Preventive Medicine 55 (2012) S68–S74

Contents lists available at SciVerse ScienceDirect

Preventive Medicine

journal homepage: www.elsevier.com/locate/ypmed

Empirical observations on longer-term use of incentives for weight loss

Leslie K. John [a,*], George Loewenstein [b], Kevin G. Volpp [c,d,e,f]

[a] Harvard Business School, USA
[b] Carnegie Mellon University, USA
[c] Center for Health Equity Research and Promotion, Philadelphia Veterans Affairs Medical Center, USA
[d] Center for Health Incentives, Leonard Davis Institute of Health Economics, USA
[e] Department of Medicine, University of Pennsylvania School of Medicine, USA
[f] Department of Health Care Management, The Wharton School, USA

ARTICLE INFO

Available online 8 February 2012

Keywords:
Weight loss
Obesity
Behavioral economics
Intervention

ABSTRACT

Behavioral economic-based interventions are emerging as powerful tools to help individuals accomplish their own goals, including weight loss. Deposit contract incentive systems give participants the opportunity to put their money down toward losing weight, which they forfeit if they fail to lose weight; lottery incentive systems enable participants to win money if they attain weight loss goals. In this paper, we pool data from two prior studies to examine a variety of issues that unpublished data from those studies allow us to address. First, examining data from the deposit contract treatments in greater depth, we investigate factors affecting deposit frequency and size, and discuss possible ways of increasing deposits. Next, we compare the effectiveness of both deposit contract and lottery interventions as a function of participant demographic characteristics. These observations may help to guide the design of future, longer-term, behavioral economic-based interventions.

Introduction

Behavioral economic-based interventions are emerging as powerful tools to help individuals accomplish behaviors that are in their self-interest but which, due to self-control problems, they have difficulty accomplishing. We have conducted two randomized controlled trials of financial incentives for weight loss (John et al., 2011; Volpp et al., 2008). Both studies use decision errors identified in the behavioral decision literature to increase the effectiveness of – 'supercharge' – the financial incentives they employ. Thus, both illustrate a major theme in our broader stream of research: that the same decision errors that often result in self-destructive behavior can be used instead to help people engage in beneficial behaviors, such as weight loss.

In the deposit contract incentive system tested in both papers, participants were given the opportunity to put their own money down toward losing weight, which was returned to them with a 1:1 match if they succeeded in losing the requisite weight, but which they forfeit if they fail to meet weight loss goals. *Over-optimism* (that one will attain one's weight loss goal) increases willingness to contribute to a deposit; *loss aversion* increases the motivation to lose weight once a deposit has been made.

In the lottery-based incentive system tested in one of the papers, participants were entered into a lottery and received earnings if they achieved their target weight. This incentive scheme was designed to play on several psychological factors: (1) the tendency to *overweight small probabilities*, which enhances the perceived likelihood of winning, and (2) *Regret aversion*, as participants were entered into the lottery each day, but could only receive any winnings if they had achieved their weight-loss goal. To maximize regret, those who failed to achieve their goals, but whose lottery numbers were drawn, were informed that they *would have* received a payout, had they met their weight-loss goal.

Both incentive systems induced short- and longer-term weight loss, although there was substantial weight regain following removal of the incentives — an issue to which we return at the end of this paper. In this paper, after reporting the basic methods and findings from the two original papers, we go into greater depth on two important issues. First, focusing on the deposit contract incentive approach, we examine factors affecting deposit frequency and size, and discuss possible modifications to the approach that could potentially increase deposits. Second, we compare the relative effectiveness of the deposit contract and lottery incentive schemes for different demographic groups.

Incentive design overview

In the JAMA study, participants were given financial incentives for losing one pound per week for each of 16 weeks. In the JGIM study, the goal was to lose one pound per week for each of 24 weeks; then in weeks 25–32, the goal was to maintain the weight loss. The goals were provided to participants as daily targets. Participants were instructed to call in each day and report their weight; those who reported a weight at or below their daily goal weight were eligible

* Corresponding author at: Marketing Unit, Harvard Business School, Morgan Hall 169, Boston, MA 02163, USA. Fax: +1 617 496 5637.
E-mail address: ljohn@hbs.edu (L.K. John).

0091-7435/$ – see front matter
doi:10.1016/j.ypmed.2012.01.022

for the financial incentives for that day. Participants were provided with daily feedback via text message advising them how much, if any, money they had earned that day. At the end of each month, participants returned to the clinic for an official weigh-in. If the clinic scale corroborated the weights they had called in, participants received the sum of the daily financial incentives they had earned in the prior month.

At the outset of each month, participants in the deposit contract incentive arms were given the opportunity to contribute between $0.01 and $3.00 for each day of the month, refundable at the end of the month if they met or exceeded their weight loss target. As an incentive for participants to contribute to deposit contracts, we matched their money 1:1. In the first study, we also included a fixed payment of $3 per day.

Participants in the lottery incentive arm (included in the first study only) were eligible for a daily lottery with an expected value of $3/day, but only if, prior to the lottery being resolved, they had reported a weight at or below their daily weight loss goal. The lottery provided infrequent large payoffs (a 1 in 100 chance at a $100 reward) and frequent small payoffs (a 1 in 5 chance at a $10 reward). Each participant chose a "lucky" 2-digit number (e.g. "27") at the outset of the study. Every day, a 2-digit number was randomly generated. If one of the generated number's digits matched the participant's lucky number (i.e., in this case, if the first digit generated was a "2" or the last digit was a "7") the participant could win $10. If the randomly drawn number matched the participant's lucky number (i.e., in this case, 27), the participant could win $100. Participants were only eligible to claim their cash prize if on that day, they had reported that their weight was at or below their daily goal weight. Similar to the deposit contract group, those in the lottery group received daily feedback about each day's payoff via text message, and only received accumulated payments if they were at or below their weight loss goal at the weigh-in at the end of the month.

Analytical approach

Section I

To examine the deposit contract intervention in greater detail, we pooled data from the deposit contract arms of JAMA '08 and JGIM '11. The resulting sample size was 63 (19 participants from the JAMA study and 44 participants from the JGIM study). The JAMA intervention was four months in duration, while the JGIM intervention was eight months. Unless otherwise indicated, the data in the figures are based on the pooled data from JAMA and JGIM for months one through four; months five–eight consist exclusively of JGIM data.

Some individuals withdrew participation — 2/19 in the JAMA deposit contract arm and 5/44 in the JGIM deposit contract arms. We used all data available from participants who withdrew, and imputed values for the missing data following withdrawal: a zero was imputed for both the dummy variable of whether they had made a deposit, and for the amount of deposit. Unless otherwise indicated, we imputed baseline weight for these participants from the first missing data point onward (i.e., participants who withdrew were assumed to have reverted to baseline weight).

Section II

We pooled the control and deposit contract conditions from the JAMA and JGIM datasets (the JGIM dataset did not include a lottery incentive condition). Both studies drew from a similar population (patients at the Philadelphia Veterans Affairs Medical Center who were offered participation in a weight loss study) and there were no significant differences between datasets in the observed demographic variables (M_{income}: JAMA = $42,419, JGIM = $42,419; proportion of Caucasian participants: JAMA = 57%; JGIM = 42% $\chi^2(1) = 2.46$, $p = .12$; proportion having attended at least some college: JAMA = 67%; JGIM = 55.4%; $\chi^2(1) = 1.62$, $p = .20$; proportion married: JAMA = 56%; JGIM = 58.5%; $\chi^2(1) = .067$, $p = .80$). Supporting the appropriateness of the decision to pool, the results are similar when restricted to the JAMA data set.

Section I: frequency and size of deposits

The success of a deposit contract system hinges on participants' willingness to actually make deposits. Given that the income level of our participants was relatively low (Median annual household income = $32,162), we set the minimum threshold for contributions at $.01 per day to increase willingness to participate. Furthermore, in the deposit contract arm of the JAMA study, we hedged by including a $3 direct daily payment for attaining the daily weight loss goal — i.e., participants who attained their daily target weight would receive $3 *regardless* of whether they had contributed to a deposit.

There were no significant demographic differences between individuals who tended to make deposit contract contributions compared to those who did not. Enrollment BMIs were similar among participants who made a deposit: 'always' (35.2), 'sometimes' (34.2), and 'never' (BMI 35.5) (Table 1). However, the small sample sizes may have impeded detection of statistically significant differences in characteristics such as educational attainment. For example, there was an intuitive, albeit non-significant tendency for those with higher educational attainments to make larger deposits.

Across both studies, the proportion of participants contributing to deposit contracts began high, but declined over time (Fig. 1A). The proportion of participants reaching their weight loss goals similarly declined over time (Fig. 1B). In the first month, 94% of participants made a deposit. Although this percentage declined to 71% by the fourth month, it is still relatively high, especially given that the goal attainment rate had also declined substantially by that point (38% of participants attained their goal

Table 1
Demographic characteristics of the deposit contract arms, grouped by frequency of deposit. Percents are calculated within row category (i.e. the percentages in each row sum to 100%). Notes: unless otherwise noted, the raw count of Ss with the given characteristic is shown in parentheses.

		Made monthly deposit?		
		Never	Sometimes	Always
Male (n = 55)		3.6% (2)	40.0% (22)	56.4% (31)
Race	Caucasian (n = 29)	3.4% (1)	34.5%(10)	62.1% (18)
	African American (n = 32)	9.4% (3)	40.6% (13)	50.0% (16)
Marital status	Single (n = 11)	18.2% (2)	45.5% (5)	36.4% (4)
	Married (n = 32)	6.3% (2)	40.6% (13)	53.1% (17)
	Divorced (n = 17)	–	29.4% (5)	70.6% (12)
	Widowed (n = 2)	–	–	100% (2)
Education	9–11 high school (n = 3)	–	66.7% (2)	33.3% (1)
	High school/GED (n = 23)	8.7% (2)	39.1% (9)	52.2% (12)
	Some college (n = 21)	9.5% (2)	42.9% (9)	47.6% (10)
	College degree (n = 9)	–	22.2% (2)	77.8% (7)
	Post grad (n = 6)	–	33.3% (2)	66.7% (4)
Mean income (median)		$46,963 ($51,888)	$41,840 ($35,000)	$41,797 ($30,000)
Starting BMI (SD)		35.5 (.3.1)	34.2 (2.6)	35.2 (2.6)
Starting weight in pounds (SD)		234.3 (17.0)	231.3 (28.5)	234.1 (27.6)

Abbreviations used in above table:
n = number of participants.
SD = standard deviation.
BMI = body mass index.

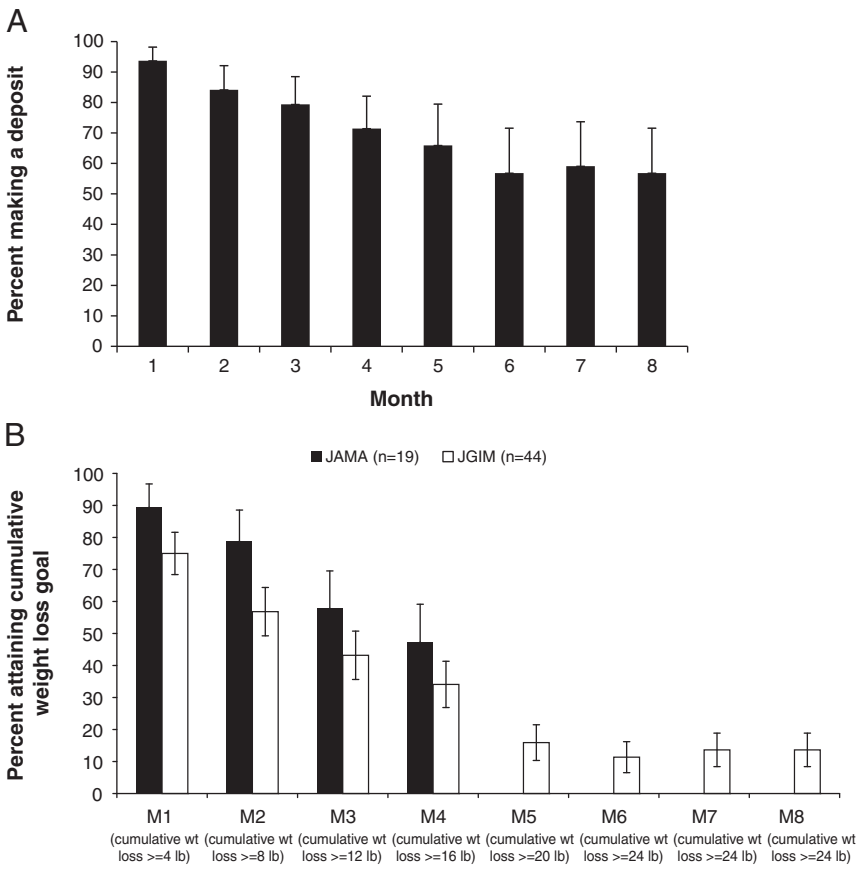

Fig. 1. Panel A: Percent of participants who made a deposit (Journal of the American Medical Association (2008) and Journal of General Internal Medicine '11 deposit contract arms pooled for months 1–4). Error bars represent upper bound of 95% binomial confidence interval. Place of data collection: Philadelphia, PA; Time of data collection: 2007–2010.Panel B: Proportion of participants who attained their cumulative monthly weight loss goal, broken down by study. Error bars represent +/− 1 standard error of the mean. Place of data collection: Philadelphia, PA; Time of data collection: 2007–2010.Panel C: Mean and median daily deposit amounts over time. Error bars represent +/− 1 standard error of the mean. Place of data collection: Philadelphia, PA; Time of data collection: 2007–2010Abbreviations used in above figures:M = meanlb = poundswt = weightJAMA = Journal of American Medical AssociationJGIM = Journal of General Internal Medicine.

in month four compared to 79.4% in month one). Perhaps testifying to abiding over-optimism, when it comes to future weight loss, by month eight, 56.8% of participants made a deposit even though only 13.6% of participants attained their goal.

Fig. 2 presents a histogram of the proportion of months in which participants made a deposit. The modal proportion was to make a deposit *every* month. The overall propensity to make a deposit was lower in the JGIM study relative to the JAMA study (70.7% vs. 82.9%); this is likely due to the fact that the JGIM study was longer, and the tendency to contribute to deposits decreased over time. When using only the first four months of the JGIM data, the proportion of months in which participants made a deposit was essentially equivalent to that observed in the JAMA paper (81.8% vs. 82.9%).

Relative to the decline in propensity to make a deposit of any magnitude, the decline in deposit amounts is sharper (Fig. 1C), and more closely resembles the decline in goal attainment over time (Fig. 1B). Participants may have (correctly) inferred that contributing to a deposit was integral to the treatment program and wanted to stay in good graces with the research coordinators. Therefore, those not inclined to contribute to deposits may have chosen to make a token contribution of say, $0.01 per day, as a goodwill gesture to the study. However, Fig. 3 shows that this tendency is not pronounced; when a deposit was made, it was generally for an amount greater than $0.01.

Even though they made the decision anew each month, most participants chose to deposit the same amount that they had deposited in the prior month (Fig. 4). Status quo bias – the tendency to disproportionately choose default options – can contribute to this pattern (Samuelson and Zeckhauser, 1988). The first deposit may serve as a default that participants choose to simply renew each month, rather than incurring the, arguably trivial, cost of thinking about how to change the deposit amount.

Perhaps not surprisingly, both the frequency and size of deposits are positively correlated with weight loss (size: $r = .572$, $p < .0005$; frequency: $r = .326$, $p = .011$). Although the former is a stronger predictor of weight loss, deposit size is still a strong predictor when controlling for deposit frequency (partial correlation = .471, $p < .0005$). Given that participants self-selected into making deposits, the causality of these relationships is difficult to disentangle: it is unclear whether frequent deposits of considerable size promote weight loss, whether the (correct) anticipation of future weight loss influences deposits, or whether a third variable, such as motivation to lose weight, independently increases both deposit behavior and weight loss.

The proportion of deposit contract participants that attained the cumulative weight loss goal each month declined over time. The degree and rate of decline are strikingly similar across the two studies, yet, as depicted in Fig. 1B, there is also evidence of a magnitude effect: the JAMA study included a $3 daily fixed payment (in addition to the 1:1 deposit match), which raised the reward, and accordingly, was associated with increased weight loss. This pattern is consistent with a large body of research documenting a positive association between magnitude of reinforcement and behavior change (Catania, 1963; Kane et al., 2004).

It is conceivable that weight loss performance in a given month might affect both the frequency and size of deposits in the subsequent month. Participants incurred the loss [reimbursement] of their deposit

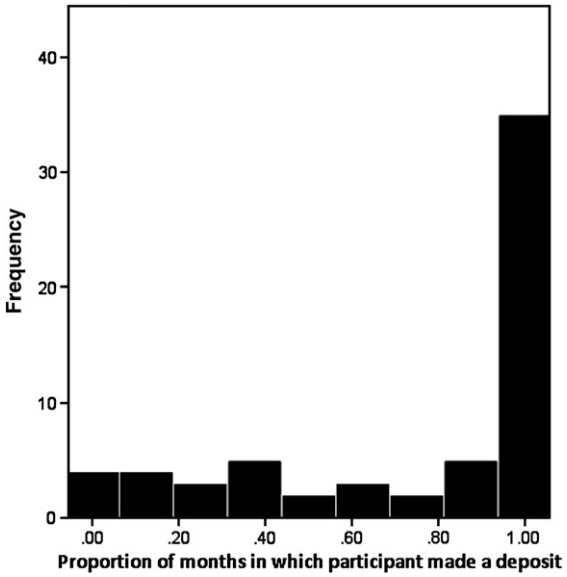

Fig. 2. Histogram of the proportion of months in which participants made deposits. 1 = made a deposit in every month of study (Journal of the American Medical Association (2008) = 4 months; Journal of General Internal Medicine (2011) = 8 months) 0 = did not make a deposit in any months. Place of data collection: Philadelphia, PA; Time of data collection: 2007–2010.

at the same session in which they could create a new deposit for the upcoming month. The close temporal proximity of these activities may make performance in a given month particularly likely to influence deposits for the subsequent month, although one can imagine causal stories going in either direction. On the one hand, someone who put an amount down and lost it as a result of failing to meet the target might decide to give up and not deposit more money; on the other hand, such a failure might lead them to raise their deposit to increase their own likelihood of reaching the target in the following month. In addition, participants received $20 simply for coming to the monthly weigh-in — a factor that may have increased the propensity to make a deposit regardless of performance on the previous month.

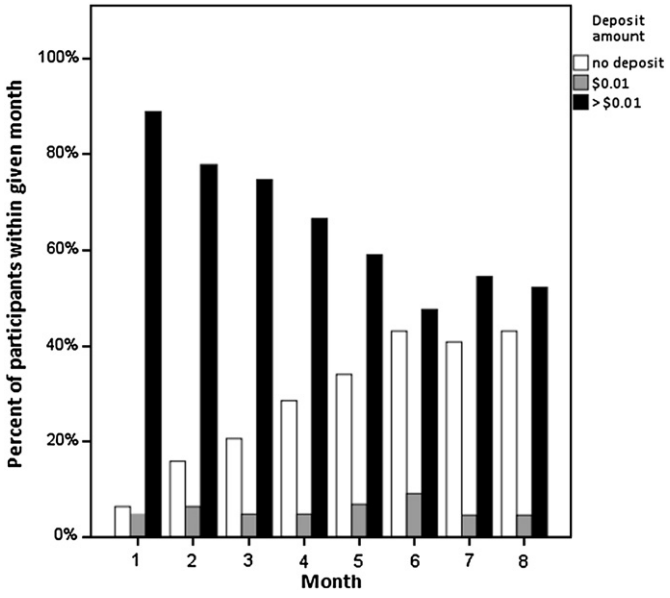

Fig. 3. Distribution of deposit contract amounts, by month. Months 1–4 use data from Journal of the American Medical Association (2008) and Journal of General Internal Medicine (2011); months 5 onward use Journal of General Internal Medicine (2011) data only. Place of data collection: Philadelphia, PA; Time of data collection: 2007–2010.

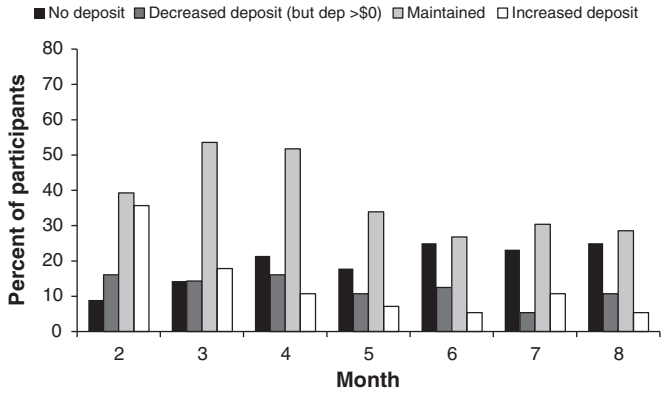

Fig. 4. Deposit amounts, relative to deposit amount in the prior month. Place of data collection: Philadelphia, PA; Time of data collection: 2007–2010.

Fig. 5A, which depicts the proportion of participants who made a deposit in relation to whether they attained their goal in the prior month, suggests that the first effect may have dominated; it suggests that weight loss success and associated reinforcement in a given month increase the likelihood of making a contribution for the subsequent month. While the contribution rate was surprisingly high even among participants who *did not* attain their goal in the preceding month: *at worst* (month 6), "only" 60% of participants who had failed to attain their goal in the preceding month (month 5) made a deposit; Fig. 5B shows that deposit amounts were much larger among participants who attained their goals on the preceding month. Those who were successful in goal attainment deposited an average of $1.41 (SD = $1.02) for the subsequent month, compared to only $0.61 (SD = .88) among those who failed to attain their goal ($F(1, 382) = 44.95$, $p < .0005$).

The psychological coding of recent losses versus gains may help to explain why the propensity to make a deposit was so high (i.e. >60%), even when the previous month's goal had not been attained. Participants contributing to deposit contracts experience a loss at the beginning of the month (i.e., upon making the deposit), but are likely to have adapted to this loss by the end of the month — the point at which successful participants regain their money (Frederick et al., 2002). Because of adaptation, successful participants may be likely to code reclaimed deposit money as a gain (as opposed to a mere refund). This situation gives rise to "house money" effects: the prospect of losing a refunded deposit is not as bad as that of a pure loss, as it is coded as a mere reduction in a gain (Thaler and Johnson, 1990). This effect may be accentuated by the fact that a participant who succeeded in the prior month would likely not have needed to physically hand over any cash to renew his deposit (the previous month's deposit is simply held for another month).

Unsuccessful participants, upon learning that they have forfeited their deposits, are likely to experience a sense of loss (although not as great as they would have had they just made the deposit) (Kahneman and Tversky, 1979). This might discourage making a new deposit, but losses induce risk seeking, which would enhance the willingness to make a deposit — particularly when presented with $20 in "house money" at the monthly check-in (the show-up incentive) and the opportunity to "break even" (i.e., by making a deposit equivalent to the amount of the forfeited cash).

Many participants continued to wager in favor of their ability to lose weight despite the accumulating evidence of their fallibility in doing so (i.e., losing that wager month after month). This pattern speaks to the pervasiveness of over-optimism (Arkes, 1991; Fischhoff, 1982; Weinstein, 1995). Although over-optimism may be a mistake according to rational models of behavior, our research

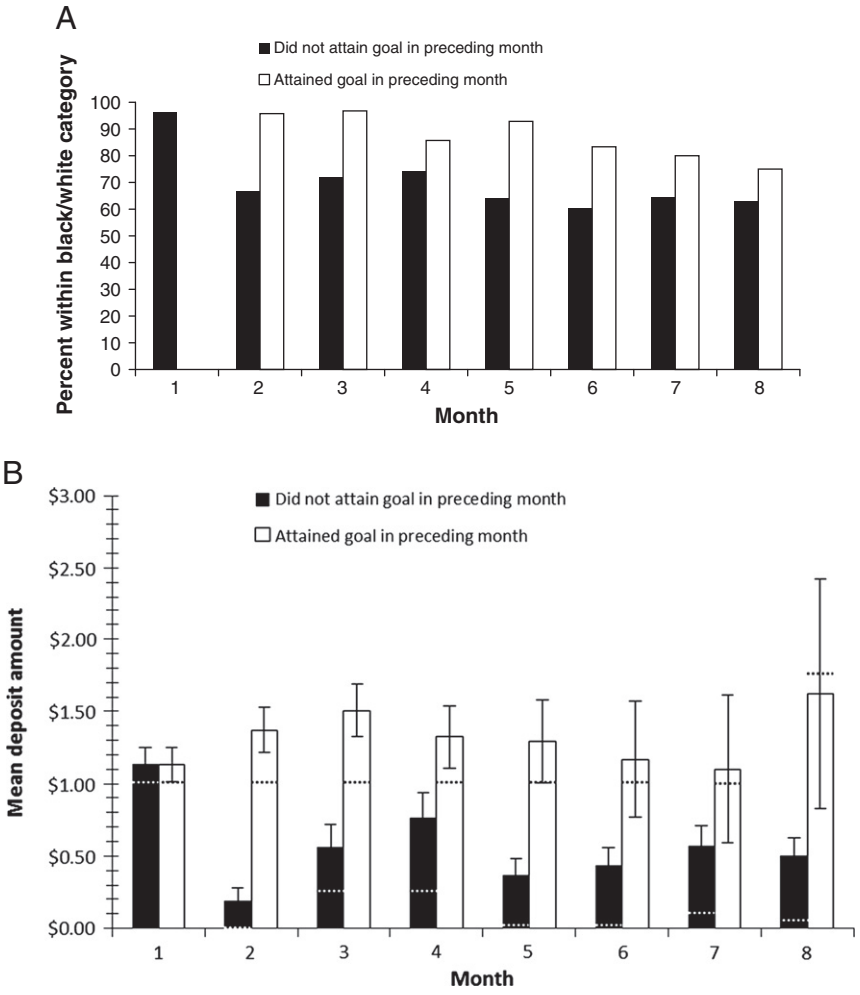

Fig. 5. A. Percent of participants who made a deposit each month, by whether the target weight was attained on the prior month. The bar for month 1 depicts the proportion of participants who made a deposit in the first month. Place of data collection: Philadelphia, PA; Time of data collection: 2007–2010.B. Mean and median daily deposit amounts, by a) month (x axis) and b) whether the target weight was attained in the prior month (bar color). Mean deposit amounts are depicted by the length of the colored vertical bars; median deposit amounts are depicted by the dashed horizontal line on each of the vertical (mean deposit amount) bars. Error bars represent +/− 1 standard error of the mean. Place of data collection: Philadelphia, PA; Time of data collection: 2007–2010.

points to its potential adaptiveness (Taylor, 1989): (unfounded) optimism could be responsible for participants' persistent willingness to make deposits despite missing their targets; the desire to reclaim one's deposit, in turn, motivated weight loss.

Implications for increasing deposits

The findings just discussed, combined with insights from behavioral economics, point to possible strategies that could be employed in future deposit contract interventions to increase the size and frequency of deposits.

Framing and peanuts effects

Framing effects refer to how, in contrast to standard economic theory, two superficially different yet formally equivalent ways of presenting options can dramatically influence choice (Tversky and Kahneman, 1981). Peanuts effects refer to the failure to appreciate how small changes "add up" (Gourville, 1998; Markowitz, 1952; Read et al., 1999). These phenomena suggest that individuals may find it more palatable to deposit, say, $30 per month when it is framed narrowly, as $1 per day for 30 days. This principle was incorporated into our studies — participants were encouraged to put *some* money down, if only a penny a day. While it may be best to frame deposit contribution decisions narrowly to encourage participation, the opposite approach may be optimal for post-deposit motivational messages geared to weight loss: after a person has made a deposit, aggregating the amount of money they stand to lose may motivate them to lose weight — "Don't lose the $30 you've put down this month!" is likely to be more a more motivating message than "Don't lose the $1 you've put down for today!"

Status quo bias

In contrast to standard economic theory, which predicts that choice should be unaffected by defaults, research has documented that people exhibit a strong tendency to stick to default options, even when the cost of switching is trivial (Johnson and Goldstein, 2003; Samuelson and Zeckhauser, 1988). This tendency could be used to increase the propensity to contribute to deposit contracts. For example, within the context of a corporate wellness program, funds could be taken from an employee's pay check (with the

employee's permission) and put toward a deposit contract to engage in healthy behaviors. If such a program were set up as a default, which employees could opt out of, participation rates would likely be far higher than if the deposits were made on an opt-in basis. Although our research suggests that this approach would facilitate behavior change, it would be important to implement it in such a way that employees do not feel cheated, or experience undue pressure to join the program. The ethical parameters of incentivizing health behavior change are important but beyond the scope of this paper; we refer the interested reader to Madison et al. (2011).

A potentially less heavy-handed way of using status quo bias to increase frequency and size of deposits would be to introduce a standard set of modest goals at the beginning of the program that gradually increase over time. It is conceivable that modest goals would increase both the frequency and size of deposits and generate more initial positive feedback for participants. Doing so at the start of the study may help participants get into the habit of making large monthly deposits by default, in turn providing a buffer against the tendency to reduce contributions as goals become more challenging over time.

Deposit transaction method

The method by which participants make deposit transactions is likely to affect outcomes; however, unlike the principles discussed above, the directionality of the effects is unclear. On the one hand, transacting electronically may increase both the frequency and magnitude of deposits because it reduces the "pain of paying" (Prelec and Loewenstein, 1998) relative to cash payments. However, this property of electronic transfer could also reduce the potency of the deposit contract if electronic money transfers blunt the feeling of having money at risk.

Section II: intervention effectiveness by demographic variables

Although most incentive programs, including ours, adopt a one-size-fits-all approach, it is possible that different approaches might be differentially effective for different populations, or even that incentive programs could be customized for individual participants. It is therefore potentially helpful to compare the effectiveness of different approaches for different demographic groups.

Income

It seems plausible that the effectiveness of different approaches might depend on the income or wealth of the participant. Due to the decreasing marginal utility of money, affluence could increase the frequency and magnitudes of deposits but it is unclear how this might affect weight loss. On the one hand, affluence could *increase* effectiveness since more money would be at stake; but it could also *decrease* effectiveness since decreasing marginal utility makes it less painful for affluent people to lose money. It is also possible that lottery incentives may be more effective among lower-income populations in light of the relative appeal of lotteries among lower-income populations. Therefore, it is unclear what, if any, effect income level may have on the effectiveness of the deposit contract intervention.

To test for these possible relationships, we first dichotomized participants by income level.[1] Next, we conducted a 2×3 between-subjects ANOVA using income (below median income versus above median income) and intervention condition (control/deposit contract/lottery) as the independent variables, and four-month weight loss as the dependent variable. We also included starting weight as a covariate because lower income participants weighed marginally more at baseline ($M_{belowMedian}$ = 238.1 lb (SD = 31.9); $M_{aboveMedian}$ = 229.4 lb (SD = 22.6); t(95.6) = 1.64, p = .11). The only statistically significant effect was that of the intervention (reported in JAMA '08 and JGIM '11); however, Fig. 6 reveals an interesting trend: the two incentive systems may be differentially effective based on income level. For participants with above median incomes, the deposit contract system seems to induce greater weight loss relative to the lottery incentive condition; however for the below median earners, if anything, this pattern is reversed.

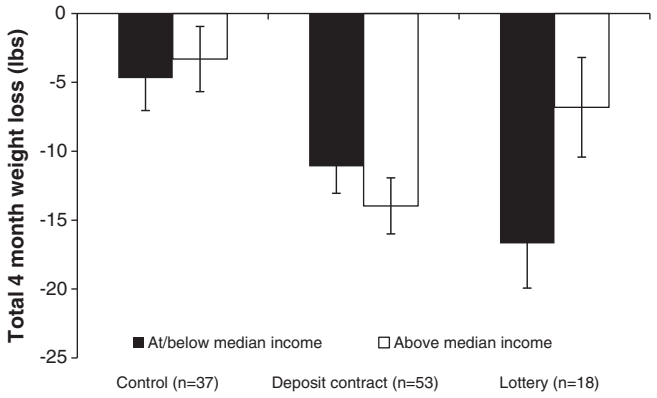

Fig. 6. Four month weight loss by intervention arm and income level, controlling for baseline weight. Control and deposit arms use the data from both Journal of the American Medical Association (2008) and Journal of General Internal Medicine (2011); Lottery arm uses data from Journal of the American Medical Association (2008), as there was no such arm in Journal of General Internal Medicine (2011). Error bars represent +/− 1 standard error of the mean. Place of data collection: Philadelphia, PA; Time of data collection: 2007–2010Abbreviation used in the figure above:n = number of participants.

Race

93.5% of participants identified themselves as either African American (48.0%) or Caucasian (45.5%); we tested whether the effectiveness of the interventions varied as a function of these two races. A 2×3 ANOVA controlling for income (income was higher among Caucasians than African Americans: Caucasian = $45,130; MAA = $32,535; t(99) = 2.17, p = .027) revealed that four month weight loss was greater among Caucasians than African Americans ($M_{Caucasian}$ = −11.2, SD = 11.1; $M_{AfricanAmerican}$ = −7.21, SD = 10.7; F(1, 94) = 7.06, p = .01).[2] However, race did not interact with the interventions (F(1, 94) = 1.71, p = .19).

Marital status

Being married (again, controlling for income) was not predictive of weight loss (F(1, 101) = 1.74, p = .19), nor did it interact with the intervention (F(1, 101) = .97, p = .38).

Education

Controlling for income, weight loss patterns were statistically similar between people with no, versus some, college education (Main effect F(1, 100) = .07, p = .79; Interaction with intervention F(1, 100) = .95, p = .39).

In summary, we did not detect any statistically significant interactions between demographic variables and intervention effectiveness; however, given the small sample sizes and exploratory nature of this analysis, additional research would be needed to more thoroughly test for possible associations. The marginally significant differential effectiveness of the lottery and deposit contract interventions as a function of income (Fig. 6) is intriguing and worthy of further investigation in a larger sample.

[1] We chose to dichotomize this variable for data analysis because it was not normally distributed.

[2] Baseline weights were not statistically different as a function of race.

Conclusion

Behavioral economic interventions hold promise in helping individuals to lose weight and live healthier lifestyles. We hope that these empirical observations will help to guide the design of future behavioral economic-based interventions. As noted in Section I, deposit contract interventions could be modified to boost the frequency and dollar amount of deposits. For example, status quo bias implies that the first deposit amount is a strong determinant of subsequent deposits, suggesting that an effective way of increasing future deposits may be to encourage people to make large initial deposits.

Future research could also examine ways of using incentives to induce long term weight loss and maintenance — a result that the present interventions did not achieve. This challenge is not unique to financial incentive-based programs; it is a challenge for weight loss programs in general. Deposit contributions and goal attainment decline over time, and as reported in JAMA (2008) and JGIM (2011), participants regain much of the weight once the incentives are removed. Future research could test ways of addressing these pitfalls. For example, researchers could investigate ways of boosting deposit contribution rates at the point at which they begin to wane; for example, the deposit contribution match could be started, or increased mid-way through the program. It could also be beneficial to taper incentives off gradually over time, instead of abruptly removing them at the end of the study, as was done in JAMA '08 and JGIM '11. Another potentially fruitful approach could be to change the incentive programs over time — for example, changing from a deposit contract structure to a lottery structure around month four may boost engagement, helping participants stay on track with their weight loss goals.

Whether financial incentives for weight loss need to be time-limited is an open-question; the ongoing use of incentives may help patients maintain weight loss long-term, and may be cost effective to insurers by reducing the cost of treating obesity-related disease such as diabetes. Section 2705 of the Affordable Care Act, which raises the percentage of employer premiums that can be used for outcome-based wellness incentives from 20% to 30% of total premiums, may lead to ongoing use of incentive-based programs (Volpp et al., 2011). If this happens, incentive program designers will be given the opportunity to design incentive programs with much larger incentives than those that have been tested to date. Careful consideration should be given to designing such interventions in ways that take account of prior research findings as well as insights from behavioral economics.

Conflict of interest statement

The authors declare that there are no conflicts of interest.

References

Arkes, H., 1991. Costs and benefits of judgment errors: implications for debiasing. Psychological Bulletin 110, 486–498.

Catania, C.A., 1963. Concurrent performances: a baseline for the study of reinforcement magnitude. Journal of Experimental Analysis of Behavior 6, 299–300.

Fischhoff, B., 1982. Debiasing. In: Kahneman, D., Slovic, P., Tversky, A. (Eds.), Judgment Under Uncertainty: Heuristics and Biases. Cambridge University Press, Cambridge, pp. 422–444.

Frederick, S., O'Donoghue, T., Loewenstein, G., 2002. Time discounting and time preference: a critical review. Journal of Economic Literature 40, 351.

Gourville, J.T., 1998. Pennies-a-day: the effect of temporal reframing on transaction evaluation. Journal of Consumer Research 24, 395–408.

John, L.K., Loewenstein, G., Troxel, A.B., Norton, L., Fassbender, J., Volpp, K.G., 2011. Financial incentives for extended weight loss: a randomized, controlled trial. Journal of General Internal Medicine 26, 621–626.

Johnson, E., Goldstein, D., 2003. Do defaults save lives? Science 302.

Kahneman, D., Tversky, A., 1979. Prospect theory: an analysis of decision making under risk. Econometrica 47, 263–291.

Kane, R.L., Johnson, P.E., Town, R.J., Butler, M., 2004. A structured review of the effect of economic incentives on consumers' preventive behavior. American Journal of Preventive Medicine 27, 327–352.

Madison, K.M., Volpp, K.G., Halpern, S.D., 2011. The law, policy, and ethics of employers' use of financial incentives to improve health. The Journal of Law, Medicine & Ethics 39, 450–468.

Markowitz, H., 1952. The utility of wealth. Journal of Political Economy 57, 151–158.

Prelec, D., Loewenstein, G., 1998. The red and the black: mental accounting of savings and debt. Marketing Science 17, 4–28.

Read, D., Loewenstein, G., Rabin, M., 1999. Choice bracketing. Journal of Risk and Uncertainty 19, 171–197.

Samuelson, W., Zeckhauser, R., 1988. Status quo bias in decision making. Journal of Risk and Uncertainty 1, 7–59.

Taylor, S.E., 1989. Positive Illusions: Creative Self-Deception and the Healthy Mind. Basic books, New York, NY.

Thaler, R., Johnson, E., 1990. Gambling with the house money and trying to break even: the effects of prior outcomes on risky choice. Management Science 36, 643–660.

Tversky, A., Kahneman, D., 1981. The framing of decisions and the psychology of choice. Science 211, 453–458.

Volpp, K., John, L., Troxel, A.B., Norton, L., Fassbender, J., Loewenstein, G., 2008. Financial incentive-based approaches for weight loss: a randomized trial. Journal of the American Medical Association 300, 2631–2637.

Volpp, K.G., Asch, D.A., Galvin, R., Loewenstein, G., 2011. Redesigning employee health incentives - lessons from behavioral economics. New England Journal of Medicine 365 (5), 388–390.

Weinstein, N.D., 1995. Resistance of personal risk perceptions to debiasing interventions. Health Psychology 14, 132–140.