

Short communication

# Cigarette smokers show steeper discounting of both food and cigarettes than money

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## Abstract

People with drug addiction show steeper discounting of drugs of abuse than money. One suggestion is that this effect is related to withdrawal processes in drug dependence. We investigated whether it could be related to the fact that drugs are directly consumable, whereas money is not. We determined whether regular cigarette smokers discount food (another consumable outcome) less steeply than cigarettes, both of which were predicted to be discounted more steeply than money. Cigarette smokers ( $N=20$ ) indicated preferences for immediate and delayed outcomes in a titration procedure that determined indifference points at various delays. In three separate conditions, the choices involved food, cigarettes, or money. The value of the delayed option was always US\$ 10 or US\$ 10 worth of the outcome. Cigarette smokers discounted both cigarettes and food more steeply than money. Most importantly, cigarettes and food were discounted to a similar degree. Cigarettes may be steeply discounted in part due to their consumable nature, rather than solely due to withdrawal-related processes.

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## 1. Introduction

Cigarette smoking is the leading cause of preventable death in the United States (Centers for Disease Control and Prevention; CDC, 2002) and has well-documented and publicized detrimental effects. In the US, packets of cigarettes bear grim health-related warnings, yet nearly 21% of the population smokes (CDC, 2005). Why do people begin and persist in smoking when it is clearly so harmful?

Cigarette smoking no doubt is multiply determined (e.g. Li, 2006). One influence may be the degree to which a person discounts future consequences. If future outcomes have little impact on current behavior, then people would not act with respect to relatively far off and probabilistic results of their actions (e.g. emphysema; CDC, 2004), but would instead be influenced mainly by the short-term reinforcing effects of smoking (e.g. 'satisfaction'; Cappelleri et al., 2007). One way to assess delay discounting (the degree to which the present value of an outcome is degraded by delay to its receipt; Mazur, 1987), is to arrange a series of questions about preferences between an immediate

option and options offered at several delays (e.g. Rachlin et al., 1991). For example, the value of a smaller immediate outcome can be adjusted until an indifference point is obtained which represents the present, discounted value of a larger delayed outcome. Outcomes tested are usually hypothetical, but the results appear to be similar with actual outcomes (e.g. Johnson and Bickel, 2002; Lagorio and Madden, 2005).

People with drug abuse problems show steep discounting of delayed hypothetical money (see e.g. Bickel and Marsch, 2001; Reynolds, 2006 for review). Steep discounting has been found with regular cigarette smokers (e.g. Bickel et al., 1999; Mitchell, 1999), opioid users (e.g. Madden et al., 1997; Odum et al., 2000), problem alcohol drinkers (e.g. Petry, 2001; Vuchinich and Simpson, 1998), and cocaine users (Coffey et al., 2003; Heil et al., 2006). Furthermore, these groups show particularly steep discounting of their drug of abuse (e.g. Bickel et al., 1999; Coffey et al., 2003; Madden et al., 1997; Petry, 2001).

Steep discounting of abused drugs may be related to withdrawal syndromes (e.g. Bickel et al., 1999; Madden et al., 1997) as part of a process by which negative reinforcers (i.e. escape from withdrawal) may be discounted more steeply than positive reinforcers (Navarick, 1982). While persuasive in some cases, this explanation does not seem to capture the scope

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of all results, though. Non-problematic drinkers of alcohol, who do not experience withdrawal, also show steep discounting of alcohol (Field et al., 2007; Odum and Rainaud, 2003; Petry, 2001). Social drinkers also discount food as steeply as they discount alcohol (Estle et al., 2007; Odum and Rainaud, 2003).

These results suggest that steep discounting of drugs of abuse may be in part related to a larger process by which consumable outcomes (e.g. food, drugs) are discounted more steeply than money, which is not directly consumed (Estle et al., 2007; Odum and Rainaud, 2003; Odum et al., 2006). What remains to be seen is whether people with drug dependence discount abused drugs more steeply than other consumable outcomes (Estle et al., 2007). The present study compared delay discounting of money, cigarettes, and food in regular cigarette smokers. The goal was to examine whether smokers would show steeper discounting of cigarettes than food, both of which were expected to be discounted more steeply than money.

## 2. Methods

### 2.1. Participants

Twenty participants were recruited through campus and community fliers. They were at least 18 years old, smoked 10 or more cigarettes per day, and scored less than 25 on the Eating Disturbance Scale (EDS-5; Rosenvinge et al., 2001). They completed the EDS-5 and described their favorite food and brand of cigarettes (type and price) during a telephone screen. All participants earned US\$ 10.00 compensation. They were tested individually in a small room. The Institutional Review Board of Utah State University approved this study.

### 2.2. Procedure

Participants gave informed consent and completed a demographic questionnaire. Index cards were used to give participants examples of scenarios they would encounter in the delay discounting assessment, which was then completed on the computer using a program written in Visual Basic.Net 2003. The instructions were similar to those used previously (e.g. Du et al., 2002; Odum et al., 2006) and indicated there were no right or wrong answers. Finally, participants completed the Fageström Test for Nicotine Dependence (FTND; Heatherton et al., 1991). Total testing took approximately 45 min.

For the delay discounting assessment, participants answered questions about three outcomes: money, cigarettes, and food. They indicated their choices using the computer mouse. Money was tested first, after which participants were randomly assigned to be tested with cigarettes or food second. On each trial, participants made choices between immediate and delayed outcomes. The delays were 1 day, 2 days, 1 week, 2 weeks, 1 month, 2 months, and 6 years, in this order. For each delay, participants completed 10 trials using a simple adjusting method (Du et al., 2002; Estle et al., 2007). The value on the first trial was always US\$ 10.00 delayed versus US\$ 5.00 now, or the equivalent in food or cigarettes based on the participant's stated price (e.g. 2 plates of pasta delayed versus 1 plate now; 2.5 packs of Marlboro Lights<sup>®</sup> delayed versus 1.25 packs of Marlboro Lights<sup>®</sup> now). For subsequent choices, the immediate amount was adjusted based on the response. If a participant chose the immediate outcome, the value of the next immediate outcome decreased. If the participant chose the delayed outcome, the value of the next immediate outcome increased. On the first trial, the adjustment was half of the difference between the immediate and delayed amounts (e.g.  $(US\$ 10.00 - US\$ 5.00)/2 = US\$ 2.50$  or the equivalent in the non-monetary outcome). For the rest of the trials, the size of the adjustment was always half of the previous adjustment. The indifference point was the midpoint between the last immediate amount chosen and the first immediate amount rejected.

Table 1  
Average demographic and participant characteristics

Variable	Result (N=20)
Gender (% male)	90
Age (years)	23.15 (0.85)
Ethnicity (% White)	85
Marital status (% single)	90
Education (years)	14.23 (0.44)
Income (US\$ monthly)	699.50 (143.10)
Number of cigarettes/day (reported during phone screen)	16.60 (1.29)
EDS-5	10.00 (0.92)
FTND	3.70 (0.47)

The number in the parentheses indicates the standard error.

### 2.3. Data analysis

The area under the curve (AUC; Myerson et al., 2001) was calculated for each outcome type for each participant. The AUC is an atheoretical measure that is normally distributed and has been used as a measure of discounting for money, drugs, and other consumable outcomes (e.g. Estle et al., 2007; Field et al., 2006, 2007; Odum and Rainaud, 2003; Odum et al., 2006). To calculate the AUC, the delays and the indifference points are first normalized, and then the area under the curve is computed (see Myerson et al., 2001, for details). The AUC ranges from 1 to 0 (larger values indicate less discounting). Pearson's *r* was used to assess the correlation between AUCs for different outcomes.

## 3. Results

Demographic characteristic of the participants are in Table 1. Fig. 1 shows the mean AUC for cigarettes and food was smaller (indicating steeper discounting) than for money. An ANOVA revealed a significant effect of outcome type,  $F(2, 59) = 15.79$ ,  $P < 0.001$ . Bonferroni's Multiple Comparison test showed a significant difference between the AUC for money and cigarettes ( $t(19) = 5.17$ ,  $P < 0.001$ ) and between the AUC for money and food ( $t(19) = 4.49$ ,  $P < 0.001$ ). The difference between the AUC for food and cigarettes was not significant ( $t(19) = 0.67$ ,  $P > 0.25$ ).

These differences in AUCs were robust at the individual as well as the group level. The AUC for money was greater (showing less discounting) than for food for 19 of 20 participants ( $P < 0.0005$  on a sign test). The AUC for money was also greater

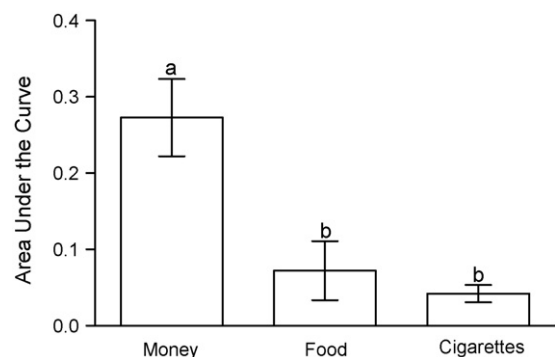


Fig. 1. Mean area under the curve for money, food, and cigarettes. Vertical lines show one standard error above and below the means. The mean of the condition marked with the letter 'a' is significantly different from the means of conditions marked with the letter 'b'. The means of conditions marked with letter 'b' are not significantly different from each other.

than for cigarettes for 19 of 20 participants. The AUC for food, however, was greater than for cigarettes for 12 of 20 participants ( $P > 0.5$ ). The AUC for money was positively but not significantly correlated with the AUC for cigarettes ( $r = 0.36$ ,  $P = 0.11$ ) or food ( $r = 0.35$ ,  $P = 0.13$ ). The AUC for cigarettes and food was significantly positively correlated ( $r = 0.71$ ,  $P = 0.0004$ ).

#### 4. Discussion

This study replicated two findings from previous research: cigarette smokers discounted cigarettes more steeply than money (e.g. Bickel et al., 1999), and food was discounted more steeply than money (Estle et al., 2007; Odum and Rainaud, 2003; Odum et al., 2006). This study is the first to suggest that cigarette smokers may discount another consumable outcome, food, as steeply as cigarettes. The mean score on the EDS-5 (a measure of disordered eating) in the present study was 10.0, similar to a population norm estimate of 9.47 (Rosenvinge et al., 2001), so it seems unlikely that co-morbid food-related problems could explain this outcome.

Cigarette smokers (Bickel et al., 1999, the present study), and people with problems with alcohol (Petry, 2001), cocaine (Coffey et al., 2003) and opiates (Madden et al., 1997; Odum et al., 2000) show steeper discounting of their drug of abuse than money. One possible reason for this finding is that drug abuse may be maintained at least in part by negative reinforcement (relief of withdrawal symptoms; see Bickel et al., 1999; Madden et al., 1997; Petry, 2001). Indeed, opioid-dependent outpatients discount money and heroin more steeply under deprivation than satiation (Giordano et al., 2002). Deprivation also increases smokers' discounting of cigarettes (Field et al., 2006) and increases the choice of immediate cigarettes over delayed money (Mitchell, 2004). The effects of withdrawal from cigarettes on delay discounting of money are so far inconsistent, though (Field et al., 2006; Mitchell, 2004).

Regardless, recent evidence suggests that while withdrawal may certainly be a part of steep discounting of abused drugs, it does not seem to explain the effect entirely. Both normal social drinkers and people with problematic drinking show steeper discounting of alcohol than money (Estle et al., 2007; Field et al., 2007; Odum and Rainaud, 2003; Petry, 2001). To account for these results, we have suggested that drugs of abuse may be discounted more steeply than money as part of a general process by which consumable outcomes are discounted more than non-consumable outcomes (Odum and Rainaud, 2003). This proposition has been supported by findings that people discount food and other beverages as steeply as alcohol, and more steeply than money (Estle et al., 2007; Odum and Rainaud, 2003). The present study adds an important piece of information by suggesting that cigarette smokers may discount food as steeply as cigarettes and more steeply than money.

There are several possibilities that could explain the similar discounting of food and cigarettes in the present study. The average score on the Fagerström Test for Nicotine Dependence (FTND; Heatherton et al., 1991) was not high in the present study (3.70), although it is similar to the mean for smokers in recently

published discounting studies (e.g. 3.57 in Field et al., 2006) and to estimates of the population values in smokers in several countries (Fagerström et al., 1996). More dependent smokers may show steeper discounting of cigarettes than food. Smokers in the present study with an FTND of 6 or higher ( $n = 4$ ; 'highly dependent' smokers; Fagerström et al., 1996) had a mean AUC for cigarettes (0.028) greater than for food (0.017), which is not in the expected direction if more dependent smokers discount cigarettes more steeply than food. Future studies could assess this possibility prospectively with more participants who score higher on the FTND.

Another possibility is the discounting shown for cigarettes and food was so steep that it precluded finding a difference. This possibility could be evaluated by examining discounting of larger amounts of the outcomes, which are in general discounted less steeply (see Green and Myerson, 2004 for review). We chose relatively small amounts in the present study because US\$ 10 worth of cigarettes or food at a time arguably has more face validity than larger amounts. The procedure was at least sensitive to differences in discounting between money and food and cigarettes, though, showing that the amount used was not too small to find any differences.

A final possibility is that cigarettes and food may have been discounted similarly because they are consumable and so the degree of discounting is in fact equal. There are a number of possibly overlapping reasons that consumable outcomes may be discounted more steeply than non-consumable outcomes (see Estle et al., 2007; Odum and Rainaud, 2003). Estle et al. (2007) proposed that directly consumable outcomes might lose value quickly with delay because of the 'inconstancy of desire' for a specific thing over time. Money, however, can be exchanged for a variety of things, and so whatever is most valued at the time may be obtained. More research is needed to determine why consumable outcomes appear to be so steeply discounted.

This study does have a number of limitations. First, the deprivation level for food and cigarettes was not controlled. Participants were given no instructions regarding their eating and smoking, and no measures of recent consumption were obtained. Future studies should control for or at least have measures of recent intake of the consumable outcomes. Second, we did not obtain measures of discounting of food in non-smoking participants. Previous research has established that smokers show steeper discounting of money than non-smokers do (e.g. Bickel et al., 1999). It would be interesting and important to know whether cigarette smokers also show steeper discounting of food, and other consumable outcomes, compared to non-smokers. Perhaps people with drug addiction discount a wide variety of outcomes more steeply than people without addiction.

Further research is required to determine the factors that produce steep discounting of consumable outcomes. More research is also needed to determine the generality of this effect and its relation to addiction. The present results do suggest, however, that people may discount drugs of abuse steeply because of a general process related to consumable outcomes, rather than solely due to withdrawal-related addictive processes.

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