Correlation of Natural Rat Behaviors in Trait Impulsivity

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Background to Impulsivity

Impulsivity is a key behavioral trait varying greatly among both human and animal individuals, arising as a result of structural and functional changes in the brain [1, 2]. It is characterized by individuals having a predisposition towards rapid, unplanned reactions to stimuli without regard to negative consequences or alternative actions. Increased impulsivity is often observed along with other behavioral abnormalities as being associated with a number of psychiatric disorders such as: substance abuse, Binge Eating Disorder and Attention Deficit Hyperactivity Disorder.

Aims

To investigate whether trait impulsivity correlates with other aspects of natural behavior in a preclinical setting we explored the relationships between locomotor activity, burrowing behavior, grooming behavior and impulsive action in the Lister Hooded rat.

Experimental Procedures

Animals used were 96 male Lister Hooded rats (Charles River Laboratories, Sulzfeld, Germany), weighing 250-270g at the start of the experiments; age approx. 9 weeks. All experiments have been approved by the local Animal Experimentation Ethics Committee.

We measured impulsive action by means of the 5-Choice Serial Reaction Time Task (5CSRTT). In this task, the rat is placed into an operant chamber (Med Associates Inc., Fairfax, USA) containing 5 apertures and a food receptacle. After initiation of a trial by a nose-poke into the food receptacle followed by 5 s delay the rat is presented with a light flash in one randomly allocated aperture. If the rat nose-pokes into the indicated aperture within the 5 s time interval after the cue then it will receive a reward of one food pellet (TestDiet 1811155 (5TUL) AIN-76A Rodent Tablet 45mg, Sandown Scientific). If the rat nose-pokes into a different chamber than the one indicated or makes no response, this is recorded as an incorrect response or an omission, respectively, and results in a time out period of 5 s during which all lights in the box are extinguished and no reward is given. A nose-poke into any aperture before the stimulus is presented is recorded as a premature response. The premature responses are used as a direct measure of impulsivity (more premature responses = higher impulsivity). Rats were trained in this task according to the standard protocol [3].

We measured burrowing activity using a steel tube, (length ca. 32.3 cm, diameter ca. 10.5 cm and elevation off ground ca. 6 cm) filled with 2 kg of normal quartz sand, placed in an empty plastic cage measuring 600 x 340 x 200 mm, facing one of the rear corners. Rats were habituated to the room for 1 hour before start of experiment. The training protocol is in two main phases. The first phase is social facilitation in which rats are placed in the burrowing set-up in pairs on two consecutive days and the amount of sand burrowed is measured. If a pair burrows less than 1500 g of sand on the first day it is swapped with a pair which has burrowed greater than 1500 g. The purpose of the social facilitation phase is to ensure the rats learn the behavior and the natural tendency of rats to imitate each other's behavior means that this phase strengthens the burrowing behavior. In the next stage of training, rats are placed individually into burrowing cages for 1 hour, and amount burrowed is recorded. This

procedure is carried out for at least 3 days and until all burrow greater than ca. 500 g. Once stable performance is seen amongst the group, the average of 4 days burrowing for each rat is used as the final measurement.

Locomotor activity was measured in three categories: distance moved (cm), rearing time (s), and rearing frequency. All three end points were measured automatically by Tru Scan ® Activity Monitors and Tru Scan © 2 software (Coulbourn Instruments, USA). Arenas consist of a 41 cm x 41 cm removable floor tray, and four 40 cm tall plastic walls. Rats were placed individually in the arenas for 30 minutes with the lights on and the 3 parameters were measured. Locomotor activity was measured twice for each rat to ensure the presence of stable performance, with a period of 3 weeks between the two measurements.

In order to measure Grooming Activity, rats were recorded for 14 hours overnight, in the dark using Noldus ® PhenoTyper ® equipment, which consists of a 45 cm x 45 cm floor, plastic walls and a PhenoTyper ® top unit (containing an infrared camera). A food tray and water bottle were attached to one of the walls, so that the rats had ad libitum access to them. Grooming activity was measured in terms of grooming time and grooming frequency (number of separate grooming bouts). A gap of at least 5 s signified separation between grooming bouts and bouts lasting less than 5 s were ignored to differentiate from scratching. Measurements were taken both automatically by EthoVision XT10 software and manually, and compared.

Experiments were carried out according to the following order:

1. First measurement of locomotor activity – 4 days.
2. Training and measurement of burrowing activity – 3 weeks.
3. Second measurement of locomotor activity – 4 days.
4. Recording of grooming videos – 7 nights.
5. 5CSRTT training and screening – 14 weeks.

Spearman Rank Correlations were performed against each natural behavior (burrowing, locomotor activity and grooming) versus % premature responses, the index of impulsivity in the 5CSRTT. 78 rats were compared due to some rats not sufficiently learning the operant task. Extreme high and low impulsive rats were selected from the top and bottom 15%, respectively, of premature responses, yielding 12 rats in each group. The average burrowing, locomotor activity and grooming values were calculated for both the high and low impulsive groups, and compared to each other using two-tailed unpaired t-tests. Statistical significance was set to $p < 0.05$.

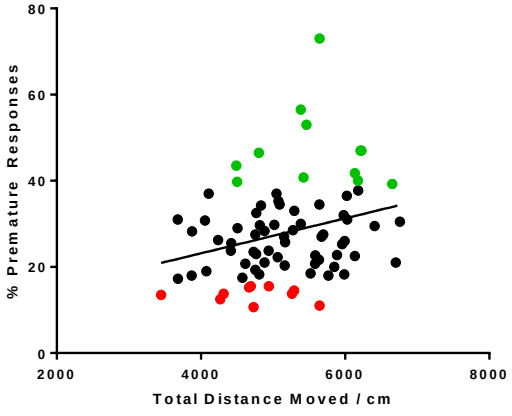

Figure 1. Correlation of first measurement of distance moved and % Premature Responses in 5CSRTT; $^{**}P = 0.0083$; n=78

Results & Conclusions

We saw no correlation with burrowing activity and premature responses in the 5CSRTT in Lister Hooded rats. The 'Low Impulsive' (LI) group burrowed a mean of 1304±10 g, and the 'High Impulsive' (HI) group burrowed an average of 1250±80 g, between which there is no significant difference. We did see a correlation with distance moved in a novel environment (first measurement of locomotor activity) ($^{**}P = 0.0083$; Figure 1) and also rearing frequency in a novel environment ($^{*}P = 0.0103$) with premature responses, but not with rearing time, nor with the second measurement of any locomotor activity parameter. The grooming

data are currently under analysis. With the data analysed so far, we can conclude that only certain parameters of locomotor activity in a novel environment are related to impulsive action.

References

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