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The Role of Probability of Success Estimates in the Sunk Cost Effect

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ABSTRACT

The sunk cost effect is manifested in a tendency to continue an endeavor once an investment has been made. Arkes and Blumer (1985) showed that a sunk cost increases one's estimated probability that the endeavor will succeed [p(*s*)]. Is this p(*s*) increase a cause of the sunk cost effect, a consequence of the effect, or both? In Experiment 1 participants read a scenario in which a sunk cost was or was not present. Half of each group read what the precise p(*s*) of the project would be, thereby discouraging p(*s*) inflation. Nevertheless these participants manifested the sunk cost effect, suggesting p(*s*) inflation is not necessary for the effect to occur. In Experiment 2 participants gave p(*s*) estimates before or after the investment decision. The latter group manifested higher p(*s*), suggesting that the inflated estimate is a consequence of the decision to invest. Copyright © 2000 John Wiley & Sons, Ltd.

KEY WORDS sunk cost; investment decisions

The sunk cost effect is manifested in a greater tendency to continue an endeavor once an investment in money, effort, or time has been made (Arkes and Blumer, 1985). Such a tendency can lead to suboptimal economic decisions, because such decisions should be based solely on future costs and benefits, not ones which have already occurred. Unfortunately the sunk cost effect has been found to be relatively robust, having been demonstrated in such diverse fields as professional sports (Staw and Hoang, 1995), venture capital investment (McCarthy *et al*., 1993), and theater attendance (Arkes and Blumer, 1985).

The purpose of this paper will be to investigate a possible cause of the sunk cost effect, namely, the unjustified inflation of the probability that an investment will succeed following an initial investment of money, effort, or time. Arkes and Blumer (1985, Experiment 4) used the following 'radar-blank plane' scenario to demonstrate this effect:

> Questionnaire 4A: As the president of an airline company, you have invested 10 million dollars 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

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apparent that their plane is much faster and far more economical than the plane your company is building. Use the following 0 to 100 scale. Write in the box the number between 0 and 100 that reflects what you think your plane's chance of financial success really is.

Questionnaire 4B was very similar to Questionnaire 4A except that construction on the plane had not yet been begun. In other words, no sunk cost had been incurred. Respondents to Questionnaire 4A estimated that the plane's probability of financial success was 0.41; respondents to Questionnaire 4B estimated the probability of success [p(*s*)] to be 0.34. The significantly higher p(*s*) estimate engendered by the sunk cost may have been responsible for the greater propensity to continue investing in the plane described in 4A compared to the one described in 4B, a finding which had been demonstrated in the immediately preceding study (Arkes and Blumer, 1985, Experiment 3). The general finding that people are more willing to continue investing in a project that has incurred a sunk cost has been demonstrated many times (e.g. Staw, 1976; Garland, 1990; Garland and Newport, 1991).

THREE POSSIBLE ROLES OF p(*s*) INFLATION

Consider the p(*s*) over-estimation documented among 3000 entrepreneurs by Cooper *et al*., (1988). These researchers asked persons who had just become business owners to estimate their new firm's p(*s*). Cooper *et al*. found that these business persons were grossly overconfident. In fact, one-third of the respondents were 100% certain that their business would succeed! Cooper *et al*. found that those entrepreneurs who were poorly prepared to take over a business were just as confident as those who were well prepared. Such data lead one to speculate that once having sunk a median of approximately $20,000 in the business, the entrepreneurs were 'ripe' for the sunk cost effect (McCarthy *et al*., 1993).

Similarly, Schmidt and Calantone (1998) asked business managers to consider the development of an automobile airbag sensor which was either an innovative product or one which involved only an incremental development over current sensors. The managers were asked to make investment decisions during each of three stages of product development. Schmidt and Calantone showed that the more innovative product resulted in significantly more 'go' investment decisions than the less innovative one even in the face of negative financial information. This manifestation of the sunk cost effect was accompanied by higher p(*s*) estimates for the more innovative product despite the fact it had financial outcome data identical to the less innovative one. Once again, inflated p(*s*) estimates were synchronized with a manifestation of the sunk cost effect.

Unfortunately the Cooper *et al*. (1988) and Schmidt and Calantone (1998) results do not allow us to choose between three possible roles the inflated p(*s*) estimate might play in the sunk cost effect. One possible role is to mediate subsequent behavior. Exhibit 1(a) depicts a situation in which the presence of a sunk cost causes an increase in the estimated p(*s*) of an endeavor. This elevated probability in turn justifies a heightened propensity to invest further resources in the endeavor. Perhaps it is the case that the entrepreneurs surveyed by Cooper *et al*. (1988) made an initial investment which then resulted in an inflated p(*s*). This over-optimistic p(*s*) estimate then would foster a subsequent decision to invest further in the business.

On the other hand, it may be the case that p(*s*) inflation is not the cause of the decision to invest further but instead is a consequence of that decision, as depicted in Exhibit 1(b). It may serve only as an *ad hoc* rationalization of the decision which has already been made. The entrepreneurs surveyed by Cooper *et al*. (1988) may have inflated their p(*s*) in an attempt to justify their prior investment activity. A third possibility is that the initial sunk cost had two simultaneous effects: it both motivated new investments and caused p(*s*) inflation. This situation is depicted in Exhibit 1(c). We will now consider all three possibilities.

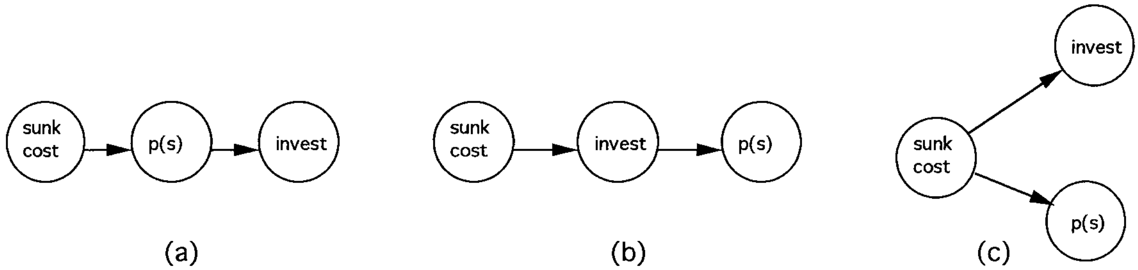

Exhibit 1. Models depicting three possible relationships between the presence of a sunk cost, the inflation of the probability of success estimate, and the heightened willingness to continue investing

PROBABILITY OF SUCCESS ESTIMATES CAN MEDIATE SUBSEQUENT BEHAVIOR

Prior investigators have suggested that estimated p(*s*) can mediate subsequent behavior. For example, Kukla (1972, 1974) suggested that achievement motivation (Arkes and Garske, 1982, Chapter 9) determines one's degree of perceived ability. This, in turn, determines one's estimated p(*s*) on a task. Due to their elevated opinion of their own ability, those with high achievement motivation perceive a task to be easy, that is, to have a high p(*s*). Thus they may exert insufficient effort on a task, resulting in performance inferior to that of persons with low achievement motivation, who, by dint of their low opinion of their ability, estimate their p(*s*) to be low. They therefore feel they have to exert great effort on the task, and they consequently do well. Note that it is the perceived p(*s*) on a task which causes one group to work less assiduously than the other. This is one example of the p(*s*) estimate's influence on subsequent behavior.

Another example is provided by the research on the illusion of control (Langer, 1975). Langer hypothesized that certain cues lead people to conclude that a task contains a component of skill rather than sheer luck. For example, allowing people to choose a raffle ticket containing a particular number rather than randomly giving people a raffle ticket leads people to value the ticket more, presumably because the chosen ticket is seen as having a higher p(*s*). This elevated p(*s*) then results in the justifiably greater value assigned to the ticket. Again, estimated p(*s*) is responsible for subsequent differences in behavior, in this instance, willingness to sell the ticket.

PROBABILITY OF SUCCESS ESTIMATES CAN BE INFLUENCED BY A PRIOR DECISION

Rather than being the cause of subsequent behavior, perhaps one's p(*s*) estimate can be influenced by a prior decision. Cognitive dissonance theory (Festinger, 1957) represents a prominent theoretical basis for hypothesizing that a decision to invest further in a project may inflate one's estimated probability that the project will succeed. If one decides to invest in a plane which has a superior competitor, one might be in a state of considerable dissonance. Two ways to reduce this dissonance would be to inflate one's estimate of the probability that one's own plane will succeed and diminish the estimated probability that the competitor's plane will succeed. Marshall Foch's assessment of his troops' position during a World War I battle would seem to be a good example of the first half of this strategy: 'Hard pressed on my right. My center is yielding. Impossible to maneuver. Situation excellent.'

Recent research by Boiney *et al.* (1997) provides another example of retrospective rationalization of prior decisions. Boiney *et al.* asked business students to consider whether to introduce a new product based upon sales projections provided by four experts. Some participants were particularly motivated to make a 'go' decision, because the company had suffered due to excessive timidity of prior decision makers when potentially promising products had been rejected by in-house decision makers. The results of the research suggested to the authors that these motivated participants desire a particular outcome (a 'go' decision) '. . . and then alter their judgment to produce an estimate supporting that decision' (Boiney *et al.*, 1997, p. 20). This causal chain of events is congruent with the model depicted in Exhibit 1(b): an investment decision is made, and estimates are then altered to rationalize the prior decision. (See also Henry and Sniezek, 1993; Hsee, 1996.)

Of course, a third possibility is that a sunk cost simultaneously promotes both an increased willingness to spend and an increased belief that the project will be successful. This situation is depicted in Exhibit 1(c). Note that neither willingness to spend nor inflated p(*s*) estimation influences the other factor according to this model.

To help distinguish between the three causal models depicted in Exhibit 1, we conducted two studies.

EXPERIMENT 1

A very simple first step in investigating the causal route between estimated p(*s*) and willingness to continue investing is to hold the former constant while varying the presence of a sunk cost. If heightened willingness to invest in the presence of a sunk cost occurs despite the fact that the estimated p(*s*) remains fixed, then we would conclude that the model depicted in Exhibit 1(a) is not an accurate description of the sunk cost effect. According to this model, if the p(*s*) is held constant, the willingness to invest must remain constant, too.

Method

Participants
One hundred and forty-eight undergraduates received partial course credit for their participation in this study. They were divided into four groups of 36 to 38 persons each.

Procedure
Four different questionnaires were used in this study. Two of them described the radar-blank plane scenario in which a 90% sunk cost had occurred. One of these two '90% sunk cost' scenarios was similar to Questionnaire 3A taken from Arkes and Blumer (1985, Experiment 3). That questionnaire is the same as the one presented near the beginning of this paper except the last two sentences were replaced by the following: 'Based upon your own consideration of all of the information on this page, what do you think is this plane's chance of being a financial success? Please write on the following line the number between 0 and 100 which expresses your opinion. ____%

Now the question is: should you invest the last 10% of the research funds to finish your radar-blank plane? Please check the box corresponding to your choice.' Participants could check either a box labeled 'Yes' or one labeled 'No'.

The other 90% sunk cost questionnaire was identical to the first except the following was inserted after the fourth sentence: 'Your marketing department, which has made very accurate estimates in the past, believes that there is only a 34% chance that your plane will be a financial success if you decide to finish constructing the plane.'

There were also two 'no sunk cost' scenarios. The first was very similar to the one used in Experiment 3 of Arkes and Blumer (1985):

> 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 dollars 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 their plane is much faster and far more economical than the plane your company could build.

Participants were then asked the usual two questions — one pertaining to the plane's chance of being a financial success and the other whether the investment should occur.

The second 'no sunk cost' questionnaire was identical to the first except for the insertion of the sentence that the marketing department had estimated that the plane's chance of success would be only 34%.

The four questionnaires thus constituted a 2×2 design. In half of the questionnaires a sunk cost was present; in half a sunk cost was absent. Within each of these two groups, p(s) was unspecified for one of the questionnaires. For the other questionnaire within each of these two groups, p(s) was fixed at the exact percentage the respondents in the Arkes and Blumer (1985) study thought would be appropriate for the project which had incurred no sunk cost. If willingness to continue investing requires inflation of the p(s) estimate, then holding this percentage fixed at 34% should diminish the magnitude of the sunk cost effect.

Results

The data are displayed in Exhibit 2. As can be seen, when the probability of success was unspecified, the presence of a sunk cost resulted in a p(s) estimate of 0.38 compared to a p(s) of 0.30 when no sunk cost was present. This difference is very similar to the 0.07 difference found by Arkes and Blumer (1985). When the p(s) was specified to be 0.34, the presence of a sunk cost resulted in a p(s) estimate of 0.37, only 0.02 higher than when a sunk cost was not present.

These p(s) data were analyzed by an analysis of variance (ANOVA), the two between-subjects factors being presence/absence of a sunk cost and the specification of the p(s) by the marketing department (not specified versus specified to be 0.34). No factors were significant. An *a priori* test on the two cells with p(s) unspecified confirmed that the sunk cost cell was significantly greater than the no sunk cost cell, $t(144) = 1.97$, $p < 0.05$.

Thus we concluded that our specification of p(s) at 0.34 was successful at preventing subjects from significantly inflating p(s). Among those participants for whom p(s) was not specified, the expected significant p(s) inflation occurred.

We then examined the participants' willingness to invest. Inspection of Exhibit 2 suggests that when no sunk cost had been incurred, participants were very likely to refrain from investing. When a sunk

Exhibit 2. Experiment 1: frequency of choosing to invest and estimated probability of success [p(s)] as a function of the presence of a sunk cost and a specified probability that the investment will be successful

	Sunk cost					
	Present			Absent		
Probability of	Invest?			Invest?		
success	Yes	No	p(s) estimate	Yes	No	p(s) estimate
34%	26	11	0.37	11	27	0.35
Not specified	24	13	0.38	7	29	0.30

cost had been incurred, investment was the modal choice. The similarity of the data in the top and bottom rows suggests that the specification of a 34% probability of success made little difference in willingness to invest.

This impression was supported by the results of a 2(Sunk Cost: present/absent) $\times$ 2[p(*s*) Estimate: Unspecified/34%] $\times$ 2(Answer to Invest Question: Yes/No) log-linear analysis. The only interaction to reach significance was the Sunk Cost by Answer to Invest Question, $z = 5.09$, $p < 0.01$. Backward elimination revealed that the three-way interaction and both two-way interactions involving the specification of p(*s*) were inconsequential. The presence of a sunk cost significantly increased willingness to invest approximately equally whether or not the p(*s*) was specified.

Discussion

The results of Experiment 1 suggest that Exhibit 1(a) is not a likely description of the relationship between estimated p(*s*) and willingness to invest. According to that model, if the p(*s*) is specified to be the same in two groups, then there could not be a difference in the likelihood of investment between those groups. This prediction was disconfirmed by the data from Experiment 1. One sunk cost group and one no sunk cost group had their p(*s*) specified to be 0.34. The manipulation check confirmed that this manipulation was successful in preventing the p(*s*) from differing significantly in those two groups. Yet the difference between these two groups in their willingness to invest more money was approximately the same as the two groups without a specified p(*s*) and in which the p(*s*) estimates did differ significantly.

Rather than serving as a cause of increased willingness to invest, the elevated p(*s*) estimate might serve as a *post hoc* rationalization of the prior decision to invest, much as would be predicted by differentiation consolidation theory (Svenson, 1992) or cognitive dissonance theory (Festinger, 1957). In light of the result of this study, the following would be the interpretation of the finding by Arkes and Blumer (1985, Experiment 4) that p(*s*) estimates were inflated in the presence of a sunk cost: having decided that the failing course of action warranted more investment, participants then justified this decision by stating that the situation was not such a lost cause, after all. The project's p(*s*) was therefore deemed to be significantly higher than that assigned by the participants in the 'no sunk cost' group. Such reasoning would be consistent with the model depicted in Exhibit 1(b).

However, the results of Experiment 1 are not inconsistent with the model depicted in Exhibit 1(c). Thus both the models in Exhibits 1(b) and 1(c) remain as possible descriptions of the sunk cost effect. Experiment 2 is designed to distinguish between these two models.

EXPERIMENT 2

Assume that the model depicted in Exhibit 1(b) is true. If it is the case that the inflation of p(*s*) estimates is a *post hoc* rationalization of a prior decision to invest, then asking participants to provide such an estimate *after* their positive investment decision should result in a higher estimate than forcing participants to provide such an estimate *before* their investment decision. This result is predicated on the assumption that if participants provide the estimate before the actual investment decision is made, no post-decision rationalization would have yet occurred. Only after the decision has been made can such rationalization take place. Hence if Exhibit 1(b) were true, we would expect an effect of the timing of the p(*s*) estimate on its magnitude: p(*s*) estimates rendered after the investment decision should be higher than estimates rendered before the decision. The model depicted in Exhibit 1(c), however, would seem to be mute with regard to the influence of the timing of the estimate on its magnitude.

Method

Participants

Two hundred and forty-one undergraduates received partial course credit for their participation in this study.

Procedure

Rather than having a sunk cost and no sunk cost questionnaire as was done in Experiment 1, this study used a small sunk cost (10%) and large sunk cost (90%) questionnaire:

> As the director of research in an airline company, you have invested 90% (10%) of the company's research 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. Just recently, another firm began marketing a plane than cannot be detected by radar. Also, it is apparent that their plane is much faster and far more economical than the plane your company is building.

At this point half of the participants read:

> You must estimate the chances that the radar-blank plane will be successful from 0% chance of success to 100% chance of success. First, estimate the chances that the plane will be successful *without* the last of the funds. Please write a percentage from 0% to 100%. Second, estimate the chances that the lane will be successful *with* the last of the funds. Please write a percentage from 0% to 100%.

These subjects then turned a page and read the following:

> Now the president would like to know if you think the project should be finished with the last of the research funds. Please indicate if you think the project should receive the funds.

Participants then checked either a box labeled 'Yes' or one labeled 'No'.

The other half of the subjects completed the question soliciting their investment decision before they estimated p(s) with and without the additional investment funds. This comprised the timing independent variable, namely, whether the p(s) estimate preceded or followed the investment decision.

Results

The data of eleven participants were discarded because they failed a logic test. They deemed p(s) to be higher if the funds were not invested than if the funds were invested. This left 230 participants in the study.

We performed a 2(Sunk Cost: 90%/10%) $\times$ 2[Timing of p(s) estimate: before/after investment decision] $\times$ 2(Choice Whether to Invest: Yes/No) $\times$ 2(With/Without funds) analysis of variance (ANOVA) on the estimated probabilities of success with the latter factor being the only within subjects variable. Note that we randomly assigned participants to the levels of the first two independent variables, but subjects self-selected into the third independent variable by choosing whether they wished to invest.

The most important result of the ANOVA was a significant main effect for the timing of the p(s) estimate. Estimates made after the investment decision averaged 0.57; estimates made before the investment decision averaged only 0.50, $F(1, 222) = 6.43$, $p < 0.02$.

Three obvious main effects were significant. The presence of a larger sunk cost resulted in significantly higher overall estimates than a smaller sunk cost, 0.59 versus 0.49, $F(1, 222) = 4.61$, $p < 0.05$.

Exhibit 3. Experiment 2: estimated probability of success as a function of the funding status of the project, the participants' decision to invest, and the magnitude of a sunk cost

	Invest?		Sunk cost		
Funding status	Yes	No	90%	10%	Row mean
Funded	0.78	0.60	0.68	0.69	0.69
Not funded	0.47	0.33	0.51	0.29	0.39
Column mean	0.62	0.47	0.59	0.49	

Estimated p(*s*) was significantly higher when the project did receive the final funding than when it did not, 0.69 versus 0.39, $F(1, 222) = 343$, $p < 0.001$. Those who chose to invest gave significantly higher overall estimates than those who chose not to invest, 0.62 versus 0.47, $F(1, 222) = 22.08$, $p < 0.001$.

Only two interactions were significant, and the relevant means are displayed in Exhibit 3.

When estimated p(*s*) was given for funded projects, the means were nearly identical whether the project was 90% completed or 10% completed (0.68 versus 0.69). This result is sensible under the assumption that fully funded projects would have equivalent probabilities of success. However, when the estimates were given for *un*funded projects, the 90% completed group gave a much higher estimate than did the 10% group (0.51 versus 0.29). This is also sensible on the grounds that a nearly completed project would be more viable than a project which is only one-tenth completed. This With/without funding × Sunk Cost interaction was significant, $F(1, 222) = 62.95$, $p < 0.001$.

Those who thought the investment of the final funds should not be made thought a funded project was more likely to succeed than an unfunded one (0.60 versus 0.33). This difference was smaller (0.27) than the difference between the p(*s*) estimates of funded and unfunded projects made by those who were in favor of investing (0.78 versus 0.47), for a difference of 0.31. Thus those who favored funding thought that the funds would have more of a positive impact than did those who would not have continued funding. This With/without funding × Choice interaction was significant, $F(1, 222) = 8.69$, $p < 0.01$.

Finally, of the 109 participants in the 90% sunk cost group, 63 chose to invest. Of the 121 participants in the 10% sunk cost group, 45 chose to invest. This difference is significant, $\chi^2(1) = 8.97$, $p < 0.01$, and replicates the usual sunk cost effect.

Discussion

The principal result is that when the p(*s*) estimate followed the investment decision it was significantly higher than when it preceded the investment decision. This suggests that the p(*s*) estimate serves as a *post hoc* rationalization of the prior investment decision. This result is most consistent with the model depicted in Exhibit 1(b). The model in Exhibit 1(c) would seem not to be able to account for the effect of the timing of the p(*s*) estimate on its magnitude.

The results from Experiment 2 also cast further doubt on the viability of the model depicted in Exhibit 1(a). In that model p(*s*) inflation is presumed to be the cause of the heightened willingness to invest after incurring a sunk cost. It is not clear how that model could accommodate the finding that the p(*s*) estimate is significantly higher if it is solicited after the investment decision is made.

Finally, the results of Experiment 2 provide an opportunity to compare the effect sizes of the two dependent variables — the proportion of participants choosing to invest and p(*s*). Using the phi coefficient as a measure of Experiment 2's correlation between the magnitude of the sunk cost (90% versus 10%) and the decision to invest (yes versus no), the proportion of variance accounted for is 4.08% (Hayes, 1963, p. 603). This estimate is close to the proportion of variance accounted for by the magnitude of the sunk cost based upon Camerer and Weber's (in press) re-analysis of the Staw and Hoang (1995) data: 4.95%.

The proportion of variance accounted for by the magnitude of the sunk cost on the p(*s*) estimates in Experiment 2 was 1.6%. Thus the impact of the sunk cost was only 30% as great on p(*s*) as on the propensity to invest. This result is consistent with the theorizing of McGuire and McGuire (1991), who advanced a general 'wishful-thinking postulate' by which the desirability of an event influences its judged likelihood. McGuire and McGuire (1991, p. 65) hypothesized a rather tight linkage between the desirability of an event and its antecedents and consequences but a much weaker linkage between the desirability of an event and its likelihood of occurrence. Based upon this analysis one would expect the prior sunk cost to have more impact on the desirability of investing than on the more distal variable of p(*s*).

A reviewer of this paper suggested another reason why the impact of sunk cost is weaker on p(*s*) estimates. When a small amount of money has been invested in a floundering project, people may believe that the p(*s*) should remain high because there is still plenty of time for product redesign or some rescue operation. On the other hand, when the sunk cost is relatively high because a project is nearly completed, there is less opportunity for any project modification which might salvage the endeavor. Hence there wold be a damper on the possibility of p(*s*) inflation. These two complementary processes would reduce the magnitude of the difference between p(*s*) estimates in low and high sunk cost situations.

GENERAL DISCUSSION

We performed two experiments designed to test the three models depicted in Exhibit 1. Because the results of Experiment 1 demonstrated that the sunk cost effect still occurred when p(*s*) was held constant, we rejected Exhibit 1(a). Because the effect of the timing of the p(*s*) estimate was consistent with Exhibit 1(b) but not 1(c), we rejected the latter in favor of the former. Thus we conclude that the evidence is more supportive of Exhibit 1(b) than the other two candidates. The main feature of Exhibit 1(b) is that inflation of the p(*s*) estimate serves as a *post hoc* justification for throwing good money after bad rather being a cause of that behavior.

There are many other examples of *post hoc* rationalizations being employed to justify prior judgments or decisions. For example, Alicke *et al.* (1994) presented college students with descriptions of decisions that had turned out either quite well or rather poorly. In one scenario (Experiment 2) participants read of a psychiatrist's decision to release a patient, Peter Garmess, back into the community. Half of the participants read that the decision turned out well: the ex-patient turned his life around, got a job, and started a family. The other half of the participants read that the decision turned out poorly: the ex-patient stabbed a man. First, participants were asked to rate the quality of the decision made by the psychiatrist to release the patient. Although participants were instructed to ignore the outcome of the decision, they could not do so; compared to the rating when the decision had turned out well, when it had turned out badly the quality of the decision was rated significantly lower. This is the usual outcome bias (Baron and Hershey, 1988). More importantly for our purposes, participants were then asked to rate the extent to which each fact in the scenario provided a sound basis for the decision that was made, or for the opposite decision. For example, one fact was 'Garmess had recently participated in a detoxification program to cure his dependency on alcohol'. Those who read that the decision had turned out well rated this and all other facts as more supportive of the decision that was made, compared to the ratings of those who had read that the decision had turned our poorly. These latter participants judged the very same facts to be more supportive of the opposite decision! This result indicates that participants performed an *a posteriori* adjustment of the data after having read about the outcome of the decision. After the decision is made and the outcome perceived, the data are reconsidered in a way that renders them consistent with the outcome.

In a similar way we suggest that those having decided to invest in a sunk cost revise their p(s) estimates upward in order to provide a rationalization for the prior investment decision.

Related social psychological theory

In the late 1950s and early 1960s a disagreement occurred concerning the process of decision bolstering. According to cognitive dissonance theorists (e.g. Decker, 1964; Festinger, 1957), attitude change took place following a decision in order to reduce or eliminate dissonant cognitions. Janis (1959) suggested that pre-decisional conflict reduction followed essentially the same principles as the post-decisional processes usually attributed to dissonance reduction. At least in the context of the sunk cost effect examined in this manuscript, the results are more consistent with the post-decisional viewpoint advocated by dissonance theorists.

A second controversy in social psychology pits intrapsychic explanations versus ones based on impression management. Cognitive dissonance theory (Festinger, 1957) comprises an intrapsychic explanation, because dissonant cognitions result in an internal drive state, and this drive motivates one to change opinions or actions. Cognitive dissonance has been suggested as a possible cause of the sunk cost effect (e.g. Bazerman *et al*., 1984). The poor performance of the entity in which one has devoted time, money, or effort constitutes an event highly dissonant with that devotion. Perhaps p(s) elevation is a means of reducing dissonance.

On the other hand, impression management has frequently been mentioned as a cause of the sunk cost effect (e.g. Bobocel and Meyer, 1994; Fox and Staw, 1979). To abandon a course of action is to advertise that the initial decision to invest was a mistake. To preserve one's appearance and possibly even one's employment, it might be better to act as if the initial decision was a good one by adding more resources to the original option.

P(s) elevation might be consistent with either explanatory framework. To bolster a prior decision, one can elevate the p(s), thereby making it consistent with other cognitions which have fostered further investment. P(s) elevation can also serve the purpose of justifying the decision to others. The fact that p(s) elevation is entirely consistent with either viewpoint supports Tetlock and Manstead's (1985) suggestion that explanations based upon intrapsychic processes may simply not be discriminable from explanations based upon impression management. Thus the current pair of studies cannot definitively support one viewpoint over the other.

Implications

There are a number of implications of the hypothesis that the p(s) estimate is a *post hoc* rationalization of the prior decision to invest rather than a cause of the decision. Perhaps the most important implication is that attempts to promote a more realistic p(s) estimate are unlikely to debias the sunk cost effect. If the one's inflated p(s) estimate were the cause of the sunk cost effect, efforts to deflate it might have a salutary effect. If it is not the cause, then such effects are less likely to be effective.

An example of this situation occurred during the 1981 Congressional debate whether to continue funding for the stupendously expensive Tennessee–Tombigbee Waterway Project. A vast sunk cost had already been incurred on this project, and Congress had to commit even more funds if the project were to be completed. An opponent of continued funding, Senator Percy of Illinois, told the Senate that not a single coal company expressed any interest whatsoever in using the Waterway. Since one of the major uses of the proposed project was to be the shipment of coal to the Gulf of Mexico, one would have thought that the coal industry's total indifference to the project would be devastating to the estimated probability of financial success of the Waterway. However, since p(*s*) estimates are not a cause of the desire to 'throw good money after bad', Senator Percy's strategy was not likely to be effective. His amendment to discontinue funding was defeated.

Another implication of this research concerns its relation to a factor which has been proposed to explain the sunk cost effect, namely, the desire not to appear to be wasteful (Arkes and Blumer, 1985). According to this viewpoint, people are reluctant to abandon a failing course of action, because to do so would be to waste the funds already expended. Compared to a 100% probability of losing the funds already spent should no further investment occur, even a small probability of rescuing the whole amount with a further investment seems relatively appealing. This comparison is even more in favor of the latter option when one considers that the 100% probability of losing the investment is made more unattractive due to the 'certainty effect' (Kahneman and Tversky, 1979), according to which certain losses are undervalued. Given the fact that the certainty effect magnifies the aversiveness of the sure loss which would follow project abandonment, inflation of the small probability that a further investment could resurrect the endeavor might provide abundant justification for continuation.

A third implication of this research is that in sunk cost situations people may not be expected value (EV) or expected utility (EU) decision makers, in the sense that expectancies may play no causal role in the investment decision. The heightened choice of the option in which one has previously invested occurs prior to the heightened p(*s*) of that option. If expectancies — p(*s*) levels — play no causal role, then other considerations, such as the desire to avoid the appearance of waste (Arkes, 1996) or the desire to complete a project (Garland and Conlon, 1998), must be more influential causes of the sunk cost effect.

J. P. Morgan once said, 'A man always has two reasons for doing anything — a good reason and the real reason'. We suggest that an elevated probability of success estimate is not the real reason for throwing good money after bad, but it can be useful as a 'good' reason when one has to rationalize the decision to oneself or to others.

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