The relatedness of the emotionality variables¹

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The variables of latency to emerge from the home cage; activity, defecation, and ratio of inner to outer units entered in the open field; start and goal times of the timidity test; and number of avoidances and inter-trial crosses during avoidance learning were intercorrelated. Of the 344 correlations that were neither test-retest reliabilities nor correlations between variables from the same test with the same unit of measurement, the proportion of correlations that was significant in the predicted direction, .128, was significantly different from the chance proportion value, .025. Only four of 48 correlations were significant in the unpredicted direction.

The relatedness of the emotionality variables has been supported by about half the individual difference correlation studies reported. Significant correlations in the predicted direction between defecation and frequency of eating in the open field, between defecation and activity in the open field, and among defecation, activity in the open field, latency to emerge, and timidity (Stone, 1932) were found by Hall (1934), Hall (1936), Biel & O'Kelly (1940), and Anderson (1938), respectively. Nonsignificant correlations among defecation and food consumption in the open field and latency to emerge, between defecation in the open field and latency to emerge, and defecation and activity in the open field were obtained by Bindra & Thompson (1953), Hunt & Otis (1953), Pare (1964), and Pare & Cullen (1965), respectively.

The present study intercorrelated nine types of variables, i.e., two latency to emerge times; activity, ratio of inner to outer squares entered, and defecation in the open field; start and goal times of the timidity test; and number of avoidances and intertrial crosses during avoidance learning. High latency, defecation, start, and goal times and low activity, inner/outer, avoidances, and crosses scores were predicted to be associated with high fear. These predictions are based, in part, on the Mowrer & Aiken (1954), Kamin (1965), and Hunt & Otis (1953) reports that a CS that was followed by shock (and therefore presumably produced fear) inhibited ongoing activity and led to an increase in defecation. The predictions for four of the variables will be discussed briefly. Higher fear in avoidance conditioning should inhibit movement and therefore lead to a decrease in avoidances and crosses. Higher fear in the open field should make the animal stay close to more familiar stimuli, which, in this apparatus, are the outer units that are bordered by the more familiar wall. The aforementioned prediction for the start variable may be incorrect because an animal with higher fear should be more moti-

vated to move into the enclosed section of the timidity apparatus, and thus obtain a lower time score.

Method

A fuller description of the procedures can be found in King (1966).

The Ss, male and female rats of the Sprague-Dawley strain, were weaned at 21 days of age. The sample sizes that were tested on the emerge-from-home-cage, open field, timidity, and avoidance conditioning tests were 80, 80, 64, and 40, respectively, and the Ss' ages were 51-63, 63-70, 167-207, and about 215 days on the first day of testing, respectively. Approximately half the Ss were of the same sex for each test.

The emerge-from-home-cage apparatus was a runway 24-1/2 in. long, 6-1/2 in. wide, and 6-3/4 in. high. It hooked onto the home cage. Two lines, at the start and 13-1/2 in. from the start, were painted on its floor.

The open field apparatus was similar to the one Broadhurst (1960) used. The field was 33 in. in diameter and was marked off into inner and outer units. The outer units were adjacent to the wall, the remainder were considered to be the inner units.

The timidity apparatus resembled Stone's (1932) apparatus. Essentially, it was a U-shaped runway. The U-shaped section was made of galvanized metal, and wooden start and goal boxes were attached to the ends of the two arms of the U. The top for the U-shaped section was opaque, but the tops for the start and goal boxes were transparent. The pathway from the start to the goal box was approximately 8 ft.

A shuttle box 29 in. long, 5 in. wide, and 10-3/4 in. high was used for the avoidance conditioning task. The onset and offset of the CS and shock were automated. A 1200 cps tone from an audio oscillator was the CS, and it was delivered 5 sec before shock onset. The shock (1.0 mA) was delivered from a Model E1064GS Grason-Stadler shock generator. An escape led to the termination of both tone and shock, an avoidance to CS termination.

The laboratory was maintained on a 12-1/2 h on, 11-1/2 h off light cycle. All Ss were tested in the dark.² To aid seeing the Ss, a dim red light was used. Trials for each test were generally run on consecutive days.

Emerge-from-home-cage testing consisted of three 5 min trials. The times (in seconds) that the rat placed either front paw squarely onto the first line (the "emerge, line 1" score) and either front paw

past the second line (the "emerge, line 2" score) of the runway were recorded for each trial.

Two 5 min trials were run on the open field. The "total activity" score was equal to the total number of units entered, and the "inner/outer" score was equal to the ratio of inner to outer units entered.

Five trials were run on the timidity test. The Ss were food-deprived 21 h before each trial, and were reinforced with one piece of Nestle's Toll House Cookie Chocolate. The time (in 0.1 seconds) that all four of the S's feet left the start box (the "start" score) and the time elapsed (in seconds) between leaving the start box and passing the line on the goal box floor with both front feet (the "goal" score) were recorded.

Avoidance conditioning continued for four days, 30 trials a day. An "avoidances" score (the number of avoidances) and a "crosses" score (the number of intertrial crosses from one side of the box to the other) were obtained for each day.

Results and Discussion

Natural log transformations of the emerge-from-home-cage and timidity test variables were made. Because sex differences were found for almost every variable of the study, within group, rather than total, correlations were calculated (McNemar, 1962, p. 328). The variables that were intercorrelated were the scores obtained for a single trial; e.g., inner/outer, Day 1; avoidances, Day 2; and goal, Day 3. Of the resulting 435 correlations, 91 were not considered because they were either test-retest reliabilities or correlations between variables from the same test with the same unit of measurement.

Of the remaining 344 correlations, only 48 were significant (.05 level, two-tailed), but 44 were significant in the predicted direction. A z-score of 12.04 ($p < .001$) was found for the difference between the proportion of significant correlations in the predicted direction, .128, and the proportion expected by chance, .025. The chance probability of obtaining 44 out of 48 significant correlations in the predicted direction is also very low ($p < .001$).

The results that were obtained were in the predicted direction and highly significant, yet they do not as strongly support the hypothesis of relatedness as one would wish, because: (a) only 12.8% of the predictions were significant, and (b) the assumptions underlying the statistical tests that were made were not fulfilled. The latter point follows from the fact that the outcomes of the correlations were not independent events.

The number of times each type of variable was a member of a significant correlation in the predicted direction was counted. The emerge, line 1; emerge, line 2; total activity; inner/outer; goal;

start; avoidances; crosses; and bolus count variables were members 11, 14, 10, 16, 24, 6, 3, 4, and 0 times, respectively. The first five variables listed appear to be related to an approximately equal extent. Four out of five of these variables resemble the variables comprising the activity factors obtained from factor analytic studies of the emotionality variables (Willingham, 1956; Furchtgott & Cureton, 1964; McClearn & Meredith, 1964). The remaining variable, the inner/outer score, is not a measure of activity, and this suggests that an activity factor more nearly reflects fear of novel stimuli than activity.

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Notes

1. Research done in partial fulfillment of the requirements for the Ph. D. degree at Stanford University.
2. This procedure was followed because it was once thought that Ss tested in the dark would exhibit greater reliability.