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RESEARCH ARTICLE

Distribution of Paw Preference in Female and Male Rats: Assessed by A Modified Version Food-Reaching Test [1]

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Summary

We re-studied the distribution of paw preference in male and female rats using a new food-reaching test. Paw preference was assessed using a modified new version of food reaching task in quadrupedal position. Of the total sample (N=165). Of 165 rats, 86 (52.12%) were right-handed, 72 (43.64%) were left-handed, and 7 (4.24%) were mixed-handed. Of the in male (N=74) 36 (48.65%) were right-handed, 35 (47.30%) were left-handed, and 3 (4.05%) were mixed-handed. The right-minus left paw reaches fitted to gaussian data with two prominent peaks due to right–and left preference. In female (N=91) 50 (54.94%) were right-handed, 37 (40.66%) were left-handed, and 4 (4.40%) were mixed-handed. The female right-preference showed a right-bais compared to males. The males left-preference were more than female left-preference.The distribution of right minus left paw reach was not U-shaped, it was J-shaped like in humans. The results indicate that the distribution of paw preference in rats is similar to that of other animals and to human handedness. It was concluded that there is a right-bias in paw rats, which is caused by the female right-preference under the influence of a biological factor. The right-pawed males were found to be least lateralized than the male left-preference, and female right-and left preference. The brain is in general more lateralized than the female brain.

Keywords: *Food reaching, Paw preference, Rat, Laterality, Handedness*

Erkek ve Dişi Sıçanlarda Modifiye Besine Uzanma Test Yöntemi ile Pençe Tercih Dağılımı

Özet

Biz, modifiye bir besine uzanma testi kullanarak, erkek ve dişi sıçanlarda pençe tercihi dağılımını çalıştık. Modifiye besine uzanma testi sıçanlarda dört ayaklı pozisyonda besine uzanması sağlayarak pençe tercihi dağılımını yeniden değerlendirildi. Toplam örneklemin (N=165) 86 (%52.12) sağlak, 72 (%43.64) solak ve 7 (%4.24) iki elli olduğu belirlendi. Erkek sıçanların (N=74) 36 (%48.65) sağlak, 35 (%47.30) solak ve 3 (%4.05) iki elli olduğu belirlendi. Dişilerin ise (N=91) 50 (%54.94) sağlak, 37 (%40.66) solak ve 4 (%4.40) iki elli olduğu belirlendi. Sağ eksi sol pençe normal dağılımı sağ ve sol tarafta pik yaparak gaus eğrisine uyuyordu. Dişilerde, erkeklere göre sağlaklığın daha baskın olduğu gözlendi. Erkekler sol pençe tercih dağılımının dişilerdeki sol pençe tercihine göre daha fazla olduğu saptandı. Sağ eksi sol pençe dağılımı U-dağılımı şeklinde değil de insanlarda olduğu gibi J-dağılımı şeklindeydi. Çalışılan sıçanlarda pençe tercihi dağılımının sonuçları, diğer hayvan ve insan el tercihi dağılımıyla benzerdi. Dişi sıçanlarda sağlaklığın baskın olma nedeni olarak hormonal faktörlerin olduğu sonucuna varıldı. Erkeklerde sağ pençe tercihi erkek sol pençe tercihi ve dişilerde sağ ve sol pençe tercihi göre daha az lateralizedir. Genelde erkek beyni dişi beyninden daha çok laterizedir.

Anahtar sözcükler: *Besine uzanma testi, Pençe tercihi, Sıçan, Laterizasyon, Ellilik*

INTRODUCTION

Right-handedness in conjunction with functions of the left brain such as language and self-consciousness can be considered as one of the most prominent human characteristics. Manuel specialization seems to be of great

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importance in relation to cognition and phyletic basis of human behavioral lateralization [1]. Handedness has been important in this continuity discontinuity debate, largely because right-handedness in humans is associated with the left hemisphere's specialization for language and speech production. Not surprisingly, the first attempts to see whether animals other than humans might be lateralized focused on measuring hand preferences in primates. The first conclusion drawn from these investigations was that on-human primates lacked any species-typical, directional bias for using a preferred hand, although individuals of some species often had hand preferences, left and right in approximately equal numbers, which were seen to be the result of learning through practice [2]. Hand preferences of primates are discussed as part of the broad perspective of brain lateralization in animals, and compared with paw preferences in non-primates. Previously, it has been suggested that primates are more likely to express a species-typical hand preference on complex tasks, especially in the case of coordinated hand use in using tools [3]. The finding of hemispheric specialization in the rat was important for the main point that I am discussing here, because it was not associated with the paw preferences of the rats. Although the rats that a study tested exhibited individual paw preferences to use either the left or right paw to reach into a tube to obtain food, there was no population bias for a preferred paw, whereas the lateralization of hemispheric function was present at a population level, as confirmed many times subsequently [4,5]. In other words, a brain can be lateralized without that lateralization being manifested as a paw or hand preference. These examples demonstrate that species-typical hand/paw preferences are present in some primates and non-primates. Even right-hand preference is not exclusive to humans and did not evolve solely in the hominid line in association with language, as postulated by some authors [6-8].

Hand preference has been centered at the very heart of a debate for a long time in the scientific arena. It has long been known that hand preference exists in animals and it is considered to be similar to the handedness of man [9].

Many factors are thought to be involved in cerebellar lateralization including sex, genetic, and cultural and social environment in which animal is reared. In a previous study it was claimed that animals having a strong left paw preference are as frequent as the ones having right paw preference. He observed such a behavior in cats, rats and mice. Annett's theory of deviation to the right in paw preference based on his observations of through-bred animals and sex dimorfizm. According to his theory, the domination of right-handedness in the development of a person and a population, which indicates a more or less equal distribution, is under the influence of cerebellar lateralization and/or related to the absence of verbal capacity. In a study it was found that right-pawed 25% of the mice were 25% were using their left paws, and 50% were ambidextrous [10,11]. Many authors studied the handedness in both men and animals; on rats, on mice, on cats and rhesus monkeys, and on orangutans and gorillas [12-14,]. On the other hand, observed an inclination to right-pawedness among house mice and left-pawedness in white mice population [15,16]. In rats, a population-level right-handedness was reported since 1930 [17-20]. There are structural and functional asymmetries at the population level in fish, amphibians, and reptiles [21]. Recently, some authors a have reported a population-level right-paw preference in rats, providing further strong support for the argument that humans are not unique in hand preference and that a homology exists between human and rat reaching movement [13].

There are, however, some other reports indicating no population-level right-handedness in rats [9]. According to some author, these seemingly inconsistent results in the literature can be explained in terms of the differences among testing methods have recently used a different method for assessing hand preference in rats [13,19]. They evaluated the frequency of paw reaching, the number of the paw entries within 10min, instead of simple counting of paw entries without considering the time, and found that the distribution of paw preference in rats is J-shaped, and there is a right-sided population bias in handedness as in humans.

This study was carried the distribution of paw preference in male and female rats using a modified new version of food reaching test in quadrupedal position and find the difference, if there is any, in paw usage between male and female animals investigated.

MATERIAL and METHODS

This research was conducted at the laboratories of the Department of Physiology at the Faculty of Medicine, Celal Bayar University. The experiments were performed on male and female Wistar rats adapted to the animal room for at least two weeks.

The paw preference of rats was assessed by the method used by modified food-reaching test [14]. This food-reaching test has been applied to cats, three feet above the food reaching test was modified and wistar albino rats (N=165) was the first time by applying the distribution of rat paw. In this cage, 24x17x12cm (LxWxH) sized transparent plastic cage was used. They could reach the food by a hole in away from the hole in front of the cage and 2 cm high. The rats in this hole in the cage to take feed pellet were observed *(Fig.1 A-B)*. Of 91 female and 74 male rat paw preference was determined by the distribution of food reaching test. Nutrients reach test for each rat right and left in a day for ten days to be repeated a total of fifty-paw. By the observer during the rat chow used to take the total number of right- and left-paw preference was determined by continuing until 50.

Fig 1. Rat observed during the use of the right paw reaching test food in quadrupedal position (A) and side view (B)

Şekil 1. Dört ayak pozisyonundaki sıçanın besine uzanma testi esnasında sağ pençesini kullanımı (A) ve yandan görünüşü (B) görülmektedir

Statistical Analysis: SPSS for Windows (V.15) was used for the statistical analysis of data. Results was calculated for each significant Wilcoxon Signed Rank Test and Mann-Whitney Test.

RESULTS

According to the paw preference in reaching for food, 165 wistar rats were observed. The frequencies of the right-left and mixed handed rats did also not fit to 25:25:50, expected from a binomial distribution. *Table 1* presents the numbers and percentages of the male and female right-, left-, and mixed-pawed rats. Statistical analysis indicated that all categories, right-left-and mixed-handers were not equal (X^2=315, df=0.122, P=.000). Applying a Z-test according to the identicality of difference between right and left paw preferences of rats, they were divided into three groups as right-pawed, left-pawed, and ambidextrous. Total sample to assess paw preference indicated that of 86 (52.12%) were right-preference 72 (43.64%) left-preference, and 7 (4.24%) ambilateral (Z=-1.639, P=0.101), Of 91 female rats, 50 (54.94%), were right-pawed 37 (40.66%) of them were left-pawed and 4 (4.40%) of them were ambidextrous (Z=-0.737, P=0.461). Of 74 male rats, 36 (48.65%) were right-pawed, 35 (47.30%) were left-pawed and 3 (4.05%) of them were ambidextrous (Z=-0.936, P=0.349). The correlation between percentages was examined. The hypothesis test of the difference of two ratios was used. As seen in *Fig. 2*; the percentage difference between the preference of right paw and that of left paw in total sample, male and female rats.

Fig. 3 shows the distributions of the right minus left paw preference in total (A) female (B) and male rats (C). Distributions of the R-L paw reaches for the female rats showed a right-bais compared to male.

Table1. *The female and male rats, the number and percentage of the right-left and mixed-paw usage*
Tablo1. *Dişi ve erkek sıçanların sağ-sol ve karışık pençe kullanım sayısı ve yüzdesi*

Rats	Right-handers		Left-handers		Mixed-handers	
	N	%	N	%	N	%
Total (165)	86	52.12	72	43.64	7	4.24
Females (91)	50	54.94	37	40.66	4	4.40
Males (74)	36	48.65	35	47.30	3	4.05

DISCUSSION

During food-reaching test rats were observed to mainly prefer to use one of their paws. This was found very interesting and worth investigation. It was not known, however, whether this was because of the task they performed, the environment they were reared, or sexual dimorphism. As result of the study conducted in our labs with through bred wistar rats, right handedness was found to be the dominant phenotype of the population. With respect to paw preference in rats, the number of the right-pawed male and female rats were found quite higher than those of the left-pawed and ambidextrous ones. Of 165 rats, 86 (52.12%) were right-handed, 72 (43.64%) were left-handed, and 7 (4.24%) were mixed-handed. There were significantly more right-handers than left-handers. Of the in male (N=74) 36 (48.65%) were right-handed, 35 (47.30%) were left-handed, and 3 (4.05%) were mixed-handed.

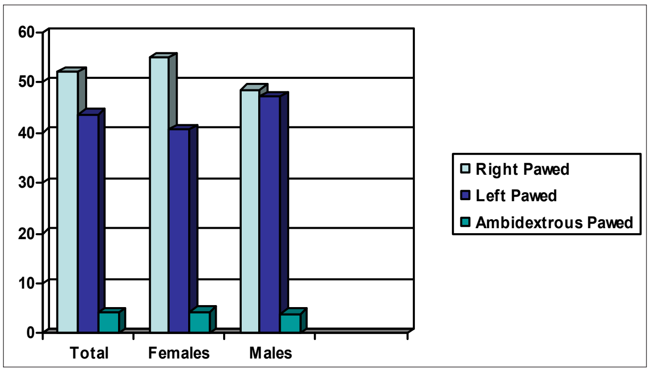

Fig 2. Distribution of right - left and ambidextrous paw preference (right + left = 50) in the total sample, female and male rats
Abscissa: Total sample,female and male, ordinate: Paw percentage of rats

Şekil 2. Toplam örneklem, dişi ve erkek sıçanlarda sağ-sol ve her iki pençe tercihi(sağ+sol=50) dağılımı
Apsis: Toplam örneklem, dişi ve erkek sıçan sayısı, Ordinat: Pençe tercih yüzdesi

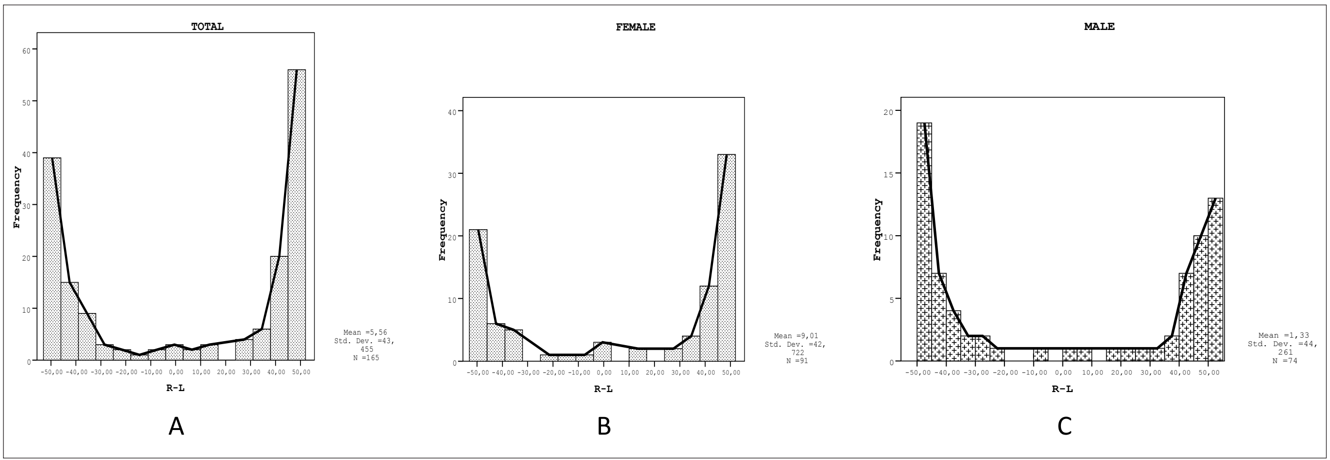

Fig 3. Illustrates the distribution of the right minus left (R-L) in the total sample (A), female (B) and male (C) rats

Şekil 3. Toplam örneklem (A), dişi (B) ve erkek (C) sıçanların sağ eksi sol (R-L) dağılımları görülmektedir

In regarding the paw preference, rats were observed to constitute a dominantly right-pawed community. That rate of right-pawedness was similar to right-handedness in men. The rate of right-pawedness in males was higher than that of females, but this was not statistically important.

In a previous study it was claimed that assertion of the distribution in total rats were 70.2%, right-pawed 19.3% left-pawed and ambidextrous 11.9%; Of the in male rats were 71.2% right-pawed, 16.9% left-pawed and 11.9% ambidextrous; Of the in male female rats were 69% right-pawed, 21.8% left-pawed and 11.9%. ambidextrous [12].

In a study it was claimed that assertion of the distribution of animals as 25% right-pawed, 25% left-pawed and 50% ambidextrous was found to be contradictory to our findings [11]. Although many scientists presume that right-handedness is peculiar to human beings, studies show that animals are also inclined to use their right paws. Although cerebellar laterally was considered to be the essential of many scientific progresses, the evolutionary basis of this odd peculiarity of human beings still a waits for further investigations; Additionally, there should be some kind of explanation regarding the deviation to the right paw preference in other animals too. There should exist the absolute precursor of right-handedness in man. 90% of human beings are right handed in respect of hand preference; but it is asserted that in animals it is distributed coincidentally. That is, only human beings form a right-handed community; but the reason for this is still unknown. From evolutionary aspect, no proof of this manner was found in other animals [11].

While one group of researchers assert that preference of hand is distributed into two groups as right-handed and left-handed; another group claims that hand preference indicates a constant distribution, not an interrupted one. Although there have been widespread thoughts trying to identify right-handedness or left-handedness with intrauterine location and hormonal effects, widespread view is that hand preference is a genetically determined peculiarity. Those who approache the subject from genetic aspect point out that especially hand preference is together with finger print asymmetry which can be observed since the middle of pregnancy period, asymmetry of eye and cerebral asymmetry. It is assumed that environmental factors and left-handedness in the family affect hand preference [22]. In a study it was claimed that the difference between male and female was formed by hormones. The difference in hand preference can be explained by means of the influence of sex characters on the brain, probably the hormone of masculinity, testosterone decreases right-handedness and increases left-handedness [23]. In other a study it was asserted that estrogen, the hormone of femininity, increases left-handedness and increases right-handedness by affecting the brain [24].

Rats are available group to research to comprehend essentials of human asymmetry. Rats are neither so dissimilar as birds, nor similar as apes. One by one rats indicate some neurophysiological and behavioral asymmetry. However there are very small number of findings to prove that rats have a behavioral asymmetry as a species [25].

In our study, in both males and females, the rate of the right-pawed was higher than both the left-pawed and the ambidextrous. Right-pawedness is the function of the left brain hemisphere, and left-pawedness is the function of the right brain hemisphere. The right brain hemisphere is related to the behavior of possessing. Meanwhile, the right brain is important for emotional cases. On earth, it is the right brain that causes people to tend to fight and to prefer avoiding fighting or makes them angry. The right brain develops more rapidly than the left brain, because the struggle for life is more important than speaking ability [17,26,27].

The present study introduced a new method to assess handedness in rats. The distribution of paw preference R- L was also j-shaped as in human hand preference.

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