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Selection for body weight induces differences in exploratory behavior and learning in mice

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Abstract. Mice that were selected for over 108 generations for body weight at the postnatal (PN) day 21 were examined in the open field (OF) test and in the Lashley maze (LM) for their exploratory behavior and spatial learning. Light (L), heavy (C) and control (K) lines of mice in three age groups: PN-21, PN-56 and PN-90, were tested once in the OF and three times in the LM. During the session in the OF the L mice displayed a steady increase of behavioral activity (sum of locomotion and rearing, climbing, sniffing, and grooming acts), whereas mice C and K habituated in the last stage. During entire session in the OF activity of the L mice was lower than that of the C and K mice. The L mice displayed high defecation/urination scores. In the learning task the L mice performed worse than the C and K mice. In conclusion, behavior of the L line was different from that of the two other lines: they showed higher anxiety and poorer spatial learning.

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Key words: body weight selection, selected line of mice, open field, Lashley maze learning, emotionality, activity;

INTRODUCTION

It is well known that selection based on one trait may change also other traits. This correlated change may depend on localization of various genes on the same chromosome or on the additive co-operation of many genes having an influence on quantitative traits. This may be an effect of a preferential use of one gene product in regulation of another gene's expression (Liu et al. 1994, Reid et al. 1995).

One of the often selected traits is body weight. It is simply measured and its phenotypic expression is a multigene effect. Therefore, correlation between the body weight trait and some physical and physiological traits has been found. It was confirmed that body weight positively correlated with the fat content (Hastings et al. 1991, Hastings and Hill 1990) and litter size (Beniwal et al. 1992). Our earlier research showed correlation of body weight with reproduction traits such as the ovulation rate, prenatal mortality and embryo number (Wirth-Dzięciołowska 1973), time of maturation and lifetime reproduction rate (Wirth-Dzięciołowska et al. 1996a, b). The animals from the selected light and heavy lines of mice differed in longevity and aging. The light mice lived longer than the heavy mice (Wirth-Dzięciołowska and Czumińska 2000). After the 64th and 90th generation, differences were found in fetuses and placenta weight, as well as in the weight of testes and seminal vesicles. All these physiological parameters had lower values in the light than heavy mice (Wirth-Dzięciołowska 1992).

Although the relationship between different phenotypes of mice and their behavior has been examined only sporadically this problem remains interesting from the neurophysiological and genetic perspective. Early reports presented controversial data about a correlation between body weight and emotionality (Falconer 1953, Fowler 1962, Holmes and Hastings 1995).

The present study was aimed at the comparison of exploratory behavior manifested as overall exploratory activity and spatial learning ability. The study involved various behavioral tests in mice selected over 108 generations for their body weight. The term "overall exploratory activity" was used to describe a whole collection of undirected behaviors including locomotion throughout space and rearing, sniffing, climbing and grooming acts (Renner and Seltzer 1991). The authors postulated that selection on body weight trait, which is the result of expression of many genes, could affect exploratory behavior. To examine this possibility, two experimental tests, based on a natural tendency of animals to explore the environment were used: the open field (OF) and the modified Lashley-III maze test (LM).

In the open field test mice are generally exposed to a new, open, lit field. These conditions are at first anxiogenic and result in low rate of the exploratory activities and high defecation scores, but the anxiety quickly habituates. Exploratory activities in the open field are displayed as horizontal locomotor activity (movement of the whole body) and vertical activity (movement of a part of the body), consisting of rearing and climbing. Relation between these two classes of activity reflects a change in the emotional level of the animals. It has been used to study differences in emotionality between strains or lines of rodents (Archer 1973, Denenberg 1969, Hall 1934, Walsh and Cummins 1976, Ramos et al. 2003), or in the behavior of evolutionary distant species of small mammals (Węsierska et al. 2003). In the present study, however, we focused on the change in overall expression of behavior in the OF. Furthermore, all behavioral responses displayed by mice under this test were scored, summed and compared in three subsequent stages of the session, as well as for the entire session. The other attribute of the rodents' behavior is their effective spatial orientation. In the Lashley maze, animals must learn to find a goal (food reward) at the end of the lit labyrinth, on the basis of distant and proximal information from space and information from self-motion. A reduction of the latency of response (time to reach a goal) and an increase in the percentage (or number) of correct choices of alleys was a measure of learning improvement.

In the present study mice from lines selected for over 108 generations for their body weight as light (L) and heavy (C) were subjected to the open field and the Lashley maze behavioral tests. A control line (K) was run in parallel. Three crucial periods in the lives of mice were compared: day of weaning and selection (postnatal 21 day), time of puberty for the heavy and control lines (postnatal day 56) and time when all lines were fully grown (postnatal day 90). In each line mice of the three age groups were investigated.

MATERIALS AND METHOD

Subjects and selection based on body weight

Mice were selected for 108 generations for the low (line L) and high (line C) body weight at weaning

(PN-21). These lines were selected from an outbreed stock constructed from inbred strains: A/St, BN/a, BALB/c and C57BL/6J (Sławiński 1974). The unselected control line (K) was run in parallel. The animals were kept in a constant photoperiod 12h and room temperature was controlled at approximately 23° C. Water and food (Labofeed H) were available *ad libitum* in the home cages.

The experiments were conducted on 270 virgin mice (half of them males, half females). In each age group 30 mice from lines L, C and K were chosen randomly from each litter at the postnatal days 21, 56, and 90 (groups: PN-21, PN-56, and PN-90, respectively). Animals were weighed at postnatal days 1, 12, 21, 56, and 90. Six to eight young mice of the same sex from two litters were placed in a cage.

Apparatus

The open field (OF) apparatus consisted of a white plywood box (600 × 600 mm, with walls 150 mm high). Lines dividing the apparatus into 36 identical squares, were painted on the floor. The apparatus was placed on the floor of a room that was not isolated acoustically. Experimental conditions were similar to those in the breeding room. Uniform light (600 lx) was emitted from a light source placed 1m above the field. The modified Lashley's III maze (LM) apparatus was a white plywood box (600 × 600 × 150 mm), divided transversely on seven alleys with six walls. The entrance to the LM apparatus was from a start box (100 × 100 × 150 mm). Six alternating gateways fixed a track to the food location, which was in the last alley. This apparatus was put in the same room as the OF.

Behavioral procedures

Each mouse was exposed to the open field for 10 minutes once daily. The animals were carried to the experimental room in their home cages. At the beginning of the session each animal was placed in the same corner facing the field's center. A week after the open field test, the maze test was conducted on the same animals. Mice were exposed to the maze for a non-limited time during three following days. Males and females were taken to the apparatus randomly. Walls and floor in each apparatus were washed and dried after each tested animal. This experimental treatment was applied once to each of the groups: PN-21, PN-56, and PN-90 of selected lines L, C, and K.

Measures

The overall activity was collected in the OF for three subsequent stages of the session, and lasted respectively 3, 4, and 3 min. During each of these stages one point was given for locomotor activity (moving from one square to another) and for such activities as rearing (standing on hind feet, either with forelegs leaning against the wall or away from the wall), grooming, sniffing and stopping. The sum of the points was an overall measure of activity. Sum of numbers of urination and defecation episodes made another score. Defecation was defined as the number of feces pellets, whereas urination as the number of urine deposits excreted in the field independently by each animal. In the LM the following parameters were counted: number of errors (revisiting a previously visited alley or visiting a closed alley) made by the mice searching for food and time to finding food. The same experimenters calculated the data for all experimental sessions.

Statistical evaluation

Data achieved in the OF and LM tests were statistically evaluated with the analysis of variance (Winer 1971). Lines (L, C, K) and sexes were treated as independent variables. In case of the OF test a three-way analysis of variance was performed with factors: line (L, C, K) × sex (males, females) and stage (three stages mentioned above). Moreover, for the OF the sum of stages was analyzed with a one-way analysis of variance for tested lines (L, C, K). In case of the LM test a three-way analysis of variance was performed with factors: line (L, C, K) × sex (males, females) and day (three days). After the analysis of variance the Fisher test was used. In cases of significant differences the Fisher test was followed by a post-hoc Duncan test for equal n. Differences were considered as significant at $P<0.05$.

All experimental procedures were conducted in accordance with the NIH Guide for the Care and Use of Laboratory Animals and were accepted by the Local Ethics Committee.

Table I

Mean (±SEM) body weight (g) in light (L), heavy (C) and control lines (K) of mice on postnatal (PN) days 1, 12, 21, 56 and 90. In each group of L, K, and C mice there were 45 males and 45 females.

line	sex	PN-1	PN-12	PN-21	PN-56	PN-90
L	female male	1.38 ± 0.20	5.11 ± 0.87	7.28 ± 0.87	17.06 ± 1.48 20.31 ± 1.81	19.94 ± 1.48 24.33 ± 1.54
C	female male	1.86 ± 0.27	8.11 ± 0.87	13.46 ± 1.74	28.47 ± 1.54 36.43 ± 2.08	31.98 ± 2.95 40.62 ± 2.95
K	female male	1.38 ± 0.33	5.79 ± 1.00	9.23 ± 1.54	25.83 ± 1.54 28.08 ± 1.81	27.01 ± 2.62 31.10 ± 2.75

Table II

Summary of the overall activity in the OF test: ANOVAs for Lines × Sexes × Stages (3 × 2 × 3) and Lines x Whole Session (3 × 1, bottom part); Groups: PN-21, PN-56, and PN-90.

	Source of changes						
Group	Lines (L) ($F_{2,252}$; P)	Sexes (S) ($F_{2,252}$; P)	Stages (St) ($F_{2,252}$; P)	Interaction L × S ($F_{2,252}$; P)	Interaction L × St ($F_{2,252}$; P)	Interaction St × S ($F_{2,252}$; P)	Interaction L × S × St ($F_{2,252}$; P)
PN-21	164.99; <0.0001	n.s.	1754.76; <0.00001	n.s.	995.28;<0.0001	n.s.	7.51;<0. 01
PN-56	50.10;<0.0001	n.s.	3657.45;<0.00001	7.35;<0.01	2684.81;<0.00001	8.48;<0.01	5.95;<0.01
PN-90	154.67;<0.0001	82.20;< 0.0001	1645.11;<0.00001	5.78;<0.01	897.53;<0.00001	n.s.	2.70;<0.05

	Group		
Source of changes	PN-21	PN-56	PN-90
Line vs. Whole Session ($F_{2,87}$; P)	47.01; <0.001	64.70; <0.001	56.19; <0.001

RESULTS

Comparison of body weight

Differences in body weight between mice from the selected lines were present already on the first postnatal day (PN-1). Mice from line C were heavier than mice from line L and the controls ($F_{2,268}$=4.88; P<0.01). Mice L were as heavy as controls at birth, but later this was no longer true. Sexual dimorphism in body weight was strongly marked at the days PN-56 and PN-90. These results are presented in the Table I.

Overall activity in the OF

Figure 1 shows the overall activity of mice of both sexes from the selected and control lines in the three subsequent stages of the OF session and for the entire session, for the three age groups. Results of statistical analyses are summarized in the Table II. A significant main effect of lines and stages of session was observed in all groups of mice, whereas the sex factor was significant only in the PN-90 group (mean number points of activity: males 55.00 ± 5.20; females 78.73 ± 5.09). Post hoc comparisons revealed that mice from the L line were less active than mice from the C and K lines (P<0.001). In these lines the highest level of activity occurred during the second stage of the session (P<0.001).

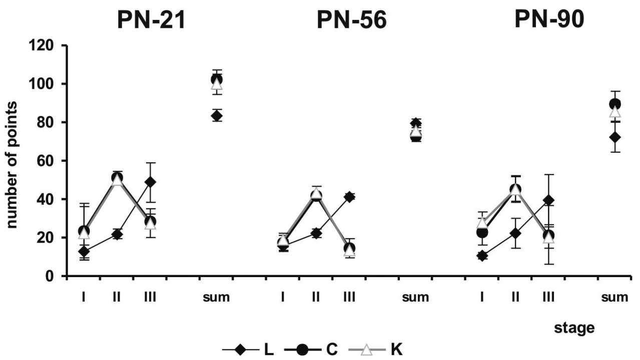

Fig. 1. Mice from the light line (L) displayed lower level of overall activity than mice from the heavy (C) and control (K) lines. Overall activity in the OF is represented as the mean (± SEM) score of the sum of locomotor activity and rearing, climbing, sniffing, and grooming in L, C, and K mice during three stages of the session (I, II, III) and for the entire session (sum). Three groups were tested: young (PN-21), at puberty (PN-56) and mature (PN-90) mice.

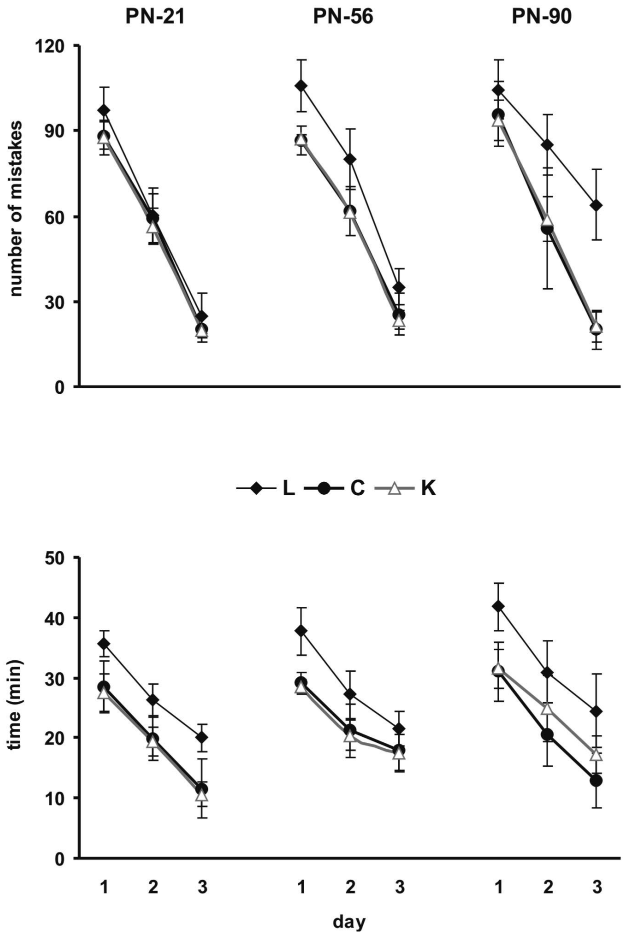

Fig. 2. Learning to find the reward in Lashley maze was poorer in the light (L) line than in the heavy (C) and control (K) lines. It was manifested by longer time (sec) to find the reward in the L mice, independent on age, and higher number of errors made at puberty and by the mature L mice. Mean (±SEM) number of mistakes and time (min) to find the reward in L, C, and K mice during three subsequent days. Three groups were tested: young (PN-21), at puberty (PN-56) and mature (PN-90) mice.

Interaction between the factors of lines and stages of the session was significant in all age groups; mice from the line L behaved differently than mice from lines C and K. Post hoc comparisons confirmed that the level of activity in mice from the line L increased from stage to stage (P<0.001), whereas mice from lines C and K were most active during the second stage (P<0.01).

Interaction between the sex and line factors was significant in groups PN-56 and PN-90. Mean scores for the overall activity were: in line L for males 78.40 ± 1.18 and for females 80.30 ± 1.05, whereas in line C and K, respectively, for males 71.46 ± 1.18, 76.19 ± 1.13 and females 74.39 ± 1.78, 74.39 ± 1.26.

Post hoc testing confirmed that at the age PN-56 the L mice of both sexes were more active than mice of the two other lines (P<0.05). At the age PN-90 males from line C were more active (92.10 ± 3.05) than other mice (line C: females 86.92 ± 5.52; line L, males and females: 78.13 ± 4.40 and 66.5 ± 5.09; control line, males and females: 88.80 ± 4.08 and 82.70 ± 3.09). Although in the line L an increase in activity was prominent in the subsequent stages of the session, for the entire session their activity was lower than that of mice from lines C and K, except for the group PN-56 (Fig. 1, sum). This was confirmed by statistical comparisons (Table II). In the OF mice from the line C displayed overall activity similar to that of the line K.

Defecation and urination in the OF

Table III shows defecation and urination scores that were counted for the whole session in the OF for both sexes, in the three lines of mice and for different age groups. In spite of individual differences, in all age groups mice from the line L defecated and urinated more than mice from lines C and K.

In the home cages defecation during one day/night period was on the same level in the mature mice of lines L and C. The mean (± SEM) number of defecation scores calculated per mouse for 20 minutes of a circadian period was: in line L for females 2.61 ± 0.5; for males 2.92 ± 0.18; in line C for females 2.52 ± 0.18; for males 2.71 ± 0.01.

Lashley maze test (LM)

Figure 2 shows the number of mistakes and the time to reach the goal box in the LM test for all selected lines in three age groups of mice, combined for males and females. The results of the statistical analyses are summarized in Table IV. The main effect of lines of mice and test days for both measures is the following: the number of mistakes and time to reach the goal box differed highly significantly in all age groups and the interaction of both those factors was also highly significant.

Post hoc comparisons, an independent analysis of both measures, revealed that in all age groups mice from the line L made higher numbers of errors and needed more time to find the reward than mice from lines C and K (P<0.0001). Improvement of performance over the 3 days of testing was observed (P<0.001).

Table III

Higher level of defecation and urination scores displayed by male and female mice from the light line (L), than from the heavy (C) and control (K) lines in the OF. Data were collected independently for groups PN-21, PN-56, and PN-90.

Lines		L			C			K		
Groups		PN-21	PN-56	PN-90	PN-21	PN-56	PN-90	PN-21	PN-56	PN-90
Number of males / females										
Defecation scores	0				0/6	2/1	1/2	6/0	2/3	2/3
	1				3/6	3/1	1/0	1/2	2/3	3/1
	2	1/5	7/5	3/5	9/3	8/11	6/8	8/10	11/9	10/8
	3	9/5	2/5	0/1	3/0	2/2	3/5	0/3		0/3
	4	5/3	5/3	8/4			2/0			
	6	0/1	1/2	4/5			2/0			
	8	0/1								
Sum		49/51	46/49	62/59	30/12	25/29	42/31	17/31	24/21	23/26
Urination scores	0			1/0	0/4	3/4	2/2	7/0	3/2	5/5
	1		1/0		7/3	4/4	11/6	7/11	5/5	5/4
	2	5/1	4/4	3/5	5/8	4/4	2/4	1/3	7/6	5/6
	3	8/8	7/7	5/0	3/0	4/3	0/2	0/1	0/2	
	4	2/4	2/4	4/4						
	5	0/1		1/0						
	6	0/1	1/0	1/2			0/1			
	7			0/4						
Sum		42/53	44/45	46/66	26/19	24/21	15/26	9/20	19/23	15/16

Table IV

Summary of performance in the LM test for number of mistakes (upper part) and time to reward (lower part): ANOVAs for Lines × Sexes × Days (3 × 2 × 3); Groups: PN-21, PN-56, and PN-90.

Source of changes	Lines (L) ($F_{2,252}$; P)	Sexes (S) ($F_{1,252}$; P)	Days (D) ($F_{2,252}$; P)	Interaction L × D ($F_{4,252}$; P)	Interaction L × S ($F_{2,252}$; P)
Group	Number of mistakes				
PN-21	5.30; <0.01	n.s.	453.22; <0.0001	n.s.	n.s
PN-56	192.01; <0.0001	n.s.	241.29; <0.0001	5.70; P<0.01	n.s.
PN-90	307.98; <0.0001	11.10; <0.01	1257.77; <0.00001	40.78; <0.001	18.65; <0.001
			Time to reward		
Group	Line (L) ($F_{2,252}$; P)	Sex (S) ($F_{1,252}$; P)	Day (D) ($F_{2,252}$; P)	Interaction L × D ($F_{4,252}$; P)	Interaction L × S ($F_{2,252}$; P)
PN-21	131.80; <0.000	n.s.	382.07; <0.0001	n.s.	n.s.
PN-56	566.62; <0.000	n.s.	3951.10; <0.0000	28.22; <0.001	n.s.
PN-90	153.11; <0.000	9.68; <0.01	337.52; <0.000	3.55; <0.01	n.s.

A significant interaction between lines and days for both of the LM measures was found in the age groups PN-56 and PN-90 (Table IV). Although at the age PN-56 mice from the line L were improving their performance constantly, on the last day they performed with a higher number of mistakes and a longer time to find the reward than mice in the same age group from the lines C and K (post hoc test: P<0.001). This “poor learning” in the line L correlated with age. In the group PN-90, mice from the line L once again performed worse than mice from lines C and K, as measured by the number of correct choices and the length of time (P<0.01). The sex factor was significant only in the PN-90 group, in which males made significantly fewer mistakes than females (mean number of mistakes for males was 193.4 ± 52.72 and for females it was 204.6 ± 59.73) (P< 0.01). Time to find the reward was 76.2 ± 8.02 for males and 80.6 ± 9.33 for females (N.S.). The interaction of the number of mistakes for the main factors, line and sex, was significant (Table IV).

Males from the line C in the age group PN-90 made fewer mistakes (140.33 ± 29.38) than females (188.67 ± 24.56) (P<0.001) from the same line and than males (259.00 ± 16.74; 166.93 ± 16.52), and females from lines L and K (248.47 ± 21.57 and 177.47 ± 9.80 respectively).

On the third day of the maze training all mice substantially reduced the number of mistakes and the time to find the reward in comparison with their initial performance. However, mice from lines C and K reduced the number of mistakes by more than 70% in all age groups, whereas mice from line L reduced this number by approximately 74%, 66%, and 38% in age groups PN-21, PN-56 and PN-90, respectively. The time to find the reward was also reduced by different proportions. Mice from lines C and K reduced the time by approximately 60%, 36% and 60% for groups PN-21, PN-56 and PN-90, respectively, whereas mice from the line L reduced the time by about 42% in all age groups.

DISCUSSION

Our results show for the first time differences in overall activity and spatial learning in mice selected exclusively for body weight for 108 generations. This difference was observed in the open field test and in the modified Lashley maze test in three critical periods of their life: postnatal days 21, 56, and 90.

In the open field mice from the line L constantly increased their overall activity, independent of age. However, during entire session their activity was lower than that of the C and K mice that both showed highest activity during the second stage of the session. In the maze test mice from all three lines improved their spatial learning each day. Both numbers of mistakes and the time to find the reward on the last day of testing were lower than on the first day. However, the performance of mice from the line L was consistently worse than that of mice from lines C and K. This effect was strongest in the 90 days-old mice.

Body weight trait and sexual dimorphism

We showed earlier that mice from our selected lines differed in body mass composition (Wirth-Dzięciołowska et al. 1997a). Light mice had lower fat content in their body before maturation and significantly higher fat content after that, in comparison to the heavy and control mice (Wirth-Dzięciołowska et al. 1997a). Body weight was the trait that significantly discriminated mice from the selected lines starting from the beginning of their life and correlated with sexual dimorphism in the aged mice. A difference between sex and body weight was dominant in the 90-days old mice. This was caused by the fact that at the day 56 the L mice were not fully mature, while mice from the lines C and K were (Wirth-Dzięciołowska et al. 1997b).

Body weight trait and open field activity

Our behavioral observations do not confirm the hypothesis that body size and overall activity levels are negatively correlated. A negative relationship between body weight and activity in a voluntary wheel-running apparatus was reported by Swallow and coauthors (1998, 1999) and Bronikowski and coauthors (2001). They found that mice selected for an increased activity in the wheel running were smaller than those from the control line. However, these authors reported no differences in the open field test. Differences in body mass between mice selected for the increased activity and the control mice correlated with differences in fat content (Swallow et al. 2001).

The light mice from our lines, that in the present experiment showed low activity in the open field had lower fat content during the experiment, but in the later period of their life they had a significantly higher fat content than the heavy (C) and control (K) mice (Wirth-Dzięciołowska et al. 1997a).

Open field overall activity

Although the open field test was criticized as highly non-specific for the purpose of drawing strong conclusions about emotionality (for review see File 2001), earlier results obtained by Flint and coauthors (1995) showed a correlation of the index of emotionality in the OF with the genetic factors influencing behavior. In the present experiments activity in the open field was analyzed as a sum of all activities without discriminating between horizontal and vertical activity, which is used for studies of anxiety or hyperactivity (Cabib et al. 2002). Nevertheless we think that behavior of the L mice may indicate an increased level of anxiety in comparison with lines C and K. To support this statement we compared the pattern of overall activity in the subsequent stages of the open field sessions and the level of defecation/urination scores. We found differences in both of these parameters between the selected lines. In the line L an increase of activity was observed with the progress of session, but it was low throughout session. It was accompanied by a persistent tigmotaxic tendency (walking near walls, personal observation) and a high defecation/urination scores. On the contrary, mice from lines C and K showed higher activity in the middle than at the beginning and end of the session, higher activity in the whole session and lower index of defecation. These indications of habituation to experimental conditions in lines C and K could be interpreted as a decrease of anxiety. Therefore, taking into account the pattern of activity of the line L during the whole OF session and in subsequent stages of the session, and high defecation/urination scores in the experimental conditions, we conclude that the line L showed a higher level of fear/anxiety, than mice from the lines C and K, that behaved similarly to each other.

Our results from the OF test differ from the results of Holmes and Hastings (1995), who showed lack of correlation between the open field behavior and body weight. Although in both experiments behavior was investigated in the open field test, there are three important differences between our experiments and those of Holmes and Hastings (1995) that could have influenced the results. First, our selection was conducted for twice more generations. Second, the age of the tested mice was different. In the present experiments mice were 21, 56 and 90 days old, while they were 50 and 72 days old in the Holmes and Hastings experiments (1995). The third difference is the duration of the open field session and data evaluation. In our experiments mice were exposed to OF for 10 min and their activity was evaluated independently in three consecutive stages of the session and for the whole session. Holmes and Hastings used a twice shorter session time and the activity was calculated for the whole session only (5 minutes of the empty OF vs 5 minutes of OF with a new object). All these experimental differences could affect the outcome and make direct comparisons impossible.

Learning ability in the Lashley maze

Tests based on spatial orientation, such as the radial maze (see rev. Crawley and Paylor 1997), water maze or the Lashley maze are frequently used when the learning/memory ability of the inbred or genetically modified (transgenic or knock-out) mice should be compared. In many of these tests animals have been trained to a criterion of a low number of errors to reach a goal (find a reward, or a platform) or to the correct choice of an arm with the reward (Balogh et al. 2000, Fleischmann et al. 2003, Owen et al. 1997, Thifault et al. 2002). The purpose of our study was preliminary evaluation of the capability to learn a spatial task by mice selected for body weight. Mice were trained to find the reward in the seven-alley maze equipped with a start box, which prevented spontaneous exploration Pisula (1994). In order to solve this task (*i.e.* to find the correct way to the end of the last alley), mice had to remember a path through six exits in seven alleys. For this purpose mice could use distinct and local cues, like visual, chemical, tactile or self-motion information during spontaneous exploration of the maze. Our results showed a difference in the level of performance between the line L and lines C and K of mice. Although on the third day of maze training all mice significantly reduced the numbers of mistakes and the time of the run in comparisons with the first day, mice from lines C and K of all age groups improved their performance much more.

Differences in the overall behavioral activity and in the learning ability observed in our lines of mice could be a result of genetic differences between the inbred strains A/St, BN/a, BALB/c and C57BL/6J used for construction of the outbreed stock (see background for selected lines - Balogh et al. 1999, Cohen et al. 2001, VanGaalen and Steckler 2000). Strain C57BL/6J shows high activity in the open field, decreased penetration of the center of the hole-board apparatus and good performance in the spatial learning tasks such as the Morris water maze and the eight-arm radial maze. Another founder strains (BALB/c and A/J) showed different behavior in the open field and poorer learning in the maze tests (Crawley et al. 1997, Kafkafi et al. 2003, Kim et al. 2002, Tang et al. 2002, Thifault et al. 2002).

CONCLUSION

We showed selection for body weight correlates not only with changed physiological traits, but influences also the overall behavioral activity and spatial learning ability of animals. Mice from the line L could be characterized as anxious and poor learners in comparison to mice from lines C and K, which are similar to each other. It could have been caused by bi-directional (contrasting) selection for body weight, but could have been also the effect of a random separation of genes during the long-time selection. Our results lay ground for further analysis of the genetic basis of differences in learning and behavior of these mice. The observed tendency for correlation of body weight and behavioral responses should be taken under consideration by breeders of laboratory animals and researchers.

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