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The Effects of Melatonin on Open Field Behavior

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GOLUS, P. AND M. G. KING. *The effects of melatonin on open field behavior.* PHARMAC. BIOCHEM. BEHAV. **15**(6) 883–885, 1981.—Open field behavior was studied in rats which had been treated intraperitoneally with 1 mg/kg of melatonin one hour prior to testing. Compared to controls, those rats which had been administered melatonin displayed less postural freezing and increased activity within the central area of the open field. Total ambulation, defecation, rearing and initial latency to move were unaffected by melatonin treatment.

Melatonin Open field behavior Emotionality Rat

THE pineal gland secretes an indoleamine, N-acetyl-5-methoxytryptamine, commonly known as melatonin [16] which may play a role in certain behavioral processes [2, 14, 15, 17]. More specifically, treatment with exogenous melatonin has been reported to affect learning tasks such as active avoidance [17] and passive avoidance [8,15]. Evidence is accumulating that melatonin administration also results in a decreased level of emotionality/arousal when treated animals are exposed to novel stimuli: melatonin significantly inhibits the defecation response during passive avoidance [8] when rats are exposed to a novelty box [9] and it has been [11] shown that melatonin attenuates the neophobic response to a novel taste stimulus [10].

The open field has been used extensively as a laboratory test of rodent emotionality (e.g., [3,5]). It is predicted therefore that treatment with melatonin should modify the emotionality/arousal of rats exposed to such an apparatus. However, Kovacs *et al.* [15] found that melatonin did not alter the exploratory activity as measured by the total number of grids entered or by the defecation response. Considering that the defecation response and total activity were the only measures used in the Kovacs *et al.* [15] study, the purpose of the present experiment was to examine more exhaustively the effect melatonin has on open field behavior by employing a number of additional measures viz. initial latency to move, rearing and freezing.

METHOD

Animals

Sixteen male Wistar rats aged 90 to 100 days at the beginning of the experiment were used. Upon arrival in the laboratory the animals were individually housed in wire mesh cages with free access to food and water. They were maintained on a 12:12 hour light:dark cycle with light on at 0600 a.m. Animals were randomly assigned to either melatonin treatment or control with eight rats per group.

Apparatus

The apparatus was based on the open field described by Broadhurst [5] and consisted of a circular enclosure constructed of white sheet metal secured onto a white wooden base. The enclosure was 80 cm in diameter and the wall 30 cm in height. The floor was subdivided by three concentric circles (9 cm, 25 cm and 40 cm in diameter) with radiating lines from the centre dividing this surface into 19 segments.

Testing occurred under dim red light (illumination open field=0.7 lux) between the 5th and 7th hours of darkness in a sound lagged air-conditioned cubicle (temperature: 23±1°C) adjoining the housing room. This follows the procedures of previous studies.

Procedure

Testing commenced after three weeks adaptation to laboratory conditions. Each animal, depending on the treatment, received an intraperitoneal (IP) injection of either melatonin (1 mg/kg) in a vehicle (0.9% NaCl, 0.01 M acetic acid and 2% ethanol) or a control injection of the vehicle. The injection took place one hour prior to testing following the practice of previous studies [8, 9, 11]. This dose of melatonin produces levels of plasma melatonin in excess of physiological levels [10]. As with the testing, all injections and transport of the animal to the testing cubicle occurred under dim red light.

Duration of the open field test was 30 min for each animal. The following measures were recorded: latency (in secs) to move from the center of the field after initial placement; defecation (the number of fecal boluses deposited); rearing frequency (the number of times the animal stood on its hindlegs); postural freezing, (remaining motionless for a minimum of 5 sec) which is a fixed action pattern to novel stimulation [3,12].

As well, peripheral crossings, the number of grid cross-

ings adjoining the wall and central crossings the number of grids traversed in the central area of the field were recorded.

RESULTS

The data from each of the measures taken was analysed by the t-test. In agreement with the findings of Kovacs *et al.* [15], neither total activity (peripheral plus central crossings) nor defecation differed significantly between the melatonin treated and control animals (p's > 0.05). Frequency of rearing and latency to move, which had not previously been reported, were also found to be non-significant.

To test for any changes in exploration, a proportional measure was employed [4,11] utilizing the central and peripheral crossing scores. This measure was derived using the formula:

$$\text{Exploration Index} = \frac{\text{Number of Central Crossings}}{\text{Number of Total Crossings (central and peripheral)}}$$

An arcsine transformation was performed on the proportional data to satisfy the assumption of normality of distribution. Analysis revealed that there was a significant difference between the groups, $t(14)=2.71$, $p<0.01$, which was the same for the untransformed data. Melatonin treated animals explored the central area of the open field more than their control counterparts (see Fig. 1) and were also found to freeze less than control animals, $t(14)=3.09$, $p<0.005$ (see Fig. 1).

DISCUSSION

As with previous studies [14,15] melatonin treatment did not affect total activity. The defecation response was also unaltered [15] by melatonin. However, Datta and King [8] have shown that melatonin inhibited the defecation response to novel stimuli whereas in the present study and that of Kovacs *et al.* [15] no effect was evident. This incongruence may be attributed to the experimental procedure used since Datta and King [8] employed a handling regimen of three minutes each day for seven days prior to testing. With the Kovacs *et al.* [15] study and the present report no such handling prior to experimentation occurred. Therefore, it is suggested that prior handling may be necessary before melatonin treatment modifies the defecation response of rats to novel stimuli.

The activity of animals within the central and peripheral sections of the open field has been considered as bipolar with respect to the degree of emotionality. Thigmotaxic animals (i.e., animals that stay close to the wall) have been viewed as timid [19], whereas those animals that are active in the central section of the field have been considered as less emotional [13]. Also, it has been emphasized that it is the pattern of behavior rather than the amount of activity in the open field which is of importance in assessing the level of exploration/emotionalty [6, 7, 12]. Thus, the present study utilized the exploration index [12] as a measure of the pattern of behavior to ascertain any behavioral changes due to treatment with melatonin.

The behavioral evidence suggests that melatonin administration decreases the emotionality/arousal of rats [8, 9, 11]. Also, administration of melatonin decreases reported high anxiety levels in humans [2]. The present findings that melatonin increases the animal's level of exploration and decreases freezing in an open field are further support for the notion that melatonin decreases emotional reactivity to novel stimuli.

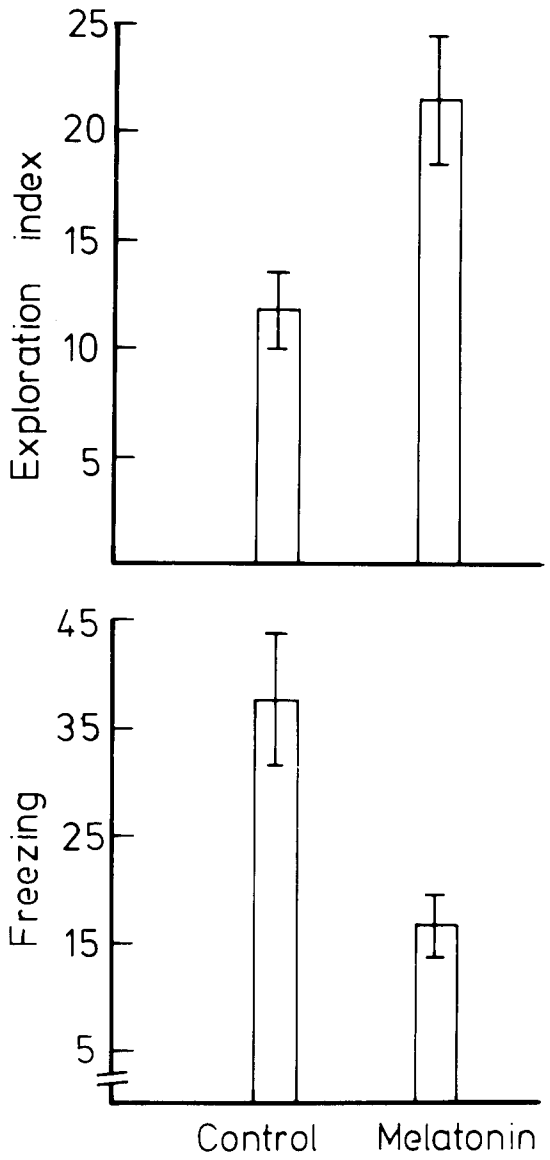

FIG. 1. The effect of melatonin (1 mg/kg) on freezing and exploration (%) within the open field (see text for details).

Brain levels of 5-HT are significantly increased within 60 minutes following IP injection of melatonin [1]. As well, brain 5-HT inhibits the stress response of the hypothalamic-pituitary-adrenal system [18, 20, 21]. therefore, the behavioral changes produced by melatonin may be in part due to the modification of the brain serotoninergic system.

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