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Sex differences in aversive memory in rats: Possible role of extinction and reactive emotional factors

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ABSTRACT

Studies usually show better spatial learning in males and stronger emotional memory in females. Spatial memory differences could relate to diverse strategies, while dissimilar stress reactions could cause emotional memory differences. We compared male and female rats in two emotional (classical emotional conditioning and aversive discrimination memory) and two emotionally "neutral" tasks: (1) plus-maze discriminative avoidance, containing two open and two enclosed arms, one of which presenting aversive stimuli (light/noise). No differences were found in learning, retrieving, or basal emotional levels, while only male rats presented extinction of the task; (2) contextual fear conditioning – a cage was paired to mild foot shocks. Upon reexposure, freezing behavior was decreased in females; (3) spontaneous alternation – the animals were expected to alternate among the arms of a four-arm maze. No differences between genders were found and (4) open-field habituation was addressed in an arena which the rats were allowed to explore for 10 min. Habituation was similar between genders. Differences were found only in tasks with strong emotional contexts, where different fear responses and stress effects could be determinant. The lack of extinction of discriminative avoidance by females points out to stronger consolidation and/or impaired extinction of aversive memories.

1. Introduction

Sex differences in learning and memory have been extensively studied in humans and animal models. Studies usually show better spatial learning in males (Astur, Tropp, Sava, Constable, & Marku, 2004; Blokland, Rutten, & Prickaerts, 2006; Jonasson, 2005; Rilea, Roskos-Ewoldsen, & Boles, 2004) and stronger emotional memory in females (Canli, Desmond, Zhao, & Gabrielli, 2002; Hamann, 2005), although males seem to have better performances in hippocampus-dependent emotional tasks (Heinsbroek, Feenstra, Boon, Van Haaren, & Van de Poll, 1988; Kudo, Qiao, Kanba, & Arita, 2004; Van Haaren & Van de Poll, 1984).

The mechanisms underlying sex-specific differences in cognitive performance are not entirely known. Regarding differences in spatial performance, some studies suggest that they are due to use of different strategies by males and females (Blokland et al., 2006; Gibbs & Johnson, 2008; Sandstrom, Kauman, & Huettel, 1998). On the other hand, the differences in spatial performance favoring males are controversial, and there is variation in the results depending on the kind of task used to evaluate spatial memory (Duff & Hampson, 2001; Postma, Jager, Kessels, Koppeschaar, & von Honk, 2004; Rahman, Abrahams, & Jussab, 2005).

Several studies on this issue were performed in rodent models in which aversive or appetitive situations are produced so that the animal can learn the task (Morris water maze and rewarded maze learning, for example) (Astur et al., 2004; Bebbington et al., 2003; Frick, Burlingame, Arters, & Berger-Sweeney, 2000; Jonasson, 2005; Kelly, Goodlett, Hulsether, & West, 1988; Seymoure, Dou, & Juraska, 1996). In this respect, sex differences in memory with significant emotional contexts have been demonstrated (Canli et al., 2002; Shors & Leuner, 2003). In addition, it is also known that stress reactions are different between genders (Shors, 2004; Shors & Leuner, 2003) and these differences could account for both emotional memory and spatial performance differences. Given the close relationship between learning/memory and anxiety/fear states (Mathews, 1990), and that alterations in the anxiety-like behavior of rodents can modify their learning and memory performances (Silva & Frussa-Filho, 2000), it can be hypothesized that different basal or reactive emotional levels could be related to the different performances in the several tasks studied. It has been suggested, for example, that better emotional memory in females could be related to different emotional impact of the stimulus (Canli et al., 2002).

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The aim of the present study is to compare the performance of male and female rats in the plus-maze discriminative avoidance task. Besides being a useful model for studying learning/memory, this animal model also provides simultaneous information about anxiety-like behavior and motor activity of the same animals. In addition, possible sex differences were also investigated in a classical emotional memory task (contextual fear conditioning) and in two spatial tasks without aversive or appetitive contexts (spontaneous alternation and open-field habituation).

2. Methods

2.1. Subjects

Five-month old male and female Wistar rats from our own colony were housed under conditions of controlled temperature (24–25 °C) and lighting (12 h light: 12 h dark, lights on 06h30). Food and water were available *ad libitum* throughout the experiments. Rats were handled in accordance with the Brazilian Society for Neuroscience and Behavior guidelines for the use of animals in research, and all experiments were approved by the local ethical committee. All efforts were made to minimize animal pain, suffering or discomfort. Different animals were used in each behavioral task.

2.2. General procedures

Before each experimental procedure, all the animals were handled for 20 min/day for 5 days. In all experiments, the animals were observed in a random order, and the apparatus was cleaned with a 5% alcohol solution after each behavioral session. The sessions were recorded by a digital camera placed above the apparatus and the behavioral parameters were registered by an animal tracking software (Anymaze, Stoelting, USA). The behavioral sessions were monitored through a computer screen placed in another room.

In order to determine estrous cycle stage, vaginal smears were obtained from all female rats for 2 weeks before as well as immediately after the behavioral sessions. There was no predominance of any stage during the experiments (data not shown).

2.3. Plus-maze discriminative avoidance task

Male ($n = 9$) and female ($n = 10$) rats were tested in this task. The apparatus employed is a modified elevated plus-maze made of wood containing two enclosed arms (50 × 15 × 40 cm) opposite to two open arms (50 × 15 cm). A 100-watt lamp was placed over the middle of one of the enclosed arms (aversive enclosed arm). In the training session, each rat was placed in the centre of the apparatus and, over a period of 10 min, every time the animal entered the enclosed arm containing the lamp, an aversive situation was produced until the animal left the arm. The aversive stimuli were the 100-watt light and an 80 dB noise applied through a speaker placed over the aversive enclosed arm. In the test session, the rats were again placed in the apparatus for 10 min, without receiving the aversive stimulation, with the lamp and the speaker still present over the aversive arm, but turned off. Afterwards, additional six male and nine female rats were submitted to the training and test session, as described, and an extinction retrieval test was performed 24 h after the test. Data from training and test session of these animals were considered together with the previous data from analysis, while data from extinction retrieval task refers only to these animals. Total number of entries in any of the arms, percent time spent in the aversive enclosed arm (time spent in aversive enclosed arm/time spent in both enclosed arms) and percent time spent in open arms (time spent in open arms/time spent in both open and enclosed arms) were registered min by min throughout the sessions and used to evaluate motor activity, learning/memory and anxiety, respectively (Silva & Frussa-Filho, 2000).

2.4. Contextual fear conditioning

Male ($n = 7$) and female ($n = 7$) rats were tested in this task that was accomplished in two consecutive days. The floor of the conditioning box (23 × 20 cm) was made of 25 stainless steel rods (15 mm diameter) through which foot shocks were delivered from a current source. The box was enclosed in a sound attenuating chamber. In the training session the rats were individually placed into the box and after 150 s were given six moderate shocks (2 s long 0.3 mA foot shocks with an interval of 30 s). Thirty seconds after the last shock, rats were returned to their home cage. In the test session, performed 24 h later, the animals were again placed in the chamber for 5 min, without receiving foot shocks. The duration of freezing behavior (defined as the complete immobility of the animal) and the number of escape attempts (defined as rearing and pushing the top of the chamber) were registered during training (pre-conditioning and conditioning phases) and test sessions.

2.5. Spontaneous alternation

Male ($n = 9$) and female ($n = 7$) were individually placed in a plus-maze, made of wood and with four-enclosed-arms (50 × 15 × 40 cm) extending from a central platform (16 × 16 cm). Thus, the animals could visit the arms via a central space. Rats were allowed to explore the apparatus for 10 min during which the number and sequence of arm entries were recorded. The individual arms were named A, B, C and D in clockwise manner. An alternation consisted of four different arm choices in four consecutive arms entries. An entry was scored when all four paws crossed into the arm. Percent alternation (number of alternations made/number of possible alternations) and total entries were calculated.

2.6. Open-field habituation

Male ($n = 9$) and female ($n = 9$) were individually placed in a circular open-field arena (84 cm in diameter) with 32 cm high walls, made of wood and painted in black. Two 10-min sessions were performed, with an interval of 24 h between them. The distance travelled, immobility duration and rearing frequency (defined as the number of times the animals rely on posterior paws), as well as time spent in the centre of the open field were measured in both sessions.

2.7. Statistical analysis

All comparisons between male and female rats in contextual freezing conditioning, spontaneous alternation and open-field habituation tasks as well as parameters obtained from the total duration of each session of plus-maze discriminative avoidance task were performed by independent samples t test. Comparisons between sessions 1 and 2 in open-field habituation were performed by paired-samples t test. The percent time spent in the aversive arm throughout plus-maze discriminative avoidance task sessions was compared by ANOVA with repeated measures, and paired-samples t test was used for specific comparisons within the behavioral session. For these analyses, behavioral sessions were divided in three blocks each: beginning (first 3 min), middle (4–7 min) and ending (last 3 min). Comparison among these blocks was used to evaluate acquisition (training) or extinction (tests) of the task.

3. Results

3.1. Plus-maze discriminative avoidance task

In the training session (Fig. 1A), ANOVA with repeated measures revealed a time (session blocks) effect [$F(2, 64) = 21.25$; $p < 0.001$] but no sex effect [$F(1, 32) = 0.96$; $p = 0.33$] or sex *x* time interaction [$F(2, 64) = 0.72$; $p = 0.49$]. Indeed, both groups presented significant decrements in aversive arm exploration in the second ($t = 2.91$; $p = 0.011$ and $t = 4.51$; $p = 0.000$ for males and females, respectively) and in the third ($t = 3.10$; $p = 0.008$ and $t = 3.61$; $p = 0.002$) blocks compared to the percent time in the aversive arm during the first session block (paired-samples *t* test, Fig. 1A).

When the whole training session was considered for analysis (Fig. 1B), female rats presented increased percent time spent in the aversive enclosed arm when compared to male rats ($t = 2.42$; $p = 0.021$), suggesting sex-related differences in task learning.

In the test session (Fig. 1C), ANOVA with repeated measures revealed significant sex [$F(1, 32) = 8.54$; $p = 0.006$] and sex *x* time interaction [$F(2, 64) = 3.48$; $p = 0.037$] but no time [$F(2, 64) = 2.06$; $p = 0.136$] effects. In the first block, no difference was found for aversive arm exploration between male and female rats ($t = 0.66$; $p = 0.51$). However, in the second ($t = 2.56$; $p = 0.015$) and third ($t = 3.30$; 0.002) blocks male rats presented increased percent time in aversive arm compared to females (independent samples *t* test, Fig. 1C). Indeed, while male rats presented increased percent time in aversive arm in blocks 2 and 3 compared to the first block (reaching statistical significance only in block 3; $t = 2.72$; $p = 0.016$), no difference was found when females' behavior in blocks 2 ($t = 0.94$; $p = 0.36$) and 3 ($t = 0.47$; $p = 0.64$) was compared to block 1 (paired-samples *t* test, Fig. 1C).

When the whole session was considered for analysis (Fig. 1D), female rats presented decreased percent time spent in the aversive enclosed arm when compared to male rats ($t = 3.63$; $p = 0.001$), suggesting sex-related differences in task retrieval. However, as shown in Fig. 1C, this seems to be due to constant avoidance of aversive arm by females throughout the session while males progressively increased aversive arm exploration (see above).

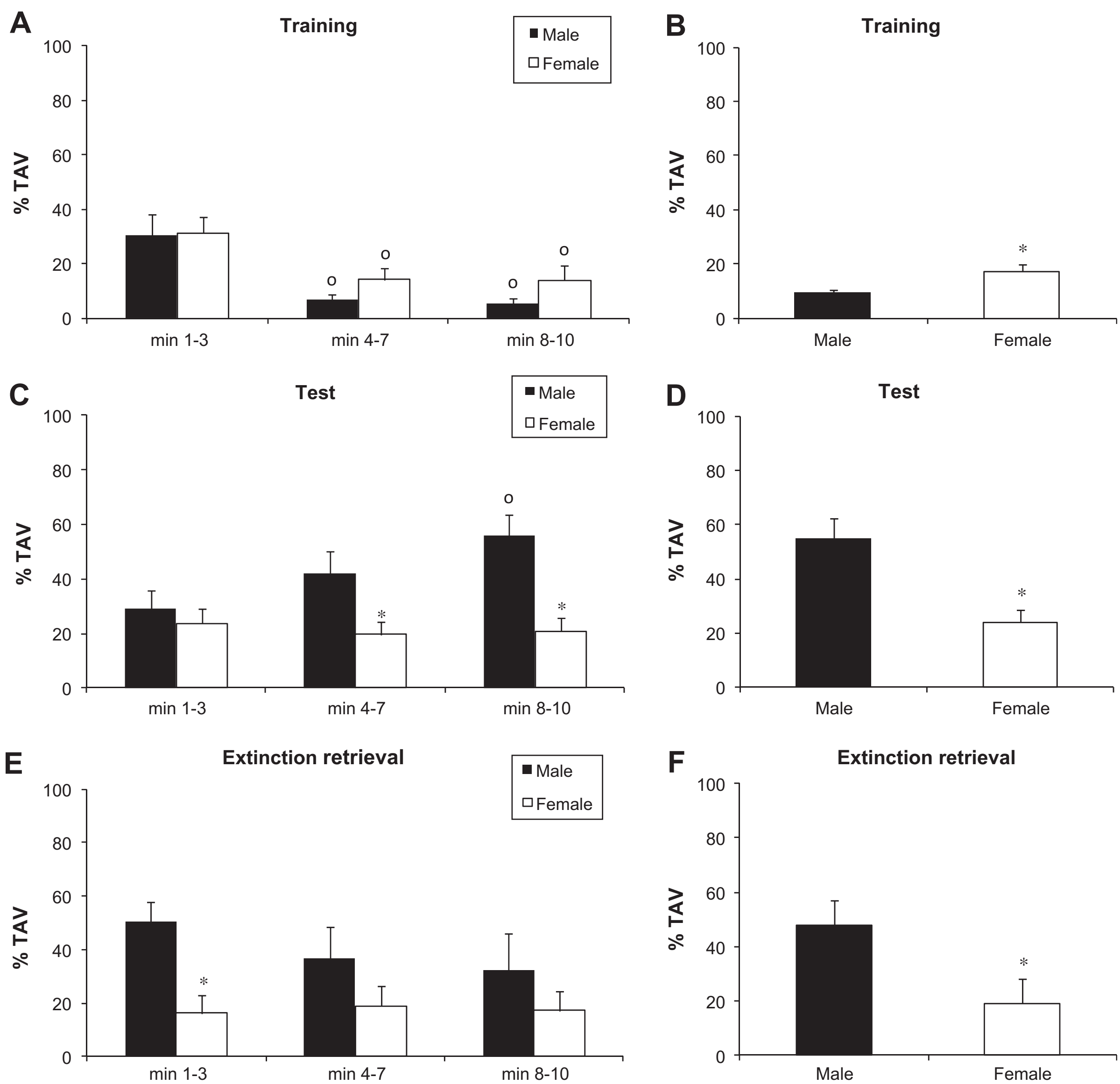

Fig. 1. Sex differences in discriminative avoidance task. Mean ± SE for percent time spent in the aversive enclosed arm (%TAV) in session blocks (A, C and E) or for the whole (B, D, F) training (A and B), test (C and D) and extinction retrieval (E, F) sessions. ANOVA with repeated measures revealed time effect in (A) and sex and time *x* sex interaction effects in (C). $^*p < 0.05$ compared to male rats (independent samples *t* test). $^op < 0.05$ compared to first session block (1–3 min) (paired-samples *t* test).

An extinction trial session was performed in order to confirm the lack of extinction by female rats. In this session (Fig. 1E), ANOVA with repeated measures did not reveal time [$F(2,26) = 1.11$; $p = 0.345$] or sex *x* time interaction [$F(2,26) = 1.65$; $p = 0.211$] effects but sex effect almost reached significance [$F(1,13) = 4.33$; $p = 0.058$]. Indeed, in all session blocks (Fig. 1E) female rats showed decreased aversive arm exploration compared to male (reaching statistical significance only in the first block; $t = 3.36$; $p = 0.005$). This effect was also found when the whole session was considered for analysis (Fig. 1F; $t = 2.25$; $p = 0.043$).

Percent time in open arms and total number of entries did not differ between sexes in any of the sessions (Tables 1 and 2).

3.2. Contextual fear conditioning

During training session, data were analyzed separately during pre-conditioning and conditioning phases.

Freezing duration (Fig. 2A) was increased in males compared to females in all phases, reaching significant levels in pre-conditioning ($t = 2.84$; $p = 0.015$) and test ($t = 2.67$; $p = 0.02$) phases.

The number of escape attempts (Fig. 2B) was decreased in females compared to males during the pre-conditioning phase ($t = 4.37$; $p = 0.001$), and no differences between genders were found in this parameter in the conditioning phase ($t = 1.32$; $p = 0.21$). However, females presented increased number of escape attempts in the test session compared to males ($t = 4.32$; $p = 0.001$).

3.3. Spontaneous alternation

As shown in Table 3, no differences were found in percent of alternation ($t = 0.57$; $p = 0.58$) or total entries in the arms of the maze ($t = 1.36$; $p = 0.19$).

3.4. Open-field habituation

Although female rats presented increased distance travelled in session 2 ($t = 2.18$; $p = 0.044$), both males and females showed open-field habituation, indicated by modified behavior in the second session: a reduction in total distance travelled ($t = 2.34$, 2.70; $p = 0.047$, 0.027 for males and females, respectively, Fig. 3A), and decreased rearing frequency by males ($t = 2.32$, 0.049, Fig. 3B). In addition, females presented increased exploration of the central zone of the open-field (Fig. 3C) in both sessions ($t = 2.39$ and 2.4; $p = 0.029$).

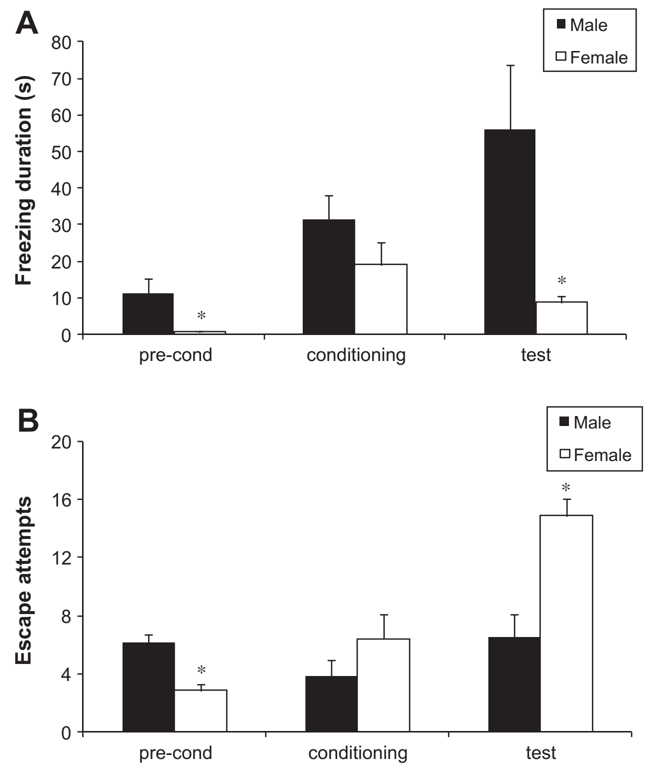

Fig. 2. Sex differences in contextual freezing conditioning: (A) mean freezing duration (s) and (B) number of escape attempts of male and female rats during the pre-conditioning (pre-cond) and conditioning phases (training session) and after contextual fear conditioning (test session). *$p < 0.05$ compared to male rats (independent samples *t* test).

Table 1
Male and female rats' behavior in plus-maze discriminative avoidance task. Percent time spent in the open arms (%TO) and total number of entries in all arms (mean ± SE) in the training, test and extinction retrieval sessions, presented by male and female rats in the plus-maze discriminative avoidance task. No significant differences were found between sexes (independent samples *t* test).

	Training	Test	Extinction retrieval
% TO			
Male	9.5 ± 1.6	3.4 ± 0.9	7.8 ± 2.5
Female	12.7 ± 4.5	9.7 ± 2.2	8.9 ± 3.0
Total entries			
Male	20.5 ± 2.7	8.2 ± 0.9	10.7 ± 2.0
Female	25.0 ± 2.7	8.2 ± 1.1	7.3 ± 1.7

Table 2
Male and female rats' behavior in plus-maze discriminative avoidance task. Total number of entries in all arms (mean ± SE) in each block of the training session presented by male and female rats in the plus-maze discriminative avoidance task. No significant differences were found between sexes (independent samples *t* test).

	1–3 min	4–7 min	8–10 min
Male	11.5 ± 1.1	9.0 ± 1.3	5.2 ± 1.2
Female	9.7 ± 0.5	8.4 ± 1.6	5.2 ± 1.0

Table 3
Spontaneous alternation of male and female rats. Percent alternation among the arms and total number of entries in all arms (mean ± SE) of the four-enclosed-arm plus-maze, presented by male and female rats. No significant differences were found between sexes (independent samples *t* test).

	Training session
% Alternation	
Male	44.4 ± 4.2
Female	48.5 ± 6.0
Total of entries	
Male	28.7 ± 4.2
Female	34.0 ± 3.0

4. Discussion

Compared to males, females showed (1) reduced extinction of the plus-maze discriminative avoidance task; (2) reduced freezing after contextual fear conditioning; (3) similar basal emotional level (plus-maze open arm exploration) and (4) similar spatial tasks performances (spontaneous alternation and open-field habituation).

Several studies performed with the plus-maze discriminative avoidance task have shown the effects of both memory-enhancing (Silva, Bellot, Vital, & Frussa-Filho, 1997) and amnesic procedures

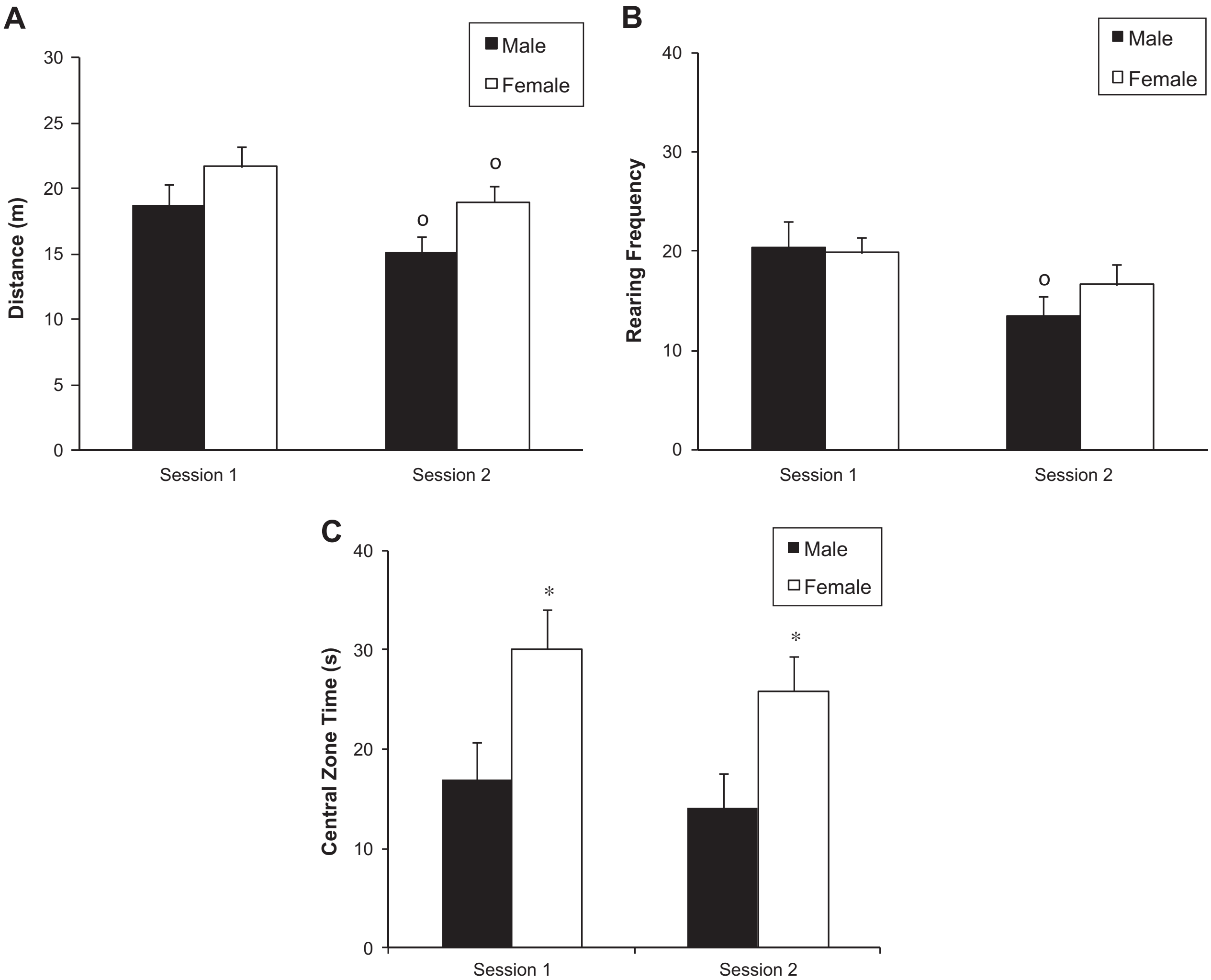

Fig. 3. Open-field habituation by male and female rats. Mean ± SE distance travelled (m) (A), rearing frequency (B) and time spent in the centre of the open-field (C) by male and female rats in two subsequent sessions in an open-field arena. $^*p < 0.05$ compared to male rats (independent samples t test). $^{o}p < 0.05$ compared to session 1 (paired-samples t test).

(Silva, Felicio, & Frussa-Filho, 1999) as well as both increase or decrement in anxiety-related behavior (Silva & Frussa-Filho, 2000) and locomotor activity (Silva et al., 2002a, 2002b) induced by drug administration or other manipulations. The model also allows the evaluation of learning of aversive arm avoidance by analyzing behavior throughout the training session (Silva et al., 2004). In the present study, females showed increased aversive arm exploration when compared to males when the whole session was considered for analysis (Fig. 1B), suggesting a possible learning difference. However, only a time effect was found when ANOVA with repeated measures was applied to compare aversive arm avoidance among session blocks (Fig. 1A), indicating that both sexes learned the task.

The difference in aversive arm exploration could be due to a difference in the exploratory activity displayed by female animals during the first session block. However, no differences were found when number of entries in all arms was compared separately in each session block (see table 2). Alternatively, the increased percent time in aversive arm by females observed when the whole session could be related to increased escape latency. Although not statistically significant, females showed increased mean time in the aversive arm (total time spent in the arm/number of entries in the arm – data not shown).

Irrespective of differences in the acquisition, both sexes have shown retrieval of the task. Indeed, although females showed decreased exploration when the whole test session was considered for analysis, when the first 3 min were analyzed (first session block), no difference was found (Fig. 1C). It should be noted that 3 min, the usual duration of the test session in previous studies, is considered enough to show retrieval of the plus-maze discriminative avoidance task (Silva & Frussa-Filho, 2000; Silva et al., 1997, 1999, 2002b).

In the present study, the test session duration was increased to 10 min in order to study memory extinction in the absence of aversive stimuli. As shown in Fig. 1C, an increase in (previously) aversive arm exploration is observed for male (but not female) rats, indicating extinction of the task. This result was corroborated by the data obtained in the extinction retrieval test, performed 24 h after this test session, in which female (but not male) rats kept avoiding the aversive arm despite the absence of aversive stimulation (Fig. 1E and F). Impaired extinction in female rats could be due to differences in the neurobiological mechanisms of extinction or even a "stronger" consolidation of aversive information, which is in line with the better emotional memory usually reported for women (Canli et al., 2002; Hamann, 2005). Reduced extinction of aversive memories could be related to both depression and anxiety disorders such as PTSD (Milad, Rauch, Pitman, & Quirk, 2006; Rauch, Shin, & Phelps, 2006), and most of these disorders seem to be more prevalent in women (Bebbington et al., 2003; Gater et al., 1998; Kendler, Thornton, & Prescott, 2001). In this respect, unpublished data from our laboratory showed that lack of extinction of the discriminative avoidance task is reverted by antidepressant treatment.

Despite showing learning, retrieval and no extinction of the plus-maze discriminative avoidance task, female rats did not show conditioned freezing in response to contextual conditioning. This finding is in accordance with previous studies (Kudo et al., 2004; Pryce, Lehmann, & Feldon, 1999) and indicates that females present a deficit in learning, consolidating or retrieving this kind of task. As mentioned before, the fact that contextual freezing conditioning is hippocampal-dependent could be related to the better performance observed in males. However, increased fear conditioning was demonstrated in males compared to females even when auditory classical conditioning (hippocampal-independent) was applied (Pryce et al., 1999), indicating that females presented impaired fear conditioning compared to males in a hippocampal-independent task as well. Oh the other hand, this assumption is not in line with results from experiment I (see above), and neither with the possible stronger emotional memory (or lower extinction) in females. In addition, the fact the tendency of females to freeze less is broadly extended to training and test phases (Fig. 2A) suggests that this decrease is not related to the memory retrieval process.

During the fear condition experiments, we observed that females, although not showing freezing response, displayed increased escape behavior compared to males. This is in accordance with the hypothesis of a preference for an active response by females as opposed to freezing showed by males (Astur et al., 2004). To address this issue, we quantified the number of escape attempts in both sexes (Fig. 2B). Indeed, females showed increased escape behavior when compared to males. Although the evaluation of escape behavior is an unusual parameter in fear conditioning tasks, this finding suggests that female rats have learned and retrieved the task, but are responding differently to this conditioning. This hypothesis is reinforced by the fact that escape attempts were increased due to conditioning in females (see Fig. 2B). In this respect, studies have shown differences between sexes in rodent fear responses, possibly because different selection pressures shaped male and female behaviors (Astur et al., 2004; Perrot-Sinal, Gregus, Boudreau, & Kalynchuk, 2004). Alternatively, the increased escape behavior observed in females could be due to enhanced general activity.

Still regarding the apparently discrepant results found in the plus-maze discriminative avoidance and contextual fear conditioning tasks, the difference in the nature of the aversive stimuli used in the two tasks should be noted: the stress caused by the shocks was probably more intense than the one caused by light and noise. Given that stress can lead to different effects on memory depending on the sex of the subject, we could hypothesize that the strong stress of the shock would impair only females' performances while the mild stress induced by the discriminative avoidance training would not be enough to cause this deficit. In line with this rationale, females usually show impaired performance when compared to males when the task involves footshocks, irrespective of the kind of paradigm (Van Haaren & Van de Poll, 1984; Heinsbroek et al., 1988; Kudo et al., 2004; Pryce et al., 1999). Indeed, there is evidence from rodent studies that acute stress impairs females' memory while not altering or even improving males' performances (Shors, Lewczyk, Pacynski, Mathew, & Pickett, 1998; Waddell, Bangasser, & Shors, 2008; Wood, Beylin, & Shors, 2001).

Because it is performed in an adaptation of the conventional plus-maze, the discriminative avoidance procedure allows the concomitant evaluation of basal emotional levels while animals are learning the task (Silva & Frussa-Filho, 2000). In the present study there was no significant difference in open arms exploration when male and female rats were compared. This result corroborates some studies performed in the conventional elevated plus-maze (Bridges & Starkey, 2004; Marcondes, Miguel, Melo, & Spadari-Bratfisch, 2001; Rauch et al., 2006; Rodgers & Cole, 1993; Stock, Foradori, Ford, & Wilson, 2000) and indicates that differences in basal emotional levels between sexes could not account for differences found in the performances. Similarly, possible differences in aversive information processing/consolidation, behavioral fear reaction or susceptibility to stress effects on memory discussed above do not seem to be related to basal emotional levels either. On the other hand, females showed increased time spent in the centre of open-field arena (Fig. 3C), which is an indication of decreased anxiety-like behavior. However, females also showed an increased exploratory activity in this apparatus (although not statistically significant – Fig. 3A). In this respect, it has been shown that parameters related to anxiety levels in animal models can be influenced by the exploratory activity level (Moser, 1989). Accordingly, in the present study, positive correlations were found between the total distance travelled and the time spent in the centre of open-field arena (Pearson's correlation test, $R = 0.67$; $p = 0.05$).

Finally, our data from spatial tasks (spontaneous alternation and open-field habituation) are not in line with the classical view of better performance presented by males in this kind of task. It should be noted, however, that the tasks used in most of the previous studies rely on appetitive or aversive contexts (for example food-rewarded behavior in radial mazes or forced swimming avoidance in water mazes (Afonso, Santana, & Rodriguez, 1993; Archer, 1977; Gater et al., 1998; Gibbs & Johnson, 2008; Gué et al., 2004). Although emotional contexts cannot be completely avoided in behavioral tasks, the spontaneous alternation maze or the open-field arena are certainly less likely to represent strong emotional contexts. Few other studies aimed to address spatial memory comparisons between sexes using more "neutral" tasks, and they are usually in line with our results, i.e., similar performances in males and females. For example, no differences between sexes were demonstrated in spontaneous alternation (Waddell et al., 2008; Wood et al., 2001). However, these results are not in line with some studies performed in humans showing a better working memory in women (Duff & Hampson, 2001; Rahaman et al., 2005), although some of these differences were due to an increased capacity of object location and verbal memory in this gender.

In conclusion, data reported here corroborate the general assumption that males and females perform differently in rodent memory models. However, the differences seem to appear mainly in tasks with strong emotional contexts, where different fear responses and stress effects could be determinant. Although possible sex differences in neurobiological mechanisms of learning and memory remain to be investigated, the lack of extinction of the discriminative avoidance task by females point out to stronger consolidation and/or impaired extinction of aversive memories. This impaired extinction of aversive information suggests difficulties in "changing" aversive into neutral information, which could account for the observed better emotional memory found in some previous studies, and also could be related to the greater prevalence of depression and anxiety disorders among female gender.

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