The Effect of Disrupted Insulin Signaling on Impulsive Choice

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Introduction

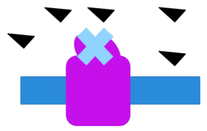
- Type 2 diabetes results when the body's insulin signaling is disrupted. Following early diagnosis, Type 2 diabetes can be reversed with adequate exercise and improved diet.
- Despite the fact that Type 2 diabetes can be reversed, the prevalence of the disease continues to increase annually.[1]
- Impulsive choice, or one's willingness to wait for a reward, is associated with binge eating and obesity. This could explain why it is difficult to make the necessary lifestyle changes to reverse the disease. [2,3]
- Furthermore, recent studies have found that disrupted insulin signaling is associated with impulsive choice.[4]
- The current study aimed to understand the relationship between disrupted insulin signaling and impulsive choice.

Methods

Subjects: 24 Male Sprague Dawley rats

Groups:

- Saline
- Insulin Receptor Antagonist (S961)



Surgery: An osmotic mini pump was implanted subcutaneously. This allowed for each solution to be delivered at a constant rate of 2.5uL/hr for 23 days

Impulsive choice task: After 7 days of exposure to the solutions, rats underwent an impulsive choice task

Impulsive Choice

SS = 5→10→20 s, 1 p

LL = 30 s, 2 p

References

1. Olokoba, A. B., Obateru, O. A., & Olokoba, L. B. (2012). Type 2 Diabetes Mellitus: A Review of Current Trends. *Oman Medical Journal*, *27*(4), 269–273.
2. Odum, A. L. (2011). Delay discounting: Trait variable? *Behav Processes*, 87(1), 1-9.
3. Davis, C., Patte, K., Curtis, C., & Reid, C. (2010). Immediate pleasures and future consequences. A neuropsychological study of binge eating and obesity. *Appetite*, 54(1), 208-213.
4. Eisenstein, S. A., Gredysa, D. M., Antenor–Dorsey, J. A., Green, L., Arbeláez, A. M., Koller, J. M., … Hershey, T. (2015). Insulin, Central Dopamine D2 Receptors, and Monetary Reward Discounting in Obesity. *PLoS ONE*, *10*(7), e0133621.
5. Kemnitz, J. W., Roecker, E. B., Weindruch, R., Elson, D. F., Baum, S.T., & Bergman, R. N. (1994). Dietary restriction increases insulin sensitivity and lowers blood glucose in rhesus monkeys. *American Journal of Physiology Endocrinology and Metabolism, 266 (1), E540-E547*
6. Odum, A. L. (2011). Delay discounting: I'm a k, You're a k. *Journal of the Experimental Analysis of Behavior, 96(3), 427-439*

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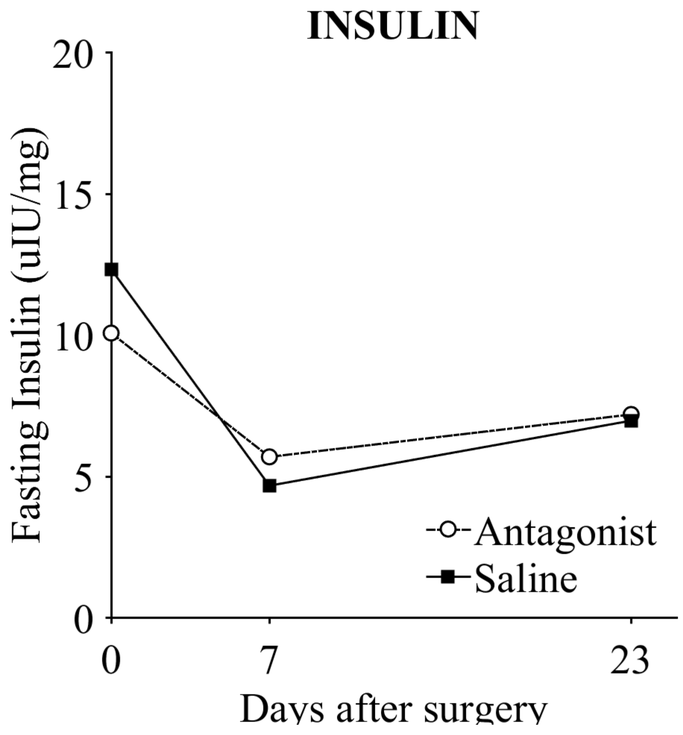
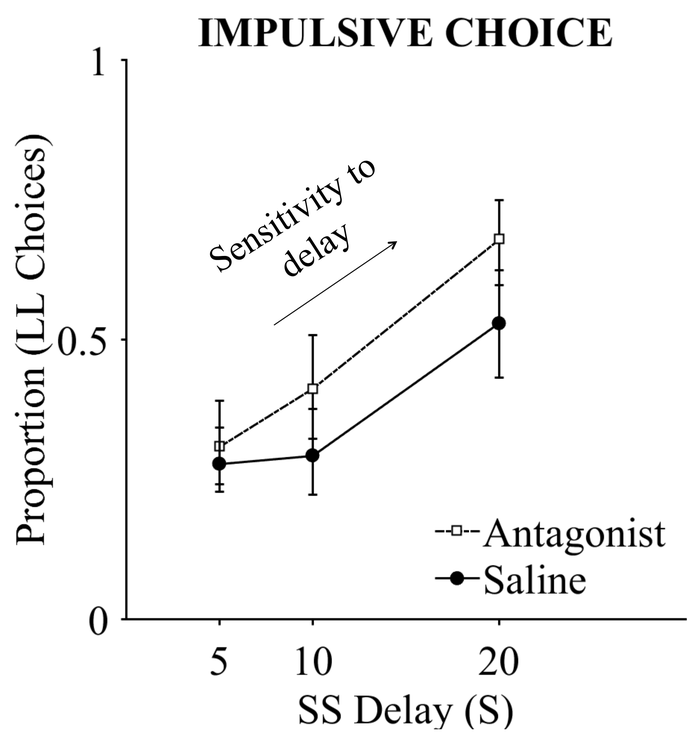
Results

Blood sample (day 0) → Osmotic Pump implantation → Food restricted (day 5) → Blood sample (day 7) → Impulsive choice task → Blood sample (day 23)



Fasting insulin levels decreased on Day 7 and then partially rebounded by Day 23, and there were no group differences.



Rats given the antagonist had a greater sensitivity to delay and an increased preference for the larger reward.

Discussion

- Fasting blood insulin levels did not differ from the control group after exposure to the antagonist.
- It is possible that food restriction (on Day 5) could have counteracted the antagonist by increasing insulin sensitivity.[5]
- While there were no group differences in fasting insulin levels, blocking insulin receptors increased sensitivity to delay and induced a preference for a larger reward.
- The alteration in sensitivity to delay is a key marker for delay discounting, or the process by which rewards decrease in value as the delay to the reward increases.[6]
- Because delay discounting is associated with binge eating and obesity, individuals with disrupted insulin signaling may not be able to change their lifestyle to reverse the disease.[3]
- Future work should investigate the source of the increased preferences for the larger reward.
- Behavioral interventions should target sensitivity to delay to increase the subjective value of delayed rewards for individuals with disrupted insulin signaling.