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INFLUENCE OF PHYSICAL EXERCISE ON MOTOR BEHAVIOR IN EXPERIMENTALLY INDUCED DEPRESSION (NOTE I)

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ABSTRACT. Depression, studied over the past 50 years in animal models with genetic or experimentally induced depression, is associated with locomotor, anxiety, motor learning and memory changes. We aimed to study in animals, male Wistar rats, in which depression was experimentally induced, the antidepressant effect of exercise on locomotor, exploratory and emotional behavior. The performance of physical exercise in animals with induced depression and the improvement of locomotor activity evidenced by us were reported by other authors (Hendriksen et al. 2012; Van Hoomissen et al. 2011). The insignificant changes of emotivity in experimental depression are not influenced by physical exercise. Physical exercise has favorable effects on motor behavior, does not influence emotivity and has antidepressant effects in animals with olfactory bulbectomy induced depression, a model that mimics major depression in humans.

Keywords: physical exercise, depression, motility, emotivity.

REZUMAT. Influenţa efortului fizic asupra comportamentului motor în depresia indusă experimental (Nota I). Depresia, studiată în ultimii 50 ani, pe modele animale genice sau cu depresie indusă experimental, este asociată cu modificări locomotorii, de anxietate, de învăţare motorie şi de memorie. Ne-am propus să studiem efectul antidepresiv al efortului asupra comportamentului locomotor, explorator şi emoţional. Ne-am propus să studiem pe animale, şobolani masculi rasa Wistar, la care s-a indus experimental depresia, efectul antidepresiv al efortului asupra comportamentului locomotor, explorator şi emoţional. Efectuarea efortului fizic la animale cu depresie indusă şi îmbunătăţirea activităţii locomotorii evidenţiată de noi, a fost semnalată şi de alţi autori (Hendriksen ş.c. 2012; Van Hoomissen ş.c. 2011). Modificările nesemnificative ale emotivităţii în depresia experimentală nu sunt influenţate de efortul fizic. Efortul fizic are efecte favorabile asupra comportamentului motor, nu influenţează emotivitatea şi are efecte antidepresive la animale cu depresie indusă prin bulbectomie olfactivă, model care simulează depresia majoră la om.

Cuvinte cheie: efort fizic, depresie, motilitate, emotivitate

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Introduction

Depression, studied over the past 50 years in animal models with genetic or experimentally induced depression, is associated with locomotor, anxiety, motor learning and memory changes.

Locomotor behavior changes in depression have been studied particularly in models of olfactory bulbectomy induced depression (Takahashi et al. 2011; Romeas et al. 2009; Gao et al. 2009; Roche et al. 2008; Mchedlidze et al. 2011) and less in models of olfactory bulbectomy induced depression and exercise (Van Hoomissen et al. 2011; Hendriksen et al. 2012).

Objectives

We aimed to study in animals, male Wistar rats, in which depression was experimentally induced, the antidepressant effect of exercise on locomotor, exploratory and emotional behavior.

Material and methods

The research was performed in male Wistar rats aged 4 months, with a weight of 200-250 g, from the Biobasis of the "Iuliu Haţieganu" University of Medicine and Pharmacy Cluj-Napoca. The studies were carried out in the Experimental Research Laboratory of the Department of Physiology, with the approval of the Bioethics Board.

Groups (n = 10 animals/group)

- group C – control group of males
- group I – males with depression
- group II – males with depression, subjected to an exercise test through the swimming test (1 hour daily for 28 days)

Behavior testing methods

- The tail suspension test – TST as an alternative to the forced swimming test (adaptation of Steru et al. 1985) for determining antidepressant activity based on the immobility time, expressed in seconds;
- The open field test (OFT) according to Denenberg and Whimby (1963) for testing spontaneous motility based on the motility score (sum of transitions/excursions) and emotivity based on the emotional score (sum of micturitions and defecations expressed in absolute values).

Examination moments: T_1 (day 1) and T_{28} (day 28)

a. Depression was induced using the Kelly method (1987) through bilateral olfactory bulbectomy
b. OFT at T_1 and T_{28}
c. Daily physical exercise – the pool swimming test after day 7 postoperatively

Statistical analysis

Statistical processing was performed with the Excel application (Microsoft Office 2007) and the StatsDirect v.2.7.2 software. The results were graphically represented using the Excel application (Microsoft Office 2007).

Results

The statistical analysis of the **TST test** values, *considering all groups*, evidenced highly statistically significant differences between at least two of the groups both at moment T_1 ($p = 1.31 \times 10^{-16}$) and at moment T_{28} ($p = 2.09 \times 10^{-18}$).

The statistical analysis of the **open field test** values **– emotional score,** *considering all groups,* evidenced no statistically significant differences between any of the groups, at moment T_1 ($p = 0.8309$) or at moment T_{28} ($p = 0.4021$).

The statistical analysis of the **open field test** values **– motility score,** *considering all groups,* evidenced highly statistically significant differences between at least two groups both at moment T_1 and at moment T_{28} ($p < 0.0001$).

The statistical analysis of the values of the studied indicators **for unpaired samples (group C – group I)**, showed:

- for the TST test
  - highly statistically significant differences between the two groups at moments T_1 and T_{28} ($p < 0.001$)
- for the open field test
  - differences without statistical significance in the *emotional score* values between the two groups at moments T_1 and T_{28} ($p>0.05$)
  - highly statistically significant differences in the *motility score* values between the two groups at moments T_1 and T_{28} ($p < 0.001$)

The statistical analysis of the values of the studied indicators **for unpaired samples (group C – group II)** showed:

- for the TST test
  - highly statistically significant differences between the two groups at moments T_1 and T_{28} ($p < 0.001$)
- for the open field test
  - differences without statistical significance in the *emotional score* values between the two groups at moments T_1 and T_{28} ($p > 0.05$)
  - highly statistically significant differences in the *motility score* values between the two groups at moments T_1 and T_{28} ($p < 0.001$)

The statistical analysis of the values of the studied indicators **for unpaired samples (group I – group II)** showed:

- for the TST test
    - highly statistically significant differences between the two groups at moment T_{28} ($p < 0.001$)
- for the open field test
    - differences without statistical significance in the *emotional score* values between the two groups at moments T_1 and T_{28} ($p > 0.05$)
    - highly statistically significant differences in the *motility score* values between the two groups at moment T_{28} ($p < 0.001$)

The statistical analysis of the values of the studied indicators **for paired samples (moments T_1 – T_{28} in group I)** showed:

- for the TST test
    - highly statistically significant differences between the two moments ($p < 0.001$)
- for the open field test
    - differences without statistical significance in the *emotional score* as well as the *motility score* values ($p > 0.05$)

The statistical analysis of the values of the studied indicators for **paired samples (moments T_1 – T_{28} in group II)** evidenced:

- for the TST test
    - highly statistically significant differences between the two moments ($p < 0.001$)
- for the open field test
    - differences without statistical significance in the *emotional score* values ($p > 0.05$)
    - highly statistically significant differences between the two moments in the *motility score* values ($p < 0.001$)

Table I.

Comparative analysis for the values of the studied indicators in the two groups and statistical significance

Group	Test			Mean	SE	Median	SD	Min.	Max.	*Statistical significance (p)* Unpaired samples	
										group C – group I	group C – group II
CONTROL GROUP	TST test	tail suspension	T_1	9.3	0.4726	9	1.4944	7	12	**7.46×10^{-12}**	**7.92×10^{-12}**
			T_{28}							**1.6×10^{-10}**	**2.78×10^{-12}**
	Open field test	emotional score	T_1	9.2	0.7424	10	2.3476	5	12	0.5975	0.8154
			T_{28}							0.2492	0.4755
		motility score	T_1							**2.63×10^{-9}**	**7.77×10^{-10}**
			T_{28}	20.1	0.6904	20	2.1833	17	23	**< 0.0001**	**0.0003**
			T_{28}							**0.0003**	**< 0.0001**
		excursions	T_1	2.93	0.0562	2.92	0.1776	2.67	3.33	**< 0.0001**	0.0754
			T_{28}							**6.67×10^{-11}**	**< 0.0001**
		time in D	T_1	3.58	0.1369	3.63	0.4329	2.83	4.17	**< 0.0001**	**< 0.0001**
			T_{28}							**3.66×10^{-16}**	**1.49×10^{-17}**
		latency time	T_1							**< 0.0001**	**< 0.0001**
			T_{28}	32.28	0.6745	32.67	2.1330	26.92	34.75	**< 0.0001**	**< 0.0001**
			T_{28}							0.33	0.5196
		excursions	T_1	10.5	0.6540	10	2.0683	8	14	**< 0.0001**	**< 0.0001**
			T_{28}							**< 0.0001**	**< 0.0001**
		time in D	T_1	32.2	2.5465	33.5	8.0526	18	42	**< 0.0001**	**0.0015**
			T_{28}							0.0006	**0.0086**
		latency time	T_1	60		60		60	60	–	–
			T_{28}							–	–
										group I – group II	
GROUP I	TST test	tail suspension	T_1	19.5	0.3416	19.5	1.0801	18	21	**0.8620**	
			T_{28}	45.7	1.5567	46	4.9227	38	52	**5.89×10^{-8}**	
	Open field test	emotional score	T_1	8.7	0.5588	8	1.7670	6	12	0.6668	
			T_{28}	8.1	0.5467	8.5	1.7288	5	11	0.4494	
		motility score	T_1	9.8	0.3590	10	1.1353	8	12	0.3565	
			T_{28}	10.4	0.3399	10.5	1.0750	8	12	**< 0.0001**	
			T_{28}	5.4	0.3399	5	1.0750	4	7	0.0533	
		excursions	T_1	3.4	0.2211	3.5	0.6992	2	4	**0.01**	
			T_{28}	6.5	0.3727	7	1.1785	5	8	0.9091	
		time in D	T_1	16.6	0.7630	17.5	2.4129	12	19	**0.0186**	
			T_{28}	19.2	0.6110	18.5	1.9322	17	22	**0.0002**	
		latency time	T_1	60		60		60	60	–	
			T_{28}	60		60		60	60	–	
										Paired samples (T_1 – T_{28})	
										group I	group II
GROUP II	TST test	tail suspension	T_1	19.4	0.4522	19	1.4298	17	22	**9.14×10^{-8}**	**1.26×10^{-6}**
			T_{28}	26.8	0.7272	27	2.2998	23	30		
	Open field test	emotional score	T_1	9	0.3944	9	1.2472	7	11	0.3288	0.4945
			T_{28}	8.6	0.3399	9	1.0750	7	10		
		motility score	T_1	9.1	0.6403	9.5	2.0248	6	12	0.3125	**1.28×10^{-5}**
			T_{28}	16.3	0.3958	16	1.2517	14	18		
			T_{28}	4.5	0.2687	4.5	0.8498	3	6		
		excursions	T_1	4.9	0.4583	4.5	1.4491	3	8	**0.002**	**0.0391**
			T_{28}	6.5	0.3727	7	1.1785	5	8		
		time in D	T_1	20.7	1.4610	20.5	4.6200	13	30	**0.0234**	**0.0469**
			T_{28}	23.6	0.7024	23.5	2.2211	19	27		
		latency time	T_1	60		60		60	60	–	–
			T_{28}	60		60		60	60		

Table II.

Statistical correlation analysis between the values of the TST and the open field test in the two groups

Indicator \ Group	Group C		Group I (T_1)		Group I (T_{28})		Group II (T_1)		Group II (T_{28})	
tail suspension – emotional score	-0.1457	*	0.2038	*	0.3825	**	-0.1246	*	-0.2157	*
tail suspension – motility score	0.4271	**	0.4531	**	0.6321	***	-0.9364	****	-0.2856	**
emotional score – motility score	0.7072	***	0.5206	***	0.8651	****	-0.0880	*	0.2643	**

For **group C**, the statistical correlation analysis between the values of the studied indicators evidenced:

- a good and positive correlation between the emotional score and the motility score
- an acceptable and positive correlation between tail suspension and the motility score

For **group I,** the statistical correlation analysis between the values of the studied indicators showed:

- at moment T_1
  - a good and positive correlation between the emotional score and the motility score
  - an acceptable and positive correlation between tail suspension and the motility score.
- at moment T_{28}
  - a very good and positive correlation between the emotional score and the motility score
  - a good and positive correlation between tail suspension and the motility score
  - an acceptable and positive correlation between tail suspension and the emotional score.

For **group II,** the statistical correlation analysis between the values of the studied indicators evidenced:

- at moment T_1
  - a very good and negative correlation between tail suspension and the motility score
- at moment T_{28}
  - an acceptable and negative correlation between tail suspension and the motility score
  - an acceptable and positive correlation between the emotional score and the motility score.

Discussions

Our results show that bilateral olfactory bulbectomy is a valid model of depression induced in rats, immobility being the proof of depressant activity. TST values significantly increased in groups I and II compared to group C at moments T_1 and T_{28} and at moment T_{28} compared to moment T_1. TST values were maximal at moment T_{28} in group I. Physical exercise determined a decrease in the immobility time, TST values at moment T_{28} were significantly decreased in group II compared to group I.

The testing of involuntary motility through OFT showed significant decreases of the motility score in groups I and II compared to group C, at moments T_1 and T_{28}. The motility score significantly increased in group II, subjected to exercise, at moment T_{28} compared to group I, and significantly increased in the same group at moment T_{28} compared to moment T_1.

The emotional score insignificantly decreased in groups I and II compared to group C and insignificantly increased in group II at moment T_{28} compared to group I.

Our results are in accordance with the data of other authors regarding the decrease of locomotor and exploratory behavior and the increase of immobility in animals with induced depression (Che et al. 2013; Tasset et al. 2010; Husain et al. 2011; Shaw et al. 2009; Wang et al. 2009; Romeas et al. 2009).

The performance of physical exercise in animals with induced depression and the improvement of locomotor activity evidenced by us were reported by other authors (Hendriksen et al. 2012; Van Hoomissen et al. 2011).

The insignificant changes of emotivity in experimental depression are not influenced by physical exercise.

Conclusions

1. Physical exercise has favorable effects on motor behavior, with the increase of the spontaneous motility score and the reduction of the immobility time in animals with bulbectomy induced depression.

2. Physical exercise does not influence emotivity, the emotional score undergoes insignificant changes in animals with bulbectomy induced depression.

3. Physical exercise has antidepressant effects in animals with olfactory bulbectomy induced depression, a model that mimics major depression in humans.

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