Individual differences in impulsive choice behavior in different strains of rats

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INTRODUCTION

Individual differences in impulsive choice behavior have been linked to a variety of behavioral problems including substance abuse, smoking, gambling, poor financial decision-making, impulsivity, and ADHD (e.g., Sonuga-Barke, et al., 1992).

Although a number of studies have examined impulsive choice behavior in **Lewis** (LEW) and **Spontaneously Hypertensive** (SHR) rats, neither of these strains has been specifically selected for impulsivity and, as a result, their appropriateness as a model for studying disorders of impulse control is potentially questionable (e.g., Alsop , 2007).

Given the potential importance of individual differences in impulsive choice as a predictor of behavioral problems, the present study sought to measure the extent of individual differences in these two strains along with their companion controls (**Wistar**, WIS and **Wistar Kyoto**, WKY) using a discrete-trial choice task in which both reward magnitude and delay to reward were manipulated across phases.

METHOD

SSLL choice task. WIS, LEW, WKY and SHR experimentally-näive male rats (n=9 per strain) were exposed to a discrete-trial choice task with a smaller-sooner reward of 1 pellet delivered after 10 s and a larger-later reward of 2 pellets delivered after 30 s. The task contained a mixture of free choice (30/session), forced choice (16/session) and peak (2/session) trials.

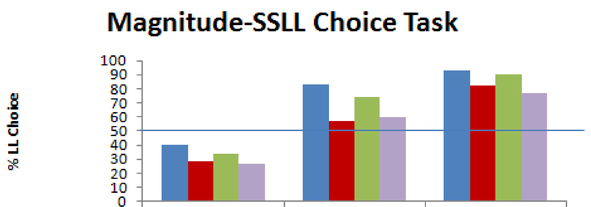
There were six phases:

Phase 1: **Baseline**
SS = 1 pellet, 10 s LL = 2 pellets, 30 s
Phase 2: **Magnitude manipulation 1**
SS = 1 pellet, 10 s LL = 3 pellets, 30 s
Phase 3: **Magnitude manipulation 2**
SS = 1 pellet, 10 s LL = 4 pellets, 30 s

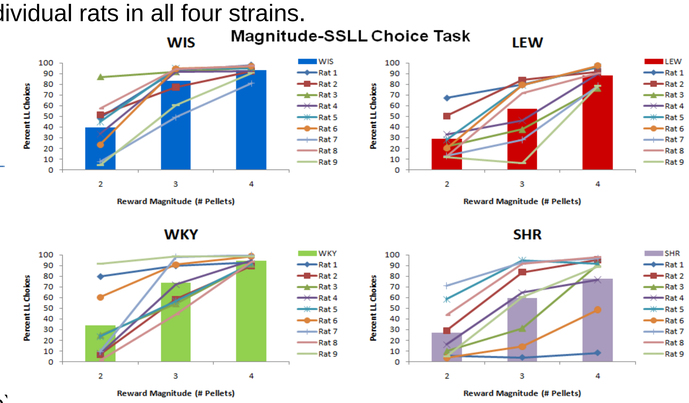
Phase 4: **Baseline (lever swap)**
SS = 1 pellet, 10 s LL = 2 pellets, 30 s
Phase 5: **Delay manipulation 1**
SS = 1 pellet, 15 s LL = 2 pellets, 30 s
Phase 6: **Delay manipulation 2**
SS = 1 pellet, 20 s LL = 2 pellets, 30 s

RESULTS

The four strains were sensitive to both of the manipulations (reward magnitude and delay to reward) across phases. There was large variation in performance of individual rats in all four strains.



	2 pellets	3 pellets	4 pellets
WIS Magnitude	39.74	82.92	93.23
LEW Magnitude	28.91	56.93	82.12
WKY Magnitude	33.86	73.70	89.87
SHR Magnitude	26.87	59.66	76.73



LL Reward Magnitude Manipulation (see figure above)

All strains showed significant adjustment to the increase in LL magnitude when compared to chance levels.

LEW vs. WIS

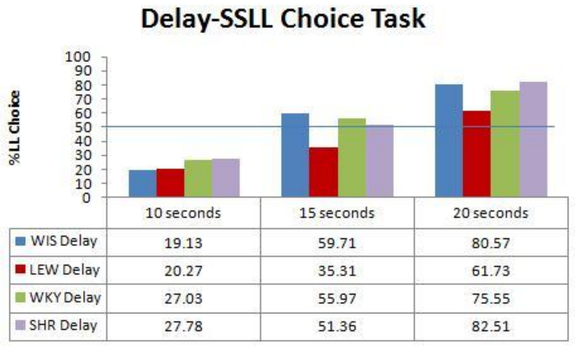
Although the LEW rats showed lower LL choices when compared to the WIS this did not quite reach statistical significance (p = .07).

Individual differences among the rats within a strain accounted for 21% of the total variance in choice behavior and contributed more variance than the strain of the rat (5%), but less variance than reward magnitude (54%).

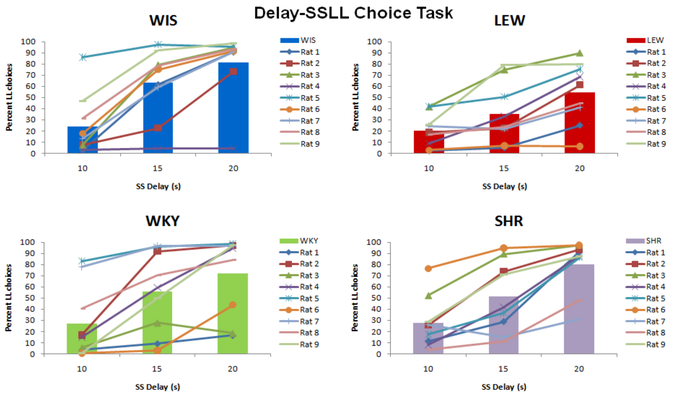
SHR vs. WKY

The SHR rats displayed lower LL choices when compared to the WIS strain (see figure above) but this did not reach statistical significance (p = .26).

Individual differences among the rat within a strain accounted for 37% of the total variance in choice behavior and contributed more variance than the strain of the rat (3%), but less variance than reward magnitude (41%).



	10 seconds	15 seconds	20 seconds
WIS Delay	19.13	59.71	80.57
LEW Delay	20.27	35.31	61.73
WKY Delay	27.03	55.97	75.55
SHR Delay	27.78	51.36	82.51



SS Delay to Reward Manipulation (see figure above)

LEW and WKY strains did not adjust fully to the increase in SS delay when compared to chance levels.

LEW vs. WIS

LEW rats presented lower LL choices when compared to the WIS strain, but this did not reach statistical significance (p = .10).

Individual differences among the rat within a strain accounted for 42% of the total variance in choice behavior and contributed more variance than the strain of the rat (8%) and the SS delay (30%).

SHR vs. WKY

There was no significant difference in the percentage of LL choices in the SHR and the WKY strains (p = .92).

Individual differences among the rat within a strain accounted for 52% of the total variance in choice behavior and contributed more variance than the strain of the rat (<1%) and the SS delay (30%).

DISCUSSION

The present study sought to compare the performance of two strains that have been reported to demonstrate increased impulsive choice (LEW and SHR) to their genetically-compatible control strains (WIS and WKY) on a discrete-trial delay discounting task.

Individual differences among the rat within a strain accounted a significant proportion of the total variance (21-52%) and contributed more variance than the strain of the rat (1-8%) across reward magnitude and delay to reward manipulations.

All four strains adjusted to the increase in LL magnitude and there were no significant differences among the strains in choice behavior. The statistical comparison of the strains was most likely undermined by the large individual differences in choice behavior.

On average, the LEW and WKY strains displayed decreased sensitivity to the increase in SS delay, which may indicate a deficit in some aspect of temporal processing or in their integration of temporal information in decision-making.

The SHR have been evaluated as a model of ADHD, with often inconsistent results. This may be due to the large individual differences within that strain and the control strains.

Given that Individual differences in choice behavior relate to a multitude of behavioral problems (i.e., gambling, drug addiction, obesity, ADHD), these strains, which have been used as models for studying disorders of impulse control, should be exhaustively explored with other procedures for their reward processing to evaluate if individual differences are maintained across different manipulations and to explore if impulsive choice behavior is a stable trait.

However, the present results suggest that the SHR and LEW strains may not be sufficiently homogeneous with respect to impulsive choice behavior to be considered as viable animal models for impulse control disorders.

REFERENCES

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