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Dynamic Sunk Costs: Importance matters when opportunity costs are explicit

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The sunk cost fallacy is a well-established phenomenon where decision makers continue to commit resources, or escalate commitment, because of previously committed efforts, even when they have knowledge that their returns will not outweigh their investment. Most research on the sunk cost fallacy is done using hypothetical scenarios where participants make a single decision to continue with a project or to abandon it. This paradigm has several limitations resulting in a relatively limited understanding of sunk cost behavior. To address some of these limitations, we created a dynamic repeated choice paradigm where sunk costs are learned over time and opportunity costs are explicit. Over three experiments we show that the sunk cost fallacy depends on the relative a priori importance of the goal being invested in. We observed escalation of commitment only when the sunk cost domain is more important than alternatives (explicit opportunity costs). Participants showed de-escalation of commitment to the sunk costs domain otherwise.

Keywords: sunk cost fallacy; opportunity costs; repeated decisions; resource allocation; multiple goal pursuit

Introduction

Time may be our most valuable resource, and balancing our time among multiple pursuits is a pervasive and recurrent decision. From simple choices, whether to answer an email or chat with a colleague, to more difficult ones such as whether to continue to pursue a college major that is unsatisfying, how we choose to spend our time may be one of the most important decisions we make on a daily basis. One complicating factor in larger allocation decisions, such as changing a college major, is the time and energy already spent pursuing that goal. Though normative economic theories posit that only incremental costs (the cost/time spent moving forward) should influence decisions, a large body of evidence has shown that previously invested resources influence future decisions. Most notably, the sunk cost effect (Arkes & Blumer, 1985) refers to the tendency to continue to invest in a project that clearly has no future benefit driven by the influence of previously invested resources. In a typical sunk cost experiment, a person is presented with a hypothetical project that is nearly completed when it becomes apparent that the project will not produce any benefit. The person is then asked if he or she should commit resources to complete the project. Although additional investment would mean throwing good money after bad, a majority of participants choose to complete the project, presumably because they view the already invested resources as wasted if the project is not finished (Arkes, 1996; Arkes & Hutzel, 1997).

A majority of sunk cost studies use the hypothetical one time choice scenario outlined previously (notable exceptions include; Arkes & Blumer, 1985 — experiment 2 and Strough, Schlosnagle, Karns, Lemaster, & Pichayayothin, 2013). Two limitations of these paradigms are that they are one time choices, whereas real life decisions of this type are made repeatedly over time, and they often do not make opportunity costs, i.e., other choice options that the resources could be put toward, explicit (see Northcraft & Neale, 1986, for one exception). For example, a decision to change your college major is a one-time choice, however if you choose not to change, the choice is available every day and your preference for continuing a commitment could change over time. A related point is that sunk costs are not always known with certainty. Dissatisfaction with a college major today could indicate that a future provided by another major would be more rewarding, or it could be a passing phase. In this case, one would expect certainty to grow with accumulating evidence of dissatisfaction, leading to stronger confidence that a course of action is becoming a sunk cost over time. The second shortcoming of typical scenario based sunk costs studies is the lack of explicit opportunity costs. When presented with a choice to continue a project or not, the framing of the choice is between a sure loss (not continuing) and a probable larger loss (continuing). In reality, not continuing a project frees resources to be used elsewhere and should actually be seen as a sure loss with probable gains. Northcraft and Neal (1986) confirmed this framing, showing that participants did not consider opportunity costs when they are not made explicit. When opportunity costs were made explicit, 12 of 20 participants switched to discontinue earlier choices. A related note is that with no explicit opportunity costs, the relative importance of a domain is unclear. Sunk costs may be easy to

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avoid in unimportant domains but more difficult in more important domains. No previous research has looked at the a priori importance of a domain in a sunk cost experiment.

Over three studies, we examined how people dynamically allocate their time among different pursuits when one pursuit does not increase sufficiently with investment (i.e., becomes a sunk cost). The paradigm we created is unique in that sunk costs are not explicitly stated, instead they are learned over time through passive feedback. Additionally, our paradigm makes opportunity costs explicit (areas in which time is not allocated to decay). Finally, we collect data on the perceived importance of domains beforehand. We find a dynamic sunk cost effect in two of the three studies with the key feature being a priori importance of a domain. When a sunk cost domain was clearly more important than the opportunity costs, participants escalated commitment towards the domain. In all other cases participants de-escalated commitment.

Experiment 1

Methods

To explore time allocation decisions, we created a computer game we called Sim-Life (see Figure 1) where participants made repeated choices to spend their free time among three domains. The status on each domain (i.e., the cumulative rewards or losses) is displayed throughout the task; the status of a domain improves over time when it is selected and decays over time when not chosen. Participants made 100 choices, simulating the number of days in an academic quarter. After each choice participants were shown a 5-second slide show of pictures representing the domain they had just selected to simulate the passage of time. The status of each domain was calculated on a 100 point scale however participants were not aware of their exact status at any point. Instead the visual feedback was presented as a scale which had ten categorical levels (i.e. the scale only moved when their underlying score crossed a ten point threshold: see (Figure 1). Table 1 displays the feedback functions for the task used in all three experiments. Because a domain's status decreases if it is not chosen, opportunity costs of choosing only one or two options are learned over time. All domains were set at 90 on trial one, visually displayed as the next to highest point on the scale, and changed accordingly depending on the choices participants made.

We varied the manner in which a domain was a sunk cost. In Condition 1, only relatively small positive point increments were obtained when the sunk cost domain was chosen. In Condition 2, relatively large decrements of points resulted when the sunk cost domain was not chosen. That is, selection produces either relatively little reward, or non-selection produces relatively large losses. Although we predicted learning effects between these conditions (sunk costs would be identified faster in Condition 1 than in Condition 2) these differences did not affect any of the global results we report here and thus are omitted for brevity.

Before starting the game, participants indicated how important each domain was to themselves in three separate questions. The first was a rank ordering of the three domains. Second, they indicated on a scale from 1 to 5 how important each domain was to them. Finally, participants allocated 100 points between the three domains representing their relative importance. Results from these three measures were consistent and we present the mean ratings for all three measures in Table 2.

In the game, participants were told that they have a set schedule of classes, studying, and work that leaves them about two hours of free time each day that they can choose to spend on one of the three domains. In Experiment 1, the three domains were friends, their romantic partner, and academics. In addition to the reason for the sunk cost (weak reward vs. strong loss), our other between-subjects condition was which domain was instantiated as the sunk cost (i.e., a losing domain). Based on pilot data, we expected academics to be considered more important than the other two domains.

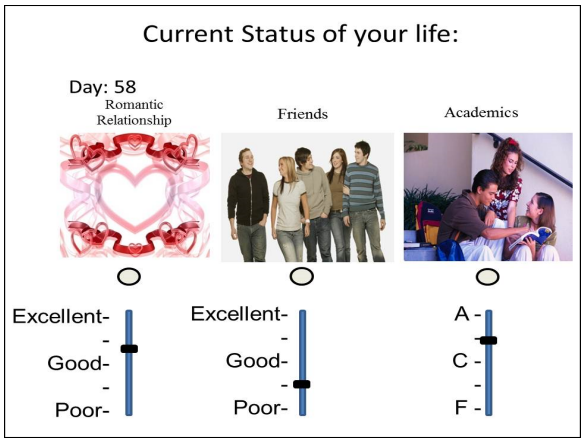

Figure 1. Screenshot of experiment 1 paradigm.

Participants

Fifty nine (37 female, median age = 20) undergraduate participants were randomly assigned to one of three conditions. The only difference between conditions was which domain was instantiated as a sunk cost: relationship, friends, or academics.

Table 1. Status points as a function of selection or non-selection for the three domains.

	Sunk Cost	Domain X	Domain Y
Condition 1			
Decay per trial	-3	-3	-3
If chosen	+4	+7	+7
Condition 2			
Decay per trial	-6	-3	-3
If chosen	+7	+7	+7

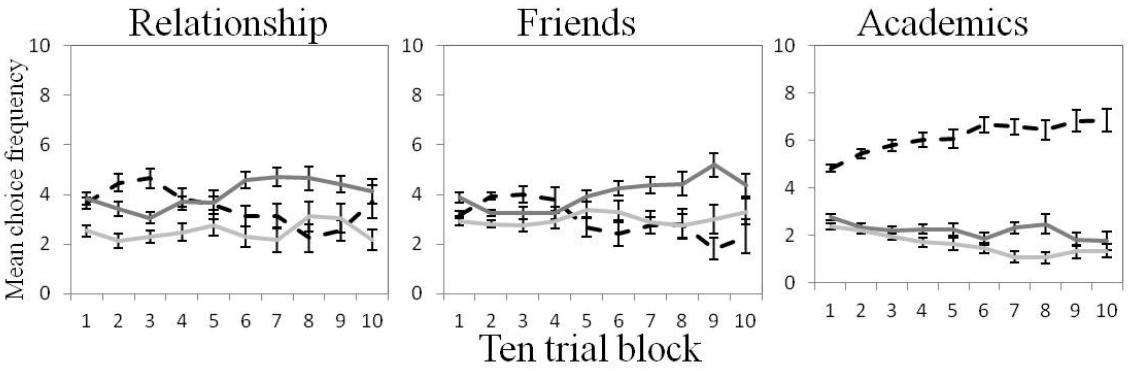

Figure 2. Experiment 1 choice frequency. The mean choice frequency across blocks of ten trials for each domain is displayed for each condition. The sunk cost domain, indicated for each condition above the graph, is represented by the dashed line.

Results

Mean importance ratings for each experiment are shown in Table 2 along with standard errors. For simplicity, we only present results of paired samples t-tests based on the 1-5 importance ratings using a Bonferroni correction. Consistent with pilot studies, participants rated academics as more important than relationship, t (58) = 7.28, $p < .001$, and friends, t (58) = 8.23, $p < .001$. There was no difference between relationship and friends, t (58) = 0.146, $p = .88$.

To analyze choice over time, we split the data into 10 sequential blocks of trials, calculating the choice frequency for each domain in each block. Mean choice proportions for each condition are shown in (Figure 2 with the domain instantiated as a sunk cost highlighted. To examine choice behavior, individual change scores across the ten blocks of trials were calculated for each participant in each domain. Negative scores indicate de-escalation of resource allocation across trials, and positive scores indicate increased resource allocation. To test whether choices between the sunk cost domain and the other two domains differed, we performed a repeated measures ANOVA on the change scores from each domain across the three conditions revealing a significant interaction between domain change scores and which domain was the sunk cost, $F(4, 110) = 2.658$, $p = .04$, $\eta^2 = .081$.

When academics (the most important domain) was the sunk cost, participants escalated their resource allocation to academics as trials progressed (mean change score = 2.03, SD = 2.83, significantly different from zero, t (30) = 3.99, $p < .001$). When the friends domain was the sunk cost, participants de-escalated commitment, allocating fewer choices to the domain as trials progressed on average (mean change score = -1, SD = 2.68) though this was not significantly different than 0, t (15) = 1.49, p = .15. When relationships was the sunk cost, participants neither escalated nor de-escalated resource allocation to that domain across trials (mean change score = 0.1765, SD = 2.5, t (15) = 1.49, p = .15).

To quantify the detrimental effect of escalating the commitment of resources to a dynamic sunk cost we examined the status of each domain at the end of the task. The status of each domain is a direct function of choice frequency (given the feedback structure in Table 1). The mean final status on a scale of 1 to 100 for each condition for Experiment 1 is shown in Table 3. When participants cut their losses, that is stop selection of domains that were not advantageous (friends and relationships), they did better overall with a mean of 2.05 in each of the sunk cost domains and an overall mean of 32.45 across all domains. In contrast, when the domain they cared most about (academics) had a sunk cost structure, they escalated commitment to that domain earning fewer points altogether with a final mean of 24.4 in that domain, and an overall mean of 11.96 across all three domains (compared to 32.45 in the other conditions).

Discussion

Results from Experiment 1 show that participants will escalate commitment in the face of sunk costs when the choice is an important domain, in this case, academics. When the sunk cost was relationships or friends, participants did not appear to have much difficulty in de-escalating time allocation towards that domain. Although our intuition is that the importance of the domain leads to the observed results, any number of alternative factors could have led to the difference between the academics condition and the other. For example, participants were college students performing an experiment in an academic building and could very easily have been performing in a manner consistent with presentation bias. Additionally, academics is a more quantifiable domain compared to the social domains of relationships and friends, and the labeling of the feedback reflects this difference (see (Figure 1). To control for these possible confounding factors, Experiment 2 was designed to make the 3 domains more equivalent and comparable.

Analyses using the other two measures of domain importance are all consistent with the reported results.

Table 2. Mean importance ratings for each domain in Experiments 1 to 3 (standard error). Importance was measured with three different scales, rank order, five-point Likert scale, and 100 point allocation.

	Experiment 1			Experiment 2			Experiment 3		
	Relationship	Friends	Academics	English	History	Math	Sociology	History	Psychology
Rank order	2.2 (.64)	2.4 (.70)	1.2 (.50)	2.2 (.79)	1.7 (.71)	1.9 (.81)	2.5 (.72)	2.2 (.53)	1.2 (.57)
Importance (1-5)	3.3 (1.1)	3.3 (1.1)	4.5 (.62)	3.2 (1.3)	4.1 (1.0)	3.8 (1.2)	2.7 (1.2)	3.2 (1.0)	4.5 (.99)
100 point allocation	25.8 (11.3)	23.6 (11.5)	48.9 (14.1)	27.2 (11.7)	38.2 (12.6)	34.5 (11.1)	24.0 (13.6)	26.5 (10.3)	49.5 (15.2)

Experiment 2

To control for differences between domains, this experiment used the same paradigm but with three academic classes as the domains making all feedback on the same scale of grades (see (Figure 3). Classes were chosen so that there would be no clear *a priori* differences in domain importance. We predicted that participants in Experiment 2 should de-escalate commitment in the face of sunk costs, regardless of which domain was instantiated as the sunk cost domain.

Methods

The same procedure from Experiment 1 was used with 72 (44 female, median age 20) undergraduate participants. All participants provided informed consent and received course credit for participating. The three domains in this experiment were three academic classes, History, English, and Math. Participants were instructed to allocate their studying time among the three classes however they wanted to over the course of 100 simulated days.

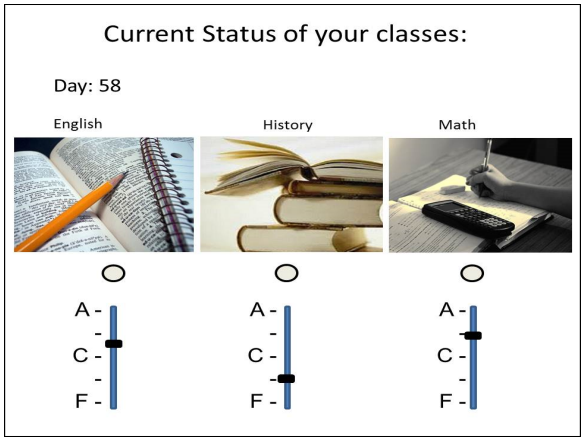

Figure 3. Screenshot from Experiment 2.

Results and Discussion

Mean importance ratings show that English was rated less important than History, t (71) = 4.95, $p < .001$, and Math, t (71) = 2.67, $p < .01$. There was no difference in importance ratings between History and Math, t (71) = 2.076, $p = .05$. (Figure 4 shows the mean choice proportion for each domain across trials. In each condition, participants initially allocated more resources to the sunk cost domain (presumably attempting to keep the three domains equal before realizing it was a sunk cost), but decreased their choices for the sunk cost domain as trials progressed. There was a significant interaction between change scores from each domain and the three sunk cost conditions, F (4, 138) = 10.55, $p < .001$, $\eta^2 = 2.15$. The decrease in choices for the sunk cost was significant for English (M = -1.42, t (23) = -3.729, $p < .001$), History (M = -1.33, t (26) = -2.66, $p = .013$), and Math (M= -1.95, t (20) = -4.34, $p < .001$) in their respective sunk cost conditions.

Experiment 2 showed that when the three domains were comparable, participants cut their losses in the face of sunk costs. That is, they behaved normatively. We designed the stimuli so that the three domains would be equally important. Though the importance ratings differed, this was driven primarily by English being rated less important than History or Math. The difference in ratings between History and Math was very small and non-significant with no class clearly more important than the other two. To further test the explanation that the importance of the domain is crucial to escalating commitment in the face of sunk costs, Experiment 3 was designed to extend both of the previous experiments using three academic classes but manipulating the importance of one.

Experiment 3

In this experiment we used the academic classes of History, Sociology, and Psychology. The importance of one domain, Psychology, was manipulated by telling participants that "although you would like to have the highest GPA at the end of the quarter, Psychology is required for your major and you need to obtain a C or better to avoid retaking the class".

Methods

With the exception of the additional instructions, experiment 3 followed the same procedure as the first two experiments with 96 undergraduate participants (55 female, median age 20) who provided informed consent and received course credit for participating.

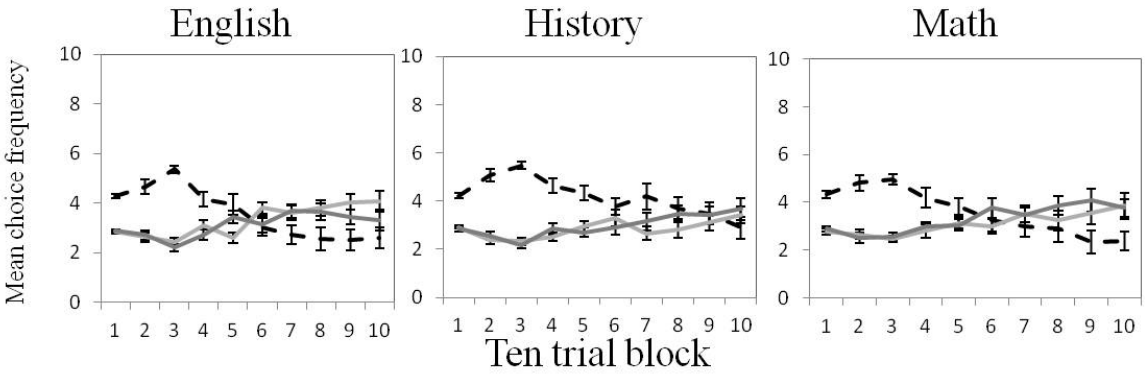

Figure 4. Experiment 2 choice frequencies. The mean choice frequency across blocks of ten trials for each domain is displayed for each condition. The sunk cost domain, indicated for each condition above the graph, is represented by the dashed line.

Results and Discussion

Table 2 lists the mean importance ratings for each domain. The manipulation of domain importance was successful with participants rating Psychology as more important than History, t (95) = 10.31, $p < .001$, and Sociology, t (95) = 9.06, $p < .001$.

Mean choice frequencies are shown in (Figure 5. In the conditions where Sociology and History were the sunk cost domain, choices mirrored the results from Experiment 2. Testing choice frequency change scores against zero show that participants de-escalated commitment for both Sociology (M = -1.94, t (32) = -4.31, $p < .001$) and History (M = -1.94, t (32) = -5.02, $p < .001$) in their respective sunk cost conditions. In the condition where the manipulated domain, Psychology, was the sunk cost, participants escalated commitment, increasing their allocation of time for Psychology, M = 1.4, t (32) = 2.99, $p < .01$.

As shown in Table 3, the mean value of each domain (essentially their GPA at the end of the game) reflects the optimality of choice strategy. In the Sociology and History conditions, participants on average failed the sunk cost domain, but passed their other two classes (the mean scores of 49 and 25 are represented as a grade of C and D respectively during the game), whereas in the Psychology condition, where participants escalated commitment in the face of sunk costs, the mean ending values indicate that on average a participant in this condition spent so much time on Psychology that he or she failed all three classes. Averaging the final status of the three domains for an individual is analogous to a semester GPA. Using this measure, participants in the Psychology condition scored significantly lower than participants in both the History condition, t (61) = 5.49, $p < .01$, d = 1.4, and the Math condition, t (61) = 6.18, $p < .01$, d = 1.6. There was no difference between the History and Math conditions, t (61) = .393, p = .696, d = .09.

Table 3. Final status of each domain in Experiment 1-3. The mean (SD) final status (0-100) for each domain (row) is shown in each condition (column).

Experiment 1			
Domain	Sunk Cost Condition		
	Relationship	Friends	Academics
Relationship	2.1 (4.9)	31.9 (33.1)	8.3 (17.7)
Friends	19.6 (29.2)	2.0 (4.9)	3.2 (9.4)
Academics	69.8 (30.0)	69.3 (33.8)	24.2 (21.3)
Experiment 2	**Sunk Cost Condition**		
	English	History	Math
English	1.2 (3.5)	17.3 (21.8)	26.8 (31.1)
History	29.8 (21.2)	1.9 (5.3)	31.7 (29.5)
Math	24.1 (27.5)	21 (26.5)	1.04 (3.0)
Experiment 3	**Sunk Cost Condition**		
	Sociology	History	Psychology
Sociology	1.6 (5.9)	24.3 (23.7)	4.9 (12.2)
History	25.4 (26.4)	0.48 (2.1)	5.7 (11.1)
Psychology	46.2 (24.7)	51.9 (20.7)	18.9 (26.1)

General Discussion

There is a large body of work in judgment and decision making detailing how human choices deviate from what are considered rational or normative standards (e.g. Shafir & LeBoeuf, 2002; Sleesman, Conlon, McNamara, & Miles, 2012). Our work follows, expands, and qualifies some of these basic finding by showing that in repeated choices, people will escalate commitment to a domain in the face of sunk costs when the domain is important. In other situations, individuals are able to cut their losses, de-escalating commitment. In contrast to typical sunk cost studies, the present tasks made the opportunity costs available by participants experiencing decrements in domains not chosen. Additionally, this study adds to our knowledge of sunk costs by creating sunk costs that are dynamic (learned over time) and measuring the perceived importance of each domain. This was sufficient information for individuals to make adjustments (de-escalate commitment) in domains that they cared equally about but not when one domain was more important.

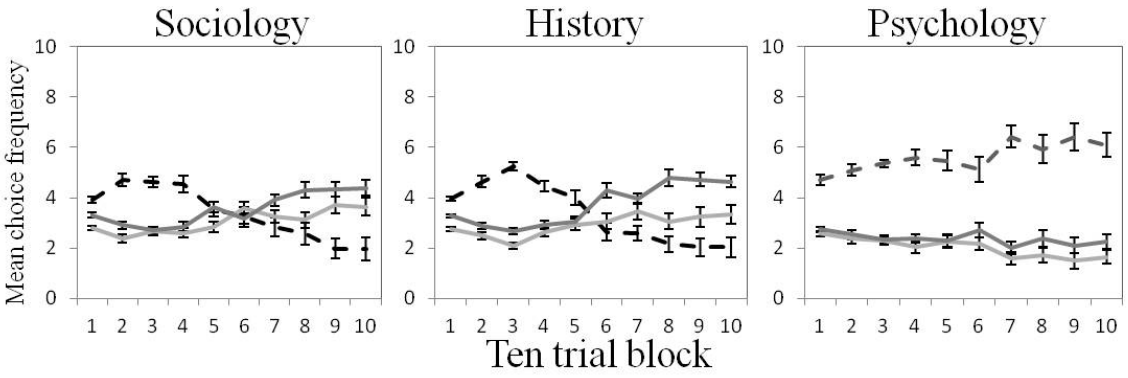

Figure 5. Experiment 3 choice frequencies. The mean choice frequency across block of ten trials for each domain is displayed for each condition. The sunk cost domain, indicated for each condition above the graph, is represented by the dashed line.

Clearly, a more important domain provides greater utility per unit of gain, however in the long run those gains could not compensate for the overall decrements observed in other aspects of the situations we created. In the last experiment for example, when the most important course was Psychology, participants earned on average only half of the points earned in the other subjects. The only time such a gain would make sense from a utility perspective would be if Psychology was weighted 75% or more than the other subjects. Even though we were successful at manipulating the importance of the Psychology course, the importance ratings do not reflect such an extreme split of weighting. We grant that the measures are imperfect; however, we believe that utility considerations alone do not explain the findings.

The motivational reasons behind the unwillingness to give up on an important domain may be traced to individuals' life history and culture that places great value in not giving up on things that matter. 'Waste not want not' and 'finish what you start' are phrases that capture what children are taught to build character and achieve long term goals (Arkes, 1996). Additionally, important domains have special emotional significance and could influence feedback processes in dynamic choice tasks leading to choices that reflect recency or primacy (Hogarth & Einhorn, 1992; González Vallejo, et al., 2013). Follow up work is needed to more fully explore the processes that lead to dynamic sunk costs in important domains but not others.

Implications from escalating commitment can be serious, both financially and personally. Aging, negative life events, and economic forces are but a few factors that can place people in a position where they would be better off disengaging from an activity once enjoyed (Worsch, et al., 2004; Dohrenwend & Dohrenwend, 1974; Held, 1986; Wrosch & Freund, 2001). For example, new parents may find that they are unable to spend the same amount of time pursuing leisure activities as they once could. Beyond external changes, personal choices about time allocation can have detrimental effects on wellbeing. Expanded work hours for example have negative effects on marital relations (White & Keith, 1990). Our results could lead to research on possible interventions designed to improve wellbeing, including making opportunity costs more salient and reframing a problematic domain to minimize its perceived importance.

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