Obesity and risk taking: A male phenomenon

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Abstract:

There is a growing tendency to regard overeating as an addiction, with obesity as its primary symptom. We propose that similar to other addictions, obesity is associated with excessive risk-taking in men, though not in women. To examine this suggestion we conducted two studies, one involving a sample of overweight and normal-weight students, and the other involving obese adults drawn from a dataset of health care clients, and a control sample of normal-weight adults. In both of these studies, we found that overweight and obese men took more risk in a laboratory task than normal-weight men, while overweight and obese women did not differ from normal-weight women in this respect. At the same time, obese women (but not overweight women) displayed higher impulsivity levels than normal-weight women. These findings shed light on the cognitive characteristics of obesity in men, and accent the importance of taking gender into account when developing research paradigms and treatment methods for obesity.

Keywords: Obesity, overeating, gender, risk taking, decision making, impulsivity, delay of gratification, individual differences.

Obesity is becoming increasingly prevalent worldwide (World Health Organization, 2011). Associated with increased incidence of diabetes, heart diseases and certain kinds of cancer, overweight and obesity are currently the fifth leading risk factor for global deaths (WHO, 2011). Therefore, it is of major importance for public health providers to identify the psychological factors that may contribute to obesity. In two studies, we examine the basic decision style implicated in the behavioral choices of obese men and women.

Specifically, while using obesity and overweight as independent variables, the behavioral pattern we are interested in is overeating (Stuart, 1967), which refers to the long-term consumption of excess food in relation to the energy that a person expends, leading to weight gaining and obesity. The current paper focuses on the similarity between basic decision processes implicated in overeating and in drug abuse. There is a growing call in the literature to regard overeating as an addiction, with obesity being its primary symptom (e.g., Gold, Frost-Pineda, & Jacobs, 2003; Volkow & Wise, 2005). Indeed, parallels in patterns of neural activity among drug addicts and morbidly obese individuals have been observed (e.g., Volkow, Wang, Fowler, & Telang, 2008).

Previous studies of drug addicts have repeatedly shown that such individuals are risk prone, as evidenced by both self-reports of sensation and thrill seeking (e.g., Ball, Carroll, & Rounsaville, 1994; Sutker, Archer, & Allain, 1978) and behavior in laboratory risk taking tasks (e.g., Bartzokis et al., 2000; Bechara et al., 2001; Grant, Contoreggi, & London, 2000; Yechiam, Busemeyer, Stout, & Bechara, 2005; Yechiam, Stout, Busemeyer, Rock, & Finn, 2005). With respect to obesity, however, while evidence has shown excessive risk taking in laboratory tasks in particular populations, such as morbidly obese or eating-disordered patients (Boeka & Lokken, 2006; Brogan, Hevey, & Pignatti, 2010; Brogan, Hevey, O'Callaghan, Yoder, & O'Shea, 2011), accounts of such impairments in overweight or obese individuals in general are limited. For instance, a reported effect of obesity on risky decision making in the Iowa Gambling task (Davis, Levitan, Muglia, Bewell, & Kennedy, 2004; the task is described below) was found to be entirely confounded by another factor, education level, in a later analysis (Davis, Patte, Curtis, & Reid, 2010).

An important fact about studies that have examined the decision style of obese individuals (e.g., Brogan et al., 2010; Davis et al., 2004; 2010; Nederkoorn, Smulders, Havermans, Roefs, & Jansen, 2006; Pignatti et al., 2006) is that the majority of them included mostly (or only) female obese participants. However, studies of drug abusers have shown that the most exacerbated risk taking behavior is exhibited by male addicts (Yechiam et al., 2005b; Stout et al., 2005; Lovallo et al., 2006). With respect to women, some studies have reported no differences in risk taking behavior between addicts and controls who did not abuse drugs (e.g., Yechiam et al., 2005b), while others have shown that female addicts exhibit a weak tendency to avoid risk, compared to non-addicts (e.g., Stout et al., 2005). Our main theoretical prediction pertains to the difference between overeating (and therefore overweight and obesity) in males and in females. We posit that as in drug abuse, overeating in men is associated with excessive risk taking; while in women there is no correlation between overeating and risk taking. We thus view excessive risk taking as a primarily male phenomenon that might contribute to a variety of behaviors associated with unwarranted consumption, including both drug abuse and obesity.

The reason why an extreme pattern of risk taking of this sort should characterize men more than women is embedded in theories of evolutionary psychology (e.g., Bateman, 1948; Williams, 1966; Trivers; 1972; Daly & Wilson, 2001). These theories suggest that because men's investment in child care is low compared to that of women, their reproductive success depends on their continual health to a lesser extent. They are therefore free to take risk with relatively minor cost to their offspring. While there are some exceptions to this (e.g., Bliss & Potter, 2002), various reviews and meta-analyses demonstrate that men take more risk than women (Arnett, 1992; Byrnes, Miller, & Schafer, 1999; Lyng, 1990, 1993).[1] Similar to other forms of risk taking, drug abuse is also typically more prevalent among men than among women (Springer, Sambrano, Sale, & Kasim, 2002; Thom, 2003; Wallace et al., 2003; Higuchi, Matsushita, & Kashima, 2006; Isralowitz & Rawson, 2006). For instance, in European Union states, men who have tried drugs outnumber women in all age groups and in all countries (EMCDDA, 2002). Thus, our main prediction is that obese and overweight men − but not women − would show a high level of risk taking compared to their normal-weight counterparts.

Unlike drug addiction, obesity is somewhat more prevalent among women then among men (WHO, 2011). While we propose excessive risk-taking as an underlying factor of obesity in men, other factors may be associated with obesity in women. One prominent factor is depression, which is more frequent in women and is considered a risk factor in obesity in women, though less so in men (e.g., Istvan, Zavela, & Weidner, 1992; Onyike et al., 2003).

<u>Assessing different aspects of risk taking</u>

Previous studies that examined decision making and risk taking among obese individuals (e.g., Davis et al., 2004; 2010) typically employed the Iowa Gambling Task (IGT; Bechara, Damasio, Damasio, & Anderson, 1994), a complex task involving two risky, disadvantageous alternatives, and two less risky, advantageous ones. However, of the disadvantageous alternatives, the one most frequently preferred (Yechiam & Busemeyer, 2005) provides a sure gain along with a small probability of loss (every selection wins 100 points with certainty, but there is a 0.1 probability of losing 1250 points). Preferring this alternative may be due to risk seeking, under its economic definition as a tendency to prefer high-payoff variance (Pratt, 1964; Markowitz, 1952; Sharpe, 1964; Preuschoff, Bossaerts, & Quartz, 2006). Yet, it may also be due to over-sensitivity to the frequency of gains, which typically results in the underweighting of rare events (e.g., Barron & Erev, 2003).

There is reason to believe that the economic sensitivity to risk (as variance) constitutes a different and independent process from the response to rare events. For instance, correlations between risk-taking levels in problems involving rare losses and problems involving equiprobable gains and losses tend to be rather modest, around 0.2-0.3 (Koritzky & Yechiam, 2010; Rakow & Rahim, 2010). Brain studies have likewise suggested different networks associated with the response to different types of risk. Sensitivity to variance was found to be associated with subcortical dopaminergic networks, such as the left and right ventral striatum extending into the subthalamic nucleus, midbrain, and mediodorsal thalamic nucleus (e.g., Preuschoff, Bossaerts, & Quartz, 2006). By contrast, sensitivity to rare events was found to be reflected in more frontal cortical networks (Tobler et al., 2008).

In order to examine the sensitivity to variance as an independent construct, in the present studies we used a behavioral task specifically designed to assess economic risk-taking, which we refer to as the Simplified Iowa Gambling Task (SIGT). In this task, the odds of gaining or losing are equal. Therefore, risk taking leads to increased payoff variance with no asymmetry in the frequency of positive and negative payoffs. One could argue that the SIGT may confound risk aversion with loss aversion: the tendency to give greater subjective weight to losses than to respective gains (Kahneman & Tversky, 1979). Indeed, while in experience-based tasks of this sort no loss aversion is typically observed for the average participant (see review in Erev, Ert, & Yechiam, 2008), loss aversion may drive the sensitivity to risk of some of the participants. Our view, though, is that losses are an important natural signal of risk, and they should be included in order to produce a reliable response to risk. For example, in several studies that examined the consistency of risk taking behavior across different sessions, significant correlations across sessions were only obtained when the risk included losses (Baucells & Villasis, 2010; Vlaev, Chater, & Stewart, 2009; Yechiam & Telpaz, in press).

One could also conceptualize risk sensitivity as the response to low-frequency gains or losses (Kahneman & Tversky, 1979; Petry, 2001). For instance, the dictionary definition of risk is “possibility of loss or injury (peril)” (Merriam Webster, 2011; see also Oxford English Dictionary, 1982). To allow for differences in this latter construct, we also administered the traditional version of the IGT, which incorporates rare losses in some of its choice alternatives.

This paper includes two studies. Study 1 examined our hypothesis with respect to overweight individuals, and Study 2 examined it with respect to obese individuals.

Study 1

This study included a sample of overweight and normal-weight participants, who were compared for risk-taking. Participants completed two experiential decision tasks assessing risk taking tendencies, the IGT and SIGT.

In addition to assessing risk taking, we also administered a test of impulsivity. While there is no single dominating definition of impulsivity, it is often described as a tendency to react to stimuli in a rapid, unplanned fashion without allowing time for complete processing of information (Dougherty, Mathias, Marsh, & Jagar, 2005; Kertzman et al., 2009).

Although the concepts “risk taking” and “impulsivity” are often used interchangeably in the literature, they are not synonymous. There is evidence that risk-taking (as a facet of decision making) and inhibitory control of impulses involve different brain mechanisms and represent different cognitive processes (for example, Bechara, 2004; Bechara & Van Der Linden, 2005; Brand, Recknor, Grabenhorst, & Bechara, 2007; Friedman & Miyake, 2004; McClure, Laibson, Loewenstein, & Cohen, 2004). Therefore, although both can occur simultaneously, an individual may display high risk-taking without being particularly impulsive, and vice versa.

Self-report tests of impulsivity have been used in several studies comparing obese and normal-weight individuals, and obese individuals were found more impulsive (e.g., Chalmers, Bowyer, & Olenick, 1990; Davis, Levitan, Smith, Tweed, & Curtis, 2006; Davis et al., 2007; Franken & Muris, 2005). Interestingly, these studies included all- or mostly-female samples. We used the impulsivity test expecting to replicate previous results regarding this trait.

Method

Participants

One hundred and twenty-seven students were recruited through ads posted at the university’s mailing lists, offering to participate in an experiment for pay. After the omission of the few individuals classified as obese (see next section), the final sample included 57 men and 64 women (See Table 1 for sample characteristics). The study was approved by the institutional ethics committee and complied with the ethical standards laid down in the 1964 Declaration of Helsinki. All participants gave their informed consent prior to their inclusion in the study.

Body Mass Index categorization

Body Mass Index (BMI = kg/m^2, the weight divided by the square of the height) was computed for each participant. According to WHO criteria, a BMI between 18 and 25 reflects normal weight, values of $25 \leq BMI < 30$ are classified as overweight, and values of 30 and above are classified as obese. Obesity is negatively associated with age and education level (Mokdad et al., 2003) and indeed, only six participants in this college-student sample were obese (five women and one man, total 4.7% of the sample). These participants were omitted from the analysis due to the respective small size of this sub-group.

Procedure

Participants attended the lab in groups of up to five persons. The tasks were presented and performed on computers, and the questionnaires were in pen-and-paper format. Each participant sat at a computer station separated from other stations by a partition. Participants were paid a show-up fee and additional sums based on the number of points gained in the tasks (see Measures section). Average earnings were NIS 52 ($13).

Measures

The Iowa Gambling Task (IGT; Bechara et al., 1994). In this task participants make repetitive selections from four decks of cards without initial information as to the payoffs they yield, and with the goal of maximizing their profit. Each card selection yields a gain, but occasionally losses occur too. Two of the decks are disadvantageous in that they yield relatively high gains along with even greater losses, resulting in a net loss. The two advantageous decks yield smaller gains combined with much smaller losses, resulting in a net gain (see Table 2).

Simplified variant of the Iowa Gambling Task (SIGT: following Lane et al., 2004). In this version of the task, the advantageous decks produce a constant small amount and the disadvantageous decks produce equiprobable gains and losses (see Table 2 and Figure 1). The latter two alternatives are risky, in that they yield gains and losses in different magnitudes, resulting in considerable variance. The expected values of the risky decks are zero points, making them the disadvantageous choice in the long run.

For each task, participants received instructions that stated the goal of accumulating as many points as possible by selecting the deck of their choice (the complete instructions appear in Bechara et al., 1994). Participants were not given information about the total number of trials (100) or the payoff distributions associated with the different decks. It was further stated that the points gained will be converted into real money at the end of the experiment and added to the participants' payoff.

The Impulsiveness Questionnaire (I7; Eysenck, Pearson, Easting, & Allsopp, 1985). This self-report questionnaire consists of Yes/No questions capturing impulsive tendencies and behaviors (e.g., "Do you often buy things on impulse?"; "Do you generally do and say things without stopping to think?"). We employed the Impulsiveness subscale, which has 19 items, in its Hebrew version (Glicksohn & Nahari, 2007).

Results

In all further analyses, the data was subjected to two-way ANOVAs, with condition (overweight vs. normal weight) and gender as the independent variables. We used t-tests to assess the single difference between cells predicted to be significant: the difference between obese and normal-weight men. Nevertheless, as the two women's groups were compared as well, we corrected the alpha terms using the Bonferroni adjustment ($\alpha < 0.025$).

Risk Taking

As expected, differences in risk taking were found in the SIGT, the task designed to measure the sensitivity to outcome variance (see Figure 2 for mean proportions of risky choice). A main effect of gender was revealed ($F_{(1,117)} = 4.28$, $p = 0.04$), with men taking more risk than women. A significant interaction between gender and condition was also observed ($F_{(1,117)} = 3.78$, $p = 0.05$), implying that overweight men took more risk compared to members of the other groups. Indeed, in a planned test of contrast, the difference between overweight and normal-weight men was significant ($t_{(55)}$=2.38, $p = 0.02$, *Cohen's d* = 0.56), while the difference between the women's groups was non-significant ($t_{(58.86)} = 0.26$, n.s.).[2]

The IGT revealed no differences in overall risky choice proportions. The two-way ANOVA results were non-significant ($F_{(1,117)} < 1$) for the main effects as well as the interaction of gender and condition. Recall, however, that the IGT features two risky and disadvantageous alternatives (decks A and B). As can be seen in Table 2, deck B yields frequent gains and rare losses. Thus, the common measurement of risk-taking in this task as the combined choice proportion of decks A and B may confound the sensitivity to payoff frequency and the underweighting of rare events (see Barron

& Erev, 2003). On the other hand, Deck A can serve as a less confounded measure of risk taking in this task, since it entails a 0.5 probability of loss (similar to the risky alternatives of the other task, the SIGT). Indeed, an analysis of Deck A choices revealed a pattern similar to that found in the SIGT: a main effect of gender ($F_{(1,117)}$ = 4.62, p = 0.04) as well as an interaction between gender and condition ($F_{(1,117)}$=7.65, p = 0.007). The proportion of Deck A choices was larger among overweight men (*M* = 0.21, *SD* = 0.21) than among normal-weight men (*M* = 0.14, *SD* = 0.07), normal-weight women (*M* = 0.14, *SD* = 0.08), or overweight women (*M* = 0.08, *SD* = 0.08). Nonetheless, the difference between obese and normal weight men (or women) was not significant on a t-test when corrected for multiple comparisons.

A similar analysis of Deck B choices revealed no significant effects.

Impulsivity

The Impulsiveness Questionnaire revealed no significant differences by gender or condition, nor was the interaction between gender and condition significant in a two-way ANOVA. Thus, we did not find high impulsivity level among overweight women or men.

Discussion

In accordance with our hypothesis, a pattern of excessive risk taking appeared among overweight men, but not among overweight women. This pattern was most pronounced in the SIGT, which includes a symmetric likelihood of gains and losses. Interestingly, we did not observe higher levels of impulsivity among the overweight women, i.e., the results of previous studies were not replicated in this sample. Notice, though, that with the exception of Franken and Muris (2005), studies of the relation between overweight and impulsivity tended to include greater variance in age and BMI than the present study (e.g., Chalmers et al., 1990; Davis et al., 2006; 2007). Perhaps the present sample was too homogenous for this phenomenon to be observed. Alternatively, it may have had other unique features that could challenge the generalizability of the findings. For this reason, we conducted Study 2, which was designed to test our hypothesis with respect to obesity in the general population, and included participants of a wider age range.

Study 2

This study's purpose was to test our hypothesis with respect to obese individuals. Its design and procedure were similar to that of Study 1. Following previous reports of poor delay of gratification among obese women (Davis et al., 2010; Weller, Cook, Avsar, & Cox, 2008), we included two measures of this tendency, to serve as benchmarks in addition to the measure of impulsivity. Delay of gratification is the act of forgoing immediate satisfaction in favor of obtaining greater rewards at a later time (Mischel, Shoda & Rodriguez, 1989). Impulsivity and delay of gratification are often regarded as related constructs (Kirby, Petry, & Bickel, 1999; Madden, Petry, Badger, & Bickel, 1997). Some studies have demonstrated moderate correlations between self-reported impulsivity and behavioral delay of gratification (Kirby, Petry, & Bickel, 1999; Madden et al., 1997; Richards, Zhang, Mitchell, & de Wit, 1999; de Wit, Flory, Acheson, McCloskey, & Manuck, 2007), though this has not always been observed (see e.g., Reynolds, Ortengren, Richards, & de Wit, 2006).

Method

Participants

Seventy-six clients of a large health service, registered at three clinics in an Israeli city, participated in the study. The sample included individuals who were categorized as being obese or having normal weight according to the WHO criteria based on BMI. Pregnant women, and people suffering from an active Axis 1 psychiatric disorder, were excluded. A pool of clients conforming to these criteria was identified and contacted by phone. The participation rate was approximately 75%. The study − including client identification and recruitment − was approved by a nation-wide Helsinki board and complied with the ethical standards laid down in the 1964 Declaration of Helsinki. All participants gave their informed consent prior to their inclusion in the study. For further background information about the sample, see Table 3.

Procedure

Participants attended individual sessions. The decision tasks were presented on a computer, and questionnaires were in a pencil-and-paper format. Height data were obtained from the clinics' records, and weight was measured by a research assistant at the end of the session. As the initial sampling was done according to the clinics' height and weight records, the weight measurement was redone in order to exclude participants who no longer matched the category from which they were sampled (normal weight or obesity). None of the recruited participants had to be excluded on this basis. The weight and BMI scores reported in Table 3 are based on the measurements done in the sessions. Participants were paid a show-up fee, which included compensation for travel time and expenses, and additional amounts based on the number of points gained in the tasks (see Measures section). The average amount paid was about NIS 180 ($46).

Measures

In addition to the procedures employed in Study 1, we also administered the following delay of gratification tests.

A delay of gratification task (Newman, Kosson, & Patterson, 1992). In this task, participants repeatedly choose between two unmarked buttons, each yielding an identical small payoff of 5 points in either 40% (low frequency) or 80% (high frequency) of the trials, and zero in the remaining trials. The low-frequency button is available for pressing as soon as each trial begins, while the high-frequency button becomes available after a ten-second delay. The task lasts 50 trials. In each trial the participant chooses whether to wait the ten seconds for better prospects of reward. At the end of the task, the points were converted into money, which was added to the sum paid to the participant at the end of the experiment. The instructions were similar to those given for the IGT and SIGT, with some changes where needed ("button" instead of "deck", etc.). After reading the instructions, and before performing the actual task, the participants completed a demonstration in which they were required to press on each button ten subsequent times. The purpose of this demonstration was to ensure participants' awareness to the fact that the delayed button was likely to produce a much higher payoff, so that their behavior in the task itself could indicate their willingness to delay gratification. A summary of the total payoffs obtained from both buttons was presented in the end of the demonstration stage, before the beginning of the task itself.

A delay discounting task (Kirby, 1997). Delay of gratification in adults is commonly measured by time discounting, which is the devaluation of future rewards in comparison to immediate ones. In this task participants are asked to indicate the amount they are willing to pay today in order to obtain a larger sum at a given point in the future (for instance, NIS100 following a 10-day delay period). The dependent measure is a parameter (k) derived from the following hyperbolic function:
$V = A / (1 + k*D)$, where V is the estimated value of an amount A that is available at delay D (measured in days), and k reflects the discount rate (Kirby, 1997).
Some of the trials were selected randomly at the end of the experiment, and the participant who indicated the highest price made the payment and received his or her earnings on due time. Participants were informed of this procedure prior to proposing their amounts.

Background information

A brief measure of intelligence, The Raven Advanced Progressive Matrices Test (part 1; Raven, 1989), was administered. Additionally, the participants completed a demographic information questionnaire.

Results

Our main analyses involved two-way ANOVAs, with condition (obese vs. normal weight) and gender as the independent variables.

Demographics and background variables

As can be seen in Table 3, the normal-weight participants had more years of education than the obese participants. However, most participants had some higher education, and the two groups did not differ significantly in age or level of intelligence (differences were analyzed with t-tests). We controlled for the potential effect of education level on our results by using ANCOVA as a secondary analysis.

Risk Taking

Significant differences in decision-making were revealed in the SIGT. The mean proportions of risky choices are depicted in Figure 3. As in Study 1, there was a significant interaction between gender and condition ($F_{(1,72)} = 9.75$, $p = 0.003$): Obese men took more risk than normal-weight men ($t_{(31.5)} = 3.39$, $p < 0.001$, *Cohen's d* = 1.25), while risk taking in women did not differ between conditions ($t_{(23.5)} = 0.89$, n.s.). In addition, there was no main effect of gender ($F < 1$), while the effect of condition was marginally significant ($F_{(1,72)} = 3.26$, $p = 0.08$).

An analysis of co-variance (ANCOVA), with years of education as a control variable, revealed similar results. The interaction between gender and condition remained significant ($F_{(1,70)} = 9.86$, $p = 0.003$), and education level had no effect.[3]

In the IGT, there was a main effect for gender ($F_{(1,72)} = 4.39$, $p = 0.04$): the mean proportions of risky and disadvantageous choices were 0.44 ($SD = 0.25$) for men and 0.56 (22) for women, indicating that men performed better than women. This is a common finding in this task (e.g., Reavis & Overman, 2001). Other differences were not found. The inclusion of years of education as a control variable in an ANCOVA did not change this pattern.

Impulsivity

The Impulsiveness Questionnaire scores revealed a significant interaction between gender and condition ($F_{(1,72)} = 6.33$, $p = 0.01$), with obese women exhibiting more impulsivity than normal-weight women (Obese women: $M = 5.32$, $SD = 3.68$; normal-weight women: $M = 2.18$, $SD = 2.55$; $t_{(34)} = 2.99$, $p = 0.005$, *Cohen's d* = 0.99), and no differences between obese men and normal-weight men (Obese men: $M = 4.05$, $SD = 2.77$; normal-weight men: $M = 4.74$, $SD = 4.16$; $t_{(38)} = 0.62$, n.s.). There were no main effects of gender ($F < 1$) or condition ($F_{(1,72)} = 2.23$, $p = 0.14$).

Interestingly, in an ANCOVA that included years of education as a control variable, these effects were diminished: education level was the only significant contributor, indicating that Impulsivity scores decreased as education level increased (gender: $F < 1$; condition: $F_{(1,70)} = 2.14$, $p = 0.15$; the interaction between gender and condition: $F_{(1,70)} = 2.96$, $p = 0.090$; years of education: $F_{(1,70)} = 12.16$, $p = 0.001$).

Delay of gratification

Delay scores in the delay of gratification task (Newman, Kosson, & Patterson, 1992), i.e., the percentage of trials in which the delayed button was selected, were fairly skewed. A Box-Cox transformation to normality was applied, yielding a best lambda score of 0.25. On average, obese women chose to wait for the greater reward less than any other group (Obese women: $M = 19\%$, $SD = 26\%$; normal-weight women: $M = 36\%$, $SD = 39\%$; obese men: $M = 37\%$, $SD = 33\%$; normal-weight men: $M = 38\%$, $SD = 42\%$). However, the interaction between gender and condition in the two-way ANOVA was not significant ($F_{(1,72)} = 1.03$, $p = 0.31$).

An analysis of co-variance (ANCOVA), with years of education as a control variable, produced similar results. The interaction between gender and condition remained insignificant ($F < 1$), and education level had no effect ($F_{(1,70)} = 2.52$, $p = 0.117$).

As this task examines the response to delay by manipulating waiting time as well as outcome probability, it may tap into risk-taking rather rather than (or in addition to) delay of gratification. We hence measured the correlations between the delay scores and the outcomes of the two tasks measuring risk taking (the proportion of risky / disadvantageous choice in the IGT and SIGT). No significant correlations were found between these measures among either men or women, or in the whole sample.

Additionally, no significant differences between obese and normal-weight individuals were revealed in the delay discounting task. Following the method proposed by Kirby and his colleagues (1997), we computed the mean scores of the parameter k, which represents devaluation of delayed payoffs (obese women: M = 0.11, SD = 0.24; normal-weight women: M = 0.15, SD = 0.35; obese men: M = 0.05, SD = 0.08; normal-weight men: M = 0.02, SD = 0.03). No significant effects were found in the two-way ANOVA. The inclusion of years of education as a control variable in an ANCOVA did not change this pattern.

The original method proposed to analyze k values (Kirby, 1997) did not include transformation to normality. However, since k was not normally distributed (Shapiro-Wilk $W = 0.39$, $p < 0.001$), we checked whether a Box-Cox transformation to normality would alter the results. Yet, no differences in k were observed following the transformation.

Discussion

The results of Study 2 provide further evidence of excessive risk taking among obese men, but not obese women. Also, in this sample we replicated previous findings of high impulsivity among obese women.

A possible interpretation with respect to the difference in risk taking is that actually non-obese males took less risk than the women sample, and that the main difference is due to this sub-sample's risk aversion. However, this interpretation assumes that risk sensitivity of men and women is comparable. Previous studies, however, have shown consistent differences between male and female students in the performance of tasks of this type (e.g., Reavis & Overman, 2001; Yechiam et al., 2005b), with female students having lower performance levels and taking somewhat more (disadvantageous) risk than men. Such differences have not been detected in samples of non-student adults (e.g., Fein, McGillivray, & Finn, 2006; Reavis & Overman, 2001). Thus, our weak interpretation of the findings is that while obese and non-obese men are different in their risk taking tendencies, such differences are not seen between obese and non-obese women.[4]

Our findings showed higher impulsivity in obese women compared to normal-weight women, and no significant differences in either of the measures of delay of gratification. This pattern is somewhat similar to that reported in Nederkoorn et al. (2006). These authors found that obese women appeared more impulsive than normal-weight women in a task measuring impulsivity, but no differences were observed in a delay discounting task (Nederkoorn et al., 2006). Also, delay discounting does not seem to characterize obese men (Weller et al., 2008; and present study), although it is a known correlate of drug addiction (e.g., Bickel & Marsch, 2001; Coffey, Gudleski, Saladin, & Brady, 2003). Possibly, delay discounting may be a feature of drug abuse that is less pertinent in over-eating and weight gaining.

Nonetheless, this issue seems to require additional investigation. Differences in delay discounting might have been overridden by such variables as education level and socio-economic status. It has been reported (Davis et al., 2010) that those with higher education tend to perform relatively well in delay discounting tasks, and so high education level can mask the difference between obese and normal-weight individuals. Additionally, in a study that found that obese women displayed greater discounting rates than either men or normal-weight women (Weller et al., 2008), the obese women were from relatively low-income households. It is important to notice, though, that differences in delay discounting in substance abusers tend to remain even after matching on education (e.g., Kirby & Petry, 2004; Madden et al., 1997).

Regarding the other measure of delay of gratification, it can be argued that the task by Newman et al. (1992) confounds delay with outcome probability. This introduces a component of risk taking into the task, which might therefore not be a straightforward measure of delay of gratification. The purpose of the demonstration carried out before the actual task was to minimize this effect, but its presence cannot be entirely ruled out. However, the absence of correlation between this task's scores and the outcomes of either the IGT or the SIGT implies that risk taking was not a major component in the delay of gratification task.

Conclusions

We found that obese as well as overweight men displayed elevated risk taking levels in an experiential decision task, while no such effect was found among women. This suggests that in men, obesity bears similarities to other addictions, which are associated with heightened risk seeking tendencies (Bechara & Damasio, 2002; Bechara et al., 2001; Grant, Contoreggi, & London, 2000). Our findings are different from those of previous studies on morbidly obese or eating-disordered individuals (Boeka & Lokken, 2006; Brogan et al., 2010, 2011). In these studies, male and female obese individuals had poor performance on the Iowa Gambling task. Possibly, though, these subpopulations have some unique features which are not shared by overweight students or obese persons drawn from a general population sample.

These findings can be interpreted as part of the more general manifestation of greater risk-taking tendencies among men. Drug abuse is more prevalent in men than in women (e.g., Thom, 2003), and so are a variety of risk taking behaviors (Byrnes et al., 1999). Risk taking, characterized by pursuing potential gains and ignoring possible losses, might be a characteristic that underlies a variety of maladaptive behaviors in men, but less so in women. This type of male risky choice syndrome was previously suggested in behaviors such as alcohol abuse and criminal conduct (e.g., Lovallo et al., 2006). We predicted and demonstrated that individuals with tendencies to overeat show this pattern as well.

Interestingly, unlike drug addiction, obesity is somewhat more prevalent among women then among men (WHO, 2011). Obesity in women may well be associated with, or explained by, different factors than in men. For instance, it has been found that men and women respond differently to eating-related factors, such as food cues, hunger, or satiety (Del Parigi et al., 2002; Greene et al., 2011; Smeets et al., 2006). In line with previous findings (Chalmers et al., 1990; Davis et al., 2006; 2007; Franken & Muris, 2005), in Study 2, which targeted obese individuals, we found that obesity in women is associated with impulsivity. As we indicated above, although the terms “risk taking” and “impulsivity” are often used interchangeably in the literature, they are not synonymous. In fact, dissociations have been demonstrated between the two constructs (see e.g., Bechara, 2004; Bechara & Van Der Linden, 2005; Brand et al., 2007; Friedman & Miyake, 2004; McClure et al., 2004). Moreover, the two constructs may be associated with different brain systems (Bechara, 2005). Thus, the current findings sustain the importance of impulsivity to the understanding of obesity in women. Our findings regarding women replicate previous works (e.g., Davis et al., 2007; Nederkoorn et al., 2006), whereas the findings regarding men are, to the best of our knowledge, novel.

Obesity is a physical state that puts one's health at high risk. With a growing prevalence of obesity in the population, seeking out ways to examine how obesity can be treated has become a first priority for health systems, societies, and governments (Abelson & Kennedy, 2004). Our findings provide a framework for researchers and other professionals to develop weight-loss and health promotion programs. We highlighted a particular decision making style associated with excessive weight gaining, and further showed that its expression is substantially moderated by the individual's gender. This implies that different intervention approaches may be used to improve the dietary choices of men and women.

We cannot yet tell whether the relation of the identified decision making style to obesity is a causal one. While we propose that these trends contribute to the maintenance of obesity and that they may well interfere with weight-loss attempts, longitudinal and other methods of research are needed to further clarify issues of time precedence and causality (for examples of such attempts recently made, see Guerrieri, Nederkoorn, Schrooten, Martijn, & Jansen, 2009; Graziano, Calkins, & Keane, 2010).

References

Abelson, P., & Kennedy, D. (2004). The obesity epidemic. *Science*, 304, 1413.

Arnett, J. (1992). Reckless behavior in adolescence: A developmental perspective. *Developmental Review*, 12, 339-373.

Ball, S.A., Carroll, K.M., & Rounsaville, B.J. (1994). Sensation Seeking, substance abuse, and psychopathology in treatment-seeking and community Cocaine abusers. *Journal of Consulting and Clinical Psychology*, 62, 1053-1057.

Barron, G., & Erev, I. (2003). Small feedback based decisions and their limited correspondence to description based decisions. *Journal of Behavioral Decision Making*, 16, 215-233.

Bartzokis, G., Lu, P., Beckson, M., Rapoport, R., Grant, S., Wiseman, E., & London, E.D. (2000). Abstinence from cocaine reduces high-risk responses on a gambling task. *Neuropsychopharmacology*, 22, 102-103.

Bateman, A. J. (1948). Intra-sexual selection in Drosophila. *Heredity,* 2, 349-368.

Baucells, M., & Villasis, A. (2010). Stability of risk preferences and the reflection effect of prospect theory. *Theory and Decision*, 68, 193-211.

Bechara, A. (2004). Disturbances of emotion regulation after focal brain lesions. *International Review of Neurobiology*, 62, 159-193.

Bechara A. (2005). Decision making, impulse control and loss of willpower to resist drugs: A neurocognitive perspective. *Nature Neuroscience,* 8, 1458-1463.

Bechara, A., & Damasio, H. (2002). Decision-making and addiction. Part I. Impaired activation of somatic states in substance dependent individuals when pondering decisions with negative future consequences. *Neuropsychologia,* 40, 1675-1689.

Bechara, A., Damasio, A.R., Damasio, H., & Anderson, S.W. (1994). Insensitivity to future consequences following damage to human prefrontal cortex. *Cognition*, 50, 7-15.

Bechara, A., Dolan, S., Denburg, N., Hindes, A., Anderson, S.W., & Nathan, P.E. (2001). Decision-making deficits, linked to a dysfunctional ventromedial prefrontal cortex, revealed in alcohol and stimulant abusers. *Neuropsychologia*, 39, 376-389.

Bechara, A., & Van Der Linden, M. (2005). Decision-making and impulse control after frontal lobe injuries. *Current Opinion in Neurology*, 18, 734-739.

Bickel, W. K., & Marsch, L. A. (2001). Toward a behavioral economic understanding of drug dependence: Delay discounting processes. *Addiction*, 96, 73–86.

Bliss, R.T. & Potter, M.E. (2002). Mutual fund managers: Does gender matter? *Journal of Business and Economic Studies*, 8, 1-15.

Boeka, A.G., & Lokken, K.L. (2006). The Iowa gambling task as a measure of decision making in women with bulimia nervosa. *Journal of the International Neuropsychological Society*, 12, 741-745.

Brand, M., Recknor, E.C., Grabenhorst, F., & Bechara, A. (2007). Decisions under ambiguity and decisions under risk: Correlations with executive functions and comparisons of two different gambling tasks with implicit and explicit rules. *Journal of Clinical and Experimental Neuropsychology*, 29, 86-99.

Brogan, A., Hevey, D., O'Callaghan, G., Yoder, R, & O'Shea, D. (2011). Impaired decision making among morbidly obese adults. *Journal of Psychosomatic Research,* 70, 89-196.

Brogan, A., Hevey, D., & Pignatti, R. (2010). Anorexia, bulimia, and obesity: Shared decision making deficits on the Iowa Gambling Task (IGT). *Journal of the International Neuropsychological Society*, 16, 711- 715.

Byrnes, J.P., Miller, D.C., & Schafer, W.D. (1999). Gender differences in risk taking: A meta analysis. *Psychological Bulletin*, 125, 367-383.

Chalmers, D.K., Bowyer, C.A., & Olenick, N.L. (1990). Problem drinking and obesity: A comparison in personality patterns and life-style. *The International Journal of the Addictions, 25*, 803-817.

Coffey, S.F., Gudleski, G.D., Saladin, M.E., & Brady, K.T. (2003). Impulsivity and rapid discounting of delayed hypothetical rewards in cocaine-dependent individuals. *Experimental and Clinical Psychopharmacology*, 11, 18–25.

Daly, M. & Wilson, M. (2001). Risk-taking, intrasexual competition, and homicide. *Nebraska Symposium on Motivation,* 4, 1-36.

Davis, C., Levitan, R.D., Muglia, P. Bewell, C., & Kennedy, J.L. (2004). Decision-making deficits and overeating: A Risk model for obesity. *Obesity Research,* 12, 929-935.

Davis, C., Levitan, R.D., Smith, M., Tweed, S., & Curtis, C. (2006). Associations among overeating, overweight, and attention deficit/hyperactivity disorder: A structural equation modelling approach. *Eating Behaviors*, 7, 266-274.

Davis, C., Patte, K., Curtis, C., & Reid, C. (2010). Immediate pleasures and future consequences. A neuropsychological study of binge eating and obesity. *Appetite,* 54, 208-213.

Davis, C., Patte, K., Levitan, R., Reid, C., Tweed, S., & Curtis, C. (2007). From motivation to behaviour: A model of reward sensitivity, overeating, and food preferences in the risk profile for obesity. *Appetite,* 48, 12-19.

de Wit, H., Flory, J.D., Acheson, A., McCloskey, M., & Manuck, S.B. (2007). IQ and nonplanning impulsivity are independently associated with delay discounting in middle-aged adults. *Personality and Individual Differences*, *42*, 111–121.

Del Parigi, A., Chen, K., Gautier, J.F., Salbe, A.D., Pratley, R.E., Ravussin, E., Reiman, E.M., & Tataranni, P.A. (2002). Sex differences in the human brain's response to hunger and satiation. *American Journal of Clinical Nutrition*, 75, 1017–1022.

Dougherty, D.M., Mathias, C.W., Marsh, D.M., & Jagar, A.A. (2005). Laboratory behavioral measures of impulsivity. *Behavioral Research Methods*, 37, 82-90.

European Monitoring Centre for Drugs and Drug Addiction (EMCDDA). (2002). 2002 Annual report on the state of the drugs problem in the European Union and Norway.

Erev, I., Ert, E., & Yechiam, E. (2008). Loss aversion, diminishing sensitivity, and the effect of experience on repeated decisions. *Journal of Behavioral Decision Making,* 21*,* 575-597.

Eysenck, S.B., Pearson, P.R., Easting, G., & Allsopp, J.F. (1985). Age norms for impulsiveness, venturesomeness and empathy in adults. *Personality and Individual Differences*, 6, 613-619.

Fein,G., McGillivray, S., & Finn, P. (2006). Normal performance on a simulated gambling task in treatment-naive alcohol-dependent individuals. *Alcoholism: Clinical & Experimental Research*, 30, 959–966.

Franken, I.H.A., & Muris, P. (2005). Individual differences in reward sensitivity are related to food craving and relative body weight in healthy women. *Appetite*, 45, 198-201.

Friedman, N.P., & Miyake, A. (2004). The relations among inhibition and interference control functions: A Latent-variable analysis. *Journal of Experimental Psychology: General*, 133, 101-135.

Glicksohn, Y., & Nahari, G. (2007). Interacting personality traits? Smoking as a test case. *European Journal of Personality*, 21, 225-234.

Gold, M.S., Frost-Pineda, K., & Jacobs, W.S. (2003). Overeating, binge eating, and eating disorders as addictions. *Psychiatric Annals*, 33, 117-122.

Grant, S., Contoreggi, C., & London, E.D. (2000). Drug abusers show impaired performance in a laboratory test of decision making. *Neuropsychologia*, 38, 1180-1187.

Graziano, P.A., Calkins, S.D., & Keane, S.P. (2010). Toddler self-regulation skills predict risk for pediatric obesity. *International Journal of Obesity*, 34, 633-641.

Greene, G.W., Schembre, S.M., White, A.A., Hoerr, S.L., Lohse, B., Shoff, S., Horacek, T., Riebe, D., Patterson, J., Phillips, B.W., Kattelmann, K.K., & Blissmer B. (2011). Identifying clusters of college students at elevated health risk based on eating and exercise behaviors and psychosocial determinants of body weight. *Journal of the American Dietetic Association,* 111, 394-400.

Guerrieri, R., Nederkoorn, C., Schrooten, M., Martijn, C., & Jansen A. (2009). Inducing impulsivity leads high and low restrained eaters into overeating, whereas current dieters stick to their diet. *Appetite*, 53, 93-100.

Higuchi, S., Matsushita, S., & Kashima, H. (2006). New findings on the genetic influences on alcohol use and dependence. *Current Opinions in Psychiatry*, 19, 253-265.

Isralowitz, R., & Rawson, R. (2006). Gender differences in prevalence of drug use among high risk adolescents in Israel. *Addictive Behaviors*, 31, 355-358.

Istvan, J., Zavela, K., & Weidner, G. (1992). Body weight and psychological distress in NHANES I. *International Journal of Obesity and Related Mental Disorders*, 16, 999-1003.

Kahneman, D., & Tversky, A. (1979). Prospect theory: An analysis of decision under risk. *Econometrica*, 47, 263-291.

Kertzman, S., Vainder, M., Vishne, T., Aizer, A., Kotler, M., & Dannon, P.N. (2009). Speed-accuracy tradeoff in decision-making performance among pathological gamblers. *European Addiction Research*, 16, 23-30.

Kirby, K.N. (1997). Bidding on the future: Evidence against normative discounting of delayed rewards. *Journal of Experimental Psychology: General*, 126, 54-70.

Kirby, K.N. & Petry, N.M. (2004). Heroin addicts and cocaine abusers have higher discount rates for delayed rewards than alcoholics or non-drug-using controls. *Addiction*, 99, 467-471.

Kirby, K.N., Petry, N.M., & Bickel, W.K. (1999). Heroin addicts have higher discount rates for delayed rewards than non-drug-using controls. *Journal of Experimental Psychology: General*, 128, 78-87.

Koritzky, G., & Yechiam, E. (2010). On the robustness of decision tasks to social desirability. *Journal of Behavioral Decision-making*, 23, 83-99.

Lane, S. D., Cherek, D. R., Pietras, C. J., & Tcheremissine, O. V. (2004). Alcohol effects on human risk taking. *Psychopharmacology*, 172, 68-77.

Lovallo, W.R., Yechiam, E., Sorocco, K.H., Vincent, A.S., & Collins, F.L. (2006). Working memory and decision-making in familial risk for alcoholism: Studies from the Oklahoma Family Health Patterns Project. *Alcoholism: Clinical and Experimental Research*, 30, 763-773.

Lyng, S. G. (1990). Edgework: A social psychological analysis of voluntary risk taking, *American Journal of Sociology*, 95, 851-886.

Lyng, S. (1993). Dysfunctional risk taking: Criminal behavior as edgework. In N.J. Bell & R.W. Bell (Eds.), Adolescent risk taking (pp. 107-130). Newbury Park: Sage.

Madden, G.J., Petry, N.M., Badger,G.J., & Bickel, W.K. (1997). Impulsive and self-control choices in opioid-dependent patients and non-drug-using control participants: drug and monetary rewards. *Experimental and Clinical Psychopharmacology*, 5, 256–262.

Markowitz, H.M. (1952). Portfolio selection. *Journal of Finance*, 7, 77-91.

McClure, S. M., Laibson, D.L., Loewenstein, G.F., & Cohen, J.D. (2004). Separate neural systems value immediate and delayed monetary rewards. *Science*, 306, 503-507.

Mischel, W., Shoda, Y., & Rodriguez, M. L. (1989). Delay of gratification in children. *Science*, 244, 933-938.

Mokdad, A.H., Ford, E.S., Bowman, B.A., Dietz, W.H., Vinicor, F., Bales, V.S., & Marks, J.S. (2003). Prevalence of obesity, diabetes, and obesity-related health risk factors, 2001. *Journal of the American Medical Association*, 289, 76-79.

Nederkoorn, C., Smulders, F., Havermans, R., Roefs, A., & Jansen, A. (2006). Impulsivity in obese women. *Appetite*, 47, 253-256.

Newman, J.P., Kosson, D.S., & Patterson, C.M. (1992). Delay of gratification in psychopathic and nonpsychopathic offenders. *Journal of Abnormal Psychology*, 101, 630-636.

Onyike, C.U., Crum, R.M., Lee, H.B., Lyketsos, C.G., & Eaton, W.W. (2003). Is obesity associated with major depression? Results from the Third National

Health and Nutrition Examination Survey. *American Journal of Epidemiology*, 158, 1139-1147.

Petry, N.M. (2001). Substance abuse, pathological gambling, and impulsiveness. *Drug and Alcohol Dependence*, 63, 29-38.

Pignatti, R., Bertella, L., Albani, G., Mauro, A., Molinari, E. & Semenza, C. (2006). Decision-making in obesity: a study using the Gambling Task. *Eating and Weight Disorders*, 11,126–132.

Pratt, J.W. (1964). Risk aversion in the small and in the large. *Econometrica*, *32*, 122-136.

Preuschoff, K., Bossaerts, P. & Quartz, S.R. (2006). Neural differentiation of expected reward and risk in human subcortical structures. *Neuron,* 51, 381-390.

Rakow, T., & Rahim, S.B. (2010). Developmental insights into experience-based decision making. *Journal of Behavioral Decision Making*, 23, 69-82.

Raven, J. (1989). The Raven progressive matrices: An overview of international norming studies. *Psychological Testing Bulletin*, 2, 7-16.

Reavis, R., & Overman, W.H. (2001). Adult sex differences on a decision-making task previously shown to depend on the orbital prefrontal cortex. *Behavioral Neuroscience,* 115, 196-206.

Reynolds, B., Ortengren, A., Richards, J.B., & de Wit, H. (2006). Dimensions of impulsive behavior: Personality and behavioral measures. *Personality and Individual Differences*, *40*, 305-315.

Richards, J. B., Zhang, L., Mitchell, S.H. & de Wit, H. (1999). Delay or probability discounting in a model of impulsive behavior: effect of alcohol, *Journal of Experimental Analysis of Behavior*, *71*, 121-143.

Sharpe, W.F. (1964). Capital asset prices: A theory of market equilibrium under conditions of risk. *Journal of Finance*, 19, 425-442.

Smeets, P.A., de Graaf, C., Stafleu, A., van Osch, M.J., Nievelstein, R.A., & van der Grond, J., 2006. Effect of satiety on brain activation during chocolate tasting in men and women. *American Journal of Clinical Nutrition*, 83, 1297-1305.

Springer, J., Sambrano, S., Sale, E., & Kasim, R. (2002). The national cross-site evaluation of high-risk youth programs: Making prevention effective for adolescent boys and girls. Gender differences in substance use and prevention (SMA Publication No. 00-3375). Rockville, MD: US Department of Health and Human Services.

Stout, J.C., Rock, S.L., Campbell, M.C., Busemeyer, J.R., & Finn, P.R. (2005). Psychological processes underlying risky decisions in drug abusers. *Psychology of Addictive Behaviors*, 19, 148-157.

Stuart, R.B. (1967). Behavioural control of overeating. *Behaviour Research and Therapy*, 5, 537-565.

Sutker, P.B., Archer, R.P., & Allain, A.N. (1978). Drug abuse patterns, personality characteristics, and relationships with sex, race, and sensation seeking. *Journal of Consulting and Clinical Psychology*, 46, 1374-1378.

Thom, B. (2003). *Risk-taking behaviour in men: Substance use and gender*. London: Health Development Agency.

Tobler, P.N., Christopoulos, G.I., O'Doherty, J.P., Dolan, R.J. & Schultz, W. (2008). Neuronal distortions of reward probability without choice. *Journal of Neuroscience*, 28, 11703–11711.

Trivers, R.L. (1972). Parental investment and sexual selection. In B. Campbell (Ed.), Sexual selection and the descent of man, 1871-1971 (pp. 134-179), Chicago: Aldine.

Van Honk, E.J., Schutter, D.J.L.G., Hermans, E.J., Putman, P.L.J., Tuiten, J.J.A., & Koppeschaar, H.P.F. (2004). Testosterone shifts the balance between sensitivity for punishment and reward in healthy young women. *Psychoneuroendocrinology*, 29, 937-943.

Vlaev, I., Chater, N., & Stewart, N. (2009). Dimensionality of risk perception: Factors affecting consumer understanding and evaluation of financial risk. *Journal of Behavioral Finance*, 10, 158-181.

Volkow, N.D., Wang, G.J., Fowler, J.S., & Telang, F. (2008). Overlapping neuronal circuits in addiction and obesity: Evidence of systems pathology. *Philosophical Transactions of the Royal Society B: Biological Science,* 363, 3191-3200.

Volkow, N.D., & Wise, R.A. (2005). How can drug addiction help us understand obesity? *Nature Neuroscience*, 8, 555-560.

Wallace, J., Bachman, J., O'Malley, P., Schulenberg, J., Cooper, S., & Johnston, L. (2003). Gender and ethnic differences in smoking, drinking and illicit drug use among American 8th, 10th and 12th grade students, 1976–2000. *Addiction*, 98, 225-234.

Weller, R.E., Cook, E.W., Avsar, K.B., & Cox, J.E. (2008). Obese women show greater delay discounting than healthy-weight women. *Appetite*, 51, 563-569. Williams, G.C. (1966). *Adaptation and natural selection*. Princeton: Princeton University Press.

World Health Organization (2011). *Obesity and Overweight*. Fact sheet no.311.

Yechiam. E., & Busemeyer, J.R. (2005). Comparison of basic assumptions embedded in learning models for experience based decision-making. *Psychonomic Bulletin and Review*, 12, 387-402.

Yechiam, E., Busemeyer, J.R, Stout, J.C. & Bechara, A. (2005a). Using cognitive models to map relations between neuropsychological disorders and human decision making deficits. *Psychological Science*, 16, 973-978.

Yechiam, E., Stout, J.C., Busemeyer, J.R., Rock, S.L., & Finn, P.R. (2005b). Individual differences in the response to forgone payoffs: An examination of high functioning drug abusers. *Journal of Behavioral Decision Making*, 18, 97-110.

Yechiam, E., & Telpaz, A. (in press). Losses induce consistency in risk taking even without loss aversion. *Journal of Behavioral Decision Making*.

Footnotes

[1] Interestingly, women were found to show more risk taking after testosterone injection (van Honk et al., 2004).

[2] Learning was observed in the SIGT. A repeated measures ANOVA revealed a decrease in risky choice level between the first and last blocks (each block = 20 trials) of the task ($F_{(1,122)} = 29.25$, $p < 0.0001$). This effect was not interacted by gender ($F < 1$) or condition ($F < 1$), and a three-way interaction was not detected either ($F_{(1,122)} = 3.21$, $p = 0.076$). Since no significant interactions were observed we focus on reporting the main effects across trials.

[3] As in Study 1, learning was observed in the SIGT. A repeated measures ANOVA revealed a decrease in risky choice level between the first and last blocks (each block = 20 trials) of the task ($F_{(1,72)} = 32.74$, $p < 0.0001$). This effect was not interacted by gender ($F < 1$) or condition ($F < 1$), and a three-way interaction was not detected either ($F_{(1,72)} = 1.06$, $p = 0.306$). Since no significant interactions were observed we focus on reporting the main effects across trials.

[4] Of the two operationalizations of risk taking - as sensitivity to variance and as response to rare losses - the former provided more predictive accuracy. Possibly, this is related to the psychological characteristics distinguishing over-eating from other forms of drug abuse; for example, the fact that the negative outcomes are relatively straightforward in the form of negative social responses. This potential difference in predictive power is an interesting avenue for further research.

Table 1. Demographics of the participants in Study 1.

	Normal-weight *18≤BMI<25*	**Overweight** *25≤BMI<30*
N	84	37
Women	46 (55%)	18 (49%)
Height [m]	1.70 (0.1)	1.71 (0.1)
Weight [Kg]*	62.47 (10.19)	79.97 (9.96)
BMI*	21.60 (2.07)	27.32 (1.25)
Age [years]	23.71 (2.48)	23.27 (2.52)

Data are number (%) or mean (SD).

* p<0.0001

Table 2. The payoffs associated with the original and the simplified versions of the Iowa Gambling Task.

	Deck	Type	Gains	Losses
Original IGT	A	Disadvantageous	100 for sure	50% to lose 250
	B	Disadvantageous	100 for sure	10% to lose 1250
	C	Advantageous	50 for sure	50% to lose 50
	D	Advantageous	50 for sure	10% to lose 250
Simplified IGT	A*	Disadvantageous	50% to gain 50, 100, 150 or 200	50% to lose 50, 100, 150 or 200
	B*	Disadvantageous	50% to gain 50, 100, 150 or 200	50% to lose 50, 100, 150 or 200
	C	Advantageous	20 for sure	-
	D	Advantageous	20 for sure	-

* The gains and losses in the SIGT are dependent, such that a person selecting A or B experiences gains *or* losses. There is an equal likelihood to obtain specific outcomes (i.e., 50, 100, 150, or 200).

Table 3. Demographics of the participants in Study 2.

	Normal-weight *18≤BMI<25*	**Obese** *BMI≥30*
N	36	40
Women	17 (47%)	19 (48%)
Height [m]	1.73 (0.08)	1.71 (0.1)
Weight [Kg]**	68 (7.05)	101.84 (14.03)
BMI**	22.8 (1.58)	34.69 (3.67)
Age [years]	34.03 (4.72)	35.18 (4.91)
Education [years]*	16.14 (2.69)	14.83 (2.33)
Intelligence [1-10]	8.11 (1.75)	7.65 (2.12)

Data are number (%) or mean (SD).

* $p<0.05$ **$p<0.0001$

Figure Captions

Figure 1. Screen shot of the Simplified Iowa Gambling Task (SIGT).

Figure 2. Risky choices in the Simplified Iowa Gambling Task (SIGT) in Study 1 by condition and gender.

Figure 3. Risky choices in the Simplified Iowa Gambling Task (SIGT) in Study 2 by condition and gender

Figure 1. Screen shot of the Simplified Iowa Gambling Task (SIGT).

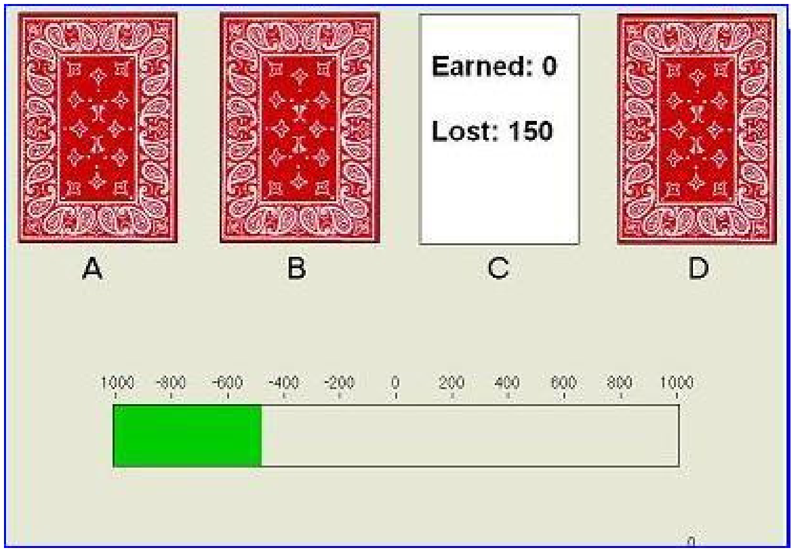

Figure 2. Risky choices in the Simplified Iowa Gambling Task (SIGT) in Study 1 by condition and gender.

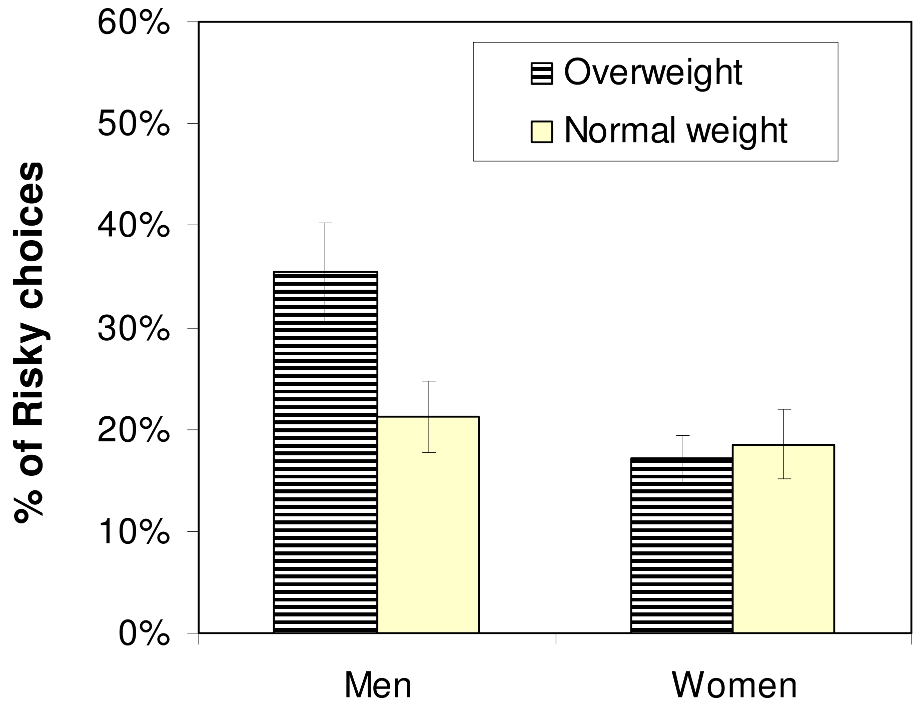

Figure 3. Risky choices in the Simplified Iowa Gambling Task (SIGT) in Study 2 by condition and gender.