Characteristics of Rabbit Food-Procuring Behavior as an Indicator of Changes in the Level of Hunger Motivation

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We proposed new method for measuring dynamic changes in hunger motivation in rabbits in the course of satisfaction of nutritional need by weight, time, and rate parameters of effective food-procuring behavior. Transformation of the amount of food eaten into the electric signals was performed using electronic weighing machine incorporated into hardware and software system. The most conclusive characteristic for decrease in hunger motivation in the course of first effective food-procuring act was the period of food-procuring cycles, which values increase significantly as animal satisfies its nutritional need, whereas amount of the food consumed for each food-procuring cycle remains constant. Integral characteristics of food-procuring behavior reflect higher level of food motivation in the course of first effective food-procuring act in comparison to the subsequent ones.

Key Words: *hunger motivation level; quantitative, temporal and rate characteristics of efficient food-procuring behavior*

One of generally accepted methods to measure hunger motivation level (HML) in animals is to determine total amount of food eaten per trial which duration depends on duration of food deprivation. In the course of effective food-procuring behavior (EFPB), food motivation decreases down to cassation of food consumption while the animal satisfies its nutritional need [3]. However, it is still unclear which EFPB characteristics represent the physiological correlates for HML reduction in the course of direct animal interaction with food stimulus, which can be explained by lack of adequate investigational method. In this connection, there is a long-felt need to develop the method of HML change measurements in the course of its satisfaction of nutritional need using weight, temporal and rate EFPB characteristics. This method will allow not only assessment of various factor effects on nutritional motivation [1,2,4], but also afford ample opportunities for investigations of eating behavior pharmacological correction [5,8].

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The aim of this study was to develop the method to measure dynamic HML changes in rabbits in the course of satisfaction of nutritional needs using weight, temporal and rate EFPB characteristics.

MATERIALS AND METHODS

Eating behavior was registered in 5 Chinchilla rabbits subjected to 24 h food deprivation. Transformation of the amount of food eaten in the course of each successive EFPB cycle into the electric signals was achieved using electronic weighing machine GF-600 incorporated into the software and hardware system MP-100. Temporal EFPB characteristics were determined by changes in electric signal level in real time. During the experiment, rabbits had free access to the excessive amount of standard pelleted feed (PK-92-390), placed in the feeder on the scale. EFPB was registered for 1 h. Number of efficient food-procuring acts (EFPA) and time intervals between them were calculated. In parallel, web-cam was used to register animal behavior.

To assess dynamic HML changes in the course of food reinforcement we used weight, temporal and

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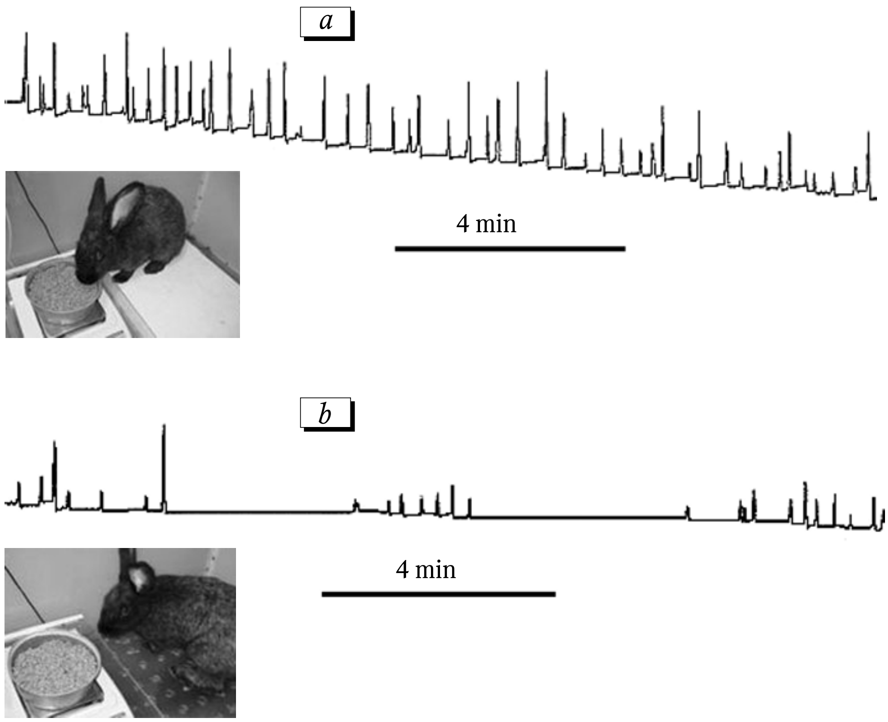

Fig. 1. Food-procuring behavior in rabbit subjected to 24 h food deprivation. *a*) start of recording, food capture phase; *b*) recording continuation, food mastication phase. Positively directed impulses reflect food capture by the rabbit; subsequent downward shift of isoelectric line reflects the amount of food consumed per food-procuring cycle.

rate parameters of food consumption in the course of each EFPB cycle, from the beginning of feeding act to the end of eating. Subsequent automated estimation of EFBP parameter was performed using microprocessor MP-100 and AcqKnowledge software. The following eating behavior parameters were established in the course of EFPA: duration of successive EFPB cycles, duration of food capture and mastication phases, weight of food eaten, as well as rate of its capture, mastication and consumption in the course of each cycle. For the purpose of statistical analysis, the data were pooled from 5 successive food-procuring acts. Integral EFPB characteristics were calculated: total amount of food eaten for each EFPA, duration of feeding acts and food consumption rate.

Statistical treatment included calculation of the sample size, as well as the means, medians, standard errors, quartiles (25 and 75%), and assessment of autocorrelations. Parameters were tested for normalcy of distribution using Shapiro—Wilk *W* test. ANOVA was employed: Fisher *F* test was used for parameters with normal distribution; Kruskal—Wallis *H* test for

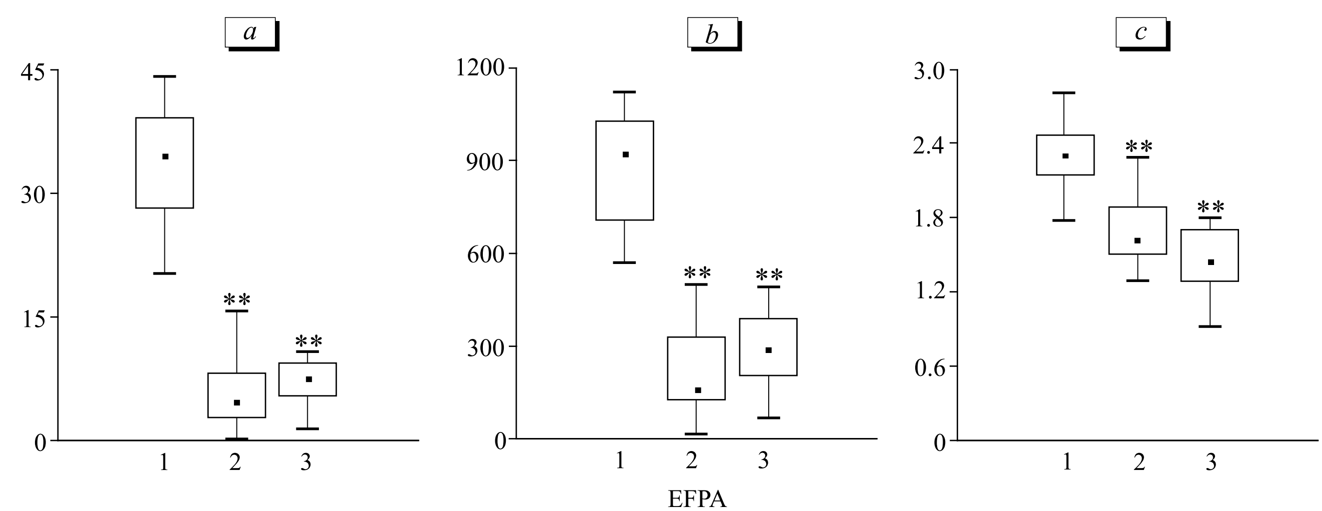

Fig. 2. Integral EFPB parameters for EFPA 1, 2, and 3 in rabbits subjected to 24 h. Ordinate: *a*) total weight (g) of the food eaten by animals per EFPA; *b*) EFPA duration (sec); *c*) rate (g/min) of food consumption during EFPA. $^{**}p<0.001$ in comparison with EFPA 1.

other parameters. Multiple sample comparison was performed: using Fisher LSD for normally distributed parameters; using Kruskal—Wallis rank sum test for other parameters. Differences were considered significant at $p<0.05$.

RESULTS

Dynamic HML changes were most clearly reflected in integral EFPA characteristics. Rabbits performed 3 EFPA in 1 h (Fig. 1). The test revealed normal dis-

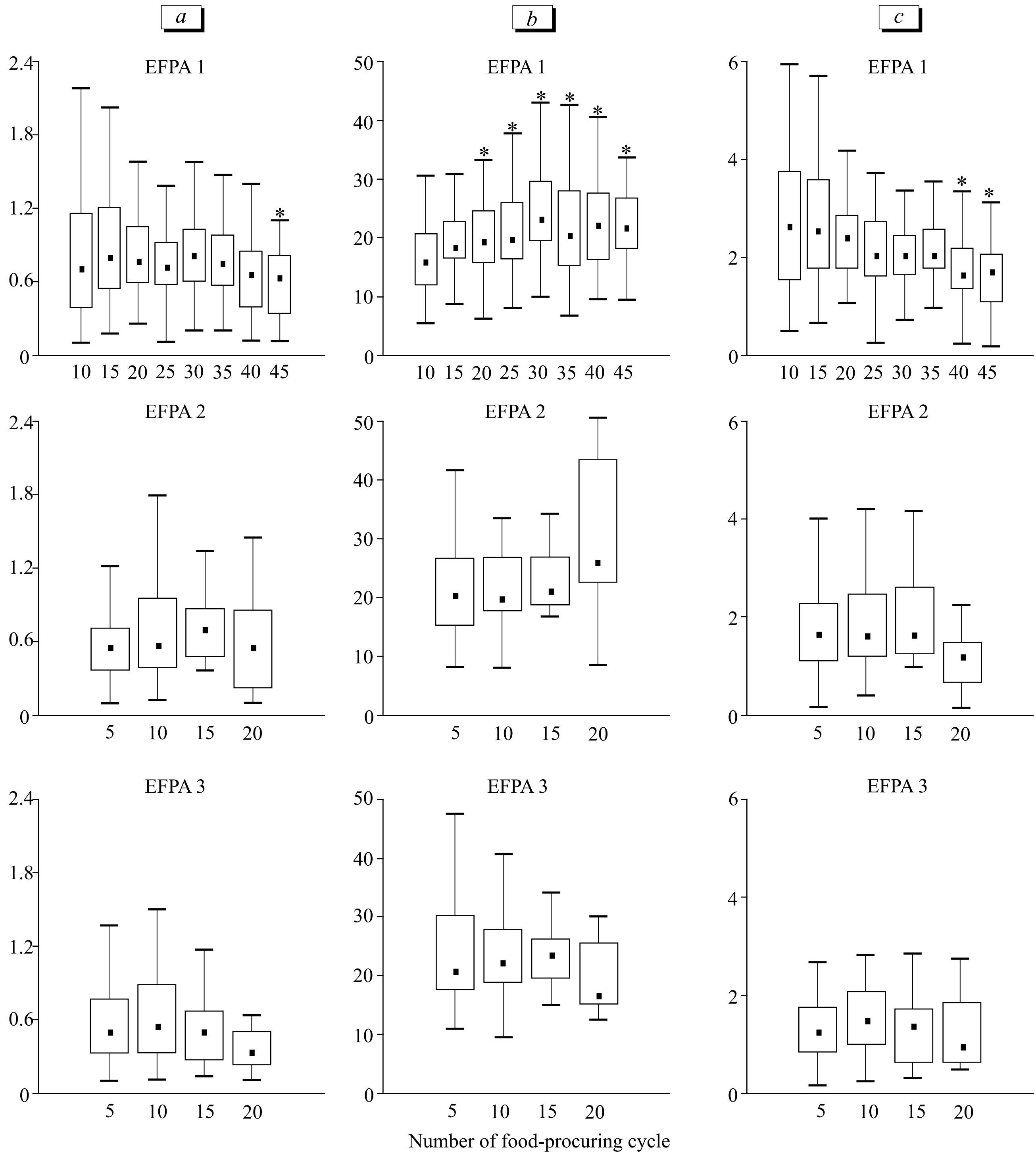

Fig. 3. Dynamics of EFBP characteristic changes during EFPA 1, 2, and 3 in rabbits subjected to 24 h food deprivation. Ordinate: *a*) weight (g) of food consumed per food-procuring cycle; *b*) periods (sec) of food-procuring cycles; *c*) rate (g/min) of food consumption per food-procuring cycle. *$p<0.05$ in comparison with group 2 (food-procuring cycles from 6 to 10) of EFPA 1.

tribution only in weight and time integral parameters (*W*=0.93; $p>0.34$). ANOVA with subsequent multiple comparisons detected significant differences between first EFPA and subsequent EFPA in terms of following integral parameters: total amount of food eaten per EFPA (*F*=83.12; $p<0.001$); EFPA duration (*F*=70.86; $p<0.001$), and food consumption rate (*H*=21.03; $p<0.001$). At the same time, there were no significant differences between EFPA 2 and EFPA 3 (Fig. 2). Rabbits ate maximum food amount during EFPA 1 (34.81 g in average), whereas food amount in AFPA 2 and EFPA 3 was 5.0-5.6 times less ($p<0.001$). The longest duration was observed for EFPA 1 (875.2 sec). For subsequent EFPA it was 3.1-3.9 times shorter ($p<0.001$). Food consumption rate was maximum during EFPA 1 (2.4 g/min) and decreased 1.5-1.6 fold in subsequent EFPA ($p<0.001$; Fig. 2). Time intervals between EFPA increased significantly ($p<0.05$).

HML fluctuations in the course of EFPA 1 were clearly evident in changes of weight and temporal and speed characteristics of EFPB cycles (Fig. 3). Testing the parameters of food-procuring behavior for distribution normality in various groups using Shapiro–Willk *W* test showed that the data did not conform the normal distribution. Autocorrelation analysis detected weak relationship between parameter values ($p>0.05$) not only in EFPA 1, but also in subsequent EFPA. Two rabbits consumed maximal amount of food (in average 2.18±0.55 g) during EFPA cycle 1, which 2.3-4.0 fold exceeded this value for subsequent cycles ($p<0.001$). The highest values of food consumption in the phase of food capture (0.22±0.05 g/sec) and its duration (9.72±2.33 sec) were also noted in the EFPB cycle 1 ($p<0.03$). These data are indicative for short-term intensification of food motivation in the portion of animals in the very beginning of EFPA 1, and probably for hedonic character of sensations emerging at this time. This regularity was not observed in the rest 3 rabbits. In this connection, the group consisted of first 5 food-procuring cycles was excluded from the subsequent statistical analysis.

In the course of almost entire EFPA 1, the amount of food consumed during the phase of food capture varied in considerably narrow range (Fig. 3), which was confirmed by ANOVA, which revealed no significant changes in weight characteristics. Statistically significant reduction of the amount of food consumed per cycle was observed only in the very end of EFPA 1, 13 min after onset of food consumption ($p<0.03$). In the course of EFPA 2 and 3, the weight of food consumed had no significant changes (Fig. 3). Different pattern was observed in respect of dynamics of cycle period changes, that steadily increased in the course of EFPA 1 as the animals consumed the food: from 16.46 to 22.39 sec in the end of EFPA (Fig. 3). Therefore, frequency of food consumption decreased from 3.64 to 2.68 cycles/min ($p<0.002$) due to significant increase in the duration of food mastication phase ($p<0.001$). Alongside with that, duration of food capture phase was virtually unchanged and remained stable not only in the course of EFPA 1, but also in subsequent EFPA, which may be explained by peculiarities in functional organization of central mastication pattern generator [6,7]. In the course of EFPA 1, the rate of food consumption (Fig. 3) invariably decreased from 3.19 to 1.80 g/min at the EFPA end. However, statistically significant changes in food consumption rate were observed only at the end of EFPA1 ($p<0.005$), 10 min after the food ingestion onset. No significant changes in food consumption rate were observed in the course of EFPA 2 and EFPA 3.

Our data confirm the ideas that the decrease in nutritional motivational arousal occurs as an animal satisfies its nutritional needs in the course of EFPB [3]. This decrease is more evident in terms of integral parameters of eating behavior: by means of significant decrease of the total amount of the food eaten during EFPA2 and EFPA3, reduction of their duration and decrease in integral rate of food consumption in comparison with corresponding parameters of EFPA1. At the same time, first signs of HML reduction are evident as early as during EFPA1 what is demonstrated by significant increase in duration of food-procuring cycles while the animal satisfies its nutritional needs.

Developed method of measuring of dynamic HML changes by the means of EFPB parameters may be employed to assess various effects on food motivation, as well as to investigate pharmacological correction of eating behavior.

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