# Original Papers

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# Individual differences in wild (WWCPS) rat – manifested in the exploration box

*Thirty nine WWCPS rats were tested in the exploration box throughout fifteen sessions. Factor analysis was run to extract the main dimensions describing rat behavior. Two factors were extracted, confirming the validity of the concept of two dimensional structure of individual differences in rats. Hierarchical cluster analysis run on factor scores showed that only three out of a possible four types of factor combinations are actually present within observed group of animals. In terms of individual differences structure, the study provide support for the view that laboratory rats are still rats.*

**Keywords:** *rat, individual differences, personality, temperament*

Studying individual differences in a laboratory rat has a long history. It dates back to the thirties, of the twentieth century(1930's) when researchers such as A. Anastasi, R. Tryon, D. Hebb or K. Wiliams (Anastasi, 1948; Anastasi & Foley, 1948; Hebb, 1953; Hebb & Wiliams, 1946; Tryon, 1929, 1940) challenged the nature or nurture controversy as well as the problem of classifying and measuring the individual differences (ID) in animals and humans. Very soon, as early as in 1941, Calvin Hall started discussion about ID in laboratory rats in terms of two basic dimensions, timidity / emotionality and activity / exploration. He included these dimensions within the framework of temperament, but in more today's criteria, they would fall (together with "wildness" and aggressiveness) into the wide "animal personality" category (Gosling & John, 1999).

A. Whimbey & V.H. Denenberg (1967) conducted a factor analysis, and showed, that rat individual differences among rats in the open field behavior are of the two-dimensional structure. The most important factor revealed by Whimbey and Denenberg was "emotional reactivity" and the second one was "exploration". The authors stressed the relative independence of these factors. This general, two dimensional structure of temperament in the rat has been widely accepted. Other multivariate methods, provided similar results. W. Pisula (1994) found, that when using a hierarchical cluster analysis, laboratory rats are mainly classified by two clusters, one "emotional" and one showing more diffusive (or exploratory) behavioral pattern.

There are important limitations of applicability of the open field method in describing the manifestations of individual differences. M. Renner (1990) convincingly listed arguments for procedural limitations of testing spontaneous activity within the open field procedure. Indeed, when rats are observed in a more complex environment, the cluster's structure obtained from multivariate cluster analysis is also more complex (Pisula, 1997). For the reasons listed above, procedure involving sufficiently long familiarization procedure and utilizing a sophisticated enough testing environment, are becoming standard conditions for the appropriate measurement of exploratory activity (Pisula, 2003, 2004; Pisula & Siegel, 2005; Pisula, Stryjek, & Nałęcz-Tolak, 2006).

The discussion about the appropriateness of making conclusions on the basis of studies involving laboratory rat has also a long history. R. B. Lockard (1968, p. 739) wrote "..... the numerous instances of differences between strains, and between wild and domesticated rats, should convince any investigator that albinus is not the place to start looking for mechanisms nature has produced nor for analyzing how they work". Eminent authors, such as R. Boice (1973, 1977), S. Barnett (1963), E. O. Price (1984, 1999), P. E. Cowan (1977), provided much of the knowledge about the laboratory vs wild rat differences. Nevertheless, the issues related to domestication effects are still subjects of debate and analyses (Künzl, Kaiser, Meier, & Sachser, 2003; Lankin & Bouissou, 2001).

R. Stryjek & W. Pisula (2008) established new colony of *Rattus Norvegicus*, based on wild individuals trapped in

the area of Warsaw, Poland. One of the purposes of this enterprise was to investigate the individual differences in wild captive rats measured in the exploration box, used previously to study the free exploration in laboratory rats (Pisula, 2003, 2004; Pisula, & Siegel, 2005; Pisula, Stryjek, & Nałęcz-Tolak, 2006).

Taking into account three arguments:

–   thatthetwo-dimensional structure of temperament (personality) in laboratory rat, involving emotionality / emotional reactivity / harm avoidance versus activity / exploration / stimulus seeking is well established and widely accepted (Ray & Hansen, 2004; Whimbey & Denenberg, 1967)

–   that the majority of previous studies were based on the behavior measurement conducted in a simplified testing environment, and on few measurement trials (Renner, 1990; Walsh & Cummins, 1976)

–   that there is a continuing controversy concerning the validity of the data obtained from laboratory animals (Künzl, Kaiser, Meier, & Sachser, 2003; Lankin & Bouissou, 2001)

we wanted to test, whether the structure of individual differences in rat, observed in highly structured and complicated testing environment (as compared to open field for instance), will take similar two-dimensional form. One could hypothesize that the complex testing environment, together with an animal that has not been fully domesticated yet, should produce more complex picture of individual differences dimensions (Sackett, 1967; Sackett, Novak, & Kroeker, 1999). Therefore, the general purpose of this study is to find out the behavioral dimensions, that describe the individual differences in wild rats (rats being at early stage of laboratorization).

## Method

### Subjects

Thirty nine (19 females and 20 males) Warsaw Wild Captive Pisula Stryjek (WWCPS) rats were used in this study. The animals were about 100 days old at the onset of the experiment.

### Apparatus

The experimental chamber used for investigation of the exploratory behavior was a box measuring 83.5 x 57.5 x 80 cm (Fig 1). It was divided into zones A, B and C by two walls running perpendicularly to the longest dimension of the cage, but leaving a free space at the site of the frontal, plexiglass wall through which a videocamera filmed animals. The lateral zones B and C contained tunnels made of dark rubber, while the central part A was empty.
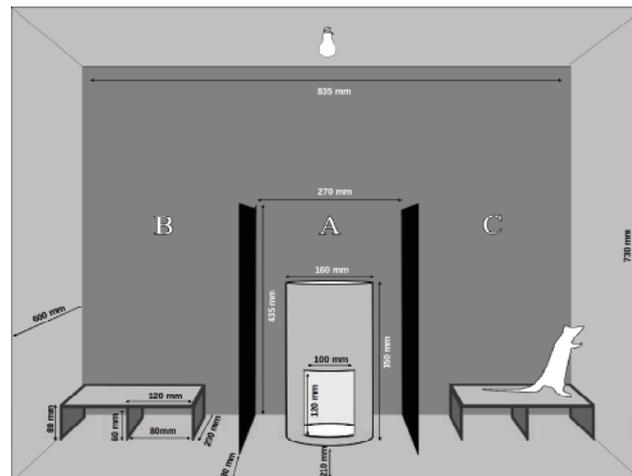


Figure 1. Experimental cage used in this study. (A) start zone (the cylinder seen in this zone was used as an animal transporter); (B) control tunnel zone; (C) experimental tunnel zone.

### Procedure

Every day, about 4-5 pm, from the beginning of the experiment onward, each animal was brought into the experimental room and the transportation container with the rat was placed in zone A of the experimental chamber for 6 minutes. The measurements took 15 days. Sessions 1st, 2nd, 5th, 6th, 9th, 10th, 11th,12th, 14th, 15th were video recorded. The experimental room was dark and completely silent. The video camera did not generate any noise that could affect the animal. It was placed approximately 2 m from the front cover of the experiment chamber. The front cover was made of transparent Plexiglas. For the purpose of analysis, the following behavioral activities were measured: sitting immobile (no visible movements, however looking calm and relaxed), rearing (standing with forelimbs in the air or against the wall), grooming (face washing, body licking), climbing the objects (climbing the top of the tunnels), jumping, freezing (remaining immobile with visible tension), and scratching.

During the measurement in all sessions, the experimenter left the experimental room immediately after placing an animal in the exploration enclosure. All animals were tested in the same cage. At the end of each test, the floor of the chamber was wiped with a moist paper towel.

## Results[1]

### Step 1, Principal Component Analysis (PCA)

Initial analysis showed, that jumping and scratching was almost absent, therefore these variables were dropped from further calculations. Consequently, the following variables (total numbers in of episodes of a given behaviour during the given trial) were included in principal component analysis: sitting immobile, rearing, grooming, climbing the

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[1]        All analyses have been performed using Tanagra software (Rakotomalala, 2005).

**Table 1**
**Factor loadings obtained in PCA analysis. A- unrotated factor matrix; B- rotated (VARIMAX rotation) factor matrix.**

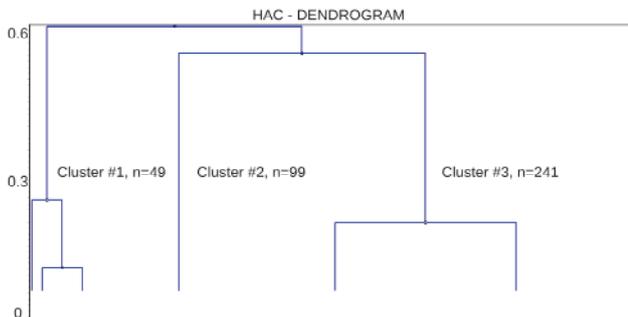|  | A – Unrotated factor matrix | | B – Rotated factor matrix | |
| --- | --- | --- | --- | --- |
|  | Factor 1 | Factor 2 | Factor 1 | Factor 2 |
| Sitting | -0.60 | -0.60 | 0.08 | 0.84 |
| Grooming | -0.48 | 0.30 | 0.56 | 0.08 |
| Rearing | 0.68 | -0.45 | -0.81 | -0.09 |
| Climbing | 0.67 | -0.35 | -0.74 | -0.16 |
| Freezing | -0.65 | -0.51 | 0.17 | 0.81 |



Figure 2. Dendrogram obtained from HAC analysis. Cluster sizes (subjects x trial) are provided near the main branches.

**Table 2**
**Descriptive statistics of extracted clusters. Means and standard deviations (parenthesis) are shown within the table cells.**

|  | Cluster 1 | Cluster 2 | Cluster 3 | Overall |
| --- | --- | --- | --- | --- |
| Freezing | 0.96 (0.79) | 0.00 (0.00) | 0.00 (0.06) | 0.12 (0.42) |
| Grooming | 2.41 (1.55) | 1.22 (0.90) | 2.48 (1.27) | 2.15 (1.34) |
| Sitting | 0.73 (1.02) | 0.03 (0.17) | 0.00 (0.06) | 0.10 (0.44) |
| Rearing | 12.69 (7.12) | 31.04 (9.77) | 14.85 (7.94) | 18.70 (11.04) |
| Climbing | 3.73 (3.18) | 11.89 (5.34) | 5.56 (3.60) | 6.94 (5.02) |

**Table 3**
**Results of Chi-square analysis of sex distribution across clusters.**

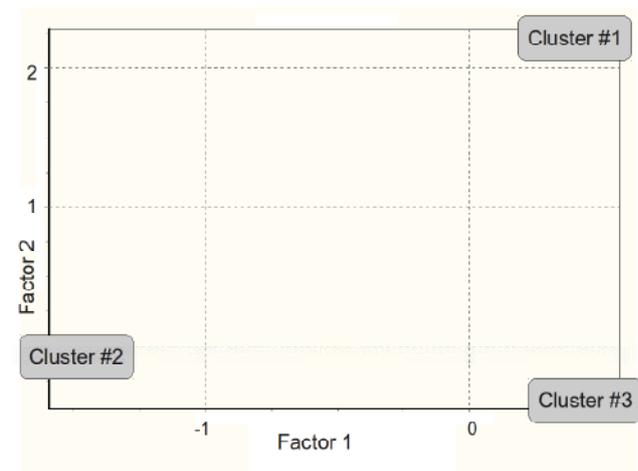|  | Females | Males | Sum |
| --- | --- | --- | --- |
| Cluster 1 | 37 (+ 40 %) | 12 ( - 37 %) | 49 |
| Cluster 2 | 38 ( - 11 %) | 61 (+ 11 %) | 99 |
| Cluster 3 | 114 ( - 0 %) | 127 (+ 0 %) | 241 |
| Sum | 189 | 200 | 389 |

*Chi² = 18.50,  p<0.001*



Figure 3. Cluster distribution across factors. Horizontal axis represents factor #1, the vertical axis stands for factor #2. The gray boxes represent location of extracted clusters in relation to factors.

objects, and freezing. As it was shown by Reise, Ventura, Nuechterlein & Kim (2005), it may be acceptable in this analysis, that the nested data structure is ignored, and all scores obtained during repeated measures are treated as coming from separate individuals. Adopting this approach for the purpose of this study, five variables, taken from thirty nine individuals, across ten trials were input to PCA. The results of PCA analysis are shown in table 1.

As it may be seen from the table 1, two factors have been extracted. The details of this result will be discussed later.

**Step 2, Hierarchical Agglomerative Clustering (HAC) analysis (Ward's method)**

Cluster analysis allows to for identification of groups of individuals, that represent determined level of similarity with respect to measured variables characterizing those individuals. In this study, factor scores coming from two factors extracted by PCA after rotation served as the variables that formed the basis for clustering. HAC is a clustering method that produces "natural" groups of examples characterized by attributes. A tree, called dendogram, where successive agglomerations are showed, starting from one example per cluster, until the whole dataset belong to one cluster, describes the clustering process. To simplify the results (the lower part of the dendrogram), a hybrid clustering variant of HAC method was applied (Rakotomalala, 2005). Three main clusters have been formed. The results of this analysis are shown in figure 2 and table 2.

The distribution of sex across clusters was analyzed with Chi-square procedure. The results of this analysis are presented in table 3, and show that cluster #1 has been formed predominantly by females, while the other clusters have no sex specific characteristics.

The relationship between extracted factors and clusters is shown in figure 3. It may be seen from this figure, that not all possible combinations of two factors are present in the group involved in the study. The combination Factor #1 (Low) and Factor#2 (High) was not present.

## Discussion

The main purpose of this study was to re-analyze the latent structure of individual differences in rats, and to compare these findings to previous conceptualizations. There were some important differences in approach to measure individual differences in rats, as compared to the previous

attempts. For instance:

- rats were tested as many as fifteen times,
- the testing environment was large and complex,
- no elements of forced activity were present in the procedure.

Two approaches were adopted: principal component analysis, and hybrid hierarchical clustering. In spite of the significant procedural differences, two dimensional structure of individual differences in WWCPS rats was re-established. This effect stays in accordance with the classic studies (Ray & Hansen, 2004; Whimbey & Denenberg, 1967), where similar structure was found. A more complex system in rats is obtained when various testing environments are applied (Ohl, Toschi, Wigger, Henniger, & Landgraf, 2001)), and therefore are rather by-products within apparatus correlations. The contents of that dimensions however is not exactly the same. The main factor extracted in this study was most negatively associated with rearing and climbing the objects in the testing environment. The appropriate label of that factor seems to fall somewhere between "risk assessment" and "information seeking". The second factor, that was loaded(observed/discovered) mostly by sitting and freezing, is probably the closest dimension to the old fashioned "emotionality" dimension, closely related to the level of anxiety. The cluster analysis run on the basic of factor scores, showed however, that not all possible combinations of trait crossings are observed in animals. Theoretically, the two-dimensional cross may result with four types of behavioral characteristics. As it is shown in figure 3 however, only three groups of individuals representing given combinations of dimensions are present. It is also worth mentioning, that one of the clusters (cluster #1) was formed mainly by the instances of behavioral patterns showed mainly by females, while the remaining two clusters were sex unspecific.

The results obtained in this study show, generally speaking, similar structure of individual differences in temperamental (or personality) characteristics in laboratory (Pisula, 1994, 1997) and wild (WWCPS) rats. Individual differences in rat temperament consist mainly of two main dimensions. The first one covers the fundamental aspect of behavior, that is information seeking (Pisula, 2007). On the one pool(end) of that axis one could place the risk assessment behavior, and on the opposite one, free spontaneous exploration. This reflects the very basic phenomenon. An organism cannot afford not gaining information about the environment. There are however intra- and inter situational differences in what kind of motivational background is actually driving the animal to explore the environment. Therefore, depending on circumstances, an animal may move from very cautious risk assessment to active, free from anxiety or fear, exploration. These differences may be a reflection of cross-situational stable characteristics, or actually present environmental conditions.

The second main factor of a rat's temperament may be called "activity". It reflects the general level of motor activity, and ranges from the total lack of locomotion, which is represented by the states such as tonic immobility or freezing, to very active moving throughout the surrounding space, and investigating the properties of proximate objects. These structure of individual differences are more or less replicated across various studies, the main difference being, that the previous ones were obtained from laboratory rats. The remaining question to be answered is to what extent they reflect the Eysenckian concepts on extra-introversion and neuroticism vs emotional stability (Eysenck & Eysenck, 1958), which are widely postulated both within human and animal psychology (Gosling & John, 1999).

This study shows that laboratory rats share the basic structure of individual differences in personality / temperament with their wild counterparts, which is an important conclusion for comparative psychologists. Therefore, at least in terms the structure of individual differences, the study provides support for the view that laboratory rats are still rats.

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