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Delay discounting and utility for money or weight loss

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Summary

Objective

Obesity is related to a bias towards smaller immediate over larger delayed rewards. This bias is typically examined by studying single commodity discounting. However, weight loss often involves choices among multiple commodities. To our knowledge, no research has examined delay discounting of delayed weight loss compared with other commodities.

Methods

We examined single commodity discounting of money and cross commodity discounting of money and weight loss in a sample of 84 adults with obesity or overweight statuses interested in weight loss. The exchange rate between money and weight loss was calculated, and participants completed two delay discounting tasks: money now versus money later and money now versus weight loss later.

Results

Participants discounted weight loss more than money ($p < 0.001$). When participants were divided into those who preferred weight loss ($n = 61$) versus money ($n = 23$), those who preferred money over weight loss discounted weight loss even more than individuals that preferred weight loss ($p = 0.003$).

Conclusions

Greater discounting of weight loss for those who preferred money suggest that idiosyncratic preferences are related to multiple commodity discounting, and greater discounting of weight loss across all participants provide insight on important challenges for weight control.

Keywords: cross commodity discounting, delay discounting, obesity, weight loss.

Temporal discounting and utility for weight loss and money

Weight loss involves making a series of health behaviour changes that result in negative energy balance by reducing energy intake and/or increasing energy expenditure (1). The rate of weight loss depends on how much health behaviour change is initiated, with greater changes resulting in greater weight loss (2). Although weight loss is a common goal for many individuals with overweight/obese statuses, many fail to respond to evidence-based treatment (3). The benefits of weight loss are often delayed, and noticeable weight loss is typically achieved gradually. Thus, to facilitate weight loss, a person must be able to curb the impulsive choices that impede achieving a negative energy balance. For this reason, research on delay discounting or the tendency to choose smaller immediate rewards (eating very palatable foods and watching a favorite show rather than exercising) over larger delayed rewards (weight loss, improved health and improved body image) is relevant for weight control (4–8).

Previous obesity research has primarily employed single commodity discounting of monetary (7,9,10), weight loss (10) or food rewards (11). However, many daily choices a person must make to lose weight involve foregoing the preferred immediate reward for the delayed reward of weight loss. Investigating temporal choices and relative values of different choices in individuals with

overweight/obese statuses is critical in understanding the obesogenic mechanisms of decision-making that could contribute to the challenges of weight control treatments.

Unfortunately, to our knowledge, no research has examined single versus cross commodity discounting of delayed weight loss compared with other commodities. In this study, we compared delay discounting for a single commodity, money, which is the most common approach to study delay discounting, to cross commodity choice of money now versus weight loss later. Exchange rates (12,13) and preference of reward (money vs. weight loss) were established to examine the relationship between utility and discounting rates. This study provides insight on temporal discounting in individuals with overweight/obesity.

Methods

Participants and procedures

Participants included 84 individuals with overweight and obese statuses (body mass index [BMI] [kg m²] ≥25), who were at least 18 years of age and interested in weight loss. Participants were recruited through Amazon Mechanical Turk (AMT), a crowdsourcing internet marketplace where small tasks are posted as human intelligence tasks (HITs) for workers to complete in exchange for monetary compensation. Participants were compensated $1.50. If the participant indicated they understood instructions and completed 100% of the survey items, they were eligible for data analyses and earned a $2.00 bonus.

The HIT was advertised to AMT users whom previous requesters had accepted 95% of their previous HITs, currently residing in the United States and were interested in weight loss. Subjects were informed they could participate in multiple study phases, the amount of time each phase would take and the compensation for completing each phase. Implied consent was obtained when participants indicated they understood the description and continued onto the survey. One-hundred and ten participants were interested in participating in the current study, and of those, 84 had overweight/obese statuses and were interested in losing weight. We restricted the sample to overweight/obese interested in losing weight to facilitate generalization to samples who would be participating in weight loss interventions.

This study consisted of two sessions. In the first session, demographics, the exchange rate between money and weight loss, and utility were assessed. To determine the exchange rate between commodities, participants

were asked to give the amount of weight (in pounds) they wanted to reasonably lose in the next 6 months and identify the maximum monetary value that amount of weight loss was worth to them ('What is the maximum amount of money you would pay to lose ____?'). Exchange rate was calculated from the mean of the amount of money one pound of weight loss was worth across all participants. This calculation served as the exchange rate used in the money versus weight loss delay discounting task in session two. Utility was assessed by asking participants if they preferred their desired weight loss or the monetary value that was equated to their desired weight loss ('Would you prefer to lose ____ pounds or receive ____ dollars?'). For example, if a participant wanted to lose 10 lb and equated 10 lb of weight loss equal to $20, then participants would be asked, 'Would you prefer to lose 10 lb or receive $20?' The dichotomous choice between the two commodities allowed for categorization by preference, as their choice would indicate a stronger preference towards either weight loss or money. In session two, participants completed two hypothetical delay discounting measures; single money-money (M-M) and cross commodity money-weight loss (M-W), and a temporal orientation measure, the Consideration of Future Consequences Scale (14). All procedures were conducted in accordance with guidelines for the ethical conduct of human research outlined by the National Institutes of Health and with the approval of the University at Buffalo Social and Behavioral Sciences Institutional Review Board.

Measures

Demographics

Race/ethnicity, income and educational level were obtained using a standardized questionnaire adapted from MacArthur's network for studies on socio-economic status and health (15). BMI was calculated from self-reported height and weight.

Money and weight loss exchange equivalence

Weight loss was transformed into a subjective monetary value through a utility function modelled after a delay discounting procedure used in cocaine-dependent individuals (16). Participants were first asked how much weight did they want to lose in the next 6 months and then were asked what was the maximum amount of money they would pay for that amount of weight loss. Lastly, participants were asked which they would prefer: the weight loss they stated that they wanted to lose in the next six months or the maximum amount of money they

stated they were willing to pay for that weight loss. This question was to determine which commodity was preferred.

Delay discounting task

The 27-item monetary choice questionnaire (M-M) was used to measure delay discounting of monetary rewards (17). A monetary and weight choices questionnaire (M-W) modelled after the monetary choice questionnaire (17) and weight loss choice questionnaire (10) was used to measure cross commodity discounting of immediate monetary and delayed weight loss rewards. In both tasks, participants are presented with a set of choices between smaller immediate rewards and larger delayed rewards. An estimate of the participant's discounting rate can be made from the pattern of choices, with those who discount the value of the delayed rewards more steeply said to be more impulsive (17).

Time perspective

The Consideration of Future Consequences Scale assessed the extent to which individuals consider the potential future outcomes of their current behaviour and the extent to which they are influenced by the imagined outcomes (14). Time perspective is associated with risky behaviours and health behaviours (18,19).

Analytical plan

Analyses of variance (ANOVA) and chi-squared test were conducted to determine differences in participant characteristics between those who preferred money or weight loss at the exchange rate for maximal weight loss. Discounting parameters, k (20) were calculated for M-M (k_{M-M}) and M-W (k_{M-W}). The raw k values were non-normally distributed, with skewness z-scores for the money preference group ($k_{M-M} = 4.10$, $p < 0.01$ and $k_{M-W} = 0.32$) and weight loss preference group ($k_{M-M} = 6.41$, $p < 0.01$ and $k_{M-W} = 3.25$, $p < 0.01$) significantly skewed. After natural log transformation (17), log k M-M ($\ln k_{M-M}$) and M-W ($\ln k_{M-W}$) distributions were normalized ($p > 0.05$) for both the money preference group ($\ln k_{M-M} = 0.79$ and $\ln k_{M-W} = 1.53$) and weight loss preference group ($\ln k_{M-M} = 1.70$ and $\ln k_{M-W}$ 1.87). Similarly, the money and weight loss preference groups' k_{M-M} kurtosis values were 13.87 and 5.96 (p's < 0.01) and k_{M-W} kurtosis values were 1.76 and 0.94 (p's < 0.01) but were normalized ($p > 0.05$) by the log transformation ($k_{M-M} = 0.71$ and 0.55; $k_{M-W} = 0.35$ and 0.54), respectively. The analytic focus used the transformed data, but the between group differences for the non-transformed k values are also

presented. The effect of preference for money versus weight loss on single versus cross commodity discounting was analyzed by examining discounting for M-M or M-W in a mixed ANOVA with preference as the between variable and M-M or M-W discounting as the within variable. Pearson product-moment correlations were used to investigate the relationship between the two discounting measures. Data analyses were completed using SYSTAT version 11 (21).

Results

Eighty-four participants were included in the analyses. Participants were 36.72 ± 13.26 (mean $\pm$ SD) years of age, 70% female, 35.98 ± 9.43 BMI (kg m^{-2}), had 14.45 ± 2.00 years of education, with $56,963.86 \pm 39,512.72 household income. The exchange rate between money and weight loss was calculated as the mean monetary value per pound of weight loss across all participants and was rounded to $13 per pound. At their ideal weight loss, 61 individuals preferred weight loss and 23 individuals preferred the amount of money equivalent to that weight loss. There were no significant differences in participant characteristics between the two preferences as shown in Table 1.

A significant main effect of type of discounting for log k values was observed, with all participants showing steeper discounting for delayed weight loss ($\ln k_{M-W} = -3.55 \pm 1.85$, mean $\pm$ SD) than money ($\ln k_{M-M} = -4.39 \pm 1.85$; $p < 0.001$). A significant interaction between preference for money or weight loss on single (M-M) versus cross commodity discounting (M-W) was observed ($p = 0.003$). As shown in Figure 1, there were no differences in M-M discounting for those who preferred money ($\ln k_{M-M} = -4.85 \pm 2.00$; $p = 0.17$) versus weight loss ($\ln k_{M-M} = -4.22 \pm 1.79$). However, weight loss was more steeply discounted in M-W for those who preferred money ($\ln k_{M-W} = -2.77 \pm 1.35$) than those who preferred weight loss ($\ln k_{M-W} = -3.85 \pm 1.94$; $p = 0.017$). The relationship between M-M and M-W discounting was $r = 0.19$, $p = 0.09$. The relationship was higher for those who valued weight loss ($r = 0.30$, $p = 0.019$), than for those who valued money ($r = 0.03$, $p = 0.90$).

Analyses using raw k values also showed a main effect of type of discounting, with steeper discounting in M-W ($k_{M-W} = 0.10 \pm 0.09$) versus M-M ($k_{M-M} = 0.04 \pm 0.06$, $p < 0.001$). There was also a significant interaction of preference for weight loss or money with type of discounting task ($p = 0.006$). There were no differences in discounting of money for those who preferred money ($k_{M-M} = 0.03 \pm .05$; $p = 0.29$) versus weight loss ($k_{M-M} = 0.05 \pm 0.06$) but significantly greater discounting of weight loss for those who preferred money

Table 1 Participant characteristics

Characteristic	Choice of money versus weight loss		p
	Money (n = 23)	Weight loss (n = 61)	
Age (years)[a]	33.53 ± 14.82	37.88 ± 12.43	0.18
Female Sex (n%)	65.23%	70.49%	0.65
Body mass index (kg m^{-2})[a]	34.62 ± 9.34	36.37 ± 9.46	0.45
Non-minority, Non-Hispanic (n%)	73.91%	81.97%	0.42
Education (years)[a]	14.39 ± 2.02	14.49 ± 2.00	0.84
Household income ($)[a]	56956.52 ± 39449.02	55327.87 ± 39579.76	0.87
Consideration of Future Consequences[ab]	3.36 ± 0.59	3.56 ± 0.74	0.25
Dollar per pound ($)[a]	12.36 ± 20.95	13.08 ± 20.54	0.89

[a]Plus-minus values are means ± SD.
[b]Ratings were made on a five-point scales; higher values indicate greater consideration of future consequence.
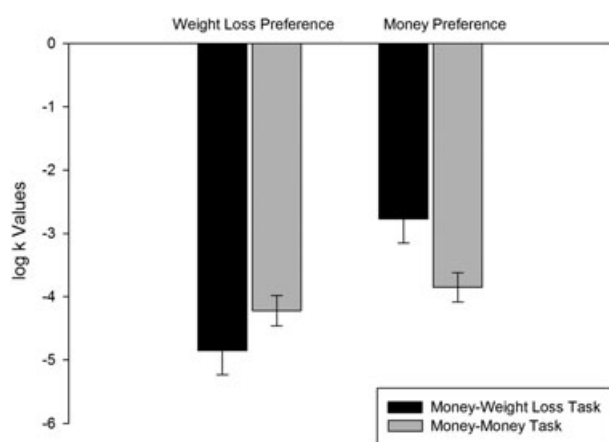

Figure 1 k values (±SEM) for participants who preferred money or weight loss on single commodity money-money tasks or cross commodity money-weight loss tasks.

($k_{M-W} = 0.13 ± 0.09$) versus those who preferred weight loss ($k_{M-W} = 0.08 ± 0.09$; $p = 0.02$).

Discussion

Our research showed the unexpected finding that individuals with overweight/obesity, whom were interested in weight loss, discounted weight loss more steeply than money. These results suggest that individuals with overweight/obese statuses who desire to lose weight generally have more difficulty foregoing immediate pleasures when faced with decisions related to weight control. This would make weight loss more challenging because the product of weight loss requires one to make many immediate sacrifices in favor of future benefits. Moreover, similarity found in M-M and M-W discounting parameters for those who preferred weight loss but not found for those who preferred money signifies utility of

rewards contributes to decision-making, consistent with previous literature (22). Targeting these obesogenic mechanisms in treatment could improve weight loss or even weight loss maintenance.

To our knowledge, no other study has demonstrated individuals with overweight/obese statuses discount weight loss more steeply than money. Lim and Bruce (10) examined weight loss rewards and showed no differences in single commodity discounting of money or weight loss. However, single commodity delay discounting studies have some limitations. Previous studies examining the discounting of money across other domains have shown a mixed pattern of results demonstrating a relationship between the two different commodities but showing differences in discounting rates between the two commodities. These differences could be contributed to sensitivity, the type of commodity and its temporal location, and the inequality in value between different commodities. Previous studies suggest that specific commodities or magnitudes of those commodities may be more sensitive in detecting certain behavioural changes than others (23), specific commodities and its availability (immediate or delayed) influences decision-making (16) and the biases towards certain commodities alters choices (24). Thus, examining monetary discounting may not capture decision-making in other domains or best represent individual's discounting. Therefore, the immediate money versus delayed weight loss may be more representative and more sensitive in capturing changes in obesogenic behavioural decision-making. Perhaps this M-W questionnaire, when used in weight-control treatments, could measure changes in discount rates in conjunction with long-term weight loss.

Our approach in calculating a monetary value that equates to pounds of weight loss may have implications towards using incentives to treat or maintain weight loss. Voluminous literature demonstrates the power of

incentives to increase patient compliance in healthcare treatments (25,26) and reduce smoking behaviour (27,28). Additionally, this approach has been applied to obesity treatment (29,30). While weight loss is often thought as its own reward, the fact that most people do not maintain weight loss suggests that the reinforcing value of weight loss is less than expected, and our data show that money is a stronger reward than weight loss. Thus, use of utility functions that may change throughout the weight loss process may provide valuable insight into how to administer incentives to improve both short-term and long-term weight loss.

This study is not without limitations. First, our sample was recruited from AMT, which may not reflect the general populace. However, research has shown AMT to be a viable research method (31) and suggests crowdsourced samples may actually be more representative of the general population (32). Also, the use of self-report is a conservative approach to establish overweight/obese status because of people's tendency to underestimate their weight and overestimate their height (33). Future directions are to implement the M-W questionnaire in a controlled laboratory setting where BMI can be objectively measured.

Perhaps the biggest challenge to the external validity of the study is the use of money as the immediate reinforcer in the cross commodity measures. Although money is a conditioned generalized reinforcer and can be used to obtain a wide variety of things people want, foregoing immediate money is not directly related to weight loss. Generally, reinforcers that inhibit the delayed goal of weight loss are the consumption of food or the engagement of sedentary behaviours. Future efforts would be to incorporate immediate choices with reinforcers that counteract weight loss (e.g. favorite palatable foods or engaging in favorite sedentary behaviours) against the delayed choice of weight loss.

Additionally, assessing the value of alternative immediate reinforcers when compared with delayed weight loss may depict weight maintenance challenges. Individuals with overweight/obese statuses interested in weight loss may subjectively value its immediate reward counterparts more (e.g. palatable foods or sedentary behaviours) than the long term outcome of weight loss. This may be more difficult for those who are strongly reinforced by initial weight loss only to find a reduction in the reinforcing value of weight loss over time. If weight loss is discounted greater than other reinforcers, then weight maintenance is even more challenging.

In summary, individuals with overweight/obesity who report a desire to lose weight tend to discount weight loss more steeply than money and the degree of discounting weight loss depends on the utility of weight loss. The implications drawn from our findings are that challenges in weight loss are ubiquitous because of greater discounting of weight loss than money, and idiosyncratic preferences may impede focus on the long-term importance of weight loss, which also has implications for weight maintenance. Furthermore, examining discounting of weight loss rewards may also prove to be predictive of weight loss success. Our findings can contribute to further determine the best behavioural approaches for weight control.

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Conflict of Interest Statement

We disclose that Dr Epstein is a consultant and has equity in Kurbo, which may be a potential competing interest. No other author has any competing interests.

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References

1. Hall KD, Heymsfield SB, Kemnitz JW, et al. Energy balance and its components: implications for body weight regulation. *Am J Clin Nutr* 2012; **95**: 989–994.

2. Artinian NT, Fletcher GF, Mozaffarian D, et al. Interventions to promote physical activity and dietary lifestyle changes for cardiovascular risk factor reduction in adults: a scientific statement from the American Heart Association. *Circulation* 2010; **122**: 406–441.

3. Jeffery RW, Drewnowski A, Epstein LH, et al. Long-term maintenance of weight loss: current status. *Health Psychol* 2000; **19**: 5–16.

4. Davis C, Patte K, Curtis C, Reid C. Immediate pleasures and future consequences. A neuropsychological study of binge eating and obesity. *Appetite* 2010; **54**: 208–213.

5. Jarmolowicz DP, Cherry JBC, Reed DD, et al. Robust relation between temporal discounting rates and body mass. *Appetite* 2014; **78**: 63–67.

6. Rasmussen EB, Lawyer SR, Reilly W. Percent body fat is related to delay and probability discounting for food in humans. *Behav Processes* 2010; **83**: 23–30.

7. Weller RE, Cook EW 3rd, Avsar KB, Cox JE. Obese women show greater delay discounting than healthy-weight women. *Appetite* 2008; **51**: 563–569.

8. Epstein LH, Salvy SJ, Carr KA, Dearing KK, Bickel WK. Food reinforcement, delay discounting and obesity. *Physiol Behav* 2010; **100**: 438–445.

9. Graham Thomas J, Seiden A, Koffarnus MN, Bickel WK, Wing RR. Delayed reward discounting and grit in men and women with and without obesity. *Obes Sci Pract* 2015; **1**: 131–135.

10. Lim SL, Bruce AS. Can't wait to lose weight? Characterizing temporal discounting parameters for weight-loss. *Appetite* 2015; **85**: 8–13.

11. Manwaring JL, Green L, Myerson J, Strube MJ, Wilfley DE. Discounting of various types of rewards by women with and without binge eating disorder: evidence for general rather than specific differences. *Psychol Rec* 2011; **61**: 561–582.

12. Fishburn PC, Rubinstein A. Time preference. *Int Econ Rev* 1982; **23**: 677–694.

13. Glimcher PW. Understanding risk: a guide for the perplexed. *Cogn Affect Behav Neurosci* 2008; **8**: 348–354.

14. Strathman A, Gleicher F, Boninger DS, Edwards CS. The consideration of future consequences – weighing immediate and distant outcomes of behavior. *J Pers Soc Psychol* 1994; **66**: 742–752.

15. Adler NE, Epel ES, Castellazzo G, Ickovics JR. Relationship of subjective and objective social status with psychological and physiological functioning: preliminary data in healthy white women. *Health Psychol* 2000; **19**: 586–592.

16. Bickel WK, Landes RD, Christensen DR, et al. Single- and cross-commodity discounting among cocaine addicts: the commodity and its temporal location determine discounting rate. *Psychopharmacology (Berl)* 2011; **217**: 177–187.

17. Kirby KN, Petry NM, Bickel WK. Heroin addicts have higher discount rates for delayed rewards than non-drug-using controls. *J Exp Psychol Gen* 1999; **128**: 78–87.

18. Daugherty JR, Brase GL. Taking time to be healthy: predicting health behaviors with delay discounting and time perspective. *Pers Individ Dif* 2010; **48**: 202–207.

19. Jeffery RW. Risk behaviors and health. Contrasting individual and population perspectives. *Am Psychol* 1989; **44**: 1194–1202.

20. Mazur JE. An adjusting procedure for studying delayed reinforcement. In: Commons ML, Mazur JE, Nevin JA, Rachlin H (eds). *Quantitative Analyses of Behavior: The Effect of Delay and of Intervening Events on Reinforcement Value*. Lawrence Erlbaum Associates, Inc.: Hillsdale, NJ, 1987, pp. 55–73.

21. Systat Software. Systat 11.0. 2004, Richmond, CA: SYSTAT Software, Inc.

22. Glimcher PW, Fehr E. *Neuroeconomics: Decision Making and the Brain*. Elsevier/AP: Academic Press: Boston, 2014.

23. Yoon JH, Higgins ST, Bradstreet MP, Badger GJ, Thomas CS. Changes in the relative reinforcing effects of cigarette smoking as a function of initial abstinence. *Psychopharmacology (Berl)* 2009; **205**: 305–318.

24. Chapman GB. Temporal discounting and utility for health and money. *J Exp Psychol Learn Mem Cogn* 1996; **22**: 771–791.

25. Giuffrida A, Torgerson DJ. Should we pay the patient? Review of financial incentives to enhance patient compliance. *BMJ* 1997; **315**: 703–707.

26. Priebe S, Yeeles K, Bremner S, et al. Effectiveness of financial incentives to improve adherence to maintenance treatment with antipsychotics: cluster randomised controlled trial. *BMJ* 2013; **347**: f5847.

27. Donatelle RJ, Prows SL, Champeau D, Hudson D. Randomised controlled trial using social support and financial incentives for high risk pregnant smokers: Significant Other Supporter (SOS) program. *Tob Control* 2000; **9**: 67–69.

28. Volpp KG, Troxel AB, Pauly MV, et al. A randomized, controlled trial of financial incentives for smoking cessation. *N Engl J Med* 2009; **360**: 699–709.

29. Jeffery RW, Wing RR, Thorson C, Burton LR. Use of personal trainers and financial incentives to increase exercise in a behavioral weight-loss program. *J Consult Clin Psychol* 1998; **66**: 777–783.

30. Volpp KG, John LK, Troxel AB, et al. Financial incentive-based approaches for weight loss: a randomized trial. *JAMA* 2008; **300**: 2631–2637.

31. Paolacci G, Chandler J, Ipeirotis PG. Running experiments on Amazon Mechanical Turk. *Judgm Decis Mak* 2010; **5**: 411–419.

32. Berinsky AJ, Huber GA, Lenz GS. Evaluating online labor markets for experimental research: Amazon.com's Mechanical Turk. *Polit Anal* 2012; **20**: 351–368.

33. Nawaz H, Chan W, Abdulrahman M, Larson D, Katz DL. Self-reported weight and height: implications for obesity research. *Am J Prev Med* 2001; **20**: 294–298.