Published in final edited form as:

J Behav Decis Mak. 2009 July 1; 22(3): 252–270. doi:10.1002/bdm.624.

The Sunk-Time Effect: An Exploration

Anton D. Navarro and Edmund Fantino

University of California San Diego

Abstract

We explored the potential for a sunk-cost effect in the realm of time. Questionnaire studies (Experiments 1–4) obtained a sunk-time effect that was robust to manipulations of prospective value, individual versus group consequences, and the effort or enjoyment inherent in the time. Behavioral experiments (Experiments 5–7) also suggested a sunk-time effect and found support for a personal responsibility by sunk cost interaction on choice behavior. We discuss theoretical implications and a potential connection to animal sunk cost phenomena.

Keywords

sunk cost; escalation; decision-making; choice; self justification; mental accounting

Past studies have indicated that a person's likelihood of selecting a particular choice option may be proportional to the amount of sunk cost linked to the choice option. In the monetary domain, the sunk-cost effect has been revealed by questionnaire experiments (Arkes and Blumer, 1985; Arkes and Hutzel, 2000; Moon, 2001) a field experiment (Arkes and Blumer, 1985), and correlational field studies (Staw and Hoang, 1995). The effect may be linear (Garland, 1990), and the relative size of the sunk cost may matter more than its absolute size (Garland and Newport, 1991). Theories handling the effect include the desire to avoid waste (Arkes & Ayton, 1999), prospect theory (Whyte, 1986), self-justification (Staw, 1976), and attempted normative decision-making (implied by Bowen, 1987; Bragger, Bragger, Hantula, & Kirman, 1998; Goltz, 1999; McCain, 1986; Navarro and Fantino, 2005; 2008).

This paper explores the sunk-cost effect in a relatively untapped domain, the temporal domain. The only study in the human literature to thoroughly test for a "sunk-time" effect produced a notable failure (Soman, 2001). This paper also explores a potential contributing factor to a sunk-time effect, personal responsibility for the sunk time. While personal responsibility has received much attention in the "escalation" paradigm, its role in the sunk-cost effect scarcely has been tested and is poorly understood. The following sections elaborate on these issues.

The potential impact of sunk time

Any behavior may be defined in terms of time spent, whether it is waiting in a checkout line, maintaining a friend, a hobby, or holding a belief. If the sunk-cost effect occurs with time, then potentially it could affect anything one does. Anecdotally, some behaviors do appear to intensify over time, for no clear reason other than the simple passage of time. In common parlance, "old habits die hard". Popular examples are relationships that persist for too long, and people who cling to a belief or attitude long after the point where opposing evidence is

overwhelming. But does such an effect with time exist? To date, the sunk-cost effect only has been demonstrated when monetary costs are involved. We know of two studies that have examined temporal costs (Fantino, Navarro, and Stolarz-Fantino, 2008; Soman, 2001), and neither study demonstrated a positive effect. The more thorough study was that of Soman (2001). In Experiments 1, 2, 3, and 6, Soman presented sunk-cost information monetarily in one set of conditions and temporally in another set, and found that monetary costs strongly influenced choice, while temporal costs had no effect. In Experiments 4 and 5, Soman found sunk time effects but only when a wage rate was explicitly stated and linked with the time or when subjects had received instruction about economic approaches to time. Soman concluded we process time and money information differently, in that we form mental accounts of the latter, but not the former. Either way, Soman's results suggest the sunk-cost effect ordinarily is restricted to money. The study by Fantino et al. (2008; Experiment 3) did provide evidence that temporal and monetary information may be processed similarly in the absence of special training, but the study revealed a reverse effect. The reverse effect relates to studies by Heath (1995) and Tan and Yates (2002) that explored a type of word problem in which the resultant level of persistence is negatively correlated with sunk cost size. This reverse effect may occur when the decision problem contains any information that would allow the decision-maker to form a "mental budget" that places a cap on spending (Heath, 1995).

In short, zero evidence suggests that the positive sunk-time effect may occur, but only a handful of studies have explored the issue. Thus, we set out to conduct further tests with different materials. We begin with the following hypothesis:

H1: The likelihood of selecting a given alternative from a set of alternatives is a function of the time already spent on the given alternative.

The above hypothesis may be overly broad in that time can vary in quality. Time may be physically effortful, boring, enjoyable, or frightening, among other things. As Soman (2001) pointed out, these qualities may dictate time effects. We assumed that any quality of sunk time that decreases its utility would exaggerate its effect. The present experiments examined two qualities: physical effort and enjoyment.

H2: *The impact of sunk time will increase in proportion to the effort involved in the sunk time.*

H3: The impact of sunk time will decrease in proportion to the enjoyment involved in the sunk time.

Next, we discuss a plausible contributor to a sunk-time effect, personal responsibility for prior spending.

Role of personal responsibility

The escalation paradigm initiated by Staw (1976) has suggested that personal responsibility is an important variable in choice behavior (Bazerman, Giuliano, & Appleman, 1984; Davis & Bobko, 1986; Schaubroeck & Davis, 1994; Schoorman & Holahan, 1996; Staw & Fox, 1977; Whyte, 1993). The key finding from this paradigm is that given a failing hypothetical R&D project, subjects tend to persist more if they were personally responsible for initiating the project than if another had initiated it. Theories handling this finding include self-perception theory (Bem, 1967), and perhaps the waste-avoidance theory of Arkes and Blumer (1985), but the dominant theory is self-justification theory (Brockner, 1992; Staw, 1976). This theory assumes that personal responsibility for a past decision spurs one to

reduce post-decisional dissonance by justifying the prior decision, resulting in continued persistence.

Before proceeding, let us clarify the difference between “escalation” and the “sunk-cost effect”. Escalation refers to persistence in a course of action, usually in the face of failure. Studies under the “escalation” label have identified several determinants of persistence, but these studies have not manipulated sunk costs. Sunk-cost effect refers to the particular impact of sunk costs on decision-making, and studies under the “sunk-cost” label have isolated sunk cost as an independent variable and examined its role in choice. Staw (1997) viewed escalation as the broader phenomenon, with the sunk-cost effect being one of escalation’s many potential sources. Staw viewed self-justification as an independent potential source of escalation

Presently, we ask, could self-justification (in other words, personal responsibility) promote the sunk cost effect? More specifically, how do the level of personal responsibility and sunk-cost combine, if at all, to produce choice? Let us state some of the possible hypotheses regarding these variables together. One is the following:

H4: Personal responsibility has a main effect on the likelihood of persistence across levels of sunk cost, but does not interact with sunk cost.

Figure 1 (top) illustrates this hypothesis.

Another hypothesis is:

H5a: Personal responsibility and sunk cost interact, such that the sunk-cost effect is exaggerated as the degree of personal responsibility increases.

Figure 1 (bottom) illustrates this hypothesis. We suggest the latter is more consistent with the flavor of self-justification theory (or even self-perception theory). The theory suggests the culpable decision maker would find it difficult to write off a large sunk cost, yet relatively easy to write off a small sunk cost. The less-culpable decision maker would find it easy to write off both large and small sunk costs. A fully non-culpable decision-maker, in fact, in the absence of any motive for justification, should not be affected at all by sunk costs,

H5b: In the absence of personal responsibility, there will be no sunk-cost effect.

Two tests of these predictions in the monetary domain (Arkes and Blumer, 1985; Whyte, 1993) have yielded inconclusive results. Arkes and Blumer (1985) tested two versions of their “radar-blank plane” problem, one beginning with “As the president of an airline company, you have invested...” (Experiment 1, high responsibility), the other with “The Acme Airlines Company has invested...” (Experiment 8, low responsibility). Comparing the two conditions, the pattern of results was most consistent with H4. Whyte (1993) performed a similar manipulation and found that personal responsibility slightly exaggerated the sunk cost effect—more consistent with H5a—although the interaction was minor and the condition with zero personal responsibility still produced a sunk-cost effect, countering H5b. Together, the studies are inconclusive but suggest personal responsibility may only be a minor factor in the sunk-cost effect. Perhaps these studies, to varying extents, motivated external justification (Fox & Staw, 1979) even in the absence of personal responsibility, since both studies asked the reader to envision a large company in the context of a competitive market, and continuing the project might help the company to save face.

A portion of the present studies was designed to further examine if and how personal responsibility and sunk costs combine to produce choice. We predicted that in an experiment that manipulated both sunk cost and personal responsibility, and in which external justification would be absent, H5 would be supported.

Overview of experiments

The present experiments serve three purposes: 1) to test for the possibility of sunk-cost effects in the temporal domain, 2) to test whether the effect of time depends on its quality, and 3) to examine if and how personal responsibility interacts with sunk time. Experiments 1 through 4 utilized the questionnaire method, and provide evidence of a sunk-time effect across varying levels of prospective value, in the context of both organizations and individuals, and across varying levels of effort or enjoyment inherent in the sunk time. Experiments 5 through 7 utilized a behavioral method, and provide evidence that personal responsibility and sunk costs may interact in accordance with H5.

Experiment 1

We begin with the questions of whether sunk time may impact choice, and whether the effort involved in the prior time matters.

Method

Subjects: 98 undergraduate male and female students participated in the experiment. The questionnaire was conducted in sequence with another experiment totaling a two-hour session with course credit as compensation.

Procedure: Participants sat alone in a small room, and faced one of three conditions randomly assigned: 1) zero time; 2) time-easy; 3) time-hard. Below are the scenarios with the manipulated portions in italics.

Condition “Zero time”:

Imagine that you are the leader of a copper-mining group. Your group’s job is to dig the ground in search of copper. Currently, your group is digging at a local spot known as “Shady Creek.”

Today is the first day of the dig.

Right away this morning, you and your group have found a vein of copper! However, there is a thick wall of quartz, which is easy to dig through, covering most of the copper. Some special equipment you have (which is 100% accurate) indicates that it will take 10 more days to dig through the quartz and collect all the copper. Unfortunately, your equipment also indicates that the amount of copper is small -- about 10 pounds. Typical mines contain upwards of 500 pounds. You have a choice to make:

A. dig the 10 more days to collect the 10 pounds of copper

B. abandon this “Shady Creek” mine and go home

What is your choice? Please circle your answer above.

Condition “Time-easy”:

Imagine that you are the leader of a copper-mining group. Your group’s job is to dig the ground in search of copper. Currently, your group is digging at a local spot known as “Shady Creek.”

So far, your group has been digging at Shady Creek for the past 60 days. The ground so far has been soft, so the time spent digging has been easy.

This morning, you and your group found a vein of copper! However, there is a thick wall of quartz, which is easy to dig through, covering most of the copper. Some special equipment you have (which is 100% accurate) indicates that it will take 10 more days to dig through the quartz and collect all the copper. Unfortunately, your equipment also indicates that the amount of copper is small -- about 10 pounds. Typical mines contain upwards of 500 pounds. You have a choice to make:

A. dig the 10 more days to collect the 10 pounds of copper

B. abandon this "Shady Creek" mine and go home

What is your choice? Please circle your answer above.

Condition "Time-hard":

Imagine that you are the leader of a copper-mining group. Your group's job is to dig the ground in search of copper. Currently, your group is digging at a local spot known as "Shady Creek."

So far, your group has been digging at Shady Creek for the past 60 days. The ground so far has been hard. The time spent digging has been very difficult and has involved a lot of effort from you and your group.

This morning, you and your group found a vein of copper! However, there is a thick wall of quartz, which is easy to dig through, covering most of the copper. Some special equipment you have (which is 100% accurate) indicates that it will take 10 more days to dig through the quartz and collect all the copper. Unfortunately, your equipment also indicates that the amount of copper is small -- about 10 pounds. Typical mines contain upwards of 500 pounds. You have a choice to make:

A. dig the 10 more days to collect the 10 pounds of copper

B. abandon this "Shady Creek" mine and go home

What is your choice? Please circle your answer above.

Results—In the "zero time" condition, 11/32 subjects (34%) chose to persist. In the "time-easy" condition, 34/62 subjects (55%) chose to persist. In the "time-hard" condition, 40/59 subjects (68%) chose to persist. A likelihood ratio chi-square revealed the effect of condition to be statistically significant, $\chi^2 = 9.5$, $df = 2$, $p < .01$. On average, the presence of sunk-time nearly doubled the persistence. The effect of effort was not significant.

Discussion—The results supported H1, but failed to support H2. The next experiment tested H1 and H3.

Experiment 2

Method

Subjects: 136 undergraduate male and female students participated in the experiment. The questionnaire was conducted in sequence with another experiment totaling a two-hour session with course credit as compensation.

Procedure: Participants sat alone in a small room, and faced one of three conditions randomly assigned: 1) zero sunk time; 2) time-exciting; 3) time-boring. Below are the scenarios with the manipulated portions in italics.

Time-enjoyable:

Imagine you are the leader of a copper mining group. Your job is to oversee your workers as they dig particular areas in search of copper. For the past month, you have been overseeing your workers at a local area called “Shady Creek”. Your own job has been easy (although you have been working the standard 40 hours/week), because surprisingly good ground conditions and weather have allowed for your workers to dig easily, with no problems.

Also, the past month has been very fun because some close friends have been staying with you. They came by surprise on the 2nd day of the dig to spend a vacation in the area (which is scenic). You have had a great time during your work because your friends have been with you, sharing stories and joking around. Plus, on your days off you have gone fishing and hiking with them and had a blast. Although you didn’t expect it at the start of the dig, the past month has been a pleasure. In fact, the time has not at all felt like work to you—it has felt like a marvelous vacation.

This morning, cold rainy weather arrived and your friends went home. However, your group struck copper! Unfortunately, a thick wall of quartz, which is very hard, is covering most of the copper. Your workers are not very experienced with quartz and would need constant, hands-on direction from you, so the job ahead of you would be quite grueling and not fun at all. Given the thickness of the quartz, you estimate it would take 10 days to remove the quartz and collect the copper. What’s worse, some special equipment you have (which is 100% accurate) indicates that the amount of copper is negligible -- only 10 pounds! Most mines contain upwards of 500 pounds.

You consider the following choice:

- A. dig the 10 more days to collect the 10 pounds of copper
- B. call off the dig

What is your choice? Please circle your answer above.

Time-aversive:

Imagine you are the leader of a copper mining group. Your job is to oversee your workers as they dig particular areas in search of copper. For the past month, you have been overseeing your workers at a local area called “Shady Creek”. Your own job has been easy (although you have been working the standard 40 hours/week), because surprisingly good ground conditions and weather have allowed for your workers to dig easily, with no problems.

Despite this, the past month has been boring because some friends that usually come along on the digs were unable to come this time. You have been quite lonely for the past month. Every day of work has been dull, and you have not enjoyed this time at all.

This morning, cold rainy weather arrived. However, your group struck copper! Unfortunately, a thick wall of quartz, which is very hard, is covering most of the copper. Your workers are not very experienced with quartz and would need constant, hands-on direction from you, so the job ahead of you would be quite

grueling and not fun at all. Given the thickness of the quartz, you estimate it would take 10 days to remove the quartz and collect the copper. What's worse, some special equipment you have (which is 100% accurate) indicates that the amount of copper is negligible -- only 10 pounds! Most mines contain upwards of 500 pounds.

You consider the following choice:

A. dig the 10 more days to collect the 10 pounds of copper

B. call off the dig

What is your choice? Please circle your answer above.

Zero time:

Imagine you are the leader of a copper mining group. Your job is to oversee your workers as they dig particular areas in search of copper. *Today, you have begun overseeing your workers at a local area called "Shady Creek".* This morning, cold rainy weather arrived. However, your group struck copper right away! Unfortunately, a thick wall of quartz, which is very hard, is covering most of the copper. Your workers are not very experienced with quartz and would need constant, hands-on direction from you, so the job ahead of you is quite grueling and not fun at all. Given the thickness of the quartz, you estimate it would take 10 days to remove the quartz and collect the copper. What's worse, some special equipment you have (which is 100% accurate) indicates that the amount of copper is negligible -- only 10 pounds! Most mines contain upwards of 500 pounds.

You consider the following choice:

A. dig the 10 more days to collect the 10 pounds of copper

B. call off the dig

What is your choice? Please circle your answer above.

Results—In the “zero time” condition, 5/38 subjects (13%) chose to persist. In the “time-enjoyable” condition, 10/40 subjects (25%) chose to persist. In the “time-aversive” condition, 18/58 subjects (31%) chose to persist. A likelihood ratio chi-square comparing the three conditions did not reach conventional significance. However, combining the two sunk-cost conditions (time-enjoyable and time-aversive), and comparing this total with the zero condition, the effect of sunk time was significant in the predicted direction, likelihood ratio $\chi^2 = 3.87$, $df = 1$, $p < .05$.

Discussion—The pattern of results from Experiment 1 was supported: a sunk-time effect was obtained while neither enjoyment during the sunk time (Experiment 2) nor the effort expended during the sunk time (Experiment 1) had an impact.

The next two experiments tested the robustness of the sunk-time effect to other manipulations. First, prior studies have shown that sunk-cost effects can disappear if the marginal cost/benefit ratio is overly high (Fantino et al., 2008). In Experiment 3, therefore, we repeated Experiment 1 with the marginal cost changed to “difficult”.

Experiment 3

Method

Subjects: 81 undergraduate male and female students participated in the experiment. The questionnaire was conducted in sequence with another experiment totaling a two-hour session with course credit as compensation.

Procedure: The conditions were identical to those of Experiment 1 except that in the sentence, “However, there is a thick wall of quartz, which is easy to dig through,” the word “easy” was replaced with the word “difficult”.

Results—In the “zero time” condition, 6/27 subjects (22%) chose to persist. In the “time-easy” condition, 16/27 subjects (59%) chose to persist. In the “time-hard” condition, 15/27 subjects (56%) chose to persist. A likelihood ratio chi-square revealed the effect of condition to be statistically significant, $\chi^2 = 9.49$, $df = 2$, $p < .01$.

Discussion—The pattern of results found in Experiment 1 was duplicated, suggesting the positive effect of sunk time, and the null effect of sunk effort, was robust to our manipulation of prospective effort.

Experiments 1–3 provide evidence for the time effect when a firm, or a group of people, is involved. Could a time effect be observed at the individual level? Experiment 4 tested this possibility.

Experiment 4

Method—We reworded the scenario to refer to an individual, instead of a group.

Low time:

Imagine that you dig the ground in search of precious stone. Currently, you are digging at a local spot known as “Shady Creek.”

Today is the first day of your dig.

Right away this morning, you have found a vein of precious stone! However, there is a thick wall of granite, which is easy to dig through, covering most of the stone. Some special equipment you have (which is 100% accurate) indicates that it will take 10 more days to dig through the granite and collect all the precious stone. Unfortunately, your equipment also indicates that the amount of precious stone is small -- about 10 pounds. Typical spots contain upwards of 500 pounds.

You have a choice to make:

- A. dig the 10 more days to collect the 10 pounds of precious stone
- B. abandon this “Shady Creek” spot and go home

What is your choice? Please circle your answer above.

High time:

Imagine that you dig the ground in search of precious stone. Currently, you are digging at a local spot known as “Shady Creek.”

So far, you have been digging at Shady Creek for the past 60 days. The ground so far has been hard, so the time spent digging has been difficult and effortful.

This morning, you have found a vein of precious stone! However, there is a thick wall of granite, which is easy to dig through, covering most of the stone. Some special equipment you have (which is 100% accurate) indicates that it will take 10 more days to dig through the granite and collect all the precious stone. Unfortunately, your equipment also indicates that the amount of precious stone is small -- about 10 pounds. Typical spots contain upwards of 500 pounds.

You have a choice to make:

- A. dig the 10 more days to collect the 10 pounds of precious stone
 - B. abandon this “Shady Creek” spot and go home
- What is your choice? Please circle your answer above.

Results—In the “low time” condition, 27/58 subjects (47%) chose to persist. In the “high time” condition, 48/56 subjects (86%) chose to persist. The difference was statistically significant, $\chi^2 = 20.41$, $df = 1$, $p < .0001$.

Discussion—Experiment 4 confirms that our observed effect may apply to individuals in addition to groups. The combined findings of Experiments 1, 2, 3, and 4 support H1. Because these experiments employed the questionnaire method, they fit in with the past research with money. While the questionnaire method is useful and informative, it is limited in that it measures beliefs, rather than behavior. We know of only two experimental studies of sunk money that involved non-hypothetical choices—the theater-ticket experiment of Arkes and Blumer (1985), and Soman (2001, Experiment 6)—and we know of no such sunk-time demonstrations¹. Therefore, in the remaining experiments we used a behavioral procedure. These experiments would also test the role of personal responsibility. Recall *H5a: Personal responsibility and sunk cost interact, such that the sunk-cost effect is exaggerated as the degree of personal responsibility increases*.

Experiment 5

The experiment required subjects to work on a 500-piece jigsaw puzzle, a task that we selected because, 1) participants would be unable to complete the task prematurely, and 2), the task required a similar level of effort throughout the task. Both features aided in maintaining a consistent expected value of persistence across sunk time. Subjects performed two different puzzles, hereby labeled the ‘preliminary puzzle’ and the ‘main puzzle’. The preliminary puzzle depicted a woman, and the main puzzle a beach. The core of the procedure was that subjects performed the main puzzle for some time, and then chose whether to continue or quit. The preliminary puzzle served to balance fatigue across sunk-time conditions.

Method—Subjects. 195 undergraduate students participated in the experiment. Procedure. The independent variables were ‘sunk time’ and ‘obligation’, administered 2×2 between-subjects. Figure 2 displays the temporal layout of the procedure.

Sunk time: Subjects in the “short” condition did the preliminary puzzle for 50 minutes, followed by the main puzzle for 10 minutes. Subjects in the “long” condition did the preliminary puzzle for 10 minutes, followed by the main puzzle for 50 minutes.

Obligation: The levels of obligation were “obligatory” and “voluntary”. All subjects were asked to perform the preliminary puzzle. Subjects in the “obligatory” condition were then obliged to do the main puzzle. Subjects in the “voluntary” condition chose whether or not to undertake the main puzzle (“Choice 1” in Figure 2).

Procedure for “voluntary” condition: Participants were tested individually in a small room. They began by completing a brief personality questionnaire. The experimenter then brought the preliminary puzzle box to the table. The experimenter provided the following rules for doing the task: 1) all connected pieces must be on the table or in your hand; 2)

¹The “entrapment” procedures of Brockner and Rubin explored progress decisions in real time (for a review, see Brockner and Rubin, 1985), but those procedures did not manipulate sunk cost and most entailed a simultaneous expenditure of money and time.

pieces in your hand or inside the box may be face up; 3) all pieces on the table must be face down. Subjects were asked to connect the most pieces possible. The experimenter started a timer on the table set to 1 hour 30 minutes and explained that the timer displayed the time left in the overall experiment and that the task would not last the entire time. (The purpose of the timer was to allow the subjects to see the amount of time that remained when facing Choice 1 and Choice 2.) Subjects performed the task unwatched.

After the duration of the preliminary puzzle time, the experimenter counted the connected pieces, recorded the number and cleared the table. Subjects received a paper that displayed Choice 1. Choice 1 read:

Now you may choose from the following options:

Option A: “Stay the Whole Time”. Complete a series of questionnaires for the rest of the time showing on the timer.

Option B: “Leave Early”. Perform another puzzle task similar to the one you just finished and earn the chance to win the big prize leaving “Experiment 236” **30 minutes early!** That is, if you choose option B, you will do a new puzzle task (like the first one but with a different puzzle) until 30 minutes remain on the timer. At that time you will roll a pair of dice. If the number you roll equals 5 or less, you may leave!

On the other hand, if the number equals 6 or more, you must stay until 15 minutes remain on the timer before you may leave. Please tell the experimenter your choice.

The consequences of each option were as stated. If participants chose Option A, then they received questionnaires (and did not enter the main portion of the experiment). If participants chose Option B, then the experimenter brought the main puzzle box. The task rules were the same as those of the preliminary puzzle. The experimenter instructed the subjects to notify the experimenter when 30 minutes remained on the timer (the time of Choice 2, shown in Figure 2). After the duration of the main puzzle, subjects received the pair of dice. If the dice outcome totaled five or less, then the subjects were excused. If the outcome totaled six or more, then subjects received a paper that displayed Choice 2. Choice 2 read:

Now you may choose from the following options:

Option A: continue the current puzzle task for another 15 minutes, then go home

Option B: complete a series of questionnaires for 15 minutes, then go home

Please tell the experimenter your choice.

The response to Choice 2 was the principal dependent variable. The consequences of each option were as stated.

Procedure for condition “obligatory”: The “obligatory” condition lacked Choice 1 and the corresponding rubric of leaving the experiment early. Specifically, 1) The timer began with 1 hour 15 minutes (instead of 1 hour 30 minutes); 2) subjects did not receive Choice 1 but instead undertook the main puzzle obligatorily; 3) subjects received Choice 2 without having rolled dice.

Results—The dependent variable of primary interest was the response to Choice 2. The datum for each subject was coded nominally as “persist” or “quit”. Choice 1 Option A responses also were coded as “quit”, although these subjects never received Choice 2. This was necessary to eliminate the potential problem of self-selection that would have biased the voluntary-short or voluntary-long means toward persistence. Thus, the data will show what

happened to all subjects who participated in the experiment (save the ones who exited on a low dice-roll).

In the “obligatory-short” condition, 19/67 subjects (28%) chose to persist. In the “obligatory-long” condition, 15/68 subjects (22%) chose to persist. In the “voluntary-short” condition, 20/76 subjects (26%) chose to persist. In the “voluntary-long” condition, 34/70 subjects (49%) chose to persist. Neither main effect reached statistical significance, but the sunk cost * obligation interaction did, $\chi^2 = 3.85$, $df = 1$, $p < .05$. Figure 3 displays the percentages of persistence as a function of condition.

An alternative way to analyze the data would be to exclude the “quit” scores of the subjects who never performed the main puzzle. These would be 23 and 17 “quit” scores in the “voluntary-short” and “voluntary-long” conditions, respectively. The percentages of persistence become 39 and 66 in the voluntary-short and voluntary-long condition, respectively. The sunk cost * obligation interaction is still statistically significant, $\chi^2 = 4.54$, $df = 1$, $p < .05$, and the main effect of obligation becomes statistically significant, $\chi^2 = 12.52$, $df = 1$, $p < .001$. Notice that the latter result—a main effect of obligation may be explained at least partly by a self-selection effect. We therefore believe the original method of analysis is more appropriate.

Discussion—The results suggest two points. First, a sunk-time effect was observed (in the voluntary condition), lending behavioral support to the conclusion drawn from Experiments 1–4. Second, the sunk-time effect depended upon high personal responsibility, in support of H5.

The purpose of the preliminary task was to balance the level of fatigue across levels of sunk cost. Was it necessary to balance fatigue level? Apparently, yes. We later conducted the same experiment but with the preliminary task duration held constant (at 10 minutes) across sunk-cost conditions. The result was no sunk-cost effect, regardless of obligation, confirming the importance of fatigue. An alternative interpretation bears mentioning, however. Perhaps in the original experiment, the lengthy preliminary task de-motivated the “short” condition subjects, while “long” condition subjects had their motivation intact, leading to a fictitious sunk-cost effect. The data at least provide some evidence to the contrary. If de-motivation had occurred as mentioned then we would expect a substantially higher dropout rate (selection of Choice 1 Option A) in the voluntary-short condition, but the dropout rates of the voluntary-short and voluntary-long conditions were similar (30% and 24%, respectively).

In Experiment 6, we further manipulated personal responsibility by altering Choice 1. Formerly, Choice 1 explicitly stated the duration of the main puzzle. In Experiment 6, the text of Choice 1 was made ambiguous, in that the duration of the main puzzle was not stated. Subjects in Experiment 6 would be less personally responsible for the outcome of Choice 1, therefore we would predict less of a sunk-cost effect.

Experiment 6

Method

Subjects: 79 undergraduate students participated in the experiment.

Procedure: The procedure was identical to that of the voluntary condition of Experiment 5, except for the text of Choice 1. The new Choice 1 read:

Now you may choose from the following options:

Option A: “Stay the Whole Time”. Complete a series of questionnaires for the rest of the time showing on the timer.

Option B: “Leave Early”. Perform another puzzle task similar to the one you just finished and earn the chance to win the big prize—leaving “Experiment 236” **early!** That is, if you choose option B, you will do a new puzzle task (like the first one but with a different puzzle) for a certain amount of time (unknown to you). Then you will roll a pair of dice. If the number you roll equals 5 or less, you may leave right away! On the other hand, if the number equals 6 or more, you must stay here a little longer before you may leave (but you will still leave **before** the timer gets to zero).

Please tell the experimenter your choice.

Results—39 and 40 subjects participated in the short and long condition, and the percentage of subjects who persisted was 26 and 29, respectively. The difference was not statistically significant.

Discussion—A study by Schoorman and Holahan (1996) has suggested that where so-called “personal responsibility” impacts choice, it is not personal responsibility *per se* but rather the simple act of choosing that attaches one to a course of action. The present results, on the other hand, suggest the simple act of choosing may be insufficient. Post-experiment interviews revealed that subjects in the long condition expected the main task to be short. Therefore we can say these subjects were “tricked” into initiating the main puzzle, and therefore they had low personal responsibility for their fate (of spending 50 minutes on a dull task). Subjects in the long condition of Experiment 5, conversely, had high personal responsibility for their fate because they chose it knowingly. Thus, Experiments 5 and 6 support H5, and also specify the type of decision that is relevant to the sunk-cost effect. Finally, we tested the robustness of H5 by repeating Experiment 5 with a different task, in Experiment 7.

Experiment 7

Method

Subjects: 261 undergraduate males and females participated in the experiment.

Procedure: The procedure was identical to that of Experiment 5 but with a different activity. Instead of putting together a jigsaw puzzle, subjects organized decks of playing cards. They were given a plastic bin containing between six and ten complete decks, each deck having a different design. Subjects were instructed to organize the cards on a table according to the following rules: 1) each deck is to form a separate, ordered column on the table; 2) first, search for every ace of hearts in the bin, then every two of hearts, then every three of hearts, and so on until king of hearts, then continue with ace through king of spades, then ace through king of diamonds, and finally ace through king of clubs; 3) cards inside the bin may not be organized in any fashion. The preliminary bin was white and contained six decks, and the main bin was red and contained 10 decks.

The experimental conditions repeated those of Experiment 5.

Results—In the “obligatory-short” condition, 11/63 subjects (18%) chose to persist. In the “obligatory-long” condition, 25/64 subjects (39%) chose to persist. In the “voluntary-short” condition, 9/66 subjects (14%) chose to persist. In the “voluntary-long” condition, 21/68 subjects (31%) chose to persist. Figure 4 displays the percentage of subjects who persisted

as a function of condition. The main effect of sunk cost was statistically significant, $\chi^2 = 12.37$, $df = 1$, $p < .001$. No other effects reached significance.

The average number of completed rows of cards was 1.27 ($SD = .54$) in the “short” conditions, and 9.50 ($SD = 4.88$) in the “long” conditions. In the “short” conditions, the highest observed number was 4 rows out of a possible 86; in the “long” conditions the highest observed number was 28 rows out of a possible 140. The average number of completed pieces among persisters and non-persisters in the “short” conditions was 1.33 and 1.26, respectively, and in the “long” conditions was 9.78 and 9.34, respectively. Neither pair of means revealed a statistically significant difference in task progress between persisters and non-persisters.

Discussion—The present results again suggest a sunk-time effect. Contrary to the finding in Experiment 5, however, the present results show the effect both in the presence and absence of personal responsibility. Why did the present results differ from those of Experiment 5? The discrepancy lies in the obligatory conditions (compare the “obligatory” lines displayed in Figures 3 and 4—the line in Figure 3 is relatively flat while the line in Figure 4 is slanted upward). One explanation involves a difference in sunk effort. Effort is a variable the experimenter has little control over—subjects ultimately decide how much effort to impart on any task, no matter the instructions or features of the experiment. The ‘obligatory’ conditions, thus, could only be obligatory in terms of time. A casual observation by the experimenter was that subjects overall appeared to impart more effort on the card-sorting task, perhaps because it was easier. Thus, we hypothesize the reason more subjects persisted in the card-sorting task is that those subjects chose to impart more effort.

To test the aforementioned effort hypothesis, we had a new group of subjects perform the puzzle and card-sorting tasks for forty minutes apiece, with order counterbalanced across subjects, and then answer several questions, including: “Which task was more difficult?” and “On which task did you expend more effort? The proportion of subjects who selected the card-sorting task as being more difficult was .16 (significantly different from .5, $t(61) = 7.19$, $p < .0001$). The proportion of subjects who reported expending more effort on the card-sorting task was .65 (significantly different from .5, $t(61) = 2.36$, $p < .05$). From the framework of personal responsibility effects, the suggestion is that in the card-sorting task, subjects in the obligatory-long condition persisted in response to their prior (private) choice to impart effort on the task. Of course, this conclusion is tentative. A more definitive conclusion would require evidence that card-sorting subjects consider the effort to be their own choice. Still, the set of findings from Experiments 5 through 7 provides support for H5b.

Finally, as we did with the puzzle experiment, we tested the role of fatigue in the card-sorting experiment. We repeated the obligatory condition but without the preliminary task. The result was no sunk cost effect, suggesting again that unequal fatigue levels may counteract any sunk-cost effect.

General Discussion

The present experiments found support for the following hypotheses: *H1: The likelihood of selecting a given alternative from a set of alternatives is a function of the time already spent on the given alternative; H5b) In the absence of personal responsibility, there will be no sunk cost effect.*

Experiments 1, 2, and 3 suggested sunk-time effects are robust to manipulations of time quality, countering H2 and H3. Does this mean time quality can be irrelevant to sunk-time phenomena? Possibly, but many factors may account for our null finding. First, subjects did

not directly experience the sunk cost. Second, the time-quality manipulations may have introduced confounds that countered any sunk cost effect. For example, more effort spent may indicate more tiredness to the reader (in Experiments 1 and 3), and more boredom spent may indicate more frustration to the reader (in Experiment 2). Third, the experiments did not tap into a potentially important factor, error in time estimation (Chaston and Kingstone, 2004). In summary, the issue of time quality needs further exploration.

Let us briefly assess a particular aspect of our behavioral procedure, namely, that subjects performed an endeavor in the absence of an explicit reward. This is within the definitional boundaries of the sunk cost effect, and plenty of real-life behaviors may occur in the absence of tangible end-goals, but at the same time most sunk-cost procedures have involved end-goals. Future research could study whether the presence versus absence of an explicit end-goal impacts the influence of time spent. In the puzzle experiment, an end-goal such as a monetary reward for completing the task might heighten the sunk-cost effect or possibly mitigate the effect of personal responsibility.

Generality of sunk cost effects across species

The human literature on the sunk-cost effect largely has operated on the assumption that such a phenomenon is uniquely human. The literature has focused on forms of behavior that only humans could engage in, such as being a financial officer, and theories accommodating the effect tend to emphasize processes that presumably only humans would engage in, such as following social norms or responding to an inner desire to prove oneself correct. However, the view that the sunk-cost effect may generalize to any form of behavior facilitates one's willingness to accept that the effect may generalize to other species as well (and vice-versa). A review by Arkes and Ayton (1999) concluded there have been no clear-cut examples of sunk-cost effects in nonhuman animals, but recent studies appear to be providing examples (Clement, Feltus, Kaiser, Zentall, 2000; Kacelnik and Marsh, 2002; Navarro and Fantino, 2005; Xochitil, Field, and Rachlin, 2006). For instance, if pigeons (Clement et al., 2000) and starlings (Kacelnik and Marsh, 2002) are given a choice between several stimuli that are equally associated with food, they will prefer the stimulus that in previous training was presented contingent on the highest workload. On the surface, this finding equates to the "adoption decisions" studied in the human literature, such as the frozen dinner problem of Arkes (1996), in which subjects preferred to utilize the most expensive of three identical frozen dinners. This finding also resonates with the present findings, in that preference for a stimulus (a future course of action) was a function of the time involved in achieving that stimulus. Clement et al. (2000) proposed an explanation for this finding -- the value of a reward (and stimuli associated with the reward) is inversely related to the hedonic state of the animal when the reward is presented. A recent study also appeared to find a personal responsibility by sunk cost interaction in pigeons (Xochitil, Field, and Rachlin, 2006). Presumably the pigeons were not engaging in self-justification.

Further work will need to establish whether all sunk cost phenomena, including those found in animals, are linked to the same causal mechanism. Nevertheless, the point is that we see a growing need to take into consideration more fundamental processes underlying sunk cost and personal responsibility effects. One such underlying process has been suggested to us (Ralph Hertwig, personal communication, May 22, 2008). Perhaps the sunk cost effect is an evolved tendency. In many environments the effect is adaptive. For example, parents in an environment of scarcity are wise to use the cue "already invested resources" in deciding which offspring to give the most resources to. An evolved tendency such as this would be expected to overgeneralize to an extent, and these over-generalizations might be what contemporary research has focused on.

Conclusion

In conclusion, we have presented evidence that the sunk-cost effect in humans is not restricted to money, but rather occurs with time as well. Four questionnaire experiments showed the temporal effect to be robust to manipulations of prospective value, individual versus group consequences, and the level of effort or enjoyment inherent in the sunk time. Two behavioral experiments also found support for sunk-time effects, and found support for the hypothesis that personal responsibility and sunk costs interact.

Acknowledgments

Research and manuscript preparation were supported by National Institute of Mental Health Grant MH57127.

References

- Arkes HR. The psychology of waste. *Journal of Behavioral Decision Making*. 1996; 9:213–224.
- Arkes HR, Ayton P. The sunk cost and concorde effects: Are humans less rational than lower animals? *Psychological Bulletin*. 1999; 125:591–600.
- Arkes HR, Blumer C. The psychology of sunk cost. *Organizational Behavior and Human Decision Processes*. 1985; 35:124–140.
- Arkes HR, Hutzler L. The role of probability of success estimates in the sunk cost effect. *Journal of Behavioral Decision Making*. 2000; 13:295–306.
- Bazerman M, Giuliano T, Appleman A. Escalation of commitment in individual and group decision-making. *Organizational Behavior and Human Performance*. 1984; 33:141–152.
- Brockner J. The escalation of commitment to a failing course of action: Toward theoretical progress. *Academy of Management Review*. 1992; 17:39–61.
- Brockner, J.; Rubin, JZ. *Entrapment in escalating conflicts: a social psychological Analysis*. New York: Springer-Verlag; 1985.
- Bem DJ. Self-perception: An alternative interpretation of cognitive dissonance phenomena. *Psychological Review*. 1967; 74:183–200. [PubMed: 5342882]
- Bowen MG. The escalation phenomenon reconsidered: Decision dilemmas or decision errors? *Academy of Management Review*. 1987; 12:52–66.
- Bragger JL, Bragger DH, Hantula DA, Kirnan JP. Hysteresis and uncertainty: The effect of information on delays to exit decisions. *Organizational Behavior and Human Decision Processes*. 1998; 74:229–253. [PubMed: 9719653]
- Chaston A, Kingstone A. Time estimation: The effect of cortically mediated attention. *Brain and Cognition*. 2004; 55:286–289. [PubMed: 15177797]
- Clement TS, Feltus JR, Kaiser DH, Zentall TR. “Work ethic” in pigeons: Reward value is directly related to the effort or time required to obtain the reward. *Psychonomic Bulletin & Review*. 2000; 7:100–106. [PubMed: 10780022]
- Davis MA, Bobko P. Contextual effects on escalation processes in public sector decision making. *Organizational Behavior and Human Decision Processes*. 1986; 37:121–138.
- Fantino, E.; Navarro, A.; Stolarz-Fantino, S. Multiple causes of the sunk cost effect. In: Burthold, Gloria R., editor. *Psychology of decision-making: Legal and healthcare settings*. Nova Science Publishers, Inc; 2008. p. 141–157.
- Fox FV, Staw BM. The trapped administrator: Effects of job insecurity and policy resistance upon commitment to a course of action. *Administrative Science Quarterly*. 1979; 24:449–471.
- Garland H. Throwing good money after bad: The effect of sunk costs on the decision to escalate commitment to an ongoing project. *Journal of Applied Psychology*. 1990; 75:728–731.
- Garland H, Newport S. Effects of absolute and relative sunk costs on the decision to persist with a course of action. *Organizational Behavior and Human Decision Processes*. 1991; 48:55–69.
- Goltz SM. Can’t stop on a dime: The roles of matching and momentum in persistence of commitment. *Journal of Organizational Behavior Management*. 1999; 19:37–63.

- Heath C. Escalation and de-escalation of commitment in response to sunk-costs: The role of budgeting in mental accounting. *Organizational Behavior and Human Decision Processes*. 1995; 62:38–54.
- Kacelnik A, Marsh B. Cost can increase preference in starlings. *Animal Behavior*. 2002; 63:245–250.
- Levin IP, Schneider SL, Gaeth GJ. All frames are not created equal: A typology and critical analysis of framing effects. *Organizational Behavior and Human Decision Processes*. 1998; 76:149–188. [PubMed: 9831520]
- McCain BE. Continuing investment under conditions of failure: A laboratory study of the limits to escalation. *Journal of Applied Psychology*. 1986; 71:280–284.
- Moon H. Looking forward and looking back: Integrating completion and sunk-cost effects within an escalation-of-commitment progress decision. *Journal of Applied Psychology*. 2001; 86:104–113. [PubMed: 11302222]
- Navarro AD, Fantino E. The sunk cost effect in pigeons and humans. *Journal of the Experimental Analysis of Behavior*. 2005; 83:1–13. [PubMed: 15762377]
- Navarro AD, Fantino E. The role of discriminative stimuli in the sunk-cost effect. *Mexican Journal of Behavior Analysis*. 2008; 33:19–29.
- Schaubroeck J, Davis E. Prospect theory predictions when escalation is not the only chance to recover sunk costs. *Organizational Behavior and Human Decision Processes*. 1994; 57:59–82.
- Schoorman DF, Holahan PJ. Psychological antecedents of escalation behavior: Effects of choice, responsibility, and decision consequences. *Journal of Applied Psychology*. 1996; 81:786–794. [PubMed: 9019126]
- Soman D. The mental accounting of sunk time costs: Why time is not like money. *Journal of Behavioral Decision Making*. 2001; 14:169–185.
- Staw BM. Knee-deep in the big muddy: A study of escalating commitment to a chosen course of action. *Organizational Behavior and Human Performance*. 1976; 16:27–44.
- Staw, BM. Escalation research: An update and appraisal. In: Shapira, Z., editor. *Organizational decision making*. Cambridge, England: Cambridge University Press; 1997. p. 191–215.
- Staw BM, Fox F. Escalation: Some determinants of commitment to a previously chosen course of action. *Human Relations*. 1977; 30:431–450.
- Staw BM, Hoang H. Sunk costs in the NBA: Why draft order affects playing time and survival in professional basketball. *Administrative Science Quarterly*. 1995; 40:474–494.
- Tan H, Yates JF. Financial budgets and escalation effects. *Organizational Behavior and Human Decision Processes*. 2002; 87:300–322.
- Whyte G. Escalating commitment to course of action: A reinterpretation. *Academy of Management Review*. 1986; 11:311–321.
- Whyte G. Escalating commitment in individual and group decision making: A prospect theory approach. *Organizational Behavior and Human Decision Processes*. 1993; 54:430–455.
- Xochitil DLP, Field D, Rachlin H. The influence of prior choices on current choice. *Journal of the Experimental Analysis of Behavior*. 2006; 85:3–21. [PubMed: 16602373]

Figure 1. Hypothetical data patterns. The top graph corresponds to hypothesis 4; the bottom graph corresponds to hypothesis 5a.

Figure 2.

Time layout of procedure of Experiments 5, 6, and 7. Horizontal bars represent sequentially the following moments: when the procedure began, when Choice 1 was made, when Choice 2 was made, and when the procedure ended. Only subjects in the “voluntary” condition were given Choice 1, during which subjects chose whether to undertake the main task or instead do questionnaires. All subjects received Choice 2, during which subjects chose whether to continue the main task or instead do questionnaires

Figure 3. Results of Experiment 5. Percentage of subjects who persisted in the task as a function of sunk time.

Figure 4. Results of Experiment 7. Percentage of subjects who persisted in the task as a function of sunk time.