A Cross-Strain Analysis of Impulsivity

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INTRODUCTION

Delay discounting is a term that describes how the value of an outcome decreases as its receipt is delayed over time. This effect can be assessed by exposing subjects to repeated choices between a small reward delivered immediately versus a larger amount delivered after a delay.

The degree to which subjects discount these delays can be quantified as a numerical value ("k"), and is widely thought to indicate individual differences in impulsivity. There are differences in average k-values across strains of the same species as well.

Delay Discounting has been correlated with traditionally impulsive populations, including substance abusers and problem gamblers.

The current research compared delay discounting in two rat strains to evaluate cross-strain differences in impulsivity. Additionally, procedural manipulations were made in an attempt to reduce the time required to obtain relaible k-values.

METHODS

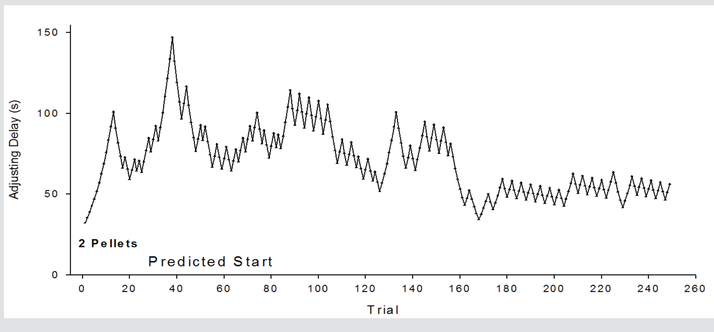
Delay Discounting

12 rats served as subjects (6 Sprague Dawley and 6 Fischer-344). Subjects made repeated choices between 1 sucrose pellet delivered immediately, versus a larger (x) amount delivered after an adjusting delay. Indifference points were quantified as the adjusting delay when subjects alternated between the two options about equally often.

In an attempt to reduce sessions required per condition, starting adjusting delays were manipulated. In some conditions, the adjusting delay started at a low initial delay (10s), which is typical from prior research. Other conditions were run in which the adjusting delay started at the predicted indifference point based on Mazur's (1987) hyperbolic discounting equation: $V=A/1+kD.$ with k = 0.25 (see Table 1).

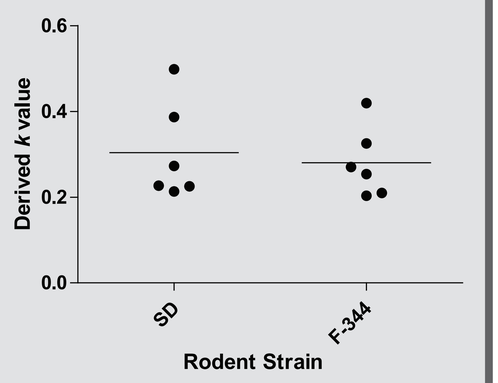
Additionally, post-hoc analyses assessed whether reliable k-values can be derived by using only two more widely divergent larger-later conditions (2 pellets and 8 pellets).

Figure 2. Trial-by-Trial Sample Performance



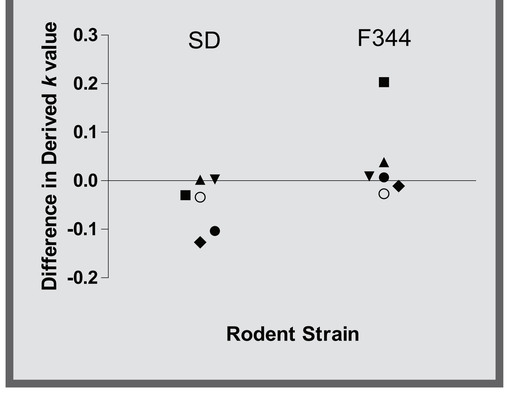
SUMMARY OF RESULTS

Figure 3. Obtained Impulsivity Values



Impulsivity Assessments:
Results from the cross-strain comparisons suggest negligible differences between obtained k-values of each strain.

Figure 4. Reliability of *k*-values



Reliability of k-values with fewer conditions:
Post-hoc analyses were run demonstrating that reliability in derived k values can be achieved by analyzing data from only two certain conditions, implicating that discounting measures can be assessed in nonhuman subjects quite rapidly even while employing steady-state methodologies.

Table 2.

SUBJECT	PEPPER 1	PEPPER 2	PEPPER 3	PEPPER 4	PEPPER 5	PEPPER 6
k VALUE	0.498256275	0.272694844	0.226617795	0.213015957	0.386848493	0.225210481
2-condition *k*	0.601660262	0.302443382	0.22482339	0.210326715	0.51386681	0.259279027
R^2	0.750277832	0.944259717	0.999838951	0.996058088	0.875658837	0.919809521
SUBJECT	**CHOCOLATE 1**	**CHOCOLATE 2**	**CHOCOLATE 3**	**CHOCOLATE 4**	**CHOCOLATE 5**	**CHOCOLATE 6**
k VALUE	0.253670769	0.20328695	0.270444082	0.419327561	0.325358529	0.209904174
2-condition *k*	0.246624917	n/a	0.232121405	0.410301521	0.336427054	0.236789893
R^2	0.990687379	0.999435791	0.950883472	0.91748541	0.83534284	0.938324753

Figure 1. Procedural Schematic

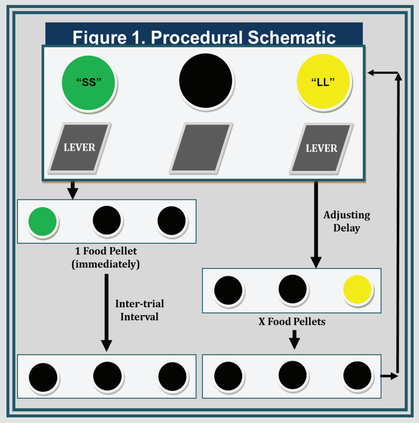


Table 1.

AMOUNT	1 Pellet	2	4	6	8
DELAY (k = 0.25)	0s	4s	12s	20s	28s

DISCUSSION

The current study demonstrated that impulsivity scores (as measured by discounting) do not differ substantially across strains. We are continuing to collect data to further establish this initial result.

Our finding that reliable k-values can be established with results from only two conditions has potential to significantly impact how delay discounting procedures are implemented in future research.

This study provides a novel method for reducing data collection time for researchers utilizing the delay discounting model. This is particularly important because this model has been widely correlated with impulsive clinical populations and is therefore frequently utilized (in particular, to assess methods to increase self-control choices).

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