

Self-control, time discounting and food consumption

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Introduction

Consumers who heavily discount their future may end up eating unhealthy and being obese. If there would be no market failures (e.g. negative externalities) or behavioral anomalies associated with their consumption of unhealthy food and obesity, government intervention may not be justified. However, if people suffer from self-control problems (and therefore fail to optimize their consumption), government intervention could be justified. There are numerous theoretical studies that explore the welfare impact of fat taxes under the assumption that people suffer from self-control problems (see e.g. O'Donoghue and Rabin, 2003; 2006). Even if we know there are market failures associated from unhealthy eating and obesity (e.g. increased health care costs, shared by all tax payers), it is therefore of interest to explore if consumers suffer from self-control problems, and if the self-control problem give rise to under investment in health, e.g. excess consumption of unhealthy food.

There is survey and experimental evidence that people often have limited self-control when it comes to food consumption – we regret eating what we just ate, we wish we would not eat as much as we do, etc. (Kahan et al., 2003; Stroebe et al., 2008; Mischel and Ayduk, 2011; Klem et al., 1998; Francis and Susman, 2009; Seeyave et al., 2009; Phelan et al., 2009). However, to what extent people suffer from self-control problems is largely unknown. And, as noted earlier, simply observing poor eating habits are not evidence enough – for some people poor eating habits may be part of a long term utility maximizing plan.

The aim of this paper is to analyze to what extent Danes suffer from limited self-control in relation to food, and how limited self-control affect their eating habits and overall health behavior. This is the first study to empirically investigate the extent to which people suffer from self-control problems and how self-control problems impact unhealthy eating, using consumer panel data.

Theoretical foundation

Following self-control models (e.g. Laibson, 1997; O'Donoghue and Rabin, 2003), we define *present-biased* preferences as:

$$U_t = u_t + \beta \sum_{\tau=t+1}^T \theta^{\tau-t} u_\tau \quad (1)$$

where u_t is the immediate utility in period t , θ is a standard discount factor and $0 < \beta < 1$ represents a time-inconsistent preference for immediate gratification, i.e., the present-bias. A present-biased

person is better off in the long run if he behaves rationally, i.e. assign an equal discount rate for all future time periods. But due to the present-bias, he is prone to immediate gratification (i.e. giving in to temptation) —he prefers to over consume harmful activities today.

Assume he consumes a harmful tempting good (unhealthy food) and a numeraire good (leisure) in each period. We normalize the price of both unhealthy food and the numeraire to unity. Let x_t denote the level of consumption of unhealthy food in period t , and z_t is consumption of the numeraire. Also, assume he experiences future disutility from consuming the unhealthy food, i.e., negative health effects from consuming too many calories. Let x_t^{**} , represent the utility maximizing level of the tempting good if he had no present bias, i.e. $\beta = 1$. Assume his immediate utility at time t is

$$U_t = \rho \ln x_t - \beta \gamma \ln x_{t-1} + z_t \quad (2)$$

where $\gamma \ln x_{A,t-1}$ is the negative externality (health effect) he imposes on himself from the tempting good, and $\beta < 1$ represents the present-bias.¹ Finally, assume that the agent faces the following budget constraint $M = x_{A,t} + z_t$ at time t , in which M is the person's endowment of the numeraire in each period. Subject to the budget constraint, he chooses the amount of the harmful tempting good, x_t , and the amount of the numeraire, z_t , in period t that maximizes

$$U_t^* = \rho \ln x_t - \beta \gamma \ln x_t + z_t \quad (3)$$

$$= (\rho - \beta \gamma) \ln x_t + z_t \quad (4)$$

Utility maximizing yields the following demand functions:

$$x_t^* = \rho - \beta \gamma \quad (5)$$

$$z_t^* = M - x_t^* = M - [\rho - \beta \gamma]. \quad (6)$$

Note that if $0 < \beta < 1$, i.e. the agent has self-control problems, he/she will consume more of unhealthy food, compared to if $\beta = 1$ (i.e. the agent has no self-control problems). We could also include the discount factor in the utility function. Since the discount factor is smaller the higher the discount rate, utility maximization yields a demand function that indicates consumption of unhealthy food is higher for people with high discount rates and smaller for people with low discount rates. The same argumentation will follow for healthy food consumption, but with opposite signs. Finally, a slightly more involved model, would include the health stock (BMI) in the utility function, instead of the negative externality only one period forward. I.e: we could make the more plausible assumption that unhealthy eating today negatively impacts a stock of health, instead of as above making the simplifying assumption that the negative impact only goes one period forward. Treating health as a “capital stock” means we can show that people with self-

¹ Following O'Donogue and Rabin (2003), assume the negative impact from unhealthy consumption goes one period forward.

control problems and high discount rates invest less in future health (i.e. have a higher BMI) than people with no self-control problems and low discount rates.

Data and empirical method

In our study, we aim at distinguishing between people with high and low discount rates, and people with and without self-control problems. A person with a high discount rate: attaches a low weight to future health, and therefore cares less about the health impact of today's unhealthy eating whereas a person with a low discount rate does the opposite. People with self-control problems fails to attach the weight he/she would like to attach to future health, and therefore over consumes unhealthy food (relative to his/her own benchmark) whereas people with no self-control problems manages to attach the appropriate weight to future health, and consumes at a long-term utility maximizing level. This implies that they have an element of regret of their behavior.

Our data is from a Danish panel of approximately 2,000 households reporting all purchases of food and other staples on a daily basis during 2007 and 2008 (the panel is maintained by GfK ConsumerTracking Scandinavia, hereafter abbreviated GfK). GfK make an effort to keep the panel representative concerning localisation of the household, age, education and family size. For every purchased good, price and quantity are recorded. A substantial amount of socio-demographics for these households are collected every year, and in 2007 and 2008 an additional large questionnaire was completed by the main shoppers of the households. In this questionnaire the households responded to questions about their knowledge of and attitudes towards healthy foods, healthy behaviour and food in general. Our sample included only households which have answered all relevant questions in the additional questionnaires in 2007 and 2008, leaving us with a total of 1,410 households.

We will use Latent Class Analysis in SAS 9.3 to identify patterns in the answers to these questionnaires and thereby identify which groups of people are to be found. The full questions from the questionnaire that are used in the LCA are shown in appendix 1. Three questions concerning the value that consumers attach to positive health behaviour are used to identify consumers with high versus low discount rates. These questions are: It is important for me to exercise, it is important for me that my food is healthy and finally if they state to be smokers or non-smokers.

To identify self-control problems we use a series of questions that concerns how satisfied the respondents are with their current behavior. The first battery of questions concerns to what extent the respondents want to change their general eating patterns and also their level of consumption of added sugar, total amount of food and fat. The next questions concern their level of planning and how satisfied they are with their level of planning. Finally we use questions on if they want to exercises more than they do now, if they are satisfied with their current weight and if they, given they are smokers, want to quit.

Results

The different goodness of fit measures from the LCA with different numbers of classes are shown in table 1 below.

Table 1: Goodness of fit measures

	2 classes	3 classes	4 classes	5 classes
Log-likelihood:	-15642.7	-15437.9	-15301.4	-15235.5
G-squared:	11140.21	10730.47	10457.53	10325.75
AIC:	11254.21	10902.47	10687.53	10613.75
BIC:	11553.53	11354.09	11291.43	11369.95
CAIC:	11610.53	11440.09	11406.43	11513.95
Adjusted BIC	11372.46	11080.9	10926.12	10912.51
Entropy:	0.65	0.74	0.77	0.76

The results from estimations with different numbers of classes show, using the BIC, CAIC and entropy measure that a model with 4 classes fits the data best, using AIC and Adjusted BIC that a model with 5 classes fit best. Due to that the decrease in AIC and adjusted BIC are minor when we go from a model with 4 to 5 classes (for a graphic representation of these measures see appendix 2) we find the model with 4 classes better in fit.

Based on the results from an estimation with 4 classes, we identify that 12.84% of the panel have a high discount rate and self control problems, whereas 34,37% of the panel have a low discount rate and self control problems, implying that approximately half of the panel have self-control problems in relation to food consumption. (Please find the exact estimation results in appendix 3)

Table 2 below shows an interpretation of the item response probabilities for the four groups. The first 3 questions that are used to identify households with high and low discount rates show that group 1 and 3 to a much larger degree than the two other groups agree to that it is important to them to exercise and to eat healthy, which we interpret as giving a high weight to future health. These two groups also include a larger share of non-smokers than the two other groups. Hence we identify groups 1 and 3 as having low discount rates and 2 and 4 as having high discount rates.

The following questions, that are used to identify groups with self-control problems versus groups with no self-control problems show that groups 1 and 2 are most likely to have self-control problems. The first battery of questions concerning to what extent the respondents want to change their eating patterns show that groups 1 and 2 to a much larger extent, think that they ought to eat less added sugar, less fat and less food in total and to a much larger degree agree to that they would like to eat healthier. The next questions concerns their level of planning, and group 1 and 2 are to a much larger extent dissatisfied with the level of planning and want to plan more than they do now. Furthermore they want to exercises more and are less satisfied with their weight. For the high discounters group 2 has a much larger share of smokers that want to quit.

Interesting enough, the high discounters agree to the question that they cannot pull them self together to exercises whereas the low discounters disagree to the question.

Table 2: Distribution of the panel in households with high versus low discount rates, self-control versus self-control problems and interpretation of Item response probabilities

	Group 1	Group 2	Group 3	Group 4
	Self control problems		No self control problems	
	Low discount rate	High discount rate	Low discount rate	High discount rate
Share of population	34.37%	12.84%	23.25%	29.55%
Questions used to identify respondents with high versus low discount rates				
It is important for me to exercise	Agree (96.9%) Disagree(0.5%)	Agree (43.5%) Disagree (21.7%)	Agree (88.0%) Disagree (4.0%)	Agree (1.8%) Disagree (35.2%)
It is important for me that my food is healthy	Agree (90.2%) Disagree (3.07%)	Agree (82,7%) Disagree (4.69%)	Agree (89.2%) Disagree (2.28%)	Agree (58.6%) Disagree (5.74%)
Smoking	Non-smoker (87.2%)	Non-smoker (79.1%)	Non-smoker (80.2%)	Non-smoker (61.2%)
Questions used to identify self control problems versus no self control problems				
To eat healthier I ought to eat	A lot less (27.9%, 10.0%, 27.9%)	A lot less (26.9%,7.6%,24.5%)	A lot less (3.2%,0.1%,6.4%)	A lot less (8.8%,3.3%,11.8%)
A lot, a little or as I do now of... ...added sugar ... amount of food, ... fat	As I do now (23.8%, 23.6%, 28.7%)	As I do now (18.2%, 44.4%, 25.3%)	As I do now (63.5%, 95.5%, 72.8%)	As I do now (67.3%, 80.2%,71.2%)
I would like to eat healthier	Agree (80.6%) Disagree (6.3%)	Agree (91.4%) Disagree (2.1%)	Agree (45.5%) Disagree (13.0%)	Agree (44.9%) Disagree (15.8%)
Do you want to plan more	50.7% dissatisfied with level of planning	61.2% dissatisfied with level of planning	29.2% dissatisfied with level of planning	34.6 % dissatisfied with level of planning
I want to exercises more	Agree (66.3%) Disagree(14.2)	Agree (86.3%) Disagree (5.5%)	Agree (48.4%) Disagree (21.2%)	Agree (27.6%) Disagree (19.4%)
I cannot pull myself together to exercise	Agree (0.6%) Disagree(91.9)	Agree (72.5%) Disagree (4.8%)	Agree (11.1%) Disagree (76.5%)	Agree (48.3%) Disagree (0%)
Do you want to quit smoking if you are a smoker	Share that want to quit 45.4%	Share that want to quit 72.7%	Share that want to quit 48.5%	Share that want to quit 33.1%
I am satiesfied with my weight	Share satisfied 11.6%	Share satisfied 9.93%	Share satisfied 59.2%	Share satisfied 54.5%

Finally, to identify the health behavior of the 4 groups we have calculated the share of obese and overweight in the four groups respectively, as shown in figure 1. The figure clearly shows that self-control problems are a much clearer predictor of obesity and overweight than is the size of the discount rate. Given the level of discount-rates, consumers with self-control problems have a higher share of both obese and overweight than consumers without self-control problems, even though, given the level of self-control, high discounters also seem to have more obese than low discounters, especially for consumers without self-control problems.

Figure 1: Share of obese and overweight in each of the 4 groups

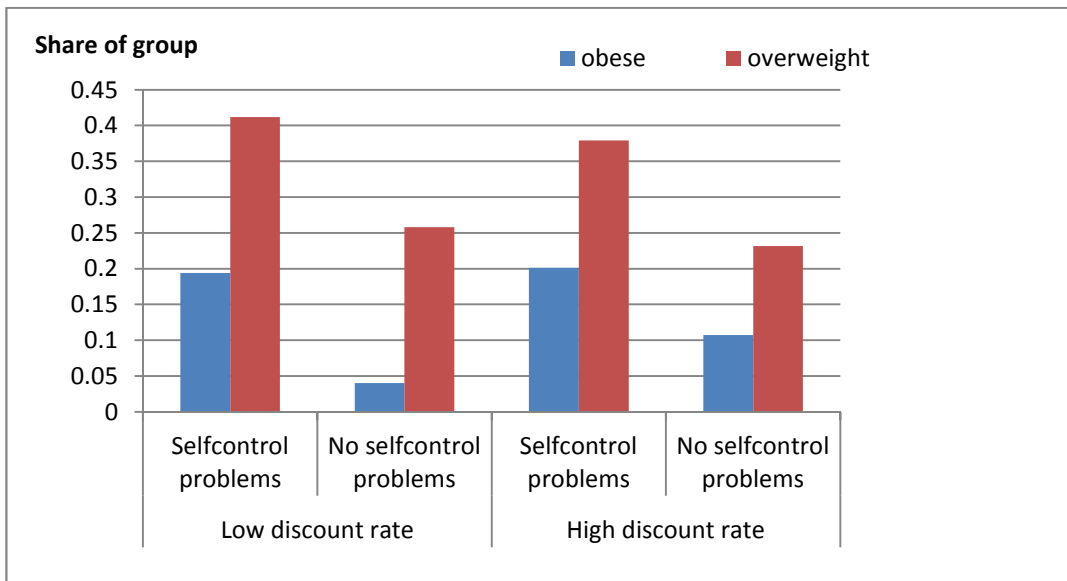


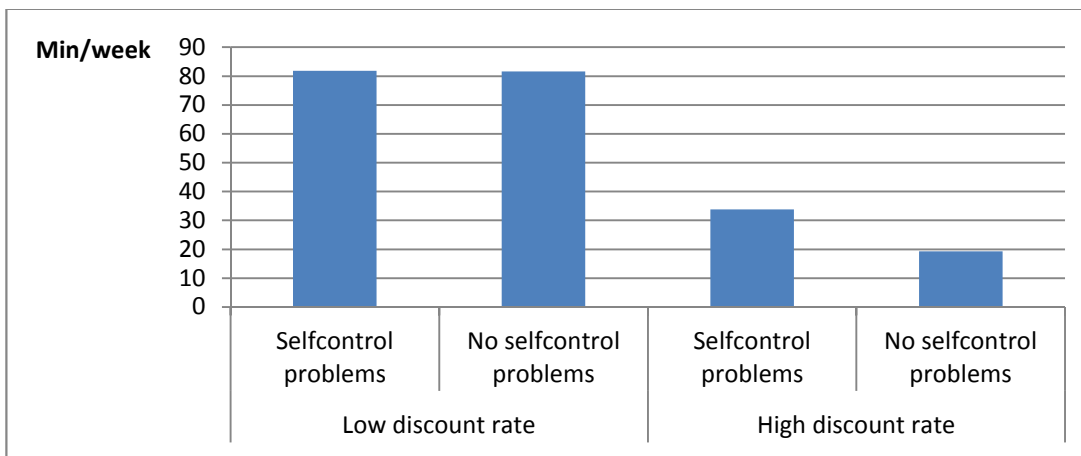
Table 3 shows the consumption of various types of food. A clear tendency is that households with low discount rate have a higher consumption of healthy foods as vegetables and fruits and a lower consumption of unhealthy foods as chips and soft drinks. Self-control problems lead to higher consumption of unhealthy foods and for the high discounters also to a smaller consumption of healthy foods as fruits and vegetables.

Table 3: Consumption of different types of food for the 4 groups

Discount rate	Selfcontrol problem	Consumption			
		Chips g/week	Soft drinks ml/week	Vegetables g/week	Fruit g/week
Low	Yes	195	351	2233	36
	No	188	317	2177	36
High	Yes	208	379	1990	32
	No	182	329	2050	34

As shown in figure 2, the discount rate seems to be the determinant of the level of hard exercises. As a comparison there are no significant differences in the number of minutes of moderate exercise among the 4 groups.

Figure 2: Average minutes of sports per week in each group



Conclusion

Based on a LCA analysis, four different groups of Danish consumers are identified, distinguishing between consumers with high versus low discount rate, self-control problems versus no self-control problems. We find that almost half of our Danish sample have self-control problems. Post calculations of food consumption also typically show the expected impact of self-control problems and time discounting on food consumption and exercising. More specifically, self-control problems seem to imply a higher consumption of unhealthy foods such as chips and soft drinks. We also find that consumption of healthy foods is generally higher in households with low discount rates, compared to those with high discount rates, and they exercise more. In sum, our empirical analysis of the relationship between the variables unhealthy food consumption and investment in health (e.g. exercising) and the variables self-control problems and time discounting seem to support the relationship predicted by theoretical studies on time discounting and unhealthy consumption.

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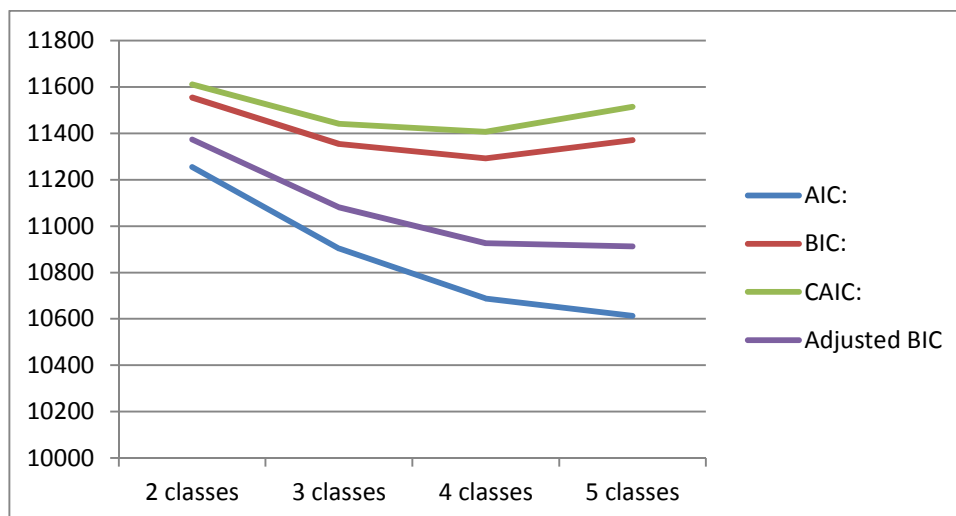
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Appendix 1: Variables used in LCA and coding

Variables to identify discount rates	It is important for me to exercise (<i>exercise_imp</i>)	Totally disagree	Disagree	Neither nor	Agree	Totally agree
	It is important for me that my food is healthy (<i>healthy_food</i>)	Totally disagree	Disagree	Neither nor	Agree	Totally agree
	CODING IN LCA	1=Disagree		2=Neither nor	3 = Agree	
	Do you smoke (<i>smoke_quit</i>) This variable is used in combination with variable that are used to identify satisfied smokers	Never smoked	Have smoked earlier ,but not any more	Party smoker	Smoker	
Variables identify self-control problems	In order to eat healthier I ought to eat ...					
	...sugar (<i>ought_sugar</i>)	a lot less	A bit less	As now	A bit more	A lot more
	...total amount of food (<i>ought_food</i>)	a lot less	A bit less	As now	A bit more	A lot more
	...fat (<i>ought_fat</i>)	a lot less	A bit less	As now	A bit more	A lot more
	CODING IN LCA	1 = a lot less	2 = a bit less	3= as now or more		
	I would like to eat healthier (<i>eat_healthier</i>)	Totally disagree	Disagree	Neither/nor	Agree	Totally agree
	I would like to exercise more (<i>exercise_want</i>)	Totally disagree	Disagree	Neither/nor	Agree	Totally agree
	I cannot pull myself together to exercises (<i>exercise_pull</i>)	Totally disagree	Disagree	Neither/nor	Agree	Totally agree
	CODING IN LCA	1= disagree		2=neither/nor	3= agree	
	Do you consider to quit smoking (<i>smoke_quit</i>)	Yes		no	Have quit	
	CODING IN LCA	1 = not smoking		2 = smoking, do not consider to quit	3=smoking consider to quit	
	Would you like to weigh more or less (<i>weight</i>)	No, I am satisfied with my weight		Kg less	Kg more	
	CODING IN LCA	1 = satisfied with weight		2 = unsatisfied with weight		
	How often do you...					
	... plan shopping for more than one day	Almost never	seldom	sometimes	often	Almost always
	...change plans because there is something more tempting in the shop	Almost never	seldom	sometimes	often	Almost always
	I would like to plan shopping better than I do now	Not at all		To a small extent	To a very large extend	
CODING IN LCA (<i>Change plan</i>)	1 = never planning	2= sometimes planning	3 = always planning, never change plans	4 = always planning, sometimes change plans	5 = always planning, always change plans	
CODING IN LCA (<i>Plan better</i>) Satisfied (saties) = do not at all or to a small extent want to plan better Dissatisfied (dissaties)= to some or to a very large extend want to plan better	never planning, 1 = Saties		Sometimes planning 2= Dissaties 3 = Saties	4 = Dissaties	5 = Saties	6 = Dissaties

Appendix 2: Graphical illustration of goodness of fit measures from LCA



Appendix 3: Estimation results from LCA

Data Summary, Model Information, and Fit Statistics (EM Algorithm)

Number of subjects in dataset: 1410
 Number of subjects in analysis: 1410
 Number of measurement items: 12
 Response categories per item: 3 3 3 6 5 3 3 3 3 3 2 3
 Number of groups in the data: 1
 Number of latent classes: 4
 Rho starting values were randomly generated (seed = 40000000).

No parameter restrictions were specified (freely estimated).

Seed selected for best fitted model: 2121215370
 Percentage of seeds associated with best fitted model: 98.00%

The model converged in 563 iterations.
 Convergence method: maximum absolute deviation (MAD)
 Convergence criterion: 0.000001000

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 Fit statistics:
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Log-likelihood: -15301.40
 G-squared: 10457.53
 AIC: 10687.53
 BIC: 11291.43
 CAIC: 11406.43
 Adjusted BIC: 10926.12
 Entropy: 0.77
 Degrees of freedom: 1180864

Test for MCAR

Log-likelihood: -10072.63
 G-squared: 229.50
 Degrees of freedom: 918537

Item response probabilities: Rho estimates (standard errors)

Response category 1:

Class:	1	2	3	4
exercise_imp:	0.0049 (0.0072)	0.2170 (0.0245)	0.0399 (0.0109)	0.3522 (0.0587)
exercise_wan:	0.1418 (0.0231)	0.0551 (0.0140)	0.2118 (0.0219)	0.1937 (0.0388)
exercise_pul:	0.9188 (0.0501)	0.0484 (0.0254)	0.7647 (0.0454)	0.0000 (0.0000)
plan_better :	0.0302 (0.0142)	0.0814 (0.0153)	0.0944 (0.0175)	0.1462 (0.0333)
change_plan1:	0.1041 (0.0203)	0.1554 (0.0207)	0.0912 (0.0161)	0.2042 (0.0346)
ought_sugar :	0.2617 (0.0310)	0.2687 (0.0246)	0.0317 (0.0139)	0.0878 (0.0280)
ought_food :	0.0997 (0.0196)	0.0764 (0.0145)	0.0012 (0.0069)	0.0326 (0.0194)
ought_fat :	0.2791 (0.0311)	0.2446 (0.0239)	0.0643 (0.0157)	0.1182 (0.0305)
eat_healthie:	0.0631 (0.0157)	0.0210 (0.0093)	0.1302 (0.0170)	0.1575 (0.0306)
healthy_food:	0.0307 (0.0108)	0.0469 (0.0113)	0.0228 (0.0076)	0.0574 (0.0197)
weight :	0.1160 (0.0295)	0.0993 (0.0194)	0.5922 (0.0308)	0.5453 (0.0481)
smoke_stop :	0.8719 (0.0220)	0.7914 (0.0224)	0.8022 (0.0224)	0.6115 (0.0415)

Response category 2:

Class:	1	2	3	4
exercise_imp:	0.0263 (0.0156)	0.3480 (0.0281)	0.0795 (0.0163)	0.6297 (0.0722)
exercise_wan:	0.1956 (0.0257)	0.0822 (0.0180)	0.3042 (0.0246)	0.5303 (0.0459)
exercise_pul:	0.0750 (0.0316)	0.2269 (0.0283)	0.1242 (0.0281)	0.5167 (0.0450)
plan_better :	0.1040 (0.0197)	0.1478 (0.0194)	0.0539 (0.0117)	0.0952 (0.0259)
change_plan1:	0.1493 (0.0228)	0.2352 (0.0233)	0.1878 (0.0204)	0.1718 (0.0355)
ought_sugar :	0.5000 (0.0331)	0.5496 (0.0278)	0.3338 (0.0274)	0.2393 (0.0385)
ought_food :	0.6647 (0.0488)	0.4800 (0.0291)	0.0438 (0.0269)	0.1650 (0.0326)
ought_fat :	0.4342 (0.0321)	0.5027 (0.0279)	0.2073 (0.0239)	0.1699 (0.0364)
eat_healthie:	0.1306 (0.0274)	0.0647 (0.0179)	0.4148 (0.0267)	0.3938 (0.0427)
healthy_food:	0.0667 (0.0163)	0.1259 (0.0188)	0.0849 (0.0161)	0.3569 (0.0420)
weight :	0.8840 (0.0295)	0.9007 (0.0194)	0.4078 (0.0308)	0.4547 (0.0481)
smoke_stop :	0.0699 (0.0160)	0.0570 (0.0134)	0.1018 (0.0153)	0.2600 (0.0369)

Response category 3:

Class:	1	2	3	4
exercise_imp:	0.9688 (0.0183)	0.4351 (0.0341)	0.8806 (0.0196)	0.0180 (0.1010)
exercise_wan:	0.6627 (0.0320)	0.8626 (0.0228)	0.4840 (0.0265)	0.2761 (0.0519)
exercise_pul:	0.0062 (0.0325)	0.7247 (0.0368)	0.1111 (0.0251)	0.4833 (0.0450)
plan_better :	0.0667 (0.0156)	0.0508 (0.0122)	0.1182 (0.0167)	0.0371 (0.0189)
change_plan1:	0.2937 (0.0298)	0.2535 (0.0240)	0.3562 (0.0245)	0.2514 (0.0377)
ought_sugar :	0.2383 (0.0310)	0.1817 (0.0243)	0.6345 (0.0322)	0.6728 (0.0450)
ought_food :	0.2356 (0.0535)	0.4436 (0.0297)	0.9550 (0.0304)	0.8024 (0.0367)
ought_fat :	0.2867 (0.0338)	0.2527 (0.0260)	0.7284 (0.0292)	0.7118 (0.0454)
eat_healthie:	0.8063 (0.0307)	0.9143 (0.0201)	0.4550 (0.0288)	0.4486 (0.0459)
healthy_food:	0.9026 (0.0192)	0.8273 (0.0212)	0.8923 (0.0175)	0.5857 (0.0454)
smoke_stop :	0.0582 (0.0165)	0.1516 (0.0197)	0.0960 (0.0164)	0.1285 (0.0306)

Response category 4:

Class:	1	2	3	4
plan_better :	0.0776 (0.0176)	0.1336 (0.0184)	0.0488 (0.0120)	0.0787 (0.0230)
change_plan1:	0.2467 (0.0274)	0.2475 (0.0234)	0.2107 (0.0213)	0.1982 (0.0350)

Response category 5:

Class:	1	2	3	4
plan_better :	0.3960 (0.0329)	0.2565 (0.0267)	0.4957 (0.0259)	0.4704 (0.0428)
change_plan1:	0.2062 (0.0255)	0.1084 (0.0184)	0.1541 (0.0185)	0.1743 (0.0323)

Response category 6:

Class:	1	2	3	4
plan_better :	0.3254 (0.0309)	0.3300 (0.0259)	0.1891 (0.0217)	0.1723 (0.0336)