, $np2 = .84$ and the Group x Session interaction were also significant, $F(11, 154) = 78.42$, $p= .001$, $np2 = .85$. Subsequent analyses conducted to explore this interaction found that the simple effect of session was significant only for the Group Water, $F(1, 14) = 272.45$, $p= .001$, indicating that the helping behavior (door-opening) only increased in the Group Water. Planned comparisons showed that during the first three sessions both groups performed in a similar way, largest $F(1, 14) = 2.33$, $p = .14$. However, the door-opening behavior was only learned by the Group Water after session four, smallest $F(1, 14) = 10.31$, $p = .006$.

Figure 2

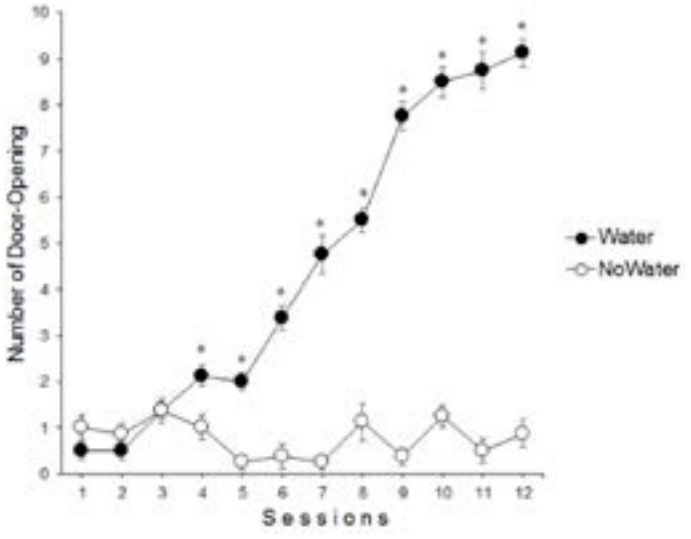

Figure 2. Mean helping behavior throughout Door-opening sessions for both groups. Error bars denote standard errors of the mean. "*" indicates

the statistical significance of differences. Only rats in Group Water performed the helping behavior, F(1, 14) = 272.45, p= .001.

Figure 3 shows the mean latencies for door-opening for both groups during the Door-opening sessions. During the first day, the latency of door-openings for rats in the Water Group was 298.5 seconds (.59) and 295.1 seconds (1.51) in the Group NoWater (standard errors are presented within brackets). On the twelfth day, the latency of door-openings for rats in the Water Group was 49 seconds (2.37) and 291.6 seconds (3.1) in the Group NoWater. A 2 (Group) x 12 (Session) ANOVA conducted with the data from that phase confirmed that only rats in the Group Water were faster to open the door as sessions progressed, finding a significant main effect of Group, F(1, 14) = 2659.70, p= .001, *n*p2 = .99 and Session, F(11, 154) = 455.69, p= .001, *n*p2 = .97. The Group x Session interaction was also significant, F(11, 154) = 456.43, p= .01, *n*p2 = .95. Subsequent analyses conducted to explore this interaction found that the simple effect of session was significant only for the Group Water, F(1, 14) = 4003.88, p= .001, indicating that only rats in the Group Water learned the helping behavior faster. Planned comparisons showed that during the first two sessions, all rats showed similar performance, all F< 1. The analyses also showed that since session five, rats in the Group Water opened the door faster, smallest F(1, 14) = 18.12, p= .001.

Figure 3

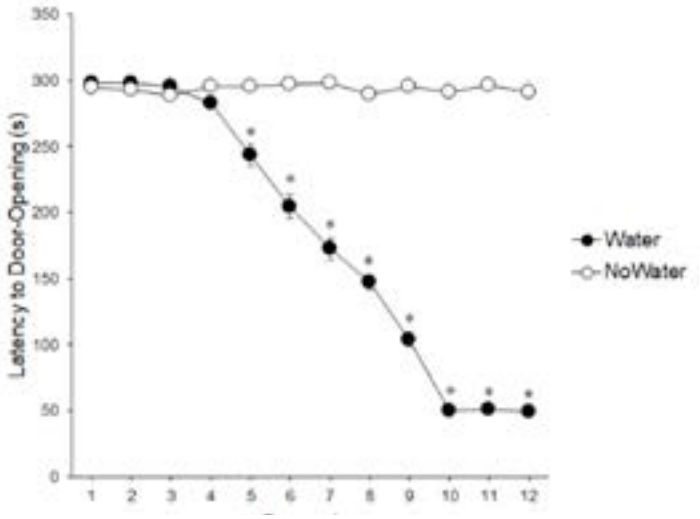

Figure 3. Mean latency for door-openings during each Door-opening session for both groups. Error bars denote standard errors of the mean. "*" indicates the statistical significance of differences. Only rats in Group Water learned the helping behavior faster, F(1, 14) = 4003.88, p= .001.

Discussion.

One experiment with rats analyzed the motivation underlying helping behavior (door-openings). Our data showed that rats did not open the door by the mere presence of a conspecific (Group NoWater). In contrast, our results demonstrate that the door-opening behavior only occurs when the rat is soaked. This finding is consistent with the mechanism of empathy (the rat vicariously feels the distress of the soaked rat, promoting affective communication and motivating the helping action; see, Decety, Norman, Bernston & Cacioppo, 2012).

The present findings replicate and extend the results of Sato et al. (2015, Experiment 1 & 2) to a situation that directly compared both manipulations in a single experimental design. Note that the similarities between our data and Sato et al.'s reports suggest that the experimental task proposed by the Japanese research group is a valid and solid paradigm to study helping behavior (altruism) in laboratory conditions. However, future experiments should complete the behavioral record by incorporating other measures of empathy such as blood levels of corticosterone and vocalizations between rats.

Additionally, it is important to note that the present data suggests that altruistic behavior is not restricted to a gender (Sato et al. used male rats in Experiment 2 while the present experiment used female rats) nor to a strain of rats (we used Wistar rats whereas Sato et al. employed Sprague-Dawley rats) supporting the theoretical view that proposes that phenomena such as prosocial behavior and emotional contagion are shared by all mammals (e. g., de Waal, 2007; Mogil, 2012).

Our findings seem inconsistent with the account that proposed that the door-opening behavior is motivated by the desire for social contact (Silberberg et al., 2014) because the Group NoWater did not learn to open the door. According to this perspective, both groups of rats should show similar levels of door-openings given that in both cases that action would lead to interaction with the rat in the pool area. However, this is not what we found. Thus, our data suggests that the desire for social contact is not sufficient to motivate the door-opening behavior (see also, Ben-Ami Bartal et al., 2011).

The present data did no support the account offered by Schwatrz et al. (2017) either. Those authors claimed that the lack of door-opening behavior reported by Sato et al (2015), Experiment 2) was due to rats being exposed to a heavier door than the one used in Experiment 1. However, such argument is not consistent with our study. On one hand, both groups of rats experienced the same door. On the other hand, R2 rats in both groups had a similar weight (see on Method section).

Thus, the present findings support the theoretical perspective that assumes that the goal of the door-opening behavior was to help R1 escape from the aversive situation (e. g., Ben-Ami Bartal et al., 2014; Bernal-Gamboa & Mason, 2016). In particular, the data here reported is consistent with the view proposed by Frans de Waal. According to his multi-level empathy model (de Waal, 2003, 2008) there are three levels of empathy: emotional contagion, concern for others, and perspective taking. The last two levels are based on emotional contagion which allows a rapid affective communication between subjects. The next level involves execution of actions to relieve others from painful situations.

Finally, the third level is the most complex and implies the attribution of emotional states in others. Hence, according to this model rats in the Group Water opened the door because the first two levels were activated (emotional contagion and concern for others). Furthermore, the performance showed by the Group NoWater could be explained by de Waal's model too (e. g., 2008 see also Preston & de Waal, 2002). Given that R1 rats in that group were not soaked in water, they did not show distress signals, preventing the activation of R2's first empathic level (emotional contagion). Therefore, the model predicts that no door-openings should have occurred. The present data support de Waal's proposal, nevertheless, future studies should continue to further evaluate the validity of that model.

Results reported here are consistent with other research that strongly suggests that rodents are a promissory model to study the psychological and neurobiological mechanisms that underlie empathy in mammals (Bernal-Gamboa, 2017; Langford et al., 2006; Panksepp & Lahvis, 2011; Panksepp & Panksepp, 2013). The development of this incipient line of research might have important implications in many levels. For example, from a comparative perspective, this kind of study may help to understand social phenomena, such as imitation and communication between subjects (e.g., Knapska, Mikosz, Werka & Maren, 2010; Nowak, Werka, & Knapska, 2013).

In addition, given that altruism is one of the major theoretical issues on evolutionary biology (e. g, Dawkins, 1976; Price, 2016, Wilson, 1975), rodent laboratory models might be used to experimentally analyze the distinct perspective accounts (e.g., Fletcher & Doebeli, 2006; Hamilton, 1964; Trivers, 1971). Finally, several authors have claimed the study of empathy in rodents might favor the development of models that may help to understand the etiology of some psychopathologies which involve empathetic deficits, such as autism and borderline personality disorder (e. g., Meyza, Ben-Ami Bartal, Monfils, Panksepp & Knapska, 2017).

In sum, the main finding of the present study is that helping behavior in rats does not depend exclusively on the desire for social contact, since door-opening behavior increased its frequency and decreased its latency only when a conspecific in an aversive situation was present. Despite that the present evidence suggests that a motivational component of empathy is responsible for the reported results, it is important to note that more research is needed in order to improve our understanding about the mechanisms underlying the door-opening behavior in rats. For instance, an additional control condition could involve testing rats with only water in the pool area. This control condition could deal with the suggestion that proximity to water might reinforcing the door opening-behavior (e.g., Schwartz et al., 2017).

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