



Published in final edited form as:

Appetite. 2015 February 1; 0: 8–13. doi:10.1016/j.appet.2014.11.001.

Can't wait to lose weight? Characterizing temporal discounting parameters for weight-loss

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Abstract

Obesity is often related to steeper temporal discounting, that is, higher decision impulsivity for immediate rewards over delayed rewards. However, previous studies have measured temporal discounting parameters through monetary rewards. The aim of this study was to develop a temporal discounting measure based on weight-loss rewards, which may help to understand decision-making mechanisms more closely related to body weight regulation. After having their heights and weights measured, healthy young adults completed the Monetary Choice Questionnaire (MCQ), and an adapted version of the MCQ, with weight-loss as a reward. Participants also completed self-reports that measure obesity-related cognitive variables. For forty-two participants who expressed a desire to lose weight, weight-loss rewards were discounted over time and had a positive correlation with temporal discounting for monetary rewards. Higher temporal discounting for weight loss rewards (i.e., preference for immediate weight loss) showed correlations with beliefs that obesity is under obese persons' control and largely due to lack of willpower, while temporal discounting parameters for monetary rewards did not. Taken together, our weight loss temporal discounting measure demonstrated both convergent and divergent validity, which can be utilized for future obesity research and interventions.

Keywords

obesity; decision-making; temporal discounting; delay discounting; weight loss; rewards

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Conflict of Interest: The authors have no competing interest regarding this study.

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INTRODUCTION

Temporal discounting, also called delay discounting, is present in humans and animals, and it indicates preference for a smaller, sooner reward versus a larger, later reward (Critchfield & Kollins, 2001; Galtres, Garcia, & Kirkpatrick, 2012). Higher or steeper temporal discounting of delayed reward is often thought to represent individual's *impulsivity* or *temporal myopia* of decision-making. (Green & Myerson, 2013). Intuitively, the ability to forego an immediate pleasurable reward for a postponed benefit should be related to self-controlled decisions and health outcomes such as eating behavior and obesity (Epstein, Salvy, Carr, Dearing, & Bickel, 2010). For example, to maintain a healthy body-weight we must often resist the temptation for immediate pleasure from delicious but calorically-dense treats. Indeed, scientific evidence is accumulating for the strong relation between temporal discounting and body mass. People carrying excess body weight, meaning those of greater body mass index (BMI), are more likely to choose smaller, more immediate monetary rewards (Bickel, et al., 2014; Borghans & Golsteyn, 2006; Ikeda, Kang, & Ohtake, 2010; Jarmolowicz, et al., 2014; Weller, Cook, Avsar, & Cox, 2008).

Individual differences in temporal discounting are most often assessed using monetary rewards. But, it has been demonstrated that temporal discounting can be applied to different commodities including food, alcohol, drug-related, sexual, or entertainment rewards as well (e.g., books and DVDs) (Chapman & Elstein, 1995; Charlton & Fantino, 2008; Estle, Green, Myerson, & Holt, 2007; Holt, Newquist, Smits, & Tiry, 2014; Tsukayama & Duckworth, 2010). Though studies have examined a variety of reward types, no studies have yet examined how using weight-loss as a reward is discounted. More than two-thirds of adults in the United States are overweight or obese (Ng, et al., 2014), and over half of U.S. adults report a desire to lose their body weight (Gallup, 2013). In our society, therefore, weight-loss is generally viewed as rewarding, which opens the possibility of applying temporal discounting measures to body weight-loss. However, the majority of previous obesity studies have employed monetary intertemporal choice tasks, and none of them have explored temporal discounting of weight loss. Investigating temporal discounting with weight-loss rewards can be particularly important to understand obesogenic mechanisms of decision-making. Particularly, considering the documented commodity-specific effects of temporal discounting, one's impulsivity for delayed monetary rewards might not apply to all aspects of obesity-related decision-making.

Successful weight-management programs typically require long-term persistence of lifestyle changes (Poirier & Despres, 2001). Weight loss is not immediate. We must be able to wait to lose weight. Thus, it is worthwhile to investigate how exactly subjective values or utilities of weight-loss rewards vary depending on outcome delays (e.g., 5 lbs weight-loss in 10 days vs. 100 days) and how they relate to obesity-related attitude measures. Being overweight or obese can cause psychosocial stress that has a tremendous negative impact on an individual (Puhl & Heuer, 2009). For example, overweight or obese persons are more likely to be perceived as less attractive, less trustworthy, and less healthy (Coetzee, Re, Perrett, Tiddeman, & Xiao, 2011; Hume & Montgomerie, 2001; Miller & Lundgren, 2010). A culture of negative social evaluations can be one of reason why so many people, even with medically healthy body weight, desire to lose weight. Thus, we hypothesized that

individual's positive or negative attitude towards obesity would affect subjective valuation or impulsivity about body immediate weight-loss.

In sum, weight loss rewards in temporal discounting choices have two very distinct psychological and physiological features, which may not be fully explained by other traditional monetary choice measures. First, the perceiving weight loss as a reward can be significantly influenced by individual's attitudes towards obesity or their body. Subjective psychological valuations of weight loss can be a critical determinant, which might be less relevant for monetary rewards. Second, the body weight loss requires "unavoidable" delays due to physiological restrictions of metabolic mechanisms, while people still may prefer to lose weight quickly. Thus, we believe further research is needed to better understand the relationship between temporal discounting of varying reward types and body mass.

The goals of the current study were to (1) examine temporal discounting based on weight loss rewards (through the Weight loss Choice Questionnaire); (2) evaluate the relationship between monetary temporal discounting and weight-loss temporal discounting; (3) understand the relationship between weight-loss temporal discounting and other obesity-related psychological factors. Overall, this study furthers our understanding of obesity-related decision-making mechanisms by investigating temporal discounting of weight-loss rewards. Furthermore, characterizing individual differences in temporal discounting rates for weight-loss rewards may provide unique and valuable information for obesity interventions that cannot be achieved through monetary rewards.

MATERIALS AND METHODS

Participants

Sixty-eight healthy college students with a mean age of 23.0 ($SD = 5.9$ years; 14 males) were recruited through the Psych Pool online research participant recruitment system at the University of Missouri – Kansas City (UMKC). Participants received course credit for participating in the experiment. The study protocol was reviewed and approved by UMKC's Institutional Review Board. Prior to the experiment, participants provided written informed consent and completed demographics questionnaires.

Measures

Body weight and height were measured to calculate Body Mass Index (BMI) (kg/m^2) by using a scale and stadiometer (Detecto PD300DHR). After measuring their body weight and height, participants completed self-report questionnaires that included the Attitudes Toward Obese Persons (ATOP) / Beliefs About Obese Persons (BAOP) scales (Allison, Basile, & Yunker, 1991) and Anti-Fat Attitudes (AFA) scale (Crandall, 1994). The ATOP and BAOP scales measure explicit attitude and beliefs regarding obesity. Higher ATOP scores indicate positive attitudes toward obese persons, while higher BAOP scores indicate stronger beliefs that obesity is not under the obese person's control. The AFA questionnaire measures negative attitudes for overweight/obese people and includes "dislike", "fear of fat" and "willpower" subscales. Higher AFA scores indicate more negative attitudes.

Temporal discounting rates of monetary rewards

Individual's temporal (delay) discounting parameter (k) for monetary rewards were measured through the Monetary Choice Questionnaire (MCQ) (Kirby, Petry, & Bickel, 1999). The MCQ includes 27 hypothetical choices between a smaller, immediate monetary reward and a larger, delayed monetary reward (e.g., \$27 today vs. \$50 in 21 days). Responses are scored to calculate subjective discounting curves using hyperbolic decay function (see Fig. 1) (Mazur, 1987).

$$V_{money} = \frac{A}{1 + k_{money} * D}$$

This equation describes the subjective value (V_{money}) of monetary rewards as a function of the given amount of money (A) and duration of reward delay (D). The k_{money} parameter represents an individual's temporal discounting rate for monetary rewards, which takes the shape of a hyperbolic function. For example, the subjective value of \$10 in 10 days for an individual who has k_{money} of 0.1 will be $10/(1 + 0.1*10) = \$5$, while the subjective value for an individual who has k_{money} of .01 will be $10/(1 + 0.01*10) = \$9.09$. If they make a choice between \$7 today and \$10 in 10 days, they will make very different decisions based on their own subjective values (utilities) of delayed rewards ($V = \$5$ and $V = \$9.09$) compared to immediate rewards (\$7). Thus, higher k parameter values represent steeper discounting over time and a stronger preference for immediate rewards, which becomes indicative of high levels of impulsivity or inability to delay gratification. In the MCQ, temporal discounting rates can be separately calculated for different delayed reward sizes (small, medium, and large) as well as one overall discounting rate.

Temporal discounting rates of weight-loss rewards

To measure an individual's temporal discounting rate of weight-loss (k_{weight}), we constructed a Weight-loss Choice Questionnaire (WCQ) by modifying the existing MCQ (see Appendix). The same values from the 27 monetary reward choices were used to construct the WCQ, but shown in a different unit of body weight (pounds) instead of the U.S. dollar (\$). For example, \$10 in the MCQ corresponded to 1 lbs. body-weight loss in the WCQ. Thus, the amounts for weight-loss varied between 1.1 lbs and 8.5 lbs, which corresponded to \$11 and \$85 in the MCQ. Similar to the MCQ, the WCQ included 27 choices between a smaller, immediate weight-loss and a larger, delayed weight-loss (e.g., 2.7 lbs today vs. 5.0 lbs in 21 days). All WCQ choices were hypothetical as are MCQ choices, but participants were encouraged to consider their choices that could be implemented as real outcomes. The exact same delay periods were used in the WCQ, which enables us to calculate temporal discounting rates for weight loss (k_{weight}) through the same method used in the MCQ (Fig. 1).

$$V_{weight} = \frac{A}{1 + k_{weight} * D}$$

Here, the subjective value (V_{weight}) of weight-loss is expressed by a function of the amount of weight-loss (A) and duration of delay (D). Similarly, higher k_{weight} parameter represents steeper temporal discounting and a stronger preference for immediate weight-loss, which corresponds to impulsivity for weight-loss. Importantly, our weight-loss choices were designed to be meaningful or valid only for individuals who are motivated to lose their body weight. Money is a well-known universal secondary reinforcer for most people. But, losing body-weight is not universally reinforcing. To address this issue we included three additional questions to our WCQ as follows - “Are you interested in losing body weight?”, “How much body weight do you wish to lose?”, “Are you currently dieting?” Thus, our data analyses included only participants who answered yes on the first validity check question. For these subjects who were interested in losing body weight, the weight-loss was conceptualized as a reinforcing outcome that participants are psychologically motivated to achieve.

RESULTS

Among sixty-eight participants, 42 participants (62%; 7 males) answered that they were interested in losing body weight in the WCQ. There was no significant group difference of age ($t_{(65)} = 1.66, p = .10$), gender ($\chi^2 = 1.49, p = .47$), college year ($\chi^2 = 2.71, p = .85$), or ethnicity ($\chi^2 = 8.45, p = .39$) between 42 subjects who indicated interest in losing body weight and 26 subjects who did not. However, not surprisingly, we observed significant BMI differences between these two groups ($t_{(65)} = 3.79, p < .001$). The mean BMI of the 42 participants who reported interest in losing weight was 25.6 ($SD = 4.8$), while the mean BMI of the 26 participants who did not express interest in losing weight was 22.5 ($SD = 7.3$). As stated earlier, 26 subjects who were not interested in losing weight were excluded in further data analyses due to the failure to confirm our requirements of the WCQ task (i.e., weight-loss serves as a reinforcer). Among the remaining 42 participants, 1 (2.4%) was of underweight status, 17 (40.5%) were of normal weight status (BMI: 18.5 ~ 25), 16 (38.1%) were of overweight status (BMI: 25 ~ 30), and 8 (19.0%) were of obese status.

For each participant, we calculated temporal discounting parameters separately for monetary rewards choices in the MCQ and body weight-loss choices in the WCQ. Mean estimates (and standard deviations) for the temporal discounting parameters of monetary rewards (k_{money}) and weight-loss (k_{weight}) were .024 ($SD = .028$) and .026 ($SD = .046$), respectively. The k_{money} ranged from .0002 to .118 and the k_{weight} ranged from .0002 to .249. Consistent with prior research (Kirby & Marakovic, 1996), both k parameters were non-normally distributed ($skewness = 2.02$ and 3.66). Therefore, following previous literature (Jarmolowicz, et al., 2014; Kirby & Marakovic, 1996) we used natural log-transformed k parameters for statistical analyses. Also, because we speculated that selecting a subset of data (42 subjects included) that might have an effect on data distributions, we performed further analyses by employing nonparametric statistics. This ensured a conservative approach. A Wilcoxon test showed no significant difference of k parameters monetary rewards and weight-loss ($p = .10$). To explore the relationship between the two log-transformed k parameters, we conducted a Spearman's rank order correlational analysis. The correlation coefficient was .33 ($p < .05$), indicating impulsivity towards immediate weight-loss shares common variance with impulsivity towards immediate monetary rewards. Also,

this result demonstrates convergent validity of the WCQ we developed. To investigate the relation between temporal discounting parameters and obesity, we performed Spearman correlational analyses with BMI scores. For our 42 participants who had interest in losing body weight, there was no significant relationship for monetary rewards ($\rho = .15, p = .35$) or weight-loss log-transformed k parameters ($\rho = -.13, p = .42$). Also, the temporal discounting parameter of weight-loss ($\ln k_{\text{weight}}$) and monetary rewards ($\ln k_{\text{money}}$) did not show significant correlation with the amount of desired weight-loss ($\rho = .05, p = .76; \rho = .17, p = .29$), or their diet status ($\rho = .20, p = .22; \rho = .18, p = .27$).

Because previous studies with monetary choices have demonstrated that the temporal discounting rates linearly *decrease* by the reward size (Jarmolowicz, et al., 2014; Kirby, et al., 1999), we explored the magnitude effect of reward size with the WCQ as well as the MCQ. For these analyses, we calculated three different temporal discounting parameters by reward sizes (small, medium, and large). The mean temporal discounting rates by monetary size were .051 ($k_{\text{money S}}$), .023 ($k_{\text{money M}}$), and .015 ($k_{\text{money L}}$). The mean temporal discounting rates by the amount of weight-loss were .051 ($k_{\text{weight S}}$), .022 ($k_{\text{weight M}}$), and .021 ($k_{\text{weight L}}$). The linear contrast of repeated-measure ANOVA showed the significant magnitude effect for both log-transformed k_{money} and k_{weight} parameters ($F_{[1,41]} = 63.26, p < .001; F_{[1,41]} = 35.21, p < .001$; Fig. 2), suggesting the WCQ shares similar characteristics with the MCQ. Additionally, we computed the consistency measure that represents the percentage of choices that were consistent with the assigned discounting rates (Kirby, et al., 1999). We calculated three different consistency rates separately by reward magnitude and average them to compute the average consistency rates. The means of consistency for the MCQ and WCQ were 98.5% (SD = 2.3%) and 96.8% (5.8%), respectively. Interestingly, the mean consistency of the WCQ was significantly lower than the mean consistency of the MCQ ($t = 2.03, p < .05$). Overall, the magnitude effect and consistency results provide further empirical support for validity and reliability of the WCQ.

Next, to investigate relationships between the temporal discounting parameter of weight-loss (k_{weight}) and obesity-related psychological variables, we performed Spearman correlational analyses with self-report scales. For our exploratory correlational analyses, we performed Bonferroni corrections for multiple comparisons. As shown in Table 1 and Fig. 3, the log-transformed k_{weight} parameter was negatively correlated with the BAOP scale ($\rho = -.45, p < .05$) and positively correlated with the willpower subscale of AFA ($\rho = .41, p < .05$), showing that higher temporal discounting rates (stronger impulsivity for immediate weight-loss) are associated with beliefs that obesity is under obese persons' control and largely due to lack of willpower. For completeness, we further performed Spearman correlational analyses with the temporal discounting parameter of monetary rewards (k_{money}). Somewhat surprisingly, the log-transformed k_{money} parameter was negatively correlated with the dislike subscale of AFA ($\rho = -.53, p < .01$), showing that higher temporal discounting rates for monetary rewards (stronger impulsivity for immediate monetary rewards) are associated with positive explicit attitudes towards obese persons. Lastly, we checked correlations between BMI scores and self-report scales. The BMI scores did not show any significant correlation with self-reports (all p values $> .05$) for our 42 subjects who indicated interest in losing body weight.

DISCUSSION

The primary purpose of the current study was to create a temporal discounting measure based on weight loss rewards, which may provide new insights into decision-making related to body mass regulation. The Weight Choice Questionnaire (WCQ), based directly on Kirby's Monetary Choice Questionnaire (Kirby, et al., 1999), has preliminary validity for those individuals who report they want to lose weight. In our data, monetary and weight-loss temporal discounting rates indeed showed a significant positive correlation, demonstrating convergent validity of the WCQ. Impulsivity towards immediate weight-loss appears to share common variance with impulsivity towards immediate monetary rewards. In other words, individuals who prefer smaller, sooner monetary rewards also prefer smaller but sooner amounts of weight loss. Furthermore, the confirmation of the magnitude effect in our weight-loss choices provides additional empirical support for the validity of the WCQ. In our study, the temporal discounting rates linearly decreased with greater amounts of weight-loss in a similar way to those of monetary rewards. This implies that participants made weight-loss choices while considering both the *amount* of weight loss and the *delays* of weight-loss as they did in the MCQ.

For both monetary rewards and weight-loss rewards, our data did not support a relation between greater body mass index and higher levels of temporal discounting (impulsivity). However, the significant relationship between body mass and temporal discounting has not always been reported (Nederkoorn, Smulders, Havermans, Roefs, & Jansen, 2006; Weller, et al., 2008). Demographic variables such as gender, age, education, and income as well as psychological variables such as intelligence, depression, and risk-seeking tendency are also known to affect temporal discounting rates (Green, Myerson, Lichtman, Rosen, & Fry, 1996; Jarmolowicz, et al., 2014; Shamosh & Gray, 2008; Weller, et al., 2008). In our study, all participants were undergraduate students, and therefore education, socioeconomic status, and IQ, several factors shown to be associated with temporal discounting rates, were relatively restricted compared to the previous studies (Jarmolowicz et al., 2014). More critically, the 42 subjects selected in our data analyses (who reported a desire to lose weight) showed significantly different BMI scores compared to the excluded subjects (who reported no desire to lose weight). Thus, our failure to replicate the positive relationship between temporal discounting (MCQ and WCQ) and body mass need to be interpreted cautiously. Future, larger replication studies in future are required to better understand this discrepancy.

In order to understand the relationship between weight-loss temporal discounting and obesity-related psychological factors, we performed exploratory correlational analyses with self-reports that measure attitudes towards obese individuals. Interestingly, people who express a desire to lose less weight sooner, showed stronger beliefs that obesity is under an individual's control and obesity is due to a lack of "willpower." Interestingly, temporal discounting rates for monetary rewards were associated with positive attitudes towards obese individuals, suggesting the specificity or "commodity effect" of two temporal discounting measures. Taken together, our results with self-reports demonstrate divergent validity of the WCQ as well as a novel utility and usefulness of our measure in obesity research.

Steeper temporal discounting of delayed weight-loss represents decision impulsivity for immediate weight-loss or temporal myopia, which may serve to hinder a healthy energy balance. The WCQ provides a new measure that indexes individual differences in temporal discounting rates for weight-loss. Furthermore, the temporal discounting rates estimated from the WCQ follow a hyperbolic decay function of weight-loss rewards, which enable us to parameterize how individuals perceive values or utilities of weight loss over the duration of delay. In particular, this information can be practically useful to set up realistic, yet also psychologically satisfying weight-loss goals in overweight and obese populations. However, it should be noted that extremely low temporal discounting rates are not necessarily beneficial. Individuals with anorexia nervosa, in particular the restricting type, had even lower discounting rates for monetary rewards than healthy weight individuals (Steinglass, et al., 2012). That is, individuals with anorexia displayed excessive self-control in waiting for deferred monetary rewards, although it is not known yet whether this effect is limited to monetary rewards.

There are several caveats worthy of mention. First, we did not collect information about medical or psychiatric conditions, or body weight history and diet history, which might be related with temporal discounting parameters for weight-loss. Second, we constructed the WCQ by converting the unit of choice set directly from U.S. dollars to pounds (e.g., 54 \$ immediately to 5.4 LBS immediately), and we cannot assume that psychological value of 1 LBS of weight loss is equivalent to that of a \$10 gain. The subjective reward values can vary across individuals according to other characteristics such as body weight status, diet history, or participants' body image. Thus, the direct comparison of temporal discounting parameter values between monetary choices and weight loss choices should be interpreted cautiously. In future studies, it will be informative to compare k parameters after equating subjective valuation for two different reward types on a common scale (Bickel, et al., 2011; Madden, Petry, Badger, & Bickel, 1997). Third, our exploratory correlational analyses revealed a significant negative correlation between impulsivity measured by the MCQ and negative attitude towards obesity (AFA: dislike). Given that several previous studies showed positive correlations between BMI and MCQ (Bickel, et al., 2014; Borghans & Golsteyn, 2006; Ikeda, et al., 2010; Jarmolowicz, et al., 2014; Weller, et al., 2008), it might be partly related to a self-serving bias. Our study alone cannot provide a clear answer. It should be tested in future studies with larger samples and broad BMI range. Lastly, we excluded 26 subjects who were not interested in losing weight in all data analyses due to the failure to confirm our requirements of the WCQ (i.e., weight-loss serves as a reinforcer). Although this requirement may pose the limits of generalizability of our WCQ measure, we believe this requirement is crucial to secure the reliability and validity of the WCQ task. For example, for subjects who do not want to lose weight, we cannot predict how they will handle choices between immediate weight-loss and delayed weight-loss, as both irrelevant to them (e.g., random choices, socially desirable choices, or pretended choices).

Parameterizing temporal discounting parameters for weight-loss may have clinical implications in obesity. In addition to realistic goal-setting, as mentioned above, interventions may choose to target temporal discounting rates. Although individual differences in temporal discounting parameters (estimated with monetary rewards) have

commonly been regarded as a stable personality trait, recent studies suggests that temporal discounting parameters can be changed or modulated by therapeutic cognitive, behavioral, or structured environmental manipulation (Koffarnus, Jarmolowicz, Mueller, & Bickel, 2013). In particular, training cognitive skills such as attention, working memory, and executive functioning is believed to be effective in changing temporal decision biases (Radu, Yi, Bickel, Gross, & McClure, 2011). Considering our results that showed positive correlations between temporal discounting of weight-loss with negative attitudes towards obesity, it may be useful to explore how clinical interventions targeting modifying maladaptive negative cognitions for obesity changes impulsivity for immediate weight loss. More research on temporal discounting of weight loss rewards is clearly needed.

Acknowledgments

This study was supported by the National Cancer Institute of the National Institutes of Health under Award Number R21CA184834 (PI: Lim).

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APPENDIX

Weight-loss Choice Questionnaire (WCQ)

For each of the next 27 hypothetical choices, please indicate which option you would prefer: the smaller immediate weight loss, or the larger weight loss in the specified number of days.

Are you interested in losing body weight? Yes / No

How much body weight do you wish to lose? _____ LBS

Are you currently dieting? Yes/No

-
- | | | |
|------------------------------|-----------------------------|--------------------------|
| 1. Would you prefer to lose | (A) 5.4 lbs immediately, or | (B) 5.5 lbs in 117 days? |
| 2. Would you prefer to lose | (A) 5.5 lbs immediately, or | (B) 7.5 lbs in 61 days? |
| 3. Would you prefer to lose | (A) 1.9 lbs immediately, or | (B) 2.5 lbs in 53 days? |
| 4. Would you prefer to lose | (A) 3.1 lbs immediately, or | (B) 8.5 lbs in 7 days? |
| 5. Would you prefer to lose | (A) 1.4 lbs immediately, or | (B) 2.5 lbs in 19 days? |
| 6. Would you prefer to lose | (A) 4.7 lbs immediately, or | (B) 5.0 lbs in 160 days? |
| 7. Would you prefer to lose | (A) 1.5 lbs immediately, or | (B) 3.5 lbs in 13 days? |
| 8. Would you prefer to lose | (A) 2.5 lbs immediately, or | (B) 6.0 lbs in 14 days? |
| 9. Would you prefer to lose | (A) 7.8 lbs immediately, or | (B) 8.0 lbs in 162 days? |
| 10. Would you prefer to lose | (A) 4.0 lbs immediately, or | (B) 5.5 lbs in 62 days? |
| 11. Would you prefer to lose | (A) 1.1 lbs immediately, or | (B) 3.0 lbs in 7 days? |
| 12. Would you prefer to lose | (A) 6.7 lbs immediately, or | (B) 7.5 lbs in 119 days? |
| 13. Would you prefer to lose | (A) 3.4 lbs immediately, or | (B) 3.5 lbs in 186 days? |
| 14. Would you prefer to lose | (A) 2.7 lbs immediately, or | (B) 5.0 lbs in 21 days? |
| 15. Would you prefer to lose | (A) 6.9 lbs immediately, or | (B) 8.5 lbs in 91 days? |
| 16. Would you prefer to lose | (A) 4.9 lbs immediately, or | (B) 6.0 lbs in 89 days? |
| 17. Would you prefer to lose | (A) 8.0 lbs immediately, or | (B) 8.5 lbs in 157 days? |
| 18. Would you prefer to lose | (A) 2.4 lbs immediately, or | (B) 3.5 lbs in 29 days? |
| 19. Would you prefer to lose | (A) 3.3 lbs immediately, or | (B) 8.0 lbs in 14 days? |
| 20. Would you prefer to lose | (A) 2.8 lbs immediately, or | (B) 3.0 lbs in 179 days? |
| 21. Would you prefer to lose | (A) 3.4 lbs immediately, or | (B) 5.0 lbs in 30 days? |
| 22. Would you prefer to lose | (A) 2.5 lbs immediately, or | (B) 3.0 lbs in 80 days? |
| 23. Would you prefer to lose | (A) 4.1 lbs immediately, or | (B) 7.5 lbs in 20 days? |
| 24. Would you prefer to lose | (A) 5.4 lbs immediately, or | (B) 6.0 lbs in 111 days? |
| 25. Would you prefer to lose | (A) 5.4 lbs immediately, or | (B) 8.0 lbs in 30 days? |
| 26. Would you prefer to lose | (A) 2.2 lbs immediately, or | (B) 2.5 lbs in 136 days? |

27. Would you prefer to lose (A) 2.0 lbs immediately, or (B) 5.5 lbs in 7 days?

HIGHLIGHTS

- We developed a new temporal discounting measure for weight loss rewards.
- Weight-loss rewards are discounted over time similar to other types of rewards.
- Temporal discounting parameters for weight loss and monetary rewards are positively correlated.
- Temporal discounting rates decrease as the magnitude of delayed weight loss increases.
- Preference for immediate weight loss is related to beliefs that obesity is controllable.

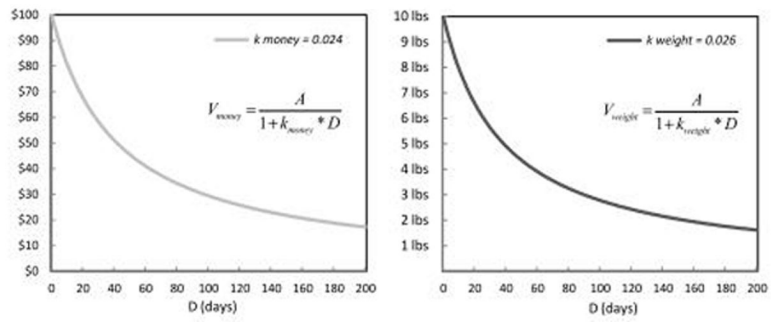


Figure 1.

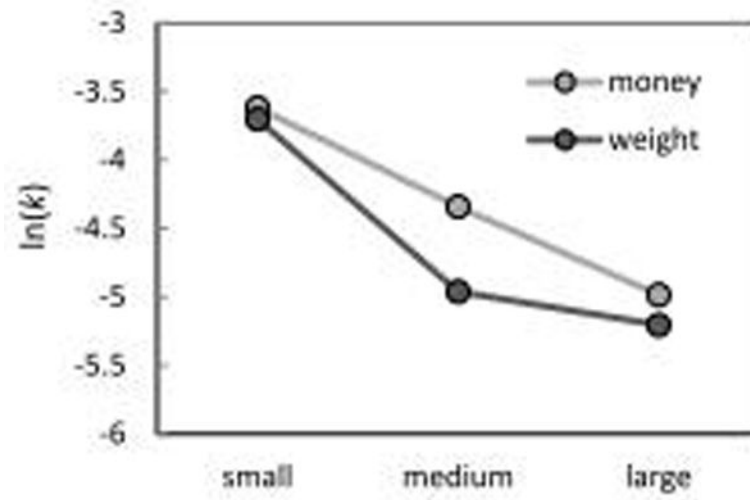


Figure 2.

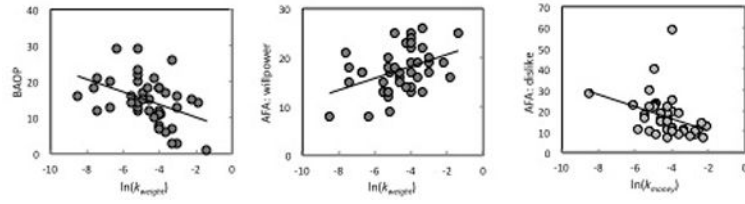


Figure 3. Scatter plots of discounting parameters against self-report scales. Discounting parameters were natural log-transformed. BAOP (Beliefs About Obese Persons). AFA (Anti-Fat Attitude).

Table 1

Spearman rank order correlations between temporal discounting parameters and self-report scales

Parameter	ATOP	BAOP	AFA dislike	AFA fear of fat	AFA willpower
<i>ln(kweight)</i>	-.32	-.45*	-.06	.20	.41*
<i>ln(bmoney)</i>	.33	-.08	-.53*	.12	.03

* $p < .05$ after Bonferroni correction.

The natural log transformation was done for temporal discounting parameters. ATOP (Attitudes Towards Obese Persons) - positive attitudes towards obese persons. BAOP (Beliefs About Obese Persons) - beliefs that obesity is not under control of obese persons. AFA (Anti-Fat Attitudes); dislike scale - negative attitudes for fat people; fear of fat - fear of becoming fat; willpower - beliefs that people become fat due to no willpower.