The sunk cost effect previously has been demonstrated with sunk costs of money, but not of time. The present studies explored the potential for a sunk "time" effect by using both the questionnaire method and a behavioral method. The results of the questionnaire experiments (Experiments 1-5) suggest that a sunk time effect does exist, and that certain qualities of the sunk time, such as how fun or boring it is, might impact the effect. The results of the behavioral experiments (Experiments 6-9) also generally suggest a sunk time effect. Some of the behavioral experiments tested the prediction that personal responsibility for initiating sunk cost is a prerequisite of the sunk time effect. The results of Experiment 6 support the prediction while the results of Experiment 8 counter it. Experiment 9 indicates that sunk effort might have been relatively prominent in Experiment 8, leaving open the possible role of personal responsibility, and Experiment 7 suggests that where personal responsibility is a necessary precursor, it is commitment to a long sunk time, rather than mere choice, that heightens persistence. The results are discussed in terms of self-justification theory as well as other theories that may account for the sunk cost fallacy.
The Sunk Cost Effect of Time: An Exploration and an Explanation

A dissertation submitted in partial satisfaction of the
requirements for the degree Doctor of Philosophy
in
Psychology

by
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2007
The dissertation of Anton Domingo Navarro is approved, and it is acceptable in quality and form for publication on microfilm:

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Chair

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2007
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The Sunk Cost Effect of Time: An Exploration and an Explanation

by

Anton Domingo Navarro

Doctor of Philosophy in Psychology

University of California, San Diego, 2007

Professor Edmund Fantino, Chair

The sunk cost effect previously has been demonstrated with sunk costs of money, but not of time. The present studies explored the potential for a sunk “time” effect by using both the questionnaire method and a behavioral method. The results of the questionnaire experiments (Experiments 1-5) suggest that a sunk time effect does exist, and that certain qualities of the sunk time, such as how fun or boring it is, might impact the effect. The results of the behavioral experiments (Experiments 6-9) also generally suggest a sunk time effect. Some of the behavioral experiments tested the prediction that personal responsibility for initiating sunk cost is a prerequisite of the sunk time effect. The results of Experiment 6 support the prediction while the results of Experiment 8 counter it. Experiment 9 indicates that sunk effort might have been relatively prominent in Experiment 8, leaving open the possible role of personal responsibility, and Experiment 7 suggests that where personal responsibility is a necessary precursor, it is commitment to a long sunk time, rather than mere choice, that heightens persistence. The results are discussed in terms of self-justification theory as well as other theories that may account for the sunk cost fallacy.
I. Introduction

Background

The literature of decision-making has documented a variety of “decision errors,” or varieties of decisions that appear to violate logical reasoning. One such error is the sunk cost fallacy, the increased tendency to persist in an endeavor as the invested amount of money, time, or effort increases (Arkes and Blumer, 1985). The tendency is considered irrational because it counters the maxim that only incremental costs and benefits should impact decisions, not past costs. The bearing of the error is suggested largely by anecdotes pointed out in the literature. One example is the funding of the Tennessee-Tombigbee Waterway (a channel connecting the Tennessee and Tombigbee rivers). In the 1970s, U.S. Congress repeatedly authorized funds for the channel despite skyrocketing cost estimates and growing indications that the channel would not even serve its intended purpose (Arkes and Blumer, 1985). The sunk-cost interpretation is that the investments early on caused the persistence later on when the project should have been canceled. Another case is the United States’ prolonged involvement in the Vietnam War (Staw, 1976). After the early years of the war produced little success, a series of escalations elongated the war for roughly a decade despite the widespread opinion that persistence was futile. To the extent that sunk costs actually prompted the final decade of the war, the exorbitant toll for the United States by the war’s end indicates how deleterious the fallacy may be. The United States involvement in the Iraq War arguably has followed a similar pattern of unwise persistence, and some analysts have interpreted the 2007 escalation in terms of sunk costs (Puvathingal and Hantula, 2007). At the level of individual decision-making, people appear to honor sunk costs quite routinely.
College students may persist in a major they dislike, scientists may press on with a fruitless research project, and a car owner may cling to an old car in constant need of repair, all in response to sunk costs. In romantic relationships, common experience suggests it is frustratingly easy to persist despite poor returns once enough emotional investment has been incurred. A few moments of reflection may turn up many more examples.

Despite appearances, of course, anecdotal cases in no way prove the existence of the sunk cost fallacy. In order for a decision to merit this label, explanations based on marginal cost and benefit must be ruled out. This is an impossible task with anecdotal cases (and surprisingly difficult with controlled experiments) since in each one a future-oriented account of behavior is readily available: The collegiate about to complete an undesirable major may in fact gain from its completion. Lovers may remain in an unsatisfactory relationship to avoid the even-worse pain of separation. Governing bodies in the midst of a losing war may be responding rationally to the limited marginal cost and benefit data available at the time. President Bush would cite this argument in regard to his recent decision to escalate, and it cannot be proven that his choice was "wrong." In line with such interpretations, some have suggested the sunk cost fallacy is only an illusion, a post hoc label for persistence in a course of action that ended up failing. Persistence appears rational at the time of the decision and therefore there is no such thing as a true “sunk cost” effect (as implied by Bowen, 1987; McCain, 1986).

So is the effect illusory or real? The possibility that it is real has, deservingly, spurred a great deal of research over the past three decades. Out of the many findings, one core finding may be summarized as follows: The effect has been obtained in
controlled studies, but only when the sunk costs are monetary, as opposed to non-monetary. Let us now examine a few experimental demonstrations of the sunk “money” effect.

**Experimental demonstrations of the sunk money effect**

Arkes and Blumer (1985) provided evidence for the sunk money effect in a landmark series of ten experiments. In the most compelling one (Experiment 2), a university theater box office sold season tickets randomly at three different prices: either the regular price or one of two discounted prices (the lucky customers who paid a discounted price were not informed of the discount until after they had requested the tickets). The result was that during the first half of the season, the full-price group attended on average one more play than each of the two discount groups, a small but statistically significant sunk cost effect. Although minor, the result is remarkable for three reasons: The effect was obtained in a natural setting; we can assume the groups were equally endowed (differing only by a few dollars); and the marginal cost and benefit of attendance presumably were equal across groups. The remainder of the experiments reported by Arkes and Blumer (1985) involved the questionnaire method. In Experiment 3, for example, participants read one of the following questions:

**Question A.** As the president of an airline company, you have invested $10 million of the company's money into a research project. The purpose was to build a plane that would not be detected by conventional radar, in other words, a radar-blank plane. When the project is 90% completed, another firm begins marketing a plane that cannot be detected by radar. Also, it is apparent that the airplane is much faster and far more economical than the plane your company is building. The question is: should you invest the last 10% of the research funds to finish your radar-blank plane?

**Question B.** As president of an airline company, you have received a suggestion from one of your employees. The suggestion is to use the last
$1 million of your research funds to develop a plane that would not be detected by conventional radar, in other words, a radar-blank plane. However, another firm has just begun marketing a plane that cannot be detected by radar. Also, it is apparent that the airplane is much faster and far more economical than the plane your company could build. The question is: should you invest the last million dollars of your research funds to build the radar-blank plane proposed by your employee?

Notice that in both questions, the dilemma is whether to spend $1 million on a project with a limited chance for success. (In Question A, the $1 million amount is not stated but may be inferred). The difference is that in Question A, millions of dollars have already been spent—sunk cost is high—whereas in Question B, there are no sunk costs. The result: 80% of the participants in the high condition answered "yes", contrasted with only 17% of the participants in the low condition. Again, the sunk cost effect was observed, and quite robustly. The remainder of the experiments using the questionnaire method revealed a sunk money effect as well.

Several more studies have obtained the effect in the domain of monetary investments (Arkes, 1996; Arkes and Hutzel, 2000; Garland, 1990; Garland and Newport, 1991; Moon, 2001). These studies have tested both “progress decisions” and “adoption decisions” also using strictly the questionnaire method. Progress decisions correspond to the radar-blank plane example above: the investor must decide whether to continue pouring investments toward an ongoing course of action. Adoption decisions correspond to the theater ticket study: one must decide whether to consume an already-purchased item. The main difference between the two types of decisions is in the nature of the incremental cost (Garland, 1990). In progress decisions the incremental cost is of the same nature as the sunk cost, while in adoption decisions incremental and sunk costs are qualitatively different. In progress decisions, the value of each alternative in the
questionnaire typically is kept ambiguous so that the reader cannot calculate exactly which alternative is optimal. (In fact, scenarios that provide complete and transparent economic information might not produce the usual sunk cost effect; Heath, 1995). The effect has been obtained with the subjective probability of success of the sunken alternative held constant across levels of sunk money (Arkes and Hutzel, 2000; Moon, 2001), showing that sunk money information is truly to blame for the effect, rather than confounded changes in the incremental costs or benefits. Beyond the existence of a basic sunk money effect, it appears the effect is linear (Garland, 1990), and the relative size of the sunk money matters more than its absolute size (Garland and Newport, 1991). The escalation literature has suggested a similar impact of monetary investments (Bazerman, Giuliano, & Appleman, 1984; Davis & Bobko, 1986; Schaubroeck & Davis, 1994; Schoorman & Holahan, 1996; Staw, 1976; Staw & Fox, 1977; Whyte, 1993). Escalation is the same concept as the sunk cost effect but the two terms relate to different methodologies. Escalation studies do not manipulate sunk cost but rather hold this factor constant while varying other factors. Regardless, given the sizable collective evidence we may tentatively conclude the sunk money effect is a true phenomenon.

Presently, two major issues remain unresolved in the sunk cost literature. One is, will non-monetary sunk costs produce an effect? Sunk-cost researchers commonly have assumed they would, but although the issue scarcely has been studied the available data point to a strictly monetary phenomenon. The second issue has received more attention but remains unresolved: what is the psychological mechanism responsible for the effect? A question central to this issue is whether personal responsibility for the previous investment on the part of the decision-maker is a necessary precursor of the sunk cost
effect. The answer has special implications for the theory of self-justification. The following sections elaborate on these issues.

**Issue #1: Money vs. time vs. effort**

The widely-accepted definition of the sunk cost effect proposed by Arkes and Blumer (1985) assumed three possible types of sunk costs: money, time, and effort. One could find types of investment that fall outside of these categories, such as deaths in a war, but for the most part the three terms cover the range of possibilities. Given this definition, and given the wealth of research on monetary investments, it is surprising that almost no published studies have examined investments of time or effort. We know of only one such study (Soman, 2001). No doubt, more are needed. Moreover, in contradiction to the above definition, Soman (2001) found no effect of sunk time. In four experiments (Experiments 1, 2, 3, and 6), sunk cost information was expressed monetarily in one set of conditions and temporally in another set. The results of each experiment showed that while the size of monetary costs affected behavior, the size of temporal costs did not. Experiments 4 and 5 found an effect of sunk time but only when a wage rate was associated with the time or when subjects received instruction about economic approaches to time. Soman suggested mental accounting explains the apparent difference between money and time: We habitually keep track of the money we have spent (i.e., we form mental accounts of monetary spending), but we largely ignore or forget the amount of time we have spent on matters. This hypothesis being true or not, the evidence to date implies the sunk cost effect is restricted to the monetary kind.

However, with only one published study on the sunk time effect and zero on the sunk effort effect, the potential for these effects begs further exploration. The ultimate
finding could bear on several issues: Is it necessary to educate people on the pitfalls of attending to sunk time and/or effort investments? Some have suggested such training with regard to monetary investments would benefit the financial decision-making of businesses and organizations. Do theories of mental accounting need to incorporate time and/or effort variables? Do theories of the sunk cost effect that work in the domain of money also work in the domain of time and/or effort? Anecdotal evidence and our imagination point to a sunk time effect, but as described earlier anecdotal cases are impossible to interpret cleanly. Resolving the issue with more controlled studies is necessary. Therefore, the present experiments are intended as a step toward discovering what impact time and effort costs may have on persistence.

Soman (2001) pointed out that a fruitful area of study might be to explore how the quality of sunk time determines its impact. Along this line, we employed a change to the conceptual distinction between time and effort sunk costs. The phrase “I spent a lot of effort” may be rephrased more accurately, “the time I spent was effortful.” The latter phrasing acknowledges that effort necessarily involves time. Also, with the latter phrasing, effort may be viewed as simply a feature of sunk time. In this manner, the “money, time, and effort” distinction is reduced to “money and time”, with time having potentially important qualifiers. Of course, there are many possible qualifiers of sunk time: time may be boring, exciting, scary, tense, or funny, to name a few. The present experiments examine two such qualifiers: degree of physical effort and degree of boredom. A prediction deducible from most of the theories covering the sunk cost effect is that any feature of sunk time that increases its negative utility will, all else equal,
exaggerate the sunk time fallacy. Accordingly, high degrees of sunk effort and boredom should raise persistence.

**Issue #2: Role of personal responsibility**

A separate issue has received more attention in the literature but remains unresolved: what is the theoretical framework from which to view the sunk cost effect? At the present time, four major theories account for behavior in sunk cost situations. Three of the theories assume the effect involves irrational behavior, and one of the theories assumes that individuals in a sunk cost scenario actually behave according to normative logic. The three "irrational" theories include self-justification, which asserts that we experience a psychological need to justify or rationalize our past behavior when it falls short of its goal (Staw, 1976); prospect theory, which posits that individuals are risk-seeking in the domain of losses, and that sunk costs place the decision-maker in the domain of losses (Whyte, 1986); and waste-avoidance, which posits that we overgeneralize a social rule akin to "don’t waste" (Arkes & Ayton, 1999). The fourth, rational theory has not been given a concrete name, but may be termed the “normative” theory. The present paper identifies this theory as a general viewpoint espoused by various studies reported in the literature (Bowen, 1987; Bragger, Bragger, Hantula, & Kirnan, 1998; Goltz, 1999; McCain, 1986, and Navarro and Fantino, 2005). These studies have offered the general suggestion that individuals in sunk cost situations attempt to undertake the course of action with the highest marginal profit. Individuals may persist in a losing course of action not because they irrationally focus on prior costs but because the changes in the contingency for the worse (in progress decisions) are not
discriminable. Given appropriate information or learning, the individual will behave optimally.

Self-justification is the theory that has received probably the most attention from sunk-cost researchers, and is the focus of the present study. (The reader is referred to the General Discussion for an explication of the remaining theories). Self-justification is a hypothetical process said to occur as a result of cognitive dissonance (Aronson, 1968; Festinger, 1957). The key finding from the forced compliance literature is that individuals will rate a dull task as being more enjoyable when they have received only a meager reward for the task compared to when they have received a sizable reward (Festinger & Carlsmith, 1959; Freedman, 1963). According to dissonance theory, performing a dull task for a meager reward may result in the following dissonant thoughts: “I’m a good decision-maker” (a thought most people maintain) yet “I made a bad decision when I agreed to perform the dull task.” The dissonance is assumed to be aversive, and self-justification is the process that reduces the dissonance—the person unconsciously justifies or rationalizes the prior decision and in essence concludes it was a “good idea.” The theory lends itself easily to a sunk cost situation. When a person has chosen a course of action that later becomes undesirable, the person will have a similar pair of dissonant thoughts as above. As in the above example, the person will reduce the dissonance by defending the prior decision. This leads to continuing with the endeavor as if it were a “good idea,” resulting in the sunk cost fallacy.

Staw (1976) was the first to test the above theory, and did so in an escalation paradigm. He hypothesized that if self-justification leads to escalation, then a person should commit most to a project when it has brought on negative consequences and the
person is responsible for initiating the endeavor. In a seminal experiment, college students answered a series of hypothetical questions in which they played the role of Financial Vice President of the "Adams & Smith Company". Subjects were told that the company had been in decline for several years and that the directors had requested that $10 million in research and development funds be made available to one of the company's two largest divisions. Subjects then read descriptions of the two divisions and decided which one should receive the $10 million. The next portion of the questionnaire was set five years later. Some subjects received news that the chosen division had declined financially, while other subjects were told the chosen division had improved. Subjects were asked to distribute an additional $20 million between the two divisions.

Meanwhile, another group of subjects faced the same “declined vs. improved” manipulation with the difference that this group only made the second decision—the first decision, subjects were informed, had been made by another financial officer. Thus, these subjects were not personally responsible for the original choice (or its outcome).

The dependent variable was the size of the allocation given to the previously-chosen division. The results were consistent with Staw’s prediction: the largest allocation came from subjects who were personally responsible for negative feedback.

Since the time of Staw's (1976) study, numerous studies have replicated the finding that given a failing course of action, personal responsibility increases commitment to that course of action (Bazerman, Giuliano, & Appleman, 1984; Davis & Bobko, 1986; Schaubroeck & Davis, 1994; Schoorman & Holahan, 1996; Staw & Fox, 1977; Whyte, 1993). This finding is the cornerstone of the self-justification account of the sunk cost effect, as no other theory directly predicts this finding. Additional evidence
in favor of self-justification comes from studies showing that, within the realm of personal responsibility, other factors that should affect a person's need to defend past behavior also affect the level of persistence. All else equal, the decision-maker will persist relatively more as job insecurity increases (Fox and Staw, 1979), and persist relatively less if coworkers are present who will shoulder the blame for the losing project (Heng, Tan, and Wei, 2003), or if personal responsibility for the failed sunk investment falls on a group rather than on an individual (Bazerman et al., 1984; Moon, Conlon, Humphrey, Quigley, Devers, & Nowakowski, 2003). Motives of justification may stem solely from social concerns—the decision-maker’s desire to prove to others that a prior decision was correct—and also from personal concerns—the decision-maker’s desire to prove to himself that a prior decision was correct (Fox and Staw, 1979). Altogether, the role of justification is widely supported.

Next, let us examine the limitations of the theory. Firstly, motives of justification apparently cease to impact behavior once economic reasons for quitting become sufficiently obvious or strong (McCain, 1986; Staw & Fox, 1977; Staw & Ross, 1978). For instance, after a person repeatedly has attempted persistence and the project is still failing, persistence tends to decrease (McCain, 1986; Staw and Fox, 1977). Self-justification wrongly predicts that persistence should increase in this situation since the decision-maker has more and more prior decisions to rationalize. Additional research indicates more generally that in sunk cost situations people are normatively motivated (Bragger, Bragger, Hantula, Kirnan, & Kutcher, 2003; Rubin & Brockner, 1975; Goltz, 1999; Navarro & Fantino, 2005; Navarro & Fantino, 2008; Northcraft & Neale, 1986). The more obvious the downturn of a course of action, the more likely the decider is to
quit or switch to an alternative course. This comprises the evidence supporting the “normative” theory of the sunk cost effect. However, there is a crucial caveat to the normative argument: “sunk cost effect” may refer specifically to the differential effect of sunk costs on behavior when economic variables are held constant. As described earlier, such an effect has been demonstrated in controlled studies (Arkes and Hutzel, 2000; Moon, 2001; and arguably the theater-ticket experiment of Arkes and Blumer, 1985). This suggests a limitation to the normative theory, and allows room for self-justification or another “irrational” theory of choice behavior. Altogether, the preceding analysis paints the following picture: Justification motives and normative motives exert opposing forces on the decision-maker, and the relative strength of the forces dictates choice.

Another limitation of self-justification is that although personal responsibility appears to promote the sunk cost effect, it remains unclear whether this factor is necessary for the sunk cost effect. Studies that have manipulated both sunk cost and personal responsibility have found a sunk cost effect despite no personal responsibility (Arkes and Blumer, 1985; Whyte, 1993). For example, Arkes and Blumer (1985, Experiment 8) repeated the radar-blank plane study with a small change in the scenario: instead of it beginning with “As the president of an airline company, you have invested…” the scenario began with “The Acme Airlines Company has invested…” In the latter case, the reader presumably is unattached and not personally responsible. The result was that sunk costs still had an effect (albeit a smaller one), a sunk cost effect that self-justification cannot explain. However, the aforementioned studies may have inadvertently motivated public or external justification (Fox & Staw, 1979). Both studies asked the reader to envision a large company in the context of a competitive market. By
continuing the project, one assumes, the company could save face and therefore remain competitive, maintain its stock value, or keep from losing its customers. External justification and internal justification may be two different things, but the point is that some form of justification may, in principle, explain the observed effect. Alternatively, the above interpretation suggests that normative considerations may have led to persistence.

To conclude, the following questions remain unresolved: To what extent does personal responsibility underlie the sunk money effect? To what extent does it underlie the sunk time or effort effects, if they exist? The latter question is the more pertinent one to the present study. If personal responsibility is shown conclusively not to be a prerequisite of the sunk cost effect in one or more investment domains, two possibilities arise. One is that multiple causes of the sunk cost effect are assumed, with self-justification being just one of those causes. The other, of course, is the recognition of a single, more predictive theory for this phenomenon.

Goals of the present experiments

The present experiments addressed the following questions: 1) what effect do sunk costs of time have on the decision of whether to persist in an endeavor; 2) does the quality of the sunk time—whether it is effortful or easy, boring or exciting—determine its impact; 3) is personal responsibility a necessary precursor of the sunk time effect?

These questions were addressed variously with the use of two different methods: questionnaires and behavioral tasks. The questionnaire method has been used by virtually all prior studies reported in the literature, and it is most valuable for its practicality. We utilized the method in half the experiments both for the practicality and
to stay consistent with prior research. At the same time, we believe the questionnaire method is highly limited in external validity—do people's guesses as to how they would behave in a hypothetical situation they have never before faced accurately reflect their outside-the-laboratory behavior in which sunk cost is experienced, not read, and choices have consequences? It is an open question with regard to the sunk cost effect that has hardly been addressed, a fact that strongly limits any real-world implications of the current literature. We address the question in the realm of sunk time. Chapter 2 contains the questionnaire experiments and Chapter 3 contains the behavioral experiments.
II. Study 1: Questionnaire Study of Sunk Time Effect

Experiment 1: Time versus money

The present experiment compared the effects of sunk money to those of sunk time in a novel progress decision involving a mine dig.

Method

Subjects. One hundred fifty male and female undergraduate students participated in the experiment. All participated as part of a 1-hour session for course credit that involved other experiments as well.

Procedure. There were three independent variables: 1) the level of Sunk Cost, 2) the level of Completion Cost, and 3) whether the costs were expressed as “time alone” or as “time + money”. Variables 1 and 2 were administered within-subjects, and variable 3 was administered between-subjects. Participants received a packet of questionnaires that contained instructions for the present experiment, six scenarios pertaining to the present experiment in counterbalanced order, and other questionnaires pertaining to unrelated experiments. The instructions for the present experiment were as follows:

Welcome to the mine dig! The year is 1886 and you are the leader of a mining group in Western Utah. You will be digging mines in search of gold. The following information will help you with your task. You're located in a geographic region that has many mines certain to contain gold. It takes days or weeks of digging a given mine before gold is reached. The average time it takes to dig one whole mine is about 20 days, although it varies widely. All mines have gold. You have plenty of time to spend on digging.

One characteristic of mines in Western Utah is that a wall of quartz surrounds the gold. When your workers hit quartz, they are able to tell exactly how much longer it will take to reach the gold.

As group leader, this is your job: you will dig one mine at a time. You must decide, when your team has hit quartz, whether to A) keep digging the mine you are at, or B) abandon that mine and move all of your workers.
to another one of the mines in your area. When you abandon a mine, you cannot go back to it and the time you spent on it is lost. Your goal is to find gold, but of course your bigger goal is to make money overall. After your session is over, the experimenter will give you a questionnaire asking about what decisions you faced during the mine dig and why you made the choices you did. If you have any questions, please ask the experimenter now. Once you begin, you may not turn to previous pages in this booklet (but you can look at this instruction page whenever you want). Each page of your booklet describes a different mine. If you are ready to begin your job, turn the page and start!

Below is the scenario from the “time-alone” condition with the independent variables of Sunk Cost and Completion Cost shown here in parentheses:

**Good morning!**
You have been digging a mine for *(0, 20, 40)* days
Your workers found a vein of gold right away this morning!
Of course, a thick wall of quartz is covering most of the gold. Your workers estimate that it will take another *(8, 32)* days to uncover the rest of the gold.
Do you want to (circle your answer)

A. continue digging this mine until it is complete (taking *(8, 32)* days)
B. abandon this mine and move all of your workers to a new one (new mines take on average 20 days to dig)

The number of days spent digging so far was the Sunk Cost, and the number of days remaining to complete the dig was the Completion Cost. In the “time + money” condition the instructions were the same except that participants were informed that each day of digging cost $25. Below is the scenario from the “time + money” condition with the independent variables shown here in parentheses:

**Good morning!**
You have been digging a mine for *(0 days, and have spent $0; 20 days, and have spent $500; 40 days, and have spent $1000)*
Your workers found a vein of gold right away this morning!
Of course, a thick wall of quartz is covering most of the gold. Your workers estimate that it will take another *(8 days*$200; *32 days*$800) to uncover the rest of the gold.
Do you want to (circle your answer)
A. continue digging this mine until it is complete (costing \(8 \text{ days} \times \$200; 32 \text{ days} \times \$800\))
B. abandon this mine and move all of your workers to a new one (new mines cost on average 20 days\(\times\)\$500)

Participants performed the experiment alone in a small room.

Results

The percentage of participants who chose “A” (persistence in the already-begun mine) in each condition is shown in Figure 1. A repeated-measures two-way ANOVA revealed a significant main effect of Sunk Cost, \(F(2, 248) = 21.44, p < .0001;\)
Completion Cost, \(F(1, 124) = 306.24, p < .0001,\) and a significant Sunk Cost \(\times\) Completion Cost interaction \(F(2, 248) = 11.66, p < .0001.\) The average persistence in the low completion cost conditions was 96%, while in the high completion cost conditions it was 40%. With respect to sunk cost, the trend depended on the level of completion cost.
When completion cost was low, sunk cost had no differential effect on persistence.
When completion cost was high, persistence was inversely related to sunk cost. As sunk cost increased from zero to 20 to 40 days, persistence dropped from 61% to 33% to 27%.
There was no significant difference between the “time-alone” and the “time + money” conditions.
Figure 1. Results of Experiment 1. Persistence as a function of sunk cost.

Discussion

Three conclusions are evident in Figure 1. First, participants were sensitive to the economic forecast. In the conditions with high completion cost, the normative choice was to switch to a new mine, because completing the already-begun mine was expected to cost more than starting and finishing a new mine. In the conditions with low completion cost, the normative choice was to persist in the already-begun mine, because completing the already-begun mine was expected to cost less than starting and finishing a new mine. Responses were sensitive to these facts. When the completion cost was low, most participants “correctly” persisted. When the completion cost was high, fewer subjects persisted. Also, in the latter condition responses depended on the level of sunk cost. As sunk cost increased, participants became more likely to choose correctly.

The above finding leads to the second conclusion, which is that we did not find the usual sunk cost effect in which sunk cost size and persistence are positively related. Instead, we found an inverse relationship—a “reverse” sunk-cost effect. Although a rare
finding, it is not without precedent. Heath (1995) found a reverse sunk-cost effect when he presented participants with very complete economic information. In Experiment 1 of his study, participants viewed the following hypothetical numbers (in millions of dollars) concerning a real estate project:

<table>
<thead>
<tr>
<th>Condition</th>
<th>Previous costs</th>
<th>Future investment</th>
<th>Sales forecast</th>
</tr>
</thead>
<tbody>
<tr>
<td>Condition A</td>
<td>$6.58</td>
<td>$1.55</td>
<td>$6.66</td>
</tr>
<tr>
<td>Condition B</td>
<td>None</td>
<td>$1.55</td>
<td>$6.66</td>
</tr>
</tbody>
</table>

Participants saw information from only one of the two conditions. “Previous costs” were money that had already been spent toward the project, “future investment” was the amount needed to complete the project, and the “sales forecast” was the amount the project would sell for upon completion. Participants faced the following choice: Spend the future investment in order to complete the project, or abandon the endeavor and use the investment toward another project that would yield a 15% return. Therefore, each condition presented the dilemma of whether to spend $1.55 million for a 430% profit, or instead spend the $1.55 million on an alternative project for a 15% profit. Obviously, the rational choice would be to complete the already-begun project. The results were startling: While 100% of the subjects in condition B chose to complete the project, only 42% of the subjects in condition A made this choice! The latter number is surprising both because it strongly violates economic norms and because it demonstrates the opposite of the usual, well-established sunk money effect. How did Heath explain this result? He hypothesized that individuals create a mental budget for a project provided that they have sufficient economic information, and that individuals will continue to
spend money toward the project as long as the accumulated expenses are within the budget. Once total spending is expected to exceed the budget, the individuals will quit spending. Heath hypothesized that participants would form a mental budget equal to the sales forecast, a notion that other experiments from Heath’s study supported.

In the present experiment, it is not obvious how participants would arrive at a mental budget. The information that would have been analogous to Heath’s sales forecast is the value of the gold, but our scenario did not state this information. In addition, it would be impossible the value of the gold would serve as a budget in the time-alone condition. So how do we explain our results? One possibility is that participants formed a budget based on the average cost of completing a new mine. This was stated as 20 days (20 days and $500, in the money conditions). Perhaps when sunk cost was zero days and the completion cost was 32 days, most participants felt completing the already-begun mine was a worthwhile gamble since the stated cost of a new mine was only an average—occasionally, this cost might exceed 32 days. When the sunk cost was 20 days, however, completion of the already-begun mine would require a total cost of 52 days (20 + 32), meaning that the mental budget would certainly be exceeded. This may explain why the main shift in behavior was observed in the middle condition (as shown in Figure 1). This analysis is only speculative. It is clear that further research is necessary to explore the possible factors that contribute to forming a “mental budget”, and more generally to the reverse sunk cost effect.

Nevertheless, the third conclusion evident in Figure 1 is the most pertinent to the present purpose: Temporal and monetary sunk costs impacted behavior similarly. These data provide the first such demonstration, and counter the conclusion drawn by Soman
(2001) that sunk money has more impact than sunk time does. Granted, it remains to be established whether the impact of sunk time holds true in the "positive" sunk cost effect. The remainder of the experiments in Chapter 2 explore the potential for a positive sunk time effect. Experiments 2, 3, 4, and 5 presented sunk time information in the manner of previous sunk money studies (such as the "radar-blank plane" experiment of Arkes and Blumer, 1985) that have revealed the positive effect. Experiments 2 through 5 also examined two potential qualifiers of sunk time: degree of physical effort and degree of boredom.

**Experiment 2: Time and physical effort**

The present experiment examined both the effect of sunk time, and whether the physical effort involved in the sunk time may modify the sunk time effect.

**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. The scenario for each condition is presented below with italics added to the sentences that varied.

**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

32 subjects participated in Conditions 1 and 2, and 34 subjects participated in Condition 3. The percentages of subjects who chose to persist were 34 in the “zero time” condition, 47 in the “time-easy” condition, and 75 in the “time-hard” condition. An ANOVA revealed the effect of condition to be statistically significant, $F(2, 95) = 6.06, p < .01$. A comparison of all pairs was performed using Tukey-Kramer HSD ($q^* = 2.381$). Only one comparison was statistically significant, that between "zero time" and "time-hard.” The mean persistence in the presence of sunk time (averaging the "time-easy" and "time-hard" conditions) was 61%. Comparing this mean with the "zero time" condition (34%) revealed a significant effect of sunk time, $F(1, 96) = 6.19, p < .02$.

Discussion

On average, the presence of sunk time costs nearly doubled the persistence. The effect of effort, however, was not statistically significant although it produced a visually apparent change in the dependent variable (47% persistence vs. 75%). To ascertain whether the near-effect was real, we tested the two effort conditions on an additional group of subjects. The percentages the second time around were 64 in the “time-easy” condition ($n = 28$) and 60 in the “time-hard” condition ($n = 27$), showing no substantial effect of the effort manipulation.

Another issue of the present experiment is that the incremental cost of persisting was small—the scenarios stated that the effort involved in digging through quartz would be “easy”. The results of Experiment 1 showed the sunk cost effect may depend on the
incremental costs associated with the choice options. In Experiment 3, therefore, we repeated Experiment 2 with the incremental cost changed to “difficult”.

**Experiment 3: Time and physical effort**

**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 2 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**

27 subjects participated in each condition. The percentages of subjects who persisted were 22 in the “zero time” condition, 59 in the “time-easy” condition, and 56 in the “time-hard” condition. An ANOVA showed the effect of condition to be statistically significant, F (2, 78) = 4.91, p < .01. A comparison of all pairs was performed using Tukey-Kramer HSD (q* = 2.389). Two comparisons were statistically significant, those between "zero time" and "time-easy,” and between "zero time" and "time-hard."

**Discussion**

The pattern of results found in the previous experiment essentially was duplicated: a sunk time effect was obtained, while effort had no impact. The similarity of the results of Experiments 2 and 3 suggests the stated incremental effort of persisting did not affect responding.
Generally, Experiments 2 and 3 support the notion of a sunk time effect, but do not indicate an effect of the quality of sunk time. However, only physical effort was examined. Another quality that could be examined is how boring or exciting the sunk time is. Manual labor could be boring or exciting depending on the circumstances: manual labor done with friends in an exotic location surely is more fun than the same labor done with emotionally distant coworkers in a dull location. Does the excitement of sunk time influence whatever impact it may have? Our prediction was that boring sunk time would generate more persistence than fun sunk time. Experiment 4 explored this possibility using a variation of the mine-dig questionnaire.

**Experiment 4: Time and fun**

**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) sunk time-fun; 3) sunk time-boring. The scenarios presented in each condition appear below with italics added to the words that varied.

**Time-fun:**

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-boring:

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
The percentage of subjects who persisted in the “zero time” (n = 38), “time-fun” (n = 40), and “time-boring” (n = 58) conditions were 13, 25, and 31, respectively. A one-way ANOVA revealed no significant effect of condition. Combining the two sunk time conditions, the percentage of persistence under sunk time was 29. Comparing this number with the “zero time” condition revealed a nearly significant effect of sunk time, F(1, 134) = 3.58, p = .06.

Discussion
The data again suggested a sunk time effect, although the effect did not reach statistical significance. The boring vs. fun manipulation, on the other hand, had no
discernable effect. The boring vs. fun manipulation was tested again in the next experiment using a different scenario.

**Experiment 5: Fun**

The next problem described a student working for a professor as a research assistant.

**Method**

Subjects. 60 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 two conditions randomly assigned: 1) time-fun; 2) time-boring. The scenarios are presented below with italics added to the sentences that varied.

Fun:

Suppose that you are working part-time as a research assistant for a professor. Four weeks ago, he asked if you wanted to undertake a particular research project on music perception (the choice was yours), and you accepted. At the time, you did not know much about the project except that it would involve conducting an experiment for several weeks, for 10 hours per week.

Now you have been conducting the experiment for four weeks. The experiment, it turns out, required that you (and the participants) constantly listen to music that you really love. The last four weeks of work, therefore, have been fun for you.

Today, looking over your papers you have discovered a serious flaw in the study. Because of the flaw, the data you collected over the four weeks may be useless. The professor gives you the choice of whether to analyze the data or not. Analyzing the data would involve number-crunching on a computer, in a quiet room, for about 10 hours. Otherwise, you would get the week off while the professor figures out a new plan.

Which would you choose?

A. Analyze the data
B. Take the week off
Boring:

Suppose that you are working part-time as a research assistant for a professor. Four weeks ago, he asked if you wanted to undertake a particular research project on music perception (the choice was yours), and you accepted. At the time, you did not know much about the project except that it would involve conducting an experiment for several weeks, for 10 hours per week.

Now you have been conducting the experiment for four weeks. The experiment, it turns out, required that you (and the participants) constantly listen to music that you find quite dull. The past four weeks of work, therefore, have been boring for you.

Today, looking over your papers you have discovered a serious flaw in the study. Because of the flaw, the data you collected over the four weeks may be useless. The professor gives you the choice of whether to analyze the data or not. Analyzing the data would involve number-crunching on a computer, in a quiet room, for about 10 hours. Otherwise, you would get the week off while the professor figures out a new plan.

Which would you choose?
A. Analyze the data
B. Take the week off

Results

The percentage of subjects who persisted in the “fun” (n = 31) and “boring” (n = 29) conditions was 55 and 24, respectively. The effect of condition was statistically significant, F (1, 58) = 6.31, p < .05.

Discussion

The “irrational” theories accounting for the sunk cost fallacy predict any feature of sunk time that decreases its utility will increase persistence, all else equal. Accordingly, our prediction was that persistence would be greater after a boring sunk time than after a fun sunk time. The results suggested the opposite effect. If future investigation corroborates the present finding as a true sunk cost effect, then a significant problem will have been posed for the “irrational” theories. However, at present we must
acknowledge possible future-oriented explanations for the present results. One possibility is that in the “fun” condition, the fun sunk time made the reader believe the incremental cost would also be fun. Another future-oriented explanation is that in the “fun” condition, the professor in the scenario was viewed more positively, causing greater allegiance. Further investigation is needed to achieve any firm conclusion, but the present finding at least provides food for thought.

Chapter II Conclusion

All together, the findings of Chapter 2 suggest three points: 1) the sunk time effect may be a measurable phenomenon, insofar as it has been revealed by the same questionnaire method that has provided the bulk of the evidence for the sunk money effect; 2) sunk time may have an impact similar to that of sunk money; and 3) the experiments failed to show conclusively that the quality of sunk time determines its impact. The General Discussion will elaborate on this final issue, but suffice it to say that the time-quality variable requires further investigation.

Chapter II Acknowledgement


The dissertation author was the primary investigator and author of the portion of the above report containing the experiment.
III. Study 2: Behavioral Study of Sunk Time Effect and Role of Personal Responsibility

Experiments 1, 2, 3, and 4 all point to the existence of a sunk time effect. Because they employed the questionnaire method, they fit in with the bulk of the past research corresponding to monetary investments. However, we believe the questionnaire method is highly limited in external validity, because it only measures one’s guess as to how one would behave in an unfamiliar situation. Moreover, the phrasing of a questionnaire carries implicit information that may influence the reader’s response, a fact that has been documented in the framing effects literature (e.g., Shlomi and McKenzie, 2006) and which, in the present view, poses a considerable problem for interpreting questionnaire findings. We know of only two demonstrations of the sunk money effect involving consequential, non-hypothetical choices—the theater-ticket experiment of Arkes and Blumer (1985), and Soman (2001, Experiment 6)—and we know of no such displays of the sunk time effect. Therefore, we designed a procedure to test for a sunk time effect in a live activity. These experiments also tested a potential cause of the sunk time effect: personal responsibility for the sunk cost. Personal responsibility has been shown to play a role in the sunk money effect, although it remains unclear whether the factor is a necessary precursor of the effect. The present experiments addressed whether personal responsibility is a necessary precursor of the sunk time effect.

Experiment 6: Puzzle task

Two goals of the present experiment were: 1) To test for a sunk cost effect of time in a live activity, and 2) to test the prediction that a prerequisite to the effect is personal
responsibility for having initiated the sunk time. Let us outline the rationale for certain aspects of the procedure.

The essence of the procedure was that participants worked on a task for either a short or a long amount of time, and then chose whether to continue the task or do something else instead. The task was working on a 500-piece jigsaw puzzle with the rule that connected puzzle pieces on the table must be *picture-face down*. The procedure would address whether an individual’s likelihood of persisting in an aversive endeavor would change with the length of time spent so far.

Our use of a jigsaw puzzle as the aversive task was somewhat arbitrary, but it was appropriate for two reasons. Firstly, we wanted a task that participants would have no chance of completing before the allotted time. The jigsaw puzzle allowed subjects to work for more than 60 minutes in the longer condition and still be far from completing the puzzle (no subject connected more than $1/5^{th}$ of the puzzle, and most connected less than $1/10^{th}$). Secondly, the puzzle task required, in our judgment, a roughly similar level of effort throughout the task, critical for holding constant the marginal cost of persisting.

Also, the procedure included a preliminary puzzle whose duration was 60 minutes minus the duration of the main puzzle, to balance the level of fatigue across levels of sunk cost. When subjects arrived at the final choice, in every condition, they had been doing puzzles (the preliminary plus the main puzzles) for exactly 60 minutes, but had worked on the main puzzle only 10 minutes in the “short” condition but 50 minutes in the “long” condition.

To test the role of personal responsibility, we added the following manipulation: in some conditions participants were obliged to undertake the main puzzle, while in other
conditions doing the main puzzle was voluntary. The former conditions were straightforward, procedurally. For the latter conditions, a scheme was necessary to induce subjects to undertake the main task. To this end, subjects were told that they would be allowed to leave the experiment early in exchange for undertaking the main puzzle.

Predictions of self-justification theory

According to self-justification, the sunk cost effect stems from defending one’s prior choice to undertake the sunk investment. For the present experiment, self-justification would predict a sunk cost effect in the voluntary condition, since subjects in the voluntary/long condition must defend having chosen to do a dull task for 50 minutes, while subjects in the voluntary/short condition would have much less of a need to defend their prior choice. On the other hand, self-justification would predict no effect of sunk cost in the obligatory condition since subjects have no prior choice to defend.

Method

Subjects. 195 undergraduate students participated in the experiment.

Procedure. The core of the procedure was that subjects spent either 10 minutes or 50 minutes putting together a jigsaw puzzle, and then chose which of the following to do for 15 minutes: continue the same puzzle or work on questionnaires. The dependent variable was the subjects’ choice of how to spend the final 15 minutes.

The experiment employed a 2 x 2 between-subjects design, for a total of four conditions. The independent variables were sunk time and degree of obligation.
Subjects in the “short” condition did a preliminary jigsaw puzzle lasting 50 minutes, followed by doing the main puzzle for 10 minutes. Subjects in the “long” condition did a preliminary puzzle lasting 10 minutes, followed by doing the main puzzle for 50 minutes.

Degree of obligation

The levels of degree of obligation were “obligatory” and “voluntary”. Subjects in the “obligatory” condition were obliged to do the main puzzle. Subjects in the “voluntary” condition chose whether or not to undertake the main puzzle. Figure 2 displays the time scheme for the “voluntary” condition.

![Figure 2](image)

**Figure 2.** Time layout of procedure of Experiments 6, 7, and 8. 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.

Procedure for condition “voluntary”

Participants were tested individually in a small room. To begin, participants completed a brief personality questionnaire. The purpose of the questionnaire, unknown to the subjects, was to distract them from the true purpose of the experiment and to give an idea of what the “questionnaires” mentioned in later choices involved.

Next, the experimenter brought a 500-piece jigsaw puzzle box to the table, the “preliminary” puzzle. The experimenter provided the following rules for doing the task:
1) all connected pieces must be on the table or in your hand; 2) 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 as many pieces as possible and to continue working indefinitely. The experimenter started a kitchen timer on the table set to 1 hour 30 minutes and explained that the timer displayed the amount of time left in the overall session and that the puzzle task would not last the entire time. (The purpose of the timer was to allow the subjects to see the amount of time that had elapsed and that remained when facing Choice 1 and Choice 2.) Subjects performed the task unwatched.

After 10 minutes (in the “long” condition) or 50 minutes (in the “short” condition) had elapsed on the timer (i.e., when the timer displayed either 80 minutes remaining or 40 minutes remaining), the experimenter entered the room, counted the number of connected pieces, recorded the number and cleared the puzzle from the table. Next, the experimenter gave the subject 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 were exactly as stated. If participants chose Option A, then they worked on a packet of questionnaires until the timer reached zero, followed by the debriefing. These questionnaires mostly were personality tests intended to keep the
subject occupied. If participants chose Option B, then the experimenter brought another
500-piece jigsaw puzzle box. This was the “main” puzzle. (The main puzzle was of the
same brand and size as the preliminary puzzle, but the picture was different—one puzzle
depicted a beach, the other a woman). The experimenter instructed the subjects to notify
when 30 minutes remained on the timer. Thus, subjects worked on this puzzle for either
10 minutes in the “short” condition or 50 minutes in the “long” condition. When 30
minutes remained on the timer (60 minutes into the grand procedure, as shown in Figure
2), participants received a pair of standard dice to roll on the table. If the outcome of the
roll totaled five or less, then the experiment ended. If the outcome totaled six or more,
then the subjects received a paper that displayed Choice 2. The text of Choice 2 was:

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 exactly as stated.

**Procedure for condition “obligatory”**

In terms of the time spent on each puzzle the “obligatory” condition was identical
to the “voluntary”. Procedurally, the “obligatory” condition lacked the 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 were given the main
puzzle obligatorily and instructed to work on it until 15 minutes remained on the timer; 3)
when 15 minutes remained on the timer, subjects directly received Choice 2 without having rolled dice.

**Results**

The dependant variable of primary interest was the response to Choice 2. The datum for each subject was coded nominally as either “persist”, if the subject chose to continue the puzzle, or “quit”, if the subject chose questionnaires.

Choice 2 responses do not account for all subjects, however, because some in the “voluntary” condition never received Choice 2. These were either 1) subjects who left the experiment early because their dice-roll outcome totaled five or less, or 2) subjects who never undertook the main puzzle because they chose Option A of Choice 1. While the former were excluded from the data analysis, the latter were included with their response coded as “quit”. This tactic for the latter subjects eliminated the problem of self-selection that might otherwise have biased the voluntary/short or voluntary/long data toward persistence, which would have occurred if either group over-represented people who particularly enjoy puzzles. Therefore, the data will show what happened to all the subjects who participated in the experiment (save the ones who exited on a low dice-roll), not just the ones who selected themselves into the main puzzle.

The number of data points in each condition was 63 in the “obligatory/short” condition, 64 in the “obligatory/long” condition, 66 in the “voluntary/short” condition, and 68 in the “voluntary/long” condition. Figure 3 displays the percentage of subjects who persisted as a function of condition. The percentages are 29 in the “obligatory/short” condition; 25 in the “obligatory/long” condition; 30 in the “voluntary/short” condition; and 49 in the “voluntary/long” condition. A two-way
ANOVA revealed no significant main effects or interaction. Planned contrasts were performed within each level of initial choice. In the “voluntary” condition, the effect of sunk cost was statistically significant, $F(1, 119) = 4.41$, $p < .05$. In the obligatory condition the effect of sunk cost was not significant.

Recall that the data for the “voluntary” condition include the scores of subjects who did not perform the main puzzle. These were 16 and 15 subjects in the “short” and “long” conditions, respectively, whose responses were coded as “quit”. Would the results within the voluntary condition look different with these scores excluded? The percentages of persistence become 41 and 66 in the short and long condition, respectively. The effect of sunk cost is still statistically significant, $F(1, 88) = 5.69$, $p < .05$.

![Figure 3. Results of Experiment 6. Percentage of subjects who persisted in the task as a function of sunk time.](image-url)
Discussion

The data pattern in Figure 3 suggests the following: In the absence of personal responsibility sunk time had no effect, while in the presence of personal responsibility sunk time did have an effect. That is, personal responsibility for the sunk time was a necessary precursor of the sunk time effect, precisely the pattern predicted by self-justification theory. Thus, the results suggest both a real impact of sunk time on persistence in a live activity, and that self-justification may explain the effect.

However, an important issue remains unclear: was it the mere “act of choosing” that led to the sunk time effect in the voluntary condition, or was it more specifically the act of **knowingly choosing a long sunk time** that led to the effect? The question distinguishes between two types of sunk cost situations—one in which the decider undertakes a course of action that unexpectedly turns out to involve a high cost, and the other in which the decider undertakes a course of action fully aware that it will involve a high cost. It stands to reason that behavior may differ in the two situations. Phrased differently, self-justification posits the motivation to defend a prior choice, but what type of choice? May the choice be an uninformed one, or must it be a fully-informed one? In Experiment 6, subjects made an “informed” choice, as Choice 1 stated how long the main puzzle would last. In Experiment 7, the voluntary condition of Experiment 6 was repeated but Choice 1 did not state how long the main puzzle would last, meaning subjects made an “uninformed” choice.

**Experiment 7: Puzzle task—mere choice vs. personal responsibility**

**Method**

Subjects. 79 undergraduate students participated in the experiment.
Procedure. The procedure was identical to the voluntary condition of Experiment 6, except that the text of Choice 1 was different. In the present experiment, Option B of Choice 1 did not state the duration of the main puzzle. The new Choice 1 read as follows:

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.

As in the voluntary condition of Experiment 6, subjects who chose Option B worked on the main puzzle until 30 minutes remained on the timer. At this time, the experimenter entered the room and gave the subject the pair of dice to roll on the table. The experiment thereafter continued in the same way as Experiment 6.

**Results**

The data were recorded in the same manner as in the voluntary condition of Experiment 6. 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 significant. The average number of completed pieces among persisters and non-persisters in the short condition was 5.78 and 2.88, respectively, and the difference between means was marginally significant, F (1, 24) = 4.15, p = .053. In the high condition, the average
number of completed pieces among persisters and non-persisters was 33.86 and 30.33, respectively, a non-significant difference.

Discussion

A study by Schoorman and Holahan (1996) has suggested that where so-called “personal responsibility” induces escalation it is in fact the act of choosing that attaches one to the choice, not personal responsibility for consequences. Schoorman and Holahan repeated Staw’s (1976) procedure (described in the Introduction) but added a condition in which the subjects’ initial choice was overruled by superiors and therefore not implemented. The crucial result was that this experimental group allocated less money to the implemented alternative than a control group that had not made an initial choice. Thus, it appears the experimental group was committed to the initial, overruled choice even though the group was not personally responsible for the events that followed. Schoorman and Holahan concluded the mere act of choosing is sufficient to attach one to a decision. The present results, on the other hand, suggest mere choice is not enough. If it were, the results of Experiment 7 should have been identical to those of the voluntary condition of Experiment 6—a sunk cost effect. That Experiment 7 revealed no sunk cost effect suggests that aside from choice, the level of personal responsibility for consequences dictates persistence. In Experiment 6 subjects in the “long” condition were likely to feel responsible for their fate (of spending 50 minutes on a dull task) because they knowingly chose it. In Experiment 7 subjects did not knowingly choose their fate. In fact, post-experiment interviews revealed that subjects in the “long” condition expected the main task to be short. In essence, these subjects were tricked by the
experimenter. Altogether, Experiment 6 and 7 taken together suggest people are motivated to defend not uninformed choices but informed ones.

In summary, Experiments 6 and 7 taken together suggest that a necessary precursor of the sunk time effect is having knowingly chosen to undertake a large sunk time. Stated differently, persistence depends on a prior informed choice (rather than an uninformed choice), consistent with the self-justification hypothesis that persistence is a function of personal responsibility for negative consequences. A limitation of Experiments 6 and 7 is that only one type of task was used. Would a different task produce similar results? In the next experiment, we repeated the procedure of Experiment 6 but with a different task in place of the jigsaw puzzle.

**Experiment 8: Card-sorting task**

**Method**

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

Procedure. The procedure was identical to that of Experiment 6 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, with 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 were identical to those of Experiment 6.

Results

Data were coded in the same manner as in Experiment 6. The number of data points in each condition was 63 in the “obligatory/short” condition, 64 in the “obligatory/long” condition, 66 in the “voluntary/short” condition, and 68 in the “voluntary/long” condition. Figure 3 displays the percentage of subjects who persisted as a function of condition. The percentages are 17 in the “obligatory/short” condition, 39 in the “obligatory/long” condition, 14 in the “voluntary/short” condition, and 31 in the “voluntary/long” condition. A two-way ANOVA revealed a significant main effect of sunk time, $F(1, 1) = 13.57, p < .01$, but the main effect of initial choice and the interaction did not reach significance. Planned comparisons were performed within each level of initial choice. In the “voluntary” condition, the effect of sunk cost was statistically significant, $F(1, 132) = 5.89, p < .02$. In the “obligatory” condition, the effect of sunk cost also was statistically significant at $F(1, 125) = 7.62, p < .01$.

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. An important conclusion of these numbers is that subjects had no chance of completing the task within the allotted time, consistent with our intention. 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.

Figure 4. Results of Experiment 8. Percentage of subjects who persisted in the task as a function of sunk time.

Discussion

The present results again suggest a sunk time effect. Contrary to the finding in Experiment 6, however, the present results show the effect both in the presence and absence of personal responsibility. At face value, the present finding suggests personal responsibility is not a necessary precursor of the sunk time effect. Why did the present experiment lead to a different result than that of Experiment 6? Comparing the results of Experiment 6 and 8, the discrepancy lies in the obligatory conditions (compare the
“obligatory” lines displayed in Figures 3 and 4—the line in Figure 3 is flat while the line in Figure 4 is slanted). What may explain the discrepancy? One possible explanation involves a difference in sunk effort. Effort is a variable the experimenter has little control over—subjects are free to choose how much effort to impart during any task. Despite our intentions, then, the obligatory conditions were not entirely obligatory in the sense that subjects could freely choose how much effort to impart. A casual observation by the experimenter was that many subjects chose not to impart effort on the puzzle task, essentially giving up on the main puzzle early on (leading to a subject “day-dreaming” while half-heartedly sifting through the puzzle pieces for the required time). The card-sorting task was easier than the puzzle task and led more subjects to choose to impart effort. Focusing on the obligatory/long data, which are at the heart of the discrepancy: We hypothesize the reason that more subjects persisted in the card-sorting task is that those subjects chose to impart more effort. If this hypothesis is supported it would allow the possibility that personal responsibility was a factor in the card-sorting task (Experiment 8). We tested the hypothesis in the final experiment.

**Experiment 9: Differentiating the Two Tasks**

**Method**

Subjects. 62 undergraduate males and females participated in the study.

Procedure. Subjects performed the puzzle and card-sorting tasks for forty minutes apiece, with order counterbalanced across subjects, and then received a paper with three questions: “Which task was more difficult?”; “On which task did you expend more effort?”; and “Which task did you enjoy more?” Below each question, subjects circled either the word “puzzle” or “card-sorting”.
Results

For each question, data were coded in binary form and a t-test was performed on the null hypothesis mean of .5. The proportion of subjects who selected the card-sorting task as being more difficult was .16. The proportion of subjects who reported expending more effort on the card-sorting task was .65. The proportion of subjects who reported enjoying the card-sorting task more was .60. The difficulty mean was significantly different from .5, $t(61) = 7.19$, $p < .001$. The effort mean was significantly different from .5, $t(61) = 2.36$, $p < .05$. The enjoyment mean was not statistically different from .5.

Our hypothesis was that a majority of subjects would report the puzzle task being more difficult while expending more effort on the card-sorting task. The four possible within-subject response patterns involving questions #1 (difficulty) and #2 (effort) were puzzle / puzzle, puzzle / card sorting, card sorting / puzzle, and card sorting / card sorting. The number that fit each pattern was 22, 30, 0, and 10, respectively. A chi-square on the four categories revealed a significant difference, $\chi^2(3, n = 62) = 33.78$, $p < .01$. A chi-square then was performed on the three observed categories, and revealed statistical significance, $\chi^2(2, n = 62) = 9.81$, $p < .01$. A chi-square next was performed comparing the puzzle / puzzle and puzzle / card sorting categories, which did not reach statistical significance.

Discussion

The data lend only mild support to the hypothesis that the perceived difficulty of the task is inversely related to the effort expended on the task. However, consistent with our hypothesis, a majority of subjects reported spending more effort on the card-sorting task. This result provides a potential reason why persistence was higher in the
obligatory/long condition of the card-sorting task (Experiment 8) than in the same condition of the puzzle task (Experiment 6): more subjects imparted sunk effort in the card-sorting task. This fact is equivalent to the assertion that more subjects were personally responsible for sunk effort in the card-sorting task. It follows that self-justification might account for the sunk time effect found in the obligatory condition of the card-sorting task. In terms of self-justification, the suggestion is that subjects in the obligatory/long condition persisted to defend their prior (private) choice to impart effort on the task.

We recognize that this conclusion is highly tentative. A more definitive conclusion would need at minimum a test to establish that subjects doing the card-sorting task consider the effort spent to be their own choice, rather than an obligation imposed on them by the experimenter. Nevertheless, the set of findings from Experiments 6 through 9 does not rule out self-justification as a source of the sunk time effect.
IV. General Discussion

The present experiments addressed the following questions: 1) what effect does sunk time have on persistence; 2) does the quality of the sunk time—whether it is effortful or easy, boring or exciting—determine its impact; 3) is personal responsibility a necessary precursor of the sunk time effect? The results suggest a tentative answer to the first and third question, although not the second. Regarding question #1, we have presented ample evidence that sunk time costs impact persistence—both in the “reverse” manner (Experiment 1), and in the positive manner. Three of the questionnaire experiments revealed a positive sunk time effect (Experiments 2, 3, and 4), as did two of the behavioral experiments (Experiments 6 and 8). To our knowledge, these are the first such demonstrations. Contrary to the conclusion drawn by Soman (2001), then, the present results suggest the sunk time effect may be a considerable phenomenon. Soman also suggested people fail to form “mental accounts” of time spent; the present findings indicate people do account for time spent, and Experiment 1, which directly compared sunk costs of time and money, suggests the two costs may be treated similarly. An obvious question arises: why did the questionnaire experiments produce an effect, while Soman’s (2001) experiments did not? Part of the answer may lie in the framing of the decision problems. Numerous studies have shown that logically equivalent pieces of information phrased differently may elicit different responses (for a review of so-called “framing effects” see Levin, 1998). The character of such potentially impactful differences in phrasing regarding sunk cost problems remains to be established, and may be an important topic of future investigation. Another, related, part of the answer may lie in the particular scenario in which sunk cost information is couched. While the
presently-used scenarios involved digging a mine, the scenarios employed by Soman involved working as a research assistant, designing a product for an invention competition, and participating in a marketing research program. For example, one of Soman’s problems was the following (2001; Experiment 2):

> You are planning to submit an entry to the ‘new invention’ competition organized by the students' club. You have spent 30 hours preparing a design for an innovative rocket engine and estimate that it will take you an additional 10 hours to finish it. You just learn that the winner of the previous year's competition was also working on a rocket engine design similar to yours. You had also thought about working on a (equally innovative and good) design for a solar-powered pump that would take about 10 hours to complete. You can submit only one entry, and since the deadline is very close, you must choose now. The question is: should you spend 10 hours to finish your rocket engine design or would you rather work on the solar-powered pump?

The above represents the “high” condition. In a “low” condition, zero hours had been spent on the rocket engine. The result was that in both conditions only about 20% of the participants preferred the sunken alternative, showing no sunk cost effect. We in fact hypothesized that the manipulation was too weak and repeated Soman’s experiment with the sunken alternative having either 30 or 200 hours. The percentage of subjects who persisted in the sunken alternative in the respective conditions was 37% (N = 51) and 45% (N = 51), a non-significant difference. Our replication does allow for two interesting interpretations, however. One, even if the manipulation had no effect, a
substantial proportion of subjects did persist in the sunken alternative, although a zero-sunk-cost control condition is necessary to evaluate whether this level of persistence reflects a true sunk cost effect. Two, it is noteworthy that combining the two studies, a sunk cost effect does appear to exist between the 30-day and 200-day conditions, roughly 29% (averaged across studies) vs. 45%. Unfortunately, this effect might simply reflect differences between the respective samples, preventing a firm conclusion. Ignoring the above interpretations, and supposing this word-problem truly does not generate a sunk time effect, why would it fail to do so when the mine-digging problem succeeds? One obvious difference between the two scenarios is that digging a mine presumably entails more physical effort than preparing a research design—the mine-digging scenario therefore might have conveyed a greater sunk effort. Another possibly important difference is that time spent on the research design may have been perceived by subjects as somehow beneficial in its own right, aside from the stated goal of the project, because the time spent might be educational, or possibly even fun, if the reader assumes (quite reasonably) that a character who enters a ‘new invention’ competition intrinsically enjoys doing such work. Beyond these more obvious differences between the scenarios, of course, any number of subtle differences has the potential to affect responding. In summary, further work will need to establish why different scenarios produce different effects, especially considering that most sunk-cost research involves this method.

Regarding question #2, Experiments 2, 3, and 4 failed to support the notion that the quality of sunk time determines its impact. Experiment 5 did suggest an effect of fun: the more fun the sunk time, the more likely the decision-maker was to persist. However, we withhold from drawing any conclusion from the result of Experiment 5 because an
interpretation in terms of sunk cost is problematic (as described in the Experiment 5 discussion). Do Experiments 2 through 4 suggest the quality of sunk time may be irrelevant to subsequent decision-making? Possibly, but more findings are needed, as many factors may account for the present null results. Firstly, subjects did not directly experience the quality of the sunk time. Reading that one has spent effort on an endeavor surely has less impact on the decision-maker than actually having put forth effort, and future behavioral experiments testing this variable may produce results quite different from (or at least more accurate than) those presently obtained through the questionnaire method. A second possible reason for the null findings is that 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 2 and 3), and more boredom spent may indicate more frustration to the reader (in Experiment 4). Thus, any sunk cost effect may have been balanced out by a perceived-marginal-cost effect. A third possible reason for the null finding is that the experiments did not tap into a potentially important factor: error in time estimation. Anecdotally, “time flies when you’re having fun.” Empirically, individuals underestimate the duration of a previous task as a function of how engrossed in the task they were (Chaston and Kingstone, 2004). The more engrossing a chunk of time is, the shorter it will seem, hence a shorter subjective sunk time. The present questionnaire experiments could not tap into such a process since the time was not experienced and the length of the time was stated explicitly (the latter also being true of the behavioral experiments). In summary, whether the quality of sunk time determines its impact remains unresolved. The issue may be a fruitful area of future investigation, ideally with behavioral or field
experiments. A simple prediction (and one deducible from the "irrational" theories covering the sunk cost effect) is that any feature of sunk time that increases its negative utility will, all else equal, exaggerate the sunk time fallacy.

Regarding question #3, our results suggest a tentative role for self-justification in the sunk time effect. Self-justification predicts that a necessary precursor of the sunk cost fallacy is personal responsibility for the sunk investment. The combined results of Experiments 6 and 7 support this prediction. The results of Experiment 8, taken at face value, counter the prediction since a sunk time effect was observed both in the presence and absence of personal responsibility. Experiment 9, however, mitigated the implication of Experiment 8 by suggesting that personal responsibility for sunk effort may have played a role in the “obligatory” condition of Experiment 8 despite our intentions. The latter conclusion is only speculative, however. The relative weight placed on this conclusion allows for two extremes in judging the role of self-justification: At one extreme, accepting the implication of Experiment 9 in full, self-justification may account for the results of Experiments 6, 7, and 8 and may be viewed as a basic cause of the sunk cost fallacy. At the other extreme, rejecting the implication of Experiment 9, self-justification may account for the results of Experiments 6 and 7, but not Experiment 8, and therefore either is only an occasional player in the sunk time effect or plays no role at all if another theory may better account for the body of findings.

A noteworthy limitation of the self-justification theory is that the presently observed personal-responsibility effect could potentially occur in the absence of self-justification. No measures were taken to establish the cognitive state of the subjects, and therefore the present study offers no direct evidence that a justification process occurred
in the proposed groups (of course, truly direct evidence may never be obtained). At least one alternative theory may account for a personal-responsibility effect: self-perception theory (Bem, 1967). The theory proposes that an individual infers his attitudes by observing his own behavior. By extension, an individual’s inference that he enjoyed performing a sunk cost may co-vary with his level of personal responsibility for the sunk cost. More generally, the source of the personal-responsibility effect could be any of several already-proposed or as-yet un-proposed mechanisms. Nevertheless, self-justification is the theory that stimulated the present predictions.

Could any of the additional theories that handle the sunk cost effect—prospect theory, waste avoidance, and the normative theory—account for the overall data more completely than self-justification does? The following section explores this possibility.

**Other theories that account for the sunk cost effect**

**Prospect theory**

Kahneman and Tversky’s (1979) prospect theory addresses how people make decisions under conditions of uncertainty, and many instances of the sunk cost effect are within its predictive range (Garland & Newport, 1991, Thaler, 1980; Whyte, 1986). As noted by Garland and Newport (1991), certain assertions of prospect theory are particularly relevant to sunk cost decisions: 1, individuals evaluate decision outcomes as gains or losses from a reference point; 2, the value function for gains is concave, and the value function for losses is convex and steeper than that for gains, as shown in Figure 5. Given these assertions, consider the decision frame adopted by a company deciding upon a project that has cost $X so far. The company will be at point A in Figure 5, which has a negative value of Y. The decision frame is as follows: Option 1, abandon the project and
accept a sure loss (resign at point A and accept the negative value Y); Option 2, spend more money on the project, risking a larger loss (point C, with a negative value of Y’) but potentially rescuing the project (achieving point B or above). As sunk cost size (X in Figure 5) increases, the equal-sized incremental cost (2X in Figure 5) diminishes in negative incremental value due to the convexity of the value function. Therefore, as sunk cost size increases, the value of Option 2 of the decision frame (the average value of points B and C) grows more positive relative to the value of A.

How can prospect theory explain the present set of results? Regarding the questionnaire experiments it would seem to predict a positive effect of sunk time, effort, and boredom (generally, any sunk aversive), and the results supported only the first of the three predictions (a fate that applies to the other “irrational” theories as well). Regarding

Figure 5. Prospect theory value function (taken from Garland, Sandefur, & Rogers, 1990).
the behavioral experiments, it is unclear how prospect theory can account for the apparent role of personal responsibility. Accounting for the combined results of Experiments 6 and 7 would require the assumption that sunk time placed subjects at point A only when subjects had knowingly chosen to go to A in the first place, an assumption that is neither deducible from prospect theory nor intuitive. Another problem is that prospect theory requires a situation in which recovering the sunk cost is possible. In our judgment, the puzzle and card-sorting tasks did not offer the possibility of “recovering” the sunk time, especially since completing the tasks was impossible. It is difficult to see how Point B in Figure 5 (or any improvement on Point A) could be achieved by persisting. The behavioral findings, then, are beyond prospect theory’s predictive range.

**Waste-avoidance**

Hal Arkes and associates have proposed that the sunk cost effect stems from a desire to avoid waste (Arkes & Blumer, 1985; Arkes, 1996; Arkes & Ayton, 1999). The key prediction is the following: the more wasteful it would appear to abandon the sunk investment, the greater the likelihood of persistence. For example, suppose two identical people each possess an unwanted baseball-game ticket. One person found the ticket on the sidewalk, while the other paid $100 for the same item. Discarding the ticket presumably would appear more wasteful to the latter individual, and therefore the latter is more likely to utilize the ticket. (Notice that prospect theory and self-justification would also predict this result). The waste-avoidance theory is attractive because of its simplicity and because “waste” is a ubiquitous concept. However, these very attributes also constitute a weakness of the theory, for “waste” is only vaguely defined. Arkes (1996, p. 214) informally suggested two definitions: “Wastefulness occurs when a person spends
more on an item than is necessary” and “Wastefulness occurs when a person does not fully utilize the item that has been purchased.” These definitions offer much room for interpretation. With the first definition taken at face value, the very existence of the progress-decision variety of the sunk cost effect proves the theory wrong—in progress decisions that involve erroneous persistence, the incremental cost objectively entails spending more than necessary and so is predicted to appear wasteful, yet the decision-maker persists in wasting. Specification of the theory would be helpful. Specification also is needed in order for it to address the well-documented effect of personal responsibility. The theory is stated informally enough that an effect in either direction appears to have no impact. Arkes and Blumer (1985) suggested the possibility that personal-responsibility status dictates the decision-maker’s perception of waste. But this suggestion only makes waste-avoidance redundant to the theory of self-justification, which was established beforehand and has a far greater empirical base. We suggest an equally plausible premise that waste is perceived independently of personal-responsibility status. Under this view, waste-avoidance would predict a sunk cost effect wherever there is waste (defined satisfactorily), regardless of the decision-maker’s level of personal responsibility, a prediction that would distinguish waste-avoidance from self-justification.

Let us see how the present results may speak to waste-avoidance. Regarding the questionnaire experiments, the theory predicts the same results as prospect theory and self-justification—an positive effect of sunk time, effort, and boredom (generally, any sunk aversive), and the results supported only the first of the three predictions, a fate that of course applies to the other “irrational” theories as well. Regarding the behavioral experiments, waste-avoidance predicts, in the present judgment, that the “voluntary” vs.
“obligatory” manipulation should have had zero effect. Clearing away the already-completed task materials should have appeared wasteful to subjects in the voluntary and obligatory conditions alike. (In both cases, clearing away the materials represents a commonsense “waste” of the already-spent time and effort). On the surface, one experiment supported the prediction (Experiment 8) while another countered it (Experiment 6). Of course, that waste-avoidance makes the aforementioned prediction is debatable, which speaks to our point that the theory would benefit from a more formal recasting.

A related issue is whether waste avoidance and self-justification are competing or instead may coexist. We believe they may coexist, if it is established that the sunk cost effect has multiple causes, with self-justification being one of those and waste-avoidance being another (although to our knowledge no formal attempt has been made to support the “multiple cause” possibility or to thoroughly flesh out the possibility in logical terms). However, in the present setting the two theories must be competing. We doubt the conclusion that self-justification caused the puzzle results while waste-avoidance caused the card-sorting results. A single theory for the combined behavioral results is more attractive and more plausible, given that the experiments were conducted in the same situation with similar procedures. Altogether, especially taking Experiment 9 into account, self-justification provides the better account of the behavioral findings.

Normative theory

Contrary to the aforementioned theories, some have suggested directly or indirectly that what appears to be a sunk cost fallacy actually reflects some type of normative decision-making (Bowen, 1987; Bragger, Bragger, Hantula, & Kirnan, 1998;
Goltz, 1999; McCain, 1986, and Navarro and Fantino, 2005). For example, Bowen (1987) suggested sunk cost situations provide highly ambiguous information to which persistence may be a quite rational response. McCain (1986) characterized sunk cost situations as learning situations, in which episodes of persistence result simply from a lack of learning. The specifics of these and related viewpoints might differ somewhat, but to suggest a unifying implication, true “sunk cost” effects do not exist, only marginal cost/benefit effects do. Can the present set of results be explained by this rational account? Regarding the questionnaire experiments, the observed sunk time effect (in Experiments 1, 2, 3, and 4) does not appear to have a rational basis because the marginal costs and benefits of persistence were stated explicitly and were held constant across levels of sunk cost. Regarding the behavioral experiments, the observed sunk time effects are in the overt sense unaccountable for by consideration of incremental costs and benefits, since the costs and benefits were held constant across sunk cost levels and fatigue was controlled with the preliminary task. The observed role of personal responsibility in Experiment 6 is not deducible from any rational account. The results of Experiment 8 might be consistent with a rational account, if subjects in Experiment 8 enjoyed performing the main card-sorting task more after 50 minutes than after 10 minutes. Persisting would then have higher utility in the 50-minute condition than in the 10-minute condition, and therefore the observed effect would have a rational basis. However, the present question is whether the value of a course of action (i.e., our likelihood of persisting in it) is dictated by explicit economic factors or by sunk costs and/or prior decisions. The results suggest that something about either performing an effortful task for a long time (Experiment 8) or having chosen to perform it for a long
time (Experiment 6 and 7 taken together) raises the probability of persisting in the task. We believe an appeal to sunk costs is appropriate.

In summary, the present set of results does not uniformly support any of the theories that account for the sunk cost effect. This alone need not discredit any of the theories—the sunk cost effect might have multiple causes, a possibility that ought to be explored more directly by future research. However, self-justification does provide the best account of the present findings.

**The use of a behavioral task**

A final note: The present behavioral experiments provide an additional contribution to the sunk cost program by opening a method of investigation that employs a live setting in which sunk costs are experienced and decisions have consequences. The sunk cost literature contains a large number of findings obtained with the questionnaire method, yet only a handful of behavioral findings. A concluding comment common to most sunk cost articles is that behavioral findings (as well as field research) are needed to validate the questionnaire findings. The present study has begun an attempt to fulfill that need, and shows promise for the practicality and fruitfulness of a behavioral method.

**Conclusion**

The present findings suggest the sunk time effect may be a measurable phenomenon, just as previous studies have suggested about the sunk money effect. Also, the present results suggest personal responsibility may have the same status in the sunk time effect as it appears to have in the sunk money effect: It is an important factor but *might* not be necessary. Finally, our use of behavioral experiments lends some validity to the conclusions derived from previous questionnaire studies reported in the literature, and
to the questionnaire studies reported presently. We urge that behavioral procedures
become the rule rather than the exception in future sunk cost research and also in other
areas of decision-making.
V. References


allocation decisions. *Organizational Behavior and Human Decision Processes* 37, 348-356.


