CONSISTENCY OF SKINNER BOX ACTIVITY MEASURES IN THE DOMESTIC RABBIT (ORYCTOLAGUS CUNICULUS)

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ABSTRACT: Consistency of individual differences in several measures of Skinner box operant and other activity and their intercorrelations in 14 chinchilla bred rabbits were studied. Reliability analysis revealed that both operant and activity measures were highly consistent (Cronbach alpha>0.87) over at least 15 days. Furthermore, locomotor activity, the tendencies to press the lever with high frequency, to make many errors, to check the presence of food in the dispenser as well as rearing were highly inter-correlated, making up a single dimension of activity. However, grooming did not correlate with these behaviors.

FOOTNOTE

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INTRODUCTION

Individual differences in behavior are well known to everyone who works with animals of virtually any species. Some of the recent reviews (Budaev, 1997a; Clark & Ehlinger, 1987; Stevenson-Hinde, 1983; Wilson et al., 1994) emphasized the importance of studying integrated behavioral phenotypes and stable traits that are consistent over time and across situations, that is, temperaments and personalities. The current evidence indicates (Budaev, 1997a,b; Royce, 1977) that two broad personality dimensions – Approach (Activity-Exploration), incorporating such traits as exploration, stimulusseeking propensity and sociability, and Fear-Avoidance, composed of shyness, fearfulness, anxiety and escape – were systematically observed in various vertebrate species (ranging from fish to humans), which implies that common adaptive, neural and hormonal mechanisms may be involved. Defensive behavior, fear and general fearfulness have been particularly well studied (see Boissy, 1995 for a review). For example, Jones, Mills and Faure (1991) showed that various measures of fearfulness in chicks are not independent and all share the same underlying factor. On the other hand, the study of the second major temperamental trait, Activity, has attracted relatively less interest (but see Budaev, 1997b; Garcia-Sevilla, 1984; Goddard & Beilharz, 1984; Gomá & Tobeña, 1985; Maier, Vandenhoff & Crowne, 1988).

In the present research we investigated the consistency of several measures of Skinner box activity and their intercorrelations in the chinchilla rabbit. While many people have studied the consistency and intercorrelations of various measures in the open field (e.g. Gomá & Tobeña, 1985; Maier et al., 1988; Ossenkopp & Mazmanian, 1985; Ossenkopp, Sorenson & Mazmanian, 1994; Tachibana, 1985; see Archer, 1973, Walsh & Cummins, 1976 for reviews), it has been suggested (Hirsch, 1962) that "Skinner developed apparatus which affords probably the most reliable measure of individual differences ever obtained in the laboratory" (p. 6), due to the fact that very lengthy tests are possible. It has been found (Reed & Pizzimenti, 1995) that in four learning tasks involving response inhibition rats' performance was consistent over time (but not across tasks). In addition, within the behavioristic framework, operant measures have proved to be very appropriate for the study of human personality and adjustment (see Harzem, 1984).

METHOD

The animals were 14 male chinchilla bred rabbits (Oryctolagus cuniculus) approximately 3-4 months of age weighting 1.6-2.0 kg. They were obtained from a local supplier. During the present study the animals were maintained in standard individual cages 43 x 65 x 40 cm. The temperature was held constant 19±1°C and the light-dark cycle was 12:12 h.

Each individual was initially trained to press the lever to obtain food in a single Skinner box: a metal grid box 65 x 85 x 85 cm with wooden floor and a single flat plastic lever 10 x 19 x 3 cm mounted 3 cm above the floor level. Both the maintenance cages and the Skinner box were situated in a single room and lit by four 60-100 W bulbs suspended 3.5 m above them. The rabbits were given a laboratory rodent chow (140 g per day). Prior to the first training session they were food-deprived for 24 hours and in the further sessions we reduced their daily ration to 1/2 of the normal. Every training and test session took place from 10:00 to 14:00 hr and was continued for 60 min. Immediately after the animal pressed the lever, a piece of carrot (0.5 g) appeared in the food dispenser at the opposite side of the box. A continuous reinforcement schedule (FR1) was used. The Skinner box was washed and cleaned with 96% alcohol after each training session. All individuals were rather easy to train in this apparatus and after a maximum of 3-4 days of training they reached the criterion of receiving a minimum of 40 carrot pieces within a 60 min. period, which corresponded to at least 10 consecutive responses without error. All training sessions were performed in presence of the observer and the rabbits were handled. This was necessary to minimize possible fear in subsequent test sessions and accustom animals to the presence of the observer.

Two-three days after a rabbit reached the criterion, he was placed into the same Skinner box for 60 min. for testing. A single observer (SVZ) recorded the following behavioral measures: (1) the number of presses of the lever; (2) the number of food pieces eaten (on some occasions the rabbits could press several times in succession, for which they were reinforced by only one food piece); (3) the frequency of errors, when the rabbit approached the lever but missed it or did not press, but went to the food dispenser and checked it for food; (4) checking the food dispenser, by approaching it and pushing his nose into it without having pressed the lever previously; (5) the frequency of rearing; (6) gross locomotor activity, that is the frequency of any movements (any horizontal activity like walking, jumping etc.) inside the Skinner box not related to the lever-pressing behavior, feeding or checking the food dispenser (the behaviors were counted as distinct units only if they were separated by other behaviors or stops); (7) the frequency of grooming (e.g. scratching, washing, licking; each unit typically lasted for up to 5 s). This test was administered five times to each individual rabbit with three days between test intervals.

RESULTS AND DISCUSSION

First of all, we analyzed the distribution of each of the 35 behavioral variables (7 behaviors x 5 test sessions) obtained. Because of small sample size (N=14), the influence of any deviation from normal unimodal distribution or an excessive skewness would have had a large detrimental effect and even a single outlier may have been very influential. However, inspection of the normal probability plots for each variable revealed no outliers in the data and the distributions approached normal in all cases. Thus, it was justified to apply parametric statistical methods to the data analysis.

A one-way repeated measures ANOVA was performed to test for possible changes in the mean values of the behavioral measures over the five test administrations. With only one exception, locomotion, the differences turned out not to be significant (see

Table 1; even in the case of locomotion, the differences between test sessions accounted for only 2.13% of variance and no linear trend was pronounced – contrast analysis, $F(1, 13)=3.06$, $p=0.103$; means over days were 30.8, 32.8, 40.8, 31.1, 43.0). This clearly indicates that the rabbits were well trained and no further improvement in learning took place.

To see to what extent the behavioral measures were consistent over the five test administrations, we performed a reliability analysis. First, for each variable, we computed the correlations between all test sessions and, second, on the basis of the resulting pairwise correlation matrices Cronbach alpha coefficients were inferred (Nunnally, 1967). All pairwise correlations turned out to be high and significant ($p<0.05$), so that the alpha coefficients were also remarkably high (Table 1). In other words, the behavioral measurements were fairly reliable and the rabbits were extremely consistent and repeatable in their behavior for at least 15 days. This allowed us to aggregate the scores over the test sessions to further diminish the contribution of unique environmental variance and measurement error (Ossenkopp & Mazmanian, 1985; Tachibana, 1985). Thus, 35 original scores were collapsed to only 7 summary measures, one for each behavior unit.

In addition, we computed two indices measuring the relative number of errors adjusted for the overall operant performance, that is, the frequency of errors divided by either the number of lever presses or the number of food pieces eaten. Both proved to be also very consistent (both alpha coefficients are 0.92), stable over repeated test sessions (repeated measures ANOVA, both $p>0.1$) and correlated closely with the overall error frequency (correlations between aggregated scores are, respectively, 0.89 and 0.85). Thus, being redundant, the indices of relative frequency of errors were not included in the subsequent principal component analysis.

The aggregated variables were intercorrelated and further subjected to the principal component analysis (Nunnally, 1967). All behavioral measures, except grooming (it correlated with no one other behavior, $r<0.34$, $N=14$, $p>0.23$), proved to be significantly and positively correlated (Table 2) with one another (it is worth noting that the rearing frequency was highly correlated with the locomotion). We also computed the Bartlett sphericity test, Kaiser-Meyer-Olkin measure of sampling adequacy and inspected off-diagonal elements of the anti-image covariance matrix (Dziuban & Shirkey, 1974). They indicated that the correlation matrix was appropriate for the principal component analysis (Bartlett's test: $\chi^2=110.4$, $df=21$, $p<0.001$; Kaiser-Meyer-Olkin measure of sampling adequacy = 0.61; only 9.5% of all anti-image covariances exceeded the conventional cut-off value of 0.09). Two principal components with the eigenvalues greater than unity were extracted, which accounted for 84.6% of the total variance. The maximum residual correlation was only 0.16 (the maximum value acceptable with $N=14$ is 0.26), further indicating that the component solution was quite satisfactory. All variables but grooming had salient loadings on the first component (see Table 3).

These results clearly indicated that in the present operant situation, individual rabbits differ primarily along a single and quite stable dimension. This trait encompasses such behaviors as horizontal locomotion, tendency to press lever with high rate, to make many errors, to check food in the dispenser frequently, as well as rearing. Furthermore, rearing is typically considered a sort of exploratory behavior (Gomá & Tobeña, 1985; Walsh & Cummins, 1976), extraversion (Garcia-Sevilla, 1984) and excitability (Lát & Gollová-Hemon, 1969) in various rodents and consistently correlates with locomotion (Gomá & Tobeña, 1985; Maier et al., 1988; Ossenkopp et al., 1994; Tachibana, 1985; Walsh & Cummins, 1976) as well as with the caloric intake per surface area (Lát & Gollová-Hemon, 1969). In rabbits, rearing in the open field test was found (Meijsser et al., 1989) to correlate with locomotion and exploration. Accordingly, this continuum distinguishes animals from "dull", inactive and careful to active, exploratory and "careless".

Thus, even though little can be said about the generality of this dimension across situations (e.g. see Reed & Pizzimenti, 1995 for a report of no consistency across situations requiring response inhibition), it seems reasonable to suppose that it might be related to general activity, sensation seeking and susceptibility to reward. As such, this dimension may be mediated by certain neurotransmitters, most probably dopamine, which is implicated in various natural (food, water) and unnatural (drugs, intracranial self-stimulation) rewards, exploratory behavior, positive affect and the extraversion personality trait (Wise & Rompre, 1989; Zuckerman, 1994). This would be a perspective topic of a future study.

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Table 1. Between-trial changes in the behavioral measures (repeated measures ANOVA) and their consistency across repeated trials, N=14

Behavioral measure	Between-trial ANOVA		Cronbach alpha
	F(4, 52)	p	
1. Lever-presses	1.23	0.31	0.90
2. Food pieces eaten	1.11	0.37	0.92
3. Errors	1.68	0.17	0.95
4. Checking the food dispenser	0.37	0.83	0.87
5. Rearing	0.49	0.74	0.91
6. Locomotion	2.75	0.04	0.97
7. Grooming	2.05	0.10	0.93

Table 2. Intercorrelations between the behavioral measures (the correlation matrix). With N=14, correlations greater than 0.53 are significant at $p<0.05$ (shown in bold type)

Behavioral measure	1	2	3	4	5	6	7
1. Lever-presses	**1.00**	**.996**	**.61**	**.56**	**.76**	**.79**	-.17
2. Food pieces eaten	**.996**	**1.00**	**.63**	**.58**	**.77**	**.82**	-.19
3. Errors	**.61**	**.63**	**1.00**	**.67**	**.53**	**.56**	.09
4. Checking the food dispenser	**.56**	**.58**	**.67**	**1.00**	**.80**	**.78**	.34
5. Rearing	**.76**	**.77**	**.53**	**.80**	**1.00**	**.92**	.07
6. Locomotion	**.79**	**.82**	**.56**	**.78**	**.92**	**1.00**	.13
7. Grooming	-.17	-.19	.09	.34	.07	.13	1.00

Table 3. The pattern of intercorrelations between the behavioral measures: Varimax rotated principal components (PC); salient loadings (>0.7) are given in bold type

Behavioral measure	PC 1	PC 2
1. Lever-presses	**0.92**	-0.27
2. Food pieces eaten	**0.93**	-0.27
3. Errors	**0.74**	0.14
4. Checking the food dispenser	**0.81**	0.46
5. Rearing	**0.91**	0.12
6. Locomotion	**0.93**	0.14
7. Grooming	-0.002	**0.95**
Eigenvalue	4.62	1.30
Variance accounted for (%)	66.07	18.50