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How perceptions of temporal distance influence satiation ☆

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HIGHLIGHTS

- Subjective time perception from last consumption episode influences satiation.
- When a consumption episode is made to feel recent consumption decreases.
- When a consumption episode is made to feel distant consumption increases.
- Curbing consumption in the field is accomplished through a simple intervention.

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ABSTRACT

Although people recover from satiation with the natural passage of time, we examine whether it is possible to influence the recovery process merely by changing the *perceived* temporal distance from past consumption. Experiment 1, a field experiment, demonstrates that influencing the perceived temporal distance from dinner-goers' last meal affects the caloric value of the meal purchased (more recent leads to smaller food purchase). In a lab environment controlling for objective temporal distance and initial satiation, Experiment 2 demonstrates that these changes in perceived temporal distance also affect the actual enjoyment of an experience (listening to a favored song). Beyond these reconstructed temporal judgments, Experiment 3 directly manipulates the perceived length of the intervening period since last consumption using an altered time clock, and replicates these effects on satiation. Our findings illustrate that simple manipulations of subjective time perception can influence consumption, even in the presence of very real physiological inputs, and provide further insight into how satiation is constructed.

Introduction

Satiation, the reduction of enjoyment associated with prolonged or repeated consumption of a stimulus, is ubiquitous (Coombs & Avrunin, 1977). Individuals satiate on everything from food (Rolls, Van Duijvenvoorde, & Rolls, 1984) to music (Nelson & Meyvis, 2008) to social interactions (Galak, Redden, & Kruger, 2009). Thankfully, satiation is not permanent—eventually, satiated individuals experience what is known as spontaneous recovery (McSweeney & Swindell, 1999; Thompson & Spencer, 1966). That is, over time, they become increasingly able to once again enjoy the dessert, song, or friend that they had tired of earlier.

Although it is relevant to so many experiences, little is known about the phenomenon of spontaneous recovery and the underlying mechanisms that make satiation persist. The conventional contention is that recovery from satiation occurs "spontaneously" with time as physiological need states increase (Cabanac, 1971) or previously stimulated areas of the brain start responding again (Thompson & Spencer, 1966). Past work has shown that the extent of this recovery can depend on: (1) the quantity previously consumed (McAlister & Pessemier, 1982); (2) the amount of variety consumed (Ratner, Kahn, & Kahneman, 1999; Rolls et al., 1981); and (3) the length of time between consumption episodes (Hetherington, Rolls, & Burley, 1989).

Recent work has modified this long-held view by demonstrating that satiation and recovery are not solely the consequences of consumption and time, but are also the result of psychological processes constructed in the moment. Demonstrating the malleability of the process, satiation has been shown to depend on the subjective perception of how much has been consumed (Higgs, 2002, 2008; Redden & Galak, 2013) and how much variety one has previously experienced (Galak et al., 2009). Although this extant work illustrates the constructed nature of satiation, no research has explored whether satiation can be

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affected not just through the natural passage of time, but also through the mere *perception* of time's passage.

Across one field and two lab experiments we demonstrate that altering subjective temporal distance from past consumption causes individuals to feel more or less satiated in the present. Our work has several important theoretical and practical implications. First, we add to the evidence that satiation and recovery are psychologically constructed rather than merely physiologically derived, and provide further insight into this process. Second, we show that independent of the objective passage of time, the subjective passage of time from a consumption episode influences satiation and recovery. This result is robust to manipulations that influence both how temporal judgments are reconstructed (Experiments 1 & 2) and how time is experienced (Experiment 3). Finally, from a practical perspective, we demonstrate how a relatively simple manipulation of subjective temporal distance can materially influence the amount of food purchased (Experiment 1), the actual enjoyment of an experience (Experiments 2 and 3), and the time spent on an activity (Experiment 3).

Experiment 1

Experiment 1 tested whether satiation and recovery depend on the subjective temporal distance from the most recent consumption of food. We predicted that by changing dinner goers' subjective sense of when they last ate we would also change the amount of food they would consequently choose to purchase and eat. Given previous work illustrating a strong link between serving size and actual consumption (Geier, Rozin, & Doros, 2006; Siegel, 1957; Wansink & Kim, 2005), we used the amount of food purchased as an indication of desired consumption and feelings of satiation.

Method

Participants and design

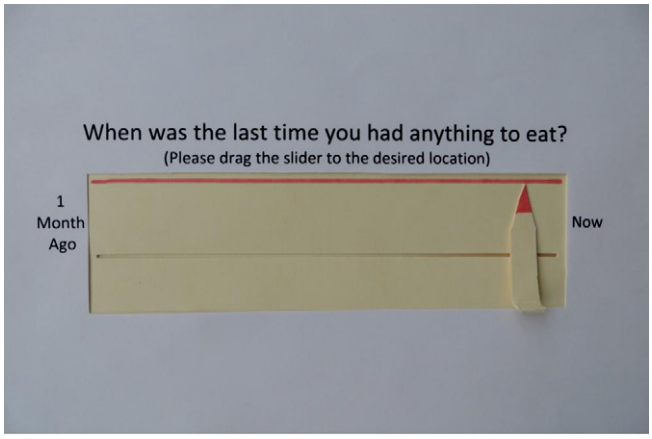
One hundred and seventy-nine (117 female, $M_{Age} = 32.94$, $SD_{Age} = 14.69$) individual dinner-going customers of a Panera Bread restaurant in an urban environment were recruited to participate in a short survey about food in exchange for $1. This study employed a one-factor between-subjects design.

Procedure

Participants were randomly assigned to one of three conditions. Participants in either the *Distant* or the *Near* conditions were asked to indicate when they last had anything to eat on a custom built response scale that consisted of a physical knob that could be moved 19 cm from right to left (Fig. 1). The knob started on the right side of the scale and participants were asked to move it to the left to reflect their answer to the scale question. To manipulate the subjective temporal distance from when participants last ate, we adapted the procedure from work in autobiographical memory for significant events (Wilson & Ross, 2003) where scale anchors differed by condition. For the *Distant* condition, the left side was anchored with "One Day Ago" and the right side of the scale was anchored with "Right Now." For the *Near* condition, the left side of the scale was anchored with "One Month Ago" and the right side was anchored with "Right Now." Participants in the *Distant* condition would presumably move the knob farther to the left than participants in the *Near* condition (measured in cm). Participants in the *Control* condition were presented with neither the slider scale nor its associated question.

Next, all participants filled out a survey, indicating "When does it seem like you last ate?" on a 9-point scale anchored with 1 ("Feels like it happened a while ago") and 9 ("Feels like it happened recently"), their age, and their gender. (There were no effects of age or gender on any measures, thus they are not discussed further.) Finally, after ordering their meals, participants returned their itemized receipts to the experimenter and were paid $1. All participants who elected to complete the experiment submitted their receipts.

Near Condition



Distant Condition

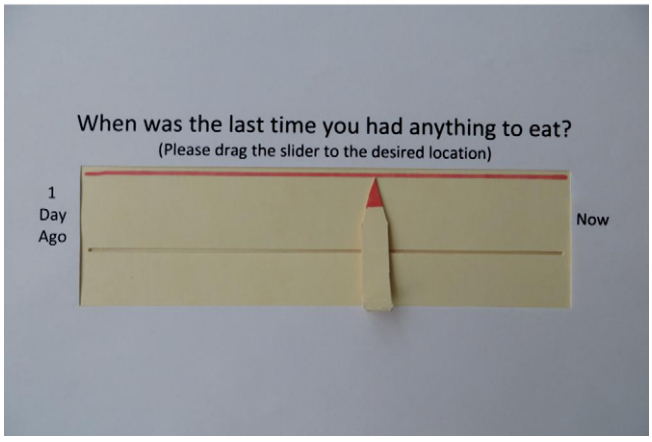


Fig. 1. Experiment 1—sample of slider scale with sample responses. Near condition. Distant condition.

Our measure of satiation and recovery is the caloric value of all items purchased. Participants presumably chose to purchase less food or items with fewer calories the more they felt satiated. The caloric content of each participant's meal was constructed using their itemized receipts and the nutritional information provided by Panera Bread (http://www.paneranutrition.com). Table 1 summarizes the results for transaction amount, caloric information, and other nutritional content.

Results and discussion

Calories purchased

We predicted that when participants felt their last meal was consumed more recently (*Near* condition) relative to the *Control* condition, they would feel less recovered from their previous meal and less willing to eat, and vice versa when made to feel as though their last meal was consumed a while ago (*Distant* condition). This prediction, however, was not entirely the case. A one-way ANOVA (temporal frame: *Control*, *Distant*, *Near*) on calories purchased revealed a marginally reliable main effect ($F(2, 176) = 2.61$, $p < .08$, $\eta_p^2 = .03$). Though participants in the *Distant* condition ($M = 815.26$ cal, $SD = 365.22$) did not eat more than those in the *Control* condition ($M = 769.09$ cal, $SD = 326.17$, $F(176) = .51$, $p = .48$, $\eta_p^2 = .003$), participants in the *Near* condition ($M = 677.65$ cal, $SD = 335.17$) did eat considerably less than those in the

Table 1
Experiment 1—Consumption information by temporal frame condition (standard deviations in parentheses).

Nutritional dimension	Near	Control	Distant
Calories	677.65_a	769.09_b	815.26_b
	(335.17)	(326.17)	(365.22)
Fat (g)	26.47_a	30.41_b	33.84_b
	(16.22)	(16.49)	(21.43)
Saturated fat (g)	8.51_a	8.61_a	11.55_b
	(5.18)	(4.57)	(7.85)
Trans fat (g)	$.21_a$	$.26_a$	$.32_a$
	(.30)	(.34)	(.42)
Cholesterol (mg)	64.00_a	68.53_a	72.22_a
	(41.25)	(48.68)	(48.09)
Sodium (mg)	1528.03_a	1788.36_{ab}	1828.10_b
	(946.21)	(729.14)	(855.83)
Carbohydrates (g)	87.61_a	100.28_a	100.08_a
	(41.21)	(43.44)	(40.24)
Fiber (g)	5.33_a	6.41_b	5.97_{ab}
	(2.85)	(2.83)	(3.00)
Sugars (g)	25.11_a	31.79_a	28.79_a
	(24.41)	(29.29)	(24.91)
Protein (g)	26.12_a	29.75_a	31.36_a
	(16.97)	(14.57)	(15.55)
Cost of meal ($)	$\$6.84_a$	$\$7.32_a$	$\$7.66_a$
	(2.59)	(2.37)	(2.45)

Note—values in rows that do not share a subscript are different from one another at the .05 level of significance.

Distant condition ($F(1, 176) = 4.98$, $p < .05$, $\eta_p^2 = .03$), and directionally less than those in the *Control* condition ($F(1, 176) = 2.14$, $p = .15$, $\eta_p^2 = .01$).

The results provide some evidence that altering subjective temporal distance affected satiation. When past consumption was made to feel nearer to the present time (*Near* condition), participants seemingly felt more satiated and had less desire to eat. However, when past consumption was framed as further from the present time (*Distant* condition), there was no effect. This result may be because food is consumed in relatively regular, temporally short intervals. Thus, it is comparatively difficult to make a previous meal feel further back in time than it actually was. Given the practical importance of finding ways to reduce consumption by making a last meal feel closer in time, we pooled the results from the *Control* and *Distant* conditions and contrasted them with the *Near* condition. Doing so, we find that participants who were made to feel as though their last meal was more recent (*Near* condition) indeed purchased substantially fewer calories than those in a pooled group that combines the *Distant* and *Control* conditions ($M_{Near} = 677.65$, $SD_{Near} = 335.17$; $M_{Pooled} = 792.79$, $SD_{Pooled} = 346.00$; $t(177) = 2.17$, $p < .05$, $d = .34$).

Subjective time perception and mediation

We have argued that our manipulation altered participants' perceptions of temporal distance from their last meal. Accordingly, we conducted a similar ANOVA on this measure and observed a reliable main effect ($F(2, 176) = 9.12$, $p < .001$, $\eta_p^2 = .09$). Consistent with the pooled analysis employed for calories purchased, participants in the *Near* condition felt that their last meal had occurred more recently than participants in the other two conditions ($M_{Near} = 6.38$, $SD_{Near} = 2.40$; $M_{Pooled} = 5.02$, $SD_{Pooled} = 2.26$; $F(177) = 3.81$, $p < .001$, $d = .58$). We next conducted a mediation analysis testing the mediating role of subjective temporal distance in the relationship between temporal framing (*Near* vs. Pooled *Distant* and *Control* conditions) and the calories purchased. As described in detail in Appendix A, subjective time perception fully mediated this relationship when pooling the *Distant* and *Control* conditions. The indirect effect for the overall model differed from zero at the 95% CI: [−68.73, −6.01] (5000 bootstrap resamples). Overall, these findings demonstrate that merely making a previous meal feel closer in time can result in fewer calories purchased, a result with important implications given the consequences of food overconsumption and obesity.

Experiment 2

The previous field experiment illustrated tangible outcomes on purchase behavior, but because of the difficulty with asking participants to separate enjoyment of their meal versus other aspects of the dining experience, we used calories purchased as a proxy for satiation. However, it is possible that rather than solely influencing satiation, the manipulation could have caused participants to feel like they *should* eat less if they ate more recently. In our next two experiments, we focus on the rate of satiation and directly test enjoyment of an experience. Experiment 2 illustrates how perceived temporal distance from past consumption can either slow or accelerate satiation in the domain of music consumption.

Method

Participants and design

The experiment consisted of two parts spaced approximately one day apart (see Appendix A for additional details on the method and results). Two hundred and ninety-four participants (171 female; 121 male; 2 unidentified; $M_{Age} = 32.78$, $SD_{age} = 11.38$) from the Amazon Mechanical Turk online panel completed Part 1 of the experiment in exchange for $1. Of the 294 participants, 182 participants (97 female; 83 male; 2 unidentified; $M_{Age} = 32.14$) completed Part 2 in exchange for $0.75. This study employed a one-factor between-subjects design.

Procedure

During Part 1, participants chose their two favorites from a list of 20 songs. They then listened to the chorus of their second favorite song and indicated how much they enjoyed listening to it. To induce satiation, they then listened to the chorus of their favorite song 12 times in a row, indicating their level of enjoyment following each repetition. Approximately 24 h later, participants completed Part 2 where they were randomly assigned to one of three temporal frame conditions. Participants in the *Distant* condition indicated when they finished Part 1 of the study on a 101-point unmarked slider scale anchored with “1 Day Ago or More” on the left side and “Now” on the right side. Participants in the *Near* condition indicated when they finished Part 1 of the study on a 101-point unmarked slider scale anchored with “1 Month Ago” on the left side and “Now” on the right side. The slider started at the right side of the scale, and participants were instructed to move the slider to indicate when they completed the first part of the study. We expected that participants in the *Distant* condition would move the slider farther to the left than participants in the *Near* condition. Those in the *Control* condition did not answer this question.

Participants in all three conditions next indicated when it seemed like they completed the first part of the study on the 9-point scale used in Experiment 1. They then listened to the choruses of their favorite and second favorite songs, indicated their enjoyment for each on the same 101-point slider scale as Part 1, and chose which of the two songs they would like to listen to in its entirety.

Results and discussion

Recovery

We first tested whether participants' recovery from the induced satiation in Part 1 differed as a function of their perception of how far back in time the initial experience felt. We expected the manipulation of temporal frame to influence the enjoyment of the experience more for the stimulus that participants satiated on (favorite song, 12 iterations) than the one they listened to only once (second favorite song, 1 iteration). A 3 (temporal frame: *Control*, *Distant*, *Near*; between subjects) × 2 (*Favorite Song*, *Second Favorite Song*; within subjects) mixed ANOVA on enjoyment ratings revealed a marginal main effect of temporal frame ($F(2, 179) = 2.45$, $p = .09$, $\eta_p^2 = .03$), a main effect of song type ($F(1, 179) = 46.36$, $p < .001$, $\eta_p^2 = .21$), and the critical

two-way interaction ($F(2, 179) = 10.48$, $p < .01$, $\eta_p^2 = .11$). We unpacked this result by conducting a one-way ANOVA (temporal frame: *Control*, *Distant*, *Near*) on enjoyment of the favorite song, revealing the predicted effect of temporal frame ($F(2, 179) = 8.08$, $p < .001$, $\eta_p^2 = .08$). Consistent with Experiment 1 (see Fig. 2), as compared to the *Control* condition, enjoyment of the favorite song decreased when participants felt they had heard it more recently (*Near* condition; $F(1, 179) = 4.14$, $p = .04$, $\eta_p^2 = .02$), and increased when participants felt they had heard it a while ago (*Distant* condition $F(1, 179) = 3.87$, $p = .05$, $\eta_p^2 = .02$). Enjoyment of the second favorite song was unaffected by temporal frame ($Fs < 1$, *ns*).

Subjective time perception and mediation

We argue that the reason for these effects is that the temporal frame manipulation affected participant's subjective sense of when they last heard the song on which they had satiated during Part 1 of the experiment, which in turn affected their enjoyment. We confirmed this by conducting a one-way ANOVA (temporal frame: *Control*, *Distant*, *Near*) on participants' subjective distance from when they last heard the song during Part 1 of the experiment. We observed a significant main effect ($F(2, 179) = 7.62$, $p < .01$, $\eta_p^2 = .08$). Compared to the *Control* condition ($M = 7.52$, $SD = 1.77$), participants in the *Near* condition felt Part 1 occurred more recently ($M = 8.18$, $SD = 1.47$; $F(1, 179) = 4.41$, $p < .05$, $\eta_p^2 = .02$), and those in the *Distant* condition felt Part 1 occurred further back in time ($M = 6.95$, $SD = 1.95$; $F(1, 179) = 3.19$, $p = .08$, $\eta_p^2 = .02$). Finally, a mediation analysis revealed that the relationship between our independent variable and enjoyment of the song was mediated by the subjective sense of when participants felt they last listened to the song. The indirect effect (−.29) for the overall model differed from zero at the 95% CI: [−.66, −.04] (5000 bootstrap resamples; see Appendix A for more details).

Experiment 3

The previous two experiments demonstrated that perceived temporal distance affected satiation in the food and music domains. The manipulation employed in both experiments required participants to explicitly reconstruct temporal judgments about past exposures. In the current experiment we instead subtly affect how time between consumption episodes is experienced. Specifically, we follow Sackett, Meyvis, Nelson, Converse, and Sackett (2010) and directly manipulate the perceived duration of an intervening experience. (We thank an anonymous reviewer for this suggestion.) Additionally, this experiment tests our theory in the new domain of art and goes beyond measures of changes in enjoyment (as in Experiment 2) to include additional behavioral measures that indicate the effects of liking for the target and related stimuli.

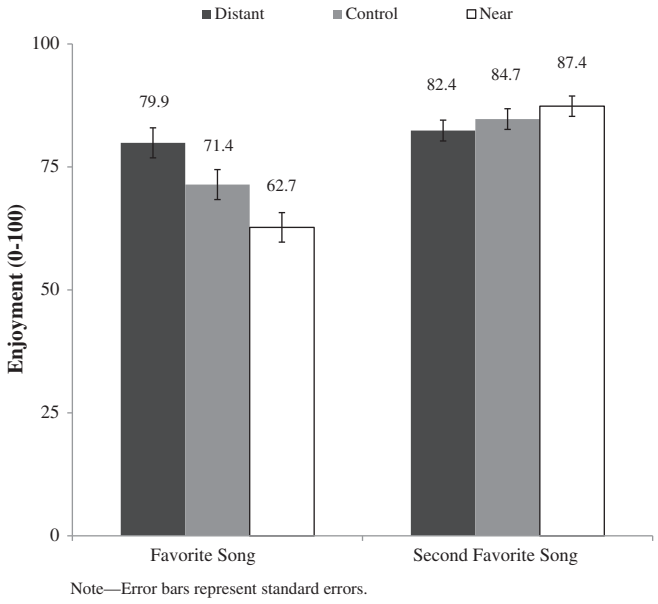


Fig. 2. Experiment 2—enjoyment of favorite and second favorite songs as a function of temporal frame.

Method

Participants and design

Two hundred participants were recruited from the Amazon mTurk panel and paid $2.50 for participation. Three of those participants experienced technical difficulties and their data were not recorded, leaving usable data from 197 participants (74 Female, $M_{Age} = 32.8$, $SD_{Age} = 11.66$). This study employed a one-factor between-subjects design.

Procedure

Participants were recruited to complete two ostensibly unrelated studies: "Art Rating Study" and "Video Study." For the "Art Rating Study," participants looked at a pleasant beach photograph (see Appendix A) 12 times in a row for 10 s at a time. Between each iteration, participants indicated "How much did you enjoy viewing this photograph just now?" on a 101-point unmarked slider scale anchored with "*I hated it*" and "*I loved it*". They were then informed that they were done with the "Art Rating Study" and were to now complete the "Video Study."

During the video study, participants watched the video "Mr. Happy Man" by Matt Morris Films (10 min and 36 s long). During the video, all participants were shown a clock displaying the number of seconds that had elapsed during the video watching task. The clock read "Time: xx seconds", where "xx" was replaced with the number of seconds that elapsed since the start of the video. However, depending on condition, this clock either displayed the time accurately (*Control*), 15% faster than reality (*Long*), or 15% slower than reality (*Short*). Specifically, the clock updated the "time" either every 1000 ms, ending with a final "time" of 636 s (*Control*), every 1150 ms, ending with a final "time" of 540 s (*Short*), or every 850 ms, ending with a final "time" of 731 s (*Long*). Participants were given no other information about the length of the video, thus we predicted they would draw inferences about the time that had passed based on the final number that appeared on the timer. We expected participants with the faster time that ended with a higher final time would feel that more time had passed than those with the slower timer that ended with the lower final time. In this way, we manipulated the perceived time between the photograph exposures and the subsequent tasks without altering the objective duration of the video.

Next, participants completed a few more questions for the "Art Rating Study." Participants first answered, "When does it seem like you last saw the beach photograph?" on a 9-point scaled anchored with 1 (*Feels like it happened a while ago*) and 9 (*Feels like it happened recently*). Participants were then again shown the same beach photograph for 5 s and indicated their liking of it on the same 101-point slider scale as used before.

As a behavioral measure of liking, participants had the opportunity to look at the photograph once more for a duration of their choosing (maximum duration of 5 min). To provide participants with incentive to view the photograph, participants were told that they would be paid $0.01 for every 30 s that they chose to look at it, for a maximum bonus of $0.10. To provide participants with disincentive to complete other tasks while viewing the photograph (e.g., checking email), participants were told that they would be required to click a button that appeared on the screen every 15 s while viewing the photograph. They were further told that if they took longer than 5 s to click this button, the program would assume they were done viewing the photograph and would end the task. Once participants indicated that they

understood the instructions, they were shown the photograph and given a choice to stop viewing it whenever they liked. While viewing the photograph they were shown a clock that (correctly) indicated how much time had elapsed.

We next included a series of measures designed to assess the extent to which our manipulation influenced liking of related stimuli. Participants answered, "How much would you like to learn about beaches like the one in the photograph?" on a 9-point scale anchored with 1 (*Not at all*) and 9 (*Very Much*), their willingness to pay for a 24" × 36" poster of the photograph on a slider scale anchored with $0 and $50, and their hypothetical preference to view the same beach photograph versus each of three new beach photographs. We included these measures to explore how our effects would generalize to satiation of related, but non-identical stimuli, as well as examine broader preference measures.

Results

Recovery

We first tested whether participants' recovery from the induced satiation in the first part of the experiment differed as a function of their perception of how far back in time the experience felt. We again expected that when participants were made to feel as though their last viewing experience was further in the past (*Long*), they would be less satiated, and thus enjoy viewing the photograph again more. Likewise, when they were made to feel as though their last viewing experience was recent (*Short*), they would feel more satiated and thus enjoy viewing the photograph again less. A one-way ANOVA on enjoyment revealed just this ($F(2, 194) = 6.61$, $p < .005$, $\eta_p^2 = .06$). When participants were made to feel that the time since last exposure was particularly long (*Long* condition), they enjoyed the photograph considerably more ($M = 78.15$, $SD = 22.07$) than when they felt that the time since last exposure was particularly short (*Short* condition; $M = 63.86$, $SD = 24.29$; $F(194) = 13.15$, $p < .001$, $\eta_p^2 = .06$). Additionally, enjoyment of the photograph in the *Control* condition fell between the *Long* and *Short* conditions ($M = 72.00$, $SD = 21.69$). Enjoyment differed between the *Control* and *Short* conditions ($F(194) = 4.17$, $p = .04$, $\eta^2 = .02$), while the difference between the *Control* and *Long* conditions was marginally significant ($F(194) = 2.40$, $p = .12$, $\eta_p^2 = .01$).

A similar pattern of results emerged for the behavioral measure of satiation: time spent looking at the photograph again. A one-way ANOVA on this measure yielded a significant main effect ($F(2, 194) = 5.43$, $p < .01$). Participants in the *Long* condition chose to view the photograph for considerably more time ($M = 150.73$ s, $SD = 134.18$) than those in the *Short* condition ($M = 81.82$ s, $SD = 107.33$; $F(1, 194) = 10.29$, $p < .01$, $\eta_p^2 = .05$). Additionally, time spent viewing the photograph in the *Control* condition fell between the *Long* and *Short* conditions ($M = 102.25$ s, $SD = 128.56$). The difference in viewing time between the *Control* and *Short* conditions was not statistically significant though in the predicted direction ($F(1, 194) = .88$, $p > .34$, $\eta_p^2 = .005$), but the difference between the *Control* and the *Long* conditions was statistically significant ($F(1, 194) = 5.01$, $p < .05$, $\eta_p^2 = .03$).

The remaining exploratory measures did not yield results that reached conventional levels of significance for the omnibus tests, although a planned Mann–Whitney *U*-test on the willingness-to-pay for a poster of the beach photograph did yield a significant difference. Those in the *Long* condition were willing to pay significantly more than those in the *Short* condition (Mann–Whitney $U = 1765.50$, $p = .04$, see Table 2 for results; note there were no significant differences for the same test between each of the *Short* and *Long* conditions and the *Control* condition). Although there were no differences between conditions for the other measures, this could simply reflect satiation from the behavioral measure where the photo was viewed on average more than 111 s and increased satiation likely contributed to choosing to end the task. Accordingly, we hesitate to draw conclusions from these results and do not report detailed analyses of these measures; however, we do report all means in Table 2.

Subjective time perception and mediation

We argue that the reason for these effects is that the manipulation affected participants' subjective sense of when they last saw the photograph on which they had satiated during the first part of the experiment, which in turn affected their enjoyment of the photograph during the second part of the experiment. We confirmed this by conducting a one-way ANOVA on participants' subjective temporal distance from when they last saw the photograph during the first part of the experiment. As predicted, we observed a significant main effect $F(2, 194) = 9.52$, $p < .001$, $\eta_p^2 = .09$). Participants in the *Long* condition felt that their last exposure to the photograph was considerably farther back in time ($M = 4.10$, $SD = 2.45$) as compared to participants in the *Short* condition ($M = 5.89$, $SD = 2.33$; $F(194) = 19.00$, $p < .001$, $\eta_p^2 = .09$). Additionally, the subjective time

Table 2
Experiment 3—responses by temporal frame condition (standard deviations in parentheses).

Measure[1]	Long	Control	Short	Primary omnibus statistic
Enjoy photograph at trial 1	78.69_a (20.29)	81.77_a (16.26)	82.27_a (16.73)	$F(2, 194) = .78$, *ns*
Enjoy photograph at trial 12	54.46_a (32.82)	55.27_a (32.23)	54.30_a (32.34)	$F(2, 194) = .02$, *ns*
Enjoy video[2]	7.39_{ab} (2.02)	7.89_b (1.26)	7.27_a (1.97)	$F(2, 194) = 2.08$, $p = .12$
Subjective time perception	4.10_a (2.45)	4.92_b (2.32)	5.89_c (2.33)	$F(2, 194) = 9.52$, $p < .001$
Enjoy photograph following manipulation	78.15_a (22.07)	72.00_{ab} (21.69)	63.86_c (24.29)	$F(2, 194) = 6.61$, $p < .005$
Time viewing photograph (seconds)	150.73_a (134.18)	102.25_{bc} (128.56)	81.82_c (107.33)	$F(2, 194) = 5.43$, $p < .01$
Learn more about beach	5.60_a (2.63)	5.70_a (2.31)	5.41_a (2.56)	$F(2, 194) = .23$, *ns*
WTP for poster[3]	$\$10.19_a$ (10.16)	$\$8.02_{ab}$ (9.20)	$\$6.64_b$ (7.56)	$\chi^2(2, N = 197) = 4.23$, $p = .12$
Total number of times choosing to re-view target photo (0–3)[4]	1.48_a (1.20)	1.72_a (1.08)	1.68_a (1.20)	$B_{Slow} = .15$, $p = .23$ $B_{Fast} = .02$, $p = .85$

[1] Measures are reported in the order in which they were collected. Values in rows that do not share a subscript are different from each other at the .05 level of significance.
[2] See Appendix A for discussion on this measure.
[3] Though the omnibus ANOVA revealed a marginally significant result ($F(2, 194) = 2.62$, $p = .08$), due to the non-normal distribution of the WTP results, we conducted a Kruskal–Wallis test and follow-up Mann–Whitney U tests. (Note: The distributions by condition do have the same shape though they are not normally distributed.)
[4] Beta coefficients derived from Poisson regression on total number of times target photograph was chosen with the *Control* condition as the referent.

perception for the *Control* condition fell between that of the *Long* and *Short* conditions ($M = 4.92$, $SD = 2.32$), and was significantly different from each (both $ps < .05$, $\eta_p^2 > .02$).

Finally, two separate mediation analyses revealed that the relationships between our independent variable and enjoyment, as well as our independent variable and time spent viewing the photo again were each mediated by the subjective sense of when participants were last exposed to the photograph (see Appendix A). The two indirect effects (−.14 and −.57 respectively) for the overall model each differed from zero at the 95% CI: [−68.73, −6.01] and [−1.90, −.01] (5000 bootstrap resamples).

General discussion

Across three experiments we find that changes in the mere perceived temporal distance from the last consumption episode influenced the caloric value of purchased meals (Experiment 1), enjoyment of a musical experience (Experiment 2), and enjoyment and time spent viewing a photograph (Experiment 3). Our work adds to the growing body of evidence that satiation is constructed, illustrating that psychological factors can influence not only perceptions of *what* is consumed (Galak et al., 2009; Morewedge, Huh, & Vosgerau, 2010; Redden, 2008; Redden & Galak, 2013), but also *when* consumption last occurred. Furthermore, while previous work has shown that subjective time perception can influence downstream judgments through naïve theories in the absence of more diagnostic information (Faro, 2010; Sackett et al., 2010), our work illustrates that such an effect can hold even when strong physiological feedback exists. In Experiment 1, participants who felt closer to their last meal purchased lower caloric meals, even among participants who had already made the decision to eat by coming to Panera Bread. In Experiment 2, this effect extended to participants' actual enjoyment of an aural experience. Finally, in Experiment 3, this effect extended to participants' actual enjoyment of and desire to reconsume a visual experience. The results were robust to manipulations that influenced both how time was reconstructed (Experiments 1 and 2) and experienced (Experiment 3). Finally, our work is unique in illustrating not just how to accelerate the recovery process, as has been done in previous work, but how to *slow* it. This provides a simple and actional approach to curbing consumption and potentially aid in fighting the obesity epidemic.

Future work could explicitly examine how the regularity of consumption intervals moderates the effect of subjective time perception on satiation. Experiment 1 demonstrated that though people could be made to feel closer to a previous consumption episode, it was more difficult to make them feel further away from a consumption episode that occurred only a few hours ago and occurs regularly. It would also be interesting to apply this work to other areas of overconsumption, such as overspending money or overinvesting time in tasks. Given that we effectively curbed behavior (e.g., quantity of food) in our studies, it is possible that similar techniques could be applied to other forms of overindulgent and maladaptive behaviors.

Finally, it would be interesting to examine when and how subjective time perception can overcome visceral, physiological factors that drive human behavior. Heavy weighting of visceral factors, such as cravings, physiological states, emotions, and physical stimuli, can explain many maladaptive, present-biased human choices that often act against our best self-interest (Loewenstein, 1996). Though we know that the extent of such present bias is driven by subjective time perception (Zauberman, Kim, Malkoc, & Bettman, 2009), this has yet to be examined specifically in the context of highly visceral, physiological influences. Our work suggests that shaping the temporal view from past consumption can shape consumption decisions in the present, however we did not specifically examine contexts where these visceral states are particularly salient. Future work can examine when and in what contexts mere time perception from the past can counteract visceral influences in the present. Likewise, given growing evidence that hunger modulates the release of satiation-related hormones (Kenny, 2013), future work could also explore whether changes in satiation from time perception influence the physiological mechanisms of satiation.

Appendix A. Supplementary data

Supplementary data to this article can be found online at http://dx.doi.org/10.1016/j.jesp.2014.01.008.

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