Discount rates for temporal food consumption and the relevance of childhood socioeconomic status

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Introduction

A recent psychology experiment found that childhood socioeconomic status could have a lasting impact on food intake regulation in adulthood (Hill et al., 2016). A mapping of those findings into an economic space suggests that variations in childhood socioeconomic status (SES) might lead to variations in people's discount rates for intertemporal allocation of food as adults. During a childhood of scarcity, it might make sense to eat as much as possible when food is available given that the next meal might be uncertain. However, if this decision-making framework persists in times of plenty, it could potentially create suboptimal consumption behaviors especially in calorie-rich environments. If evidence is found to support this hypothesis, it would mean that childhood SES can generate a profound impact on people's future decisions.

The primary research question is to what extent people exhibit temporal discounting and present bias in the realm of food consumption. While there is much contemporary debate about the true underlying nature of observed hyperbolic or quasi-hyperbolic preferences, illustrations of the theory commonly refer to food consumption behaviors (i.e. eating the whole bag of potato chips) as prime examples. It is somewhat surprising then, that while many studies have examined discounting behavior with regards to money or hypothetical rewards, ours is among the first to apply experimental techniques towards temporal decisions regarding food allocation.

Given the intuition that quasi-hyperbolic discounting behavior might be more likely to be associated with goods like food than with money (Andersen et al. 2014), we had expected to find strong evidence of present bias for consumption of popcorn over time due to the visceral, sensory-inducing nature of food. However, results show no evidence of present bias in the full aggregate sample nor in aggregate samples of participants based on childhood SES. We do find differences in the discount factor.

Literature

Frederick et al. (2002) provided a comprehensive review of time discounting. An especially relevant point they make is that at the time, it was standard to assume linear utility in the magnitude of choice objects. This assumption would bias estimates of time preference upward if in fact the utility was concave (Frederick et al. 2002). Subsequent progress in research led to the development of joint-estimation strategies for time and risk parameters that allowed for testing of the utility curvature rather than relying on a linear assumption (e.g. Andersen et al. 2008). Andreoni and Spregner (2012) also contributed an innovation by designing a survey instrument that allows participants to make convex choices rather than the standard dichotomous corner solutions of choices between smaller sooner and larger later payouts (Andreoni and Spregner 2012).

Theory

Participants make several allocation decisions. In the CTB framework, subject choose a set of two allocations, c_t and c_{c+k} from a convex budget set under varying circumstances of interest rates (r), allocation weeks (t), and delay lengths between weeks (k). The budget set is,

$$(1+r)c_t + c_{t+k} = m$$

and utility is specified with constant relative risk aversion:

$$U(c) = \frac{c^{1-\theta}}{1-\theta} = \frac{c^{\alpha}}{\alpha}$$

where $\theta = 1 - \alpha$ is the coefficient of relative risk aversion.

Thus, we can express the utility using a time-separable, stationary, quasi-hyperbolic framework:

$$U(c_t, c_{t+k}) = \frac{1}{\alpha}(c_t)^{\alpha} + \beta^{p}\delta^{k}\frac{1}{\alpha}(c_{t+k})^{\alpha}$$

where α captures the utility function curvature, β is a measure of present bias with p=1 serving as an indicator if the sooner allocation day is in the present and p=0 indicating the sooner allocation day is in the future at which point the equation is the standard hyperbolic form. δ is the discount factor.

Methods

To examine temporal discounting and present bias in food consumption choices, we conducted an experiment over 4 weeks using a primary food reward (popcorn). Subjects were asked to allocate two distributions of popcorn using a set of 24 Convex Time Budgets (CTB) over three two-week intervals. We adapt the CTB procedures used in Andreoni, Kuhn, and Spregner (2014).

Subjects were informed that one of the 24 choices will be drawn at random and would be the actual popcorn allocations they received during the study. After subjects completed the CTB choice sets in week 1, they next completed a questionnaire inquiring about their current hunger level and popcorn preferences. While subjects filled out the questionnaire, we used a randomly generated number to pick the binding choice for each participant, and distributed popcorn to subjects eligible to receive popcorn in week 1. We returned for the next three weeks on the same day and time. During weeks 2 and 3 only popcorn was distributed. In week 4, we administered three other survey instruments in addition to distributing popcorn. The additional surveys included a demographic questionnaire, the Yale Food Addiction survey, and a subjective perception test. If all elements of the experiment were completed satisfactorily, subjects received a compensation of $20 for their time during the 4th week of the study.

To measure childhood SES we utilized the same procedure as in Hill et al. 2016. Participants used a scale of 1 to 7 to answer how much they agree (7) or disagree (1) with three questions.

1) My family had enough money for things growing up.

2) I grew up in a relatively wealthy neighborhood.

3) I felt relatively wealthy compared to others my age.

Each participant's responses for the three questions were average to generate a composite measure. The full sample was then divided into two subsamples, "higher SES" for composites of 5-7 and "lower SES" for 1-4.

Also in the demographic survey, to we asked participants to indicate "*Which best describes how you decided to answer the questions three weeks ago about the quantities of popcorn."* We supplied the choices *Pick the largest quantity, Pick the soonest quantity, Random, Pick to make the distributions about equal,* and *Other* with a blank for the participants to fill in any reason they wanted.

Estimation

Similarly to the estimation method used by Cheung (2015), given the allocation actually chosen by the subject in each task, we can express the multinomial logit probability of the observed choice as

$$Pr(U^*) = \frac{\exp(U^*)}{\exp(U_1) + \exp(U_2) + \exp(U_3) + \exp(U_4) + \exp(U_5)}$$

and we are able to estimate α, β, and δ using maximum likelihood to maximized the probability of observed choices. The model was estimated in R using the maxlik package using BFGS.

Results

Participant decision behavior is graphed in Figures 1-4. Figure 1 shows the aggregate behavior for all participants. The variation in interest rates of the choice sets is shown on the x-axis, and the mean number of later cups of popcorn chosen is on the y-axis. Figure 1 shows very little variation with the mean around two cups for all interest rates. Theory suggests that we should see the trend of increasing

mean popcorn allocations to the later date as the interest rate rises, hover this figure suggests that our participants do not display the expected discounting behavior.

Figure 2 shows the aggregate behavior for respondents who self-reported the decision-making heuristic representing consumption smoothing (pick to make the distributions about equal). Similarly as in Figure 1, this group shows a mean of 2 cups for all interest rates, though in this case this behavior is less surprising given that the middle choice for all decisions had an allocation of two cups for the later distribution date. It appears that this group did indeed prioritize equality in the two distributions.

Figure 3 shows the aggregate behavior for respondents who self-reported the decision-making heuristic of picking the largest quantity of popcorn. It is clear from the figure that this group also did generally behave as their heuristic suggests with consistently high means for the later popcorn distribution. The first interest rate graphed is 0 (gross rate of 1), so for these choices, participants were able to get the largest quantity of popcorn (4 cups) on the sooner date which explains the relatively lower means for the later allocation (between 2.5 and 3) shown on the graph.

Figure 4 shows the mean responses for later popcorn allocation for the group of participants who admitted that they made random choices. Accordingly, this graph does seem to reflect random choices. We have not reported a graph regarding the decision heuristic “pick the soonest quantity” because no participants indicated it as their decision-making framework.

Results from the multinomial logit maximum likelihood regressions for the full sample and for the two subsamples divided by childhood SES are reported in Table 1. All estimates are significant above the 99.99% level. Utility curvature (alpha) is found to be convex (alpha<1) for all groups. Present bias (beta) is not found for any groups in aggregate (beta ~ 1). The discount factor (delta) does show variation between the two SES groups with delta=0.891 for the full sample, 0.686 for the group with lower childhood SES and 1.007 for the group with higher childhood SES.

Discussion

Experiments with real non-monetary rewards present an additional set of logistical challenges for researchers. Given the lack of expected present bias in the results, we have examined the experimental procedures in depth and determined several procedural improvements that will be implemented in future experiments to provide more clarity into this behavior. It is possible that the participants were somewhat confused by the CTB format, however this seems likely to be the case only for the group who reporting choosing randomly. The consumption smoothing group and the largest quantity group both chose allocations in line with their stated heuristics suggesting that they did understand the protocol.

Most CTB experiments utilize allocations of 100 “tokens” between sooner and later dates with varying “token exchange rates” that represent the different experimental interest rates. This allows researchers more freedom in choosing interest rates to measure. By using an actual good, we are bound to only vary the interest rates in ways that result in meaningful differences in the quantity of the good and also by a potential saturation limit of the good (e.g. 20 cups of popcorn would be infeasible in the experimental setting). Choices of real goods, however, do more accurately reflect the real world situations that people face than hypothetical situations or choices between money payments (very few people actually win lotteries). Therefore, we hope to spur discussion and more research into experimental procedures for measuring temporal discounting of real consumption goods.

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Figure 1:

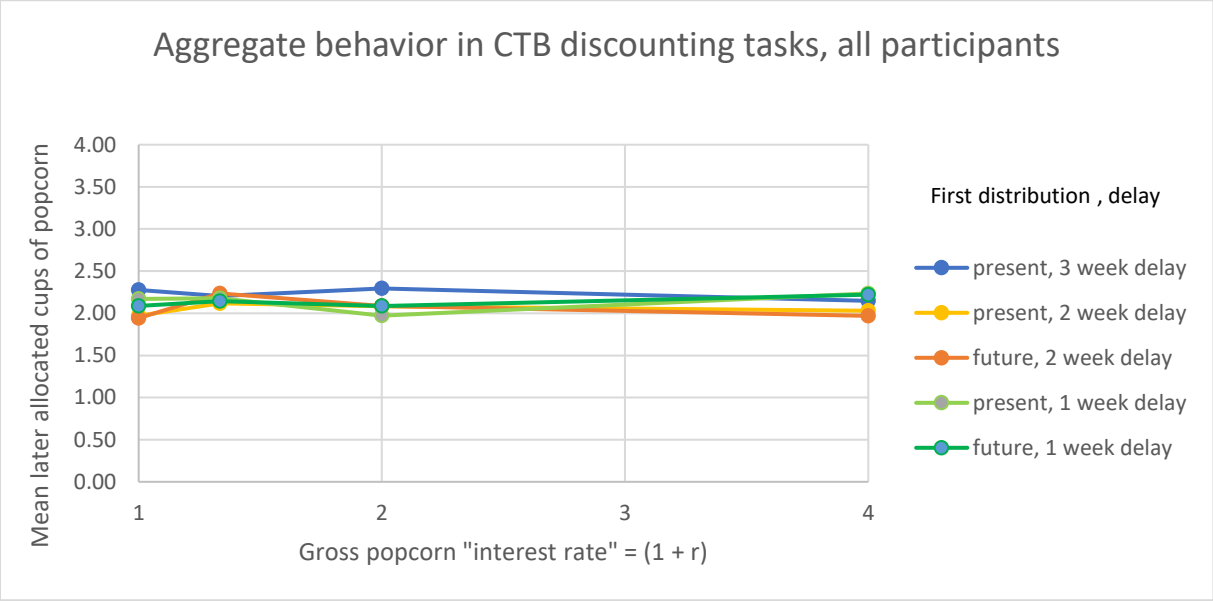

Figure 2:

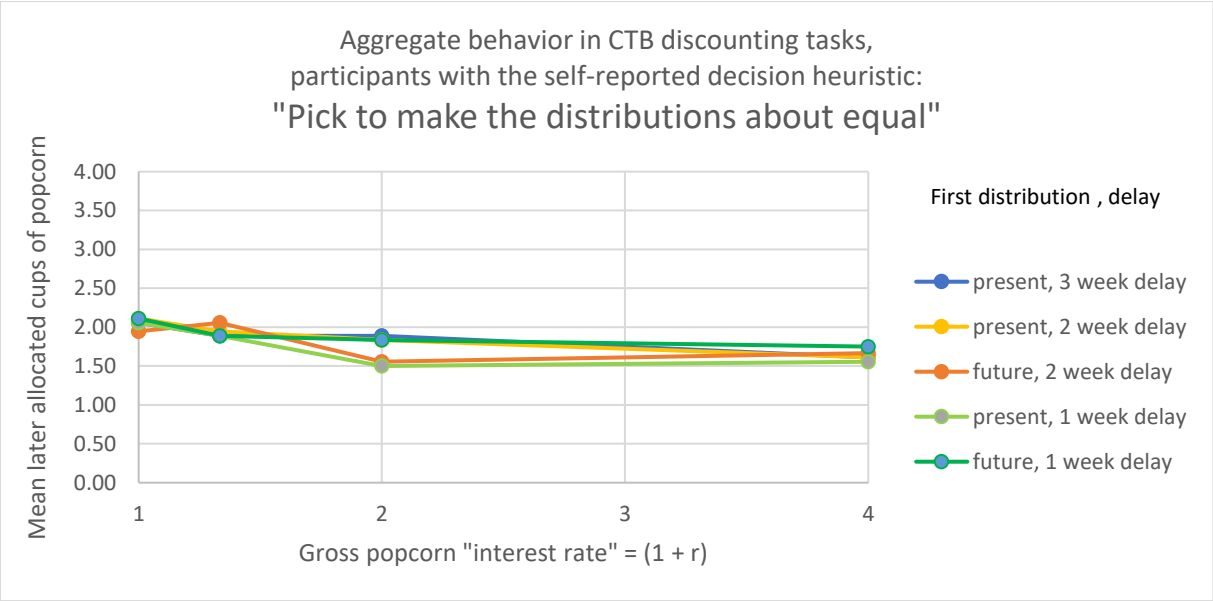

Figure 3:

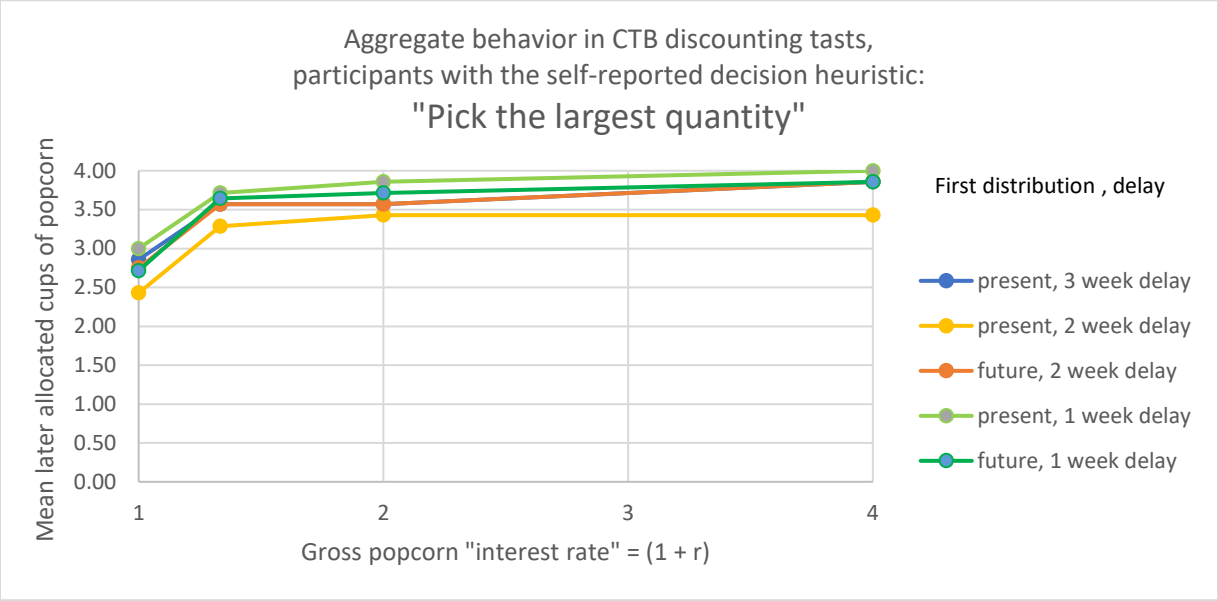

Figure 4:

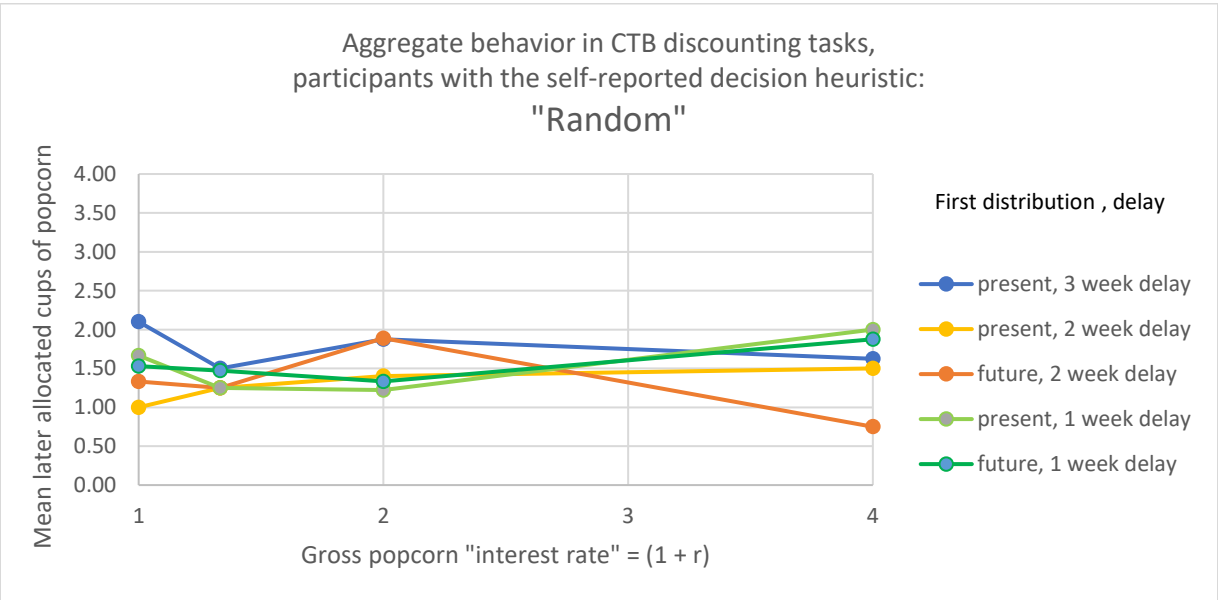

Table 1: Estimates of time preference parameters: utility curvature (alpha), present bias (beta), and annual discount factor (delta), via multinomial logit, maximum likelihood.

	Full Sample		Lower SES		Higher SES	
	Estimate	SE	Estimate	SE	Estimate	SE
Alpha	0.660***	0.024	0.759***	0.052	0.602***	0.026
Beta	1.013***	0.084	1.104***	0.181	0.960***	0.096
Delta	0.891***	0.030	0.686***	0.055	1.007***	0.040

Significance codes: 0 '***' 0.001 '**' 0.01 '*'