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Different Olfactory System Deficits Affect the Antigonadal Action of Light Deprivation Differently in Male Rats

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Twenty-eight day-old male rats were subjeted to: 1) Blinding-olfactory bulbectomy, 2) Blinding-peripheral anosmia, 3) Blinding-accessory olfactory bulbectomy and 4) Blinding-sham olfactory operation. A set of rats remained intact. Six weeks later, their pituitary-gonads-accessory sex organs were studied. Bulbectomy as well as peripheral anosmia exaggerated the antigonadal effects of blindness, while the accessory olfactory system impairment did not. It is suggested that olfactory bulbectomy potentiation of the antigonadal effects of light deprivation is due to a lack of sensory function rather than to bulbectomy itself and that the accessory olfactory system which is involved in the priming pheromonal effects does not play any role in the inhibition of the antigonadal effects of blindness.

Key words: Accessory olfactory bulbectomy, Anosmia, Blindness, LH, Olfactory bulbectomy.

Anosmia by surgical removal of the olfactory bulbs in the rat is known to potentiate the antigonadal effects of light deprivation (10, 13, 14). However, besides the lacking of smell, bulbectomy has several disruptive side effects. Firstly, it interrups the olfactory sensory functions (1) as well as non-sensory functions of the olfactory bulbs (7). Secondly, besides the main olfactory receptors, bulbectomy also interferes with the input from other receptors. Olfactory bulbectomy results in the interruption of the anatomical integrity of the vomeronasal, terminal, trigeminal and perivascular nerves (6). Among them, the main and the accessory olfactory systems (vomeronasal system) are the better documented ones to play a role in the reproductive physiology of rodents (2). Olfactory and vomeronasal systems differ not only in their anatomical pathways and in their projections into the diencephalon (18), but also in their roles related with the reproductive processes (16, 19).

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The following experiment was carried out to further investigate the effects of different olfactory insults on the antigonadal action of light deprivation by the study of the pituitary-gonads-accessory sex organs axis in blinded male rats bearing several olfactory impairments.

Materials and Methods

Male Wistar rats (62.2 ± 1.3 g) of 28 days of age raised in our laboratory were rendered blind by bilateral optic enucleation and submitted to one of the following olfactory insults: 1) Bulbectomy. Olfactory bulbs on both sides were exposed by removal of a small part of the frontal region of the skull roof and incision of the dura mater. The olfactory bulbs were removed by aspiration. 2) Peripheral anosmia was performed by sectioning the olfactory filaments at their emerging through the cribiforme plate, while a 11×3.5 mm aluminium plate was placed between each olfactory bulb and the cribiforme plate in an attempt to avoid reinervation of the glomeruli. 3) Suction of a small part of the dorso cranial area of the bulbs, which mainly involves the accessory olfactory bulbs, under a dissecting microscope, was used as a technique of producing accessory olfactory bulbectomy. Only rats with effective lesions were included in the results. 4) Rats used as surgical controls were similarly treated except that, after the opening of the skull, no lesion was made in the olfactory structures. One set of rats was left intact. All operations were performed under ip tribromoethanol anesthesia (25 mg/100 g b.w.). After surgery the rats were placed 4-6 per cage in a light (12 L: 12 D; lights on at 07.00) and temperature (23°C) controlled room. Sanders rat chow and tap water were provided ad libitum.

Six weeks after operations the rats were killed by decapitation between 10.00 and 12.00 h. Trunk blood was collected and allowed to clot at 4°C overnight. The serum was removed after clotted blood centrifugation and stored at —20°C until assayed for LH. At autopsy, gonads, accessory sex organs, spleen and body weights were recorded. Serum levels of LH were measured as recommended in the directions supplied with NIAMDD kit and expressed in terms of the corresponding LH-RP-1 reference preparation. To avoid interassay variations all samples were measured in the same assay. Intraassay coefficient of variation was 9 % and the sensitivity 1 ng aliquot.

All data were statistically treated using one-way analysis of variance. Differences among the means of groups were made by the multiple comparison test of Tuckey.

Results

The reproductive organs weight and the serum LH levels appear in Table I. Blindness significantly reduced the accessory sex organs growth when compared with those of intact rats. Bulbectomy and peripheral anosmia potentiated the antigonadal effects of blindness as can be seen in the significant lower LH levels and in the inferior relative growth of gonads and accessory sex organs. These parameters in accessory olfactory bulbectomized rats did not differ from those of the blinded sham olfactory operated group. There were no differences noted in the weight of the spleen regardless of the group (control of non-specific growth).

Discussion

Olfactory bulbectomy, as previously reported (14), potentiates the antigonadal actions of light deprivation as manifested by the lower serum levels of LH

Table I. *Effects of blindness and several olfactory deficits from the age of 4 weeks.*
Mean ($\bar{x} \pm$ SEM) body weight (g), relative (mg/100 g BW) gonads and accessory sex organ weights and serum levels of LH (ng/ml) 10-week-old male rats in parenthesis number of determinations. I: Intact, E: Blinded, S: Sham olfactory operated, Bx: Bulbectomized, A: Peripheral deafferented, AOBx: Accessory olfactory deafferented. (a: $p < 0.01$ *vs* I), b: $p < 0.01$ *vs* E-S), (c: $p < 0.01$ *vs* E-Bx).

Groups	Body	LH	Testes	Seminal vesicles	Ventral prostate	Spleen
I	275.5 ± 5.1 (14)	11.9 ± 2.8 (10)	988.4 ± 27.5 (14)	94.5 ± 6.0 (14)	101.7 ± 4.9 (14)	216.5 ± 10.4 (14)
E-S	235.5 ± 7.2 (14)[a]	7.9 ± 2.1 (10)	1009.9 ± 49.3 (14)	56.3 ± 6.4 (14)[a]	63.5 ± 5.9 (14)[a]	239.7 ± 19.2 (14)
E-Bx	181.8 ± 4.8 (10)[ab]	4.4 ± 0.9 (10)[a]	583.5 ± 80.9 (10)[ab]	10.7 ± 1.3 (10)[ab]	12.1 ± 1.4 (10)[ab]	251.3 ± 17.5 (10)
E-A	222.0 ± 8.5 (13)[ac]	5.1 ± 0.3 (6)[a]	831.3 ± 48.4 (13)[abc]	23.3 ± 3.5 (13)[ab]	41.5 ± 5.7 (13)[abc]	250.9 ± 15.9 (12)
E-AOBx	236.5 ± 5.4 (20)[a]	12.1 ± 3.0 (8)	1075.5 ± 25.0 (20)	65.8 ± 6.5 (20)[a]	73.2 ± 8.9 (20)[a]	234.7 ± 11.9 (9)

and by the reduction in weight of gonads, seminal vesicles and ventral prostate. Pinealectomy is a very well known manipulation to prevent these effects (13). Peripheral anosmia also potentiates the antigonadal action of blindness (Table I) but to a lesser extent than bulbectomy does. Although this fact should be interpreted with caution, since some olfactory nerves might have remained intact, it is reasonable to think bulbectomy-potentiated antigonadal action of light deprivation is due to an effect of the anosmia rather than to a loss of non-olfactory functions of the olfactory bulbs (7). The results describe new details on the possible mechanism involved in the role of olfaction in the neuroendocrine-reproductive axis. While the main olfactory influences are of significance in preventing the antigonadal effects of blindness, the vomeronasal influences are not. A similar lack in the potentiation of the antigonadal effects of blindness by accessory olfactory bulbectomy has been obtained by intracranial sectioning of the vomeronasal nerves (unpublished observations).

The accessory olfactory bulbs which receive chemosensory input from the vomeronasal organs, send projections to the «vomeronasal amygdala»; on the other hand, main olfactory bulbs send projections to the olfactory tubercle, prepyriform cortex, ventrolateral enthorinal area and to the «olfactory amygdala» (18). Furthermore, projections from the vomeronasal amygdala arrive predominantly at the medial hypothalamus (8), while the projections of the olfactory amygdala do so at the piriform and enthorinal cortex, subiculo, bed nucleus of the stria terminalis and at the olfactory tubercle (9).

Sexual related opposite functions of both olfactory systems have been reported. Electrochemical stimulation of the above cited amygdala areas produce activatory and inhibitory influences on the gonadotrophin secretion, respectively (3). The electrochemical stimulation in the main olfactory bulb of ovariectomized estrogen-primed rats has no effects on the release of LH, but when the stimulus was applied in the accessory olfactory bulb a release of LH took place (4). While the oxygen uptake fluctuates during the estral cycle of the rat in the accessory olfactory bulb, it does not show differences in the main olfactory bulb (15). In the absence of vomeronasal receptors, female mice are not able to show a neuroendocrine response to male pheromones but they are able to detect male odours; in the absence of olfactory receptors, the discrimination of male odours is not possible, but the neuroendocrine response is maintained (11).

A dual gonadotrophic function of the olfactory sense arises. The main olfactory input would be preferentially concerned with: mating behavior (12), discrimination of sexual preferences (11) and with the inhibition of the antigonadal effects of blindness (10, 13, 14), wherever the neural sites at which the pineal antigonadotrophic substances, as melatonin, act (14). The accessory olfactory input, mainly related with priming pheromones (16, 17) would stimulate the hypothalamus-pytuitary-axis (4, 5) and consequently the gonadal function (20).

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Resumen

Se estudia en ratas macho de 28 días de edad el efecto de las siguientes manipulaciones experimentales: 1) Ceguera-bulbectomía olfatoría, 2) Ceguera-anosmia periférica, 3) Ceguera-bulbectomía del sistema olfatorio accesorio, y 4) Ceguera-falsa operación olfatoria, sobre el eje hipófisis-gónadas-órganos sexuales accesorios

a las seis semanas de la operación. Un grupo de ratas permanece intacto. Tanto la bulbectomía olfatoria como la anosmia periférica potencian los efectos antigonadales de la ceguera, mientras que el déficit del sistema olfatorio accesorio no produce efecto alguno. Se concluye que la potenciación de los efectos antigonadales de la deprivación de la luz es debida a una pérdida de percepción sensorial más que a la bulbectomia y que el sistema olfatorio accesorio, que está involucrado en los efectos endocrinológicos feromonales, no participa en la inhibición olfatoria de los efectos antigonadales de la ceguera.

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