The Effects of Bariatric Surgery on Delay Discounting Modeling in Obesity

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Background

- Disorders linked to abnormal eating behavior like anorexia nervosa, binge-eating, and obesity have been linked to impulsivity through delay-discounting (DD) paradigms[1,2,3], and past research suggests that insufficient inhibitory control drives obesity-related behaviors.[4, 5]
- It remains unknown how morbidly obese patients discount future rewards and whether they show differences between different types of rewards (i.e. primary rewards like food vs. secondary rewards like money).
- One of the most successful weight loss interventions is gastric bypass surgery; past research has shown the effects of bariatric surgery on physiological symptoms of obesity [6].
- It is still unknown how the physiological changes of bariatric surgery are linked to changes in DD for different rewards and, more generally, impatience.

Research Questions

- How do morbidly obese participants discount rewards over time?
- Are there differences in delay discounting (DD) between food and monetary rewards in obesity?
- How does bariatric surgery influence DD behavior in obese patients?

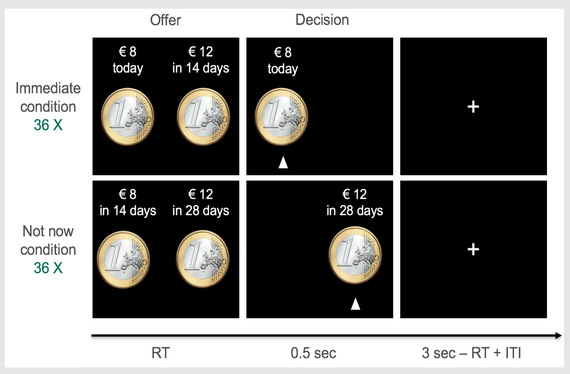
Study 1: *Indifference point task*

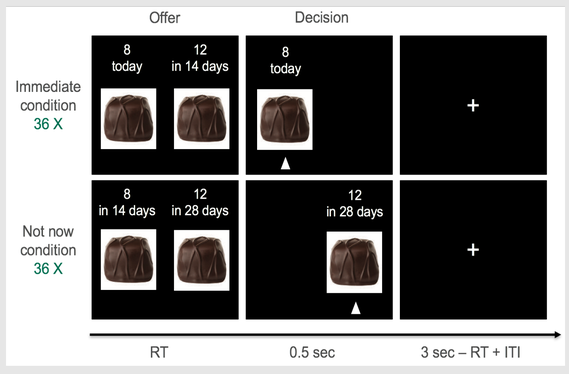
Group (All Females)	T0 Pre-op	T1 3-month post-op	T2 12-month post-op
Obese Patients Age: 33.7±1.8 , BMI>30	72	45	37
Lean Controls Age: 38.6±2.5, BMI: 22 ±0.40	39	33 **(6 months after)**	
Obese controls (no surgery) Age: 37.6±2.4, BMI: 31.8±0.5	29	---	

- Do you prefer receiving 4 candies (Euros) now, or 4 in a week?
- Do you prefer receiving 4 candies (Euros) now, or 5 in a week?
- Do you prefer receiving 4 candies (Euros) now, or 6 in a week?
- Do you prefer receiving 4 candies (Euros) now, or 7 in a week?
- Do you prefer receiving 4 candies (Euros) now, or 8 in a week?
- Do you prefer receiving 4 candies (Euros) now, or 9 in a week?
- Do you prefer receiving 4 candies (Euros) now, or 10 in a week?
- Do you prefer receiving 4 candies (Euros) now, or 11 in a week?
- Do you prefer receiving 4 candies (Euros) now, or 12 in a week?

Study 2: *Delay discounting task[2]*

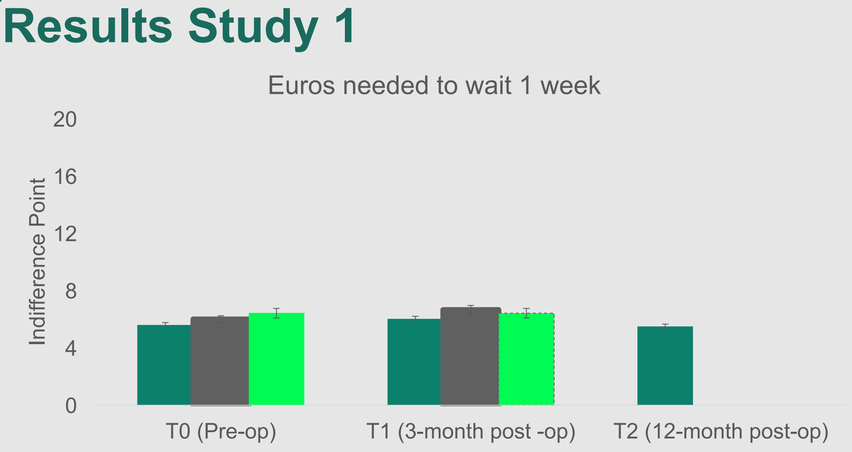
Group (All Females)	T0 Pre-op	T1 6-month post-op
Obese Patients Age: 34.6±1.8, BMI: 44±2.5	17	15
Lean controls Age: 38±13, BMI: 21.7±1.4	45	34
Obese controls (no surgery) Age: 37.6±2.4, BMI: 31.8±0.5	29	-----

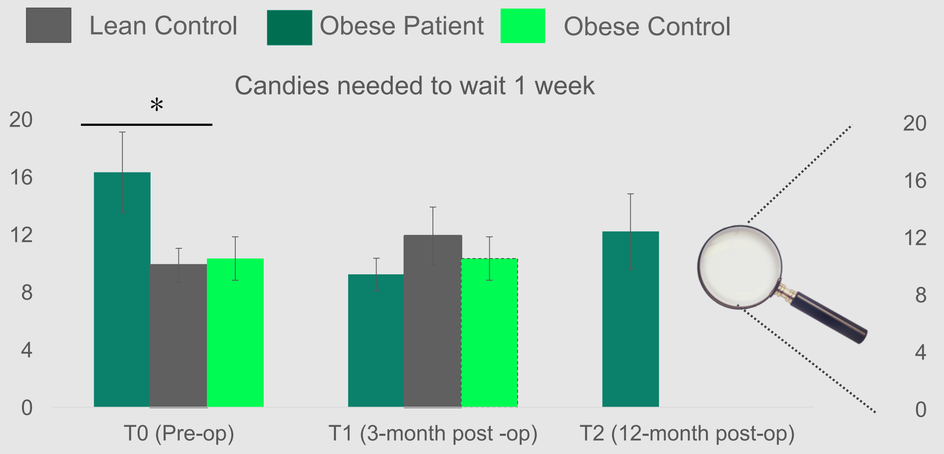


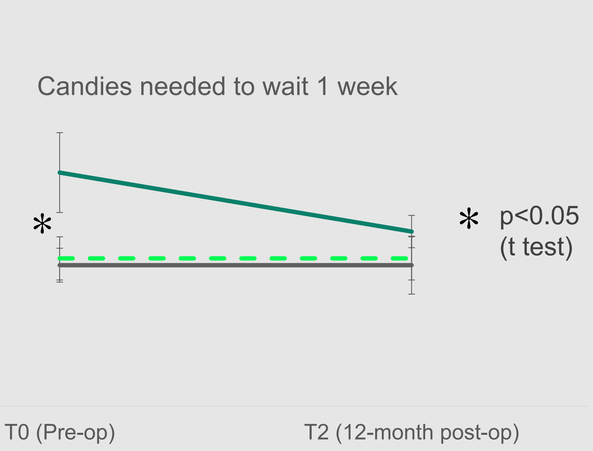


- Delays, amounts of reward (smaller sooner, larger later) and timing (immediately; not now) varied
- Two sessions of 72 trials each: one for food and one for money

Results Study 1

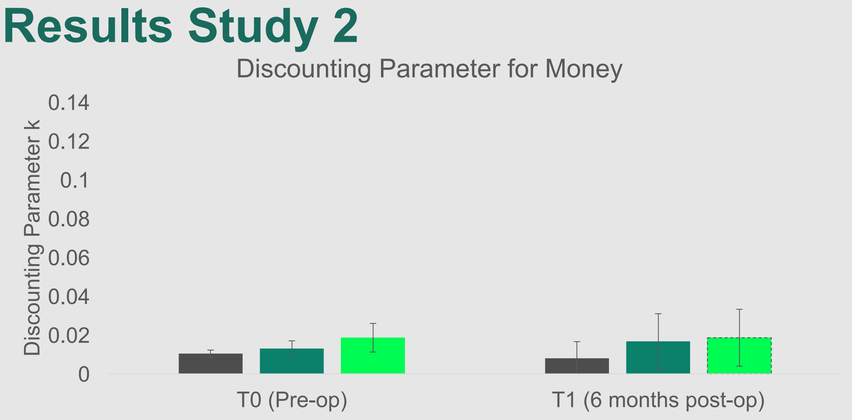


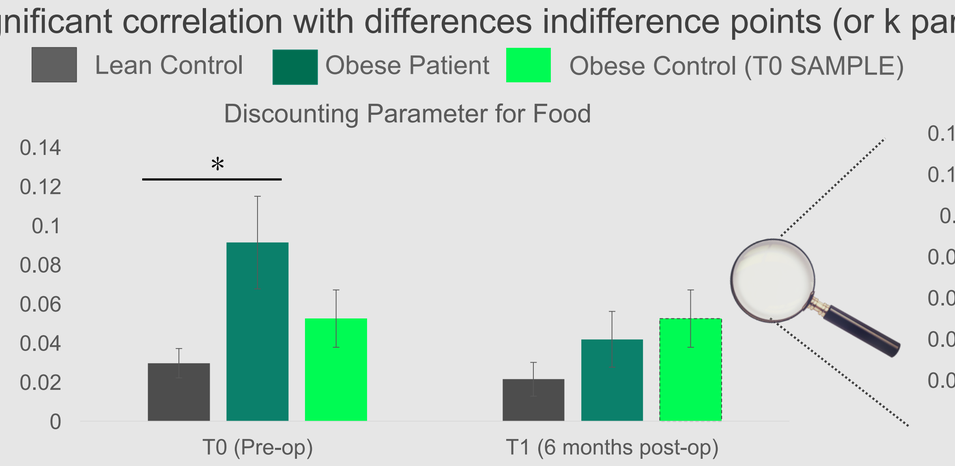


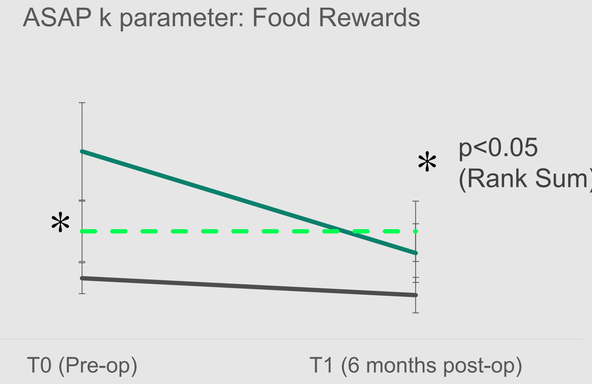


- Differences in hunger state in patients showed no significant correlation with differences indifference points (or k parameter estimates in study 2) for food.

Results Study 2







- There exist no significant preference reversals between the “now” and “not now” conditions.
- BIC comparisons for all participants revealed the as-soon-as-possible (ASAP) model fitted best, compared to the beta-delta and hyperbolic models.

ASAP model[7]: $SV = g(D_{ASAP})\frac{A}{1+k(D-D_{ASAP})}$, where $g(D_{ASAP}) = \frac{1}{1+kD_{ASAP}}$

- k is the discounting parameter for ASAP model. A higher parameter indicates higher discounting of future rewards.

Discussion

- Candidate obese participants for bariatric surgery discount future food rewards significantly more than obese and lean control groups, as shown in both indifference point and delay discounting tasks.
- These differences in impatience are specific to food rewards and do not extend to monetary rewards.
- After bariatric surgery, obese patients discount future food rewards less than before surgery
- Further research will compare how neural activity and biomarkers like leptin and gut bacteria richness mediate these effects.

References: 1) Davis, C., Patte, K., Curtis, C., & Reid, C. (n.d.). Immediate pleasures and future consequences. A neuropsychological study of binge eating and obesity. *Appetite,* 208-213. doi:10.1016/j.appet.2009.11.002 **2)** Decker, J. H., Figner, B., & Steinglass, J. E. (2015). On weight and waiting: Delay discounting in anorexia nervosa pretreatment and posttreatment. In *Biological Psychiatry*. http://doi.org/10.1016/j.biopsych.2014.12.016; **3)** Schiff, S., Amodio, P., Testa, G., Nardi, M., Montagnese, S., Caregaro, L., … Sellitto, M. (2016). Impulsivity toward food reward is related to BMI: Evidence from intertemporal choice in obese and normal-weight individuals. *Brain and Cognition*, *110*, 112–119. http://doi.org/10.1016/j.bandc.2015.10.001 **4)** Appelhans, B. M., Woolf, K., Pagoto, S. L., Schneider, K. L., Whited, M. C., & Liebman, R. (2011). Inhibiting Food Reward: Delay Discounting, Food Reward Sensitivity, and Palatable Food Intake in Overweight and Obese Women. *Obesity, 19*(11), 2175-2182. doi:10.1038/oby.2011.57 **5)** Weller, R. E., Cook, E. W., III, Avsar, K. B., & Cox, J. E. (n.d.). Obese women show greater delay discounting than healthy-weight women. *Appetite, 51*, 563-569. doi:10.1016/j.appet.2008.04.010 **6)** Scholtz, S., Miras, A. D., Chhina, N., Prechtl, C. G., Sleeth, M. L., Daud, N. M., … Goldstone, A. P. (2014). Obese patients after gastric bypass surgery have lower brain-hedonic responses to food than after gastric banding. *Gut*, *63*(6), 891–902. http://doi.org/10.1136/gutjnl-2013-30500 **7)** Kable, J. W., Glimcher, P.W., Kable, J.W., & Glimcher, P.W. (2010). An " As Soon As Possible " Effect in Human Intertemporal Decision Making : Behavioral Evidence and Neural Mechanisms, 2513–2531. http://doi.org/10.1152/jn.00177.2009