Sticking to plans: capacity limitation or decision-making bias?
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4. Behavioral Entrapment in a Dynamic Environment: Sunk Costs or Task Completion?

In decision making literature behavioral entrapment has primary been explained in terms of sunk cost but recent studies have shown that task completion can provide an alternative explanation. Both explanations were examined in the context of the real time simulation of a fire control task. Participants were required to handle multiple fires that occurred sequentially. Results of the fourth experiment showed a reversed sunk cost effect that we ascribed to high subjective time pressure. In a fifth experiment we added a static condition in order to identify the attribution of a real time component. Behavioral entrapment appeared to be stronger in static scenarios, probably because participants lacked the opportunity to adjust their strategy. In the static condition behavioral entrapment could be explained by task completion. In the dynamic condition there was a reversed sunk cost effect but only when the task was not near completion.

Introduction

People have a tendency to stick to their initial plan even if a change in the environment would require a revision. Several phenomena have been identified that reflect this behavioral entrapment, such as escalation of commitment (Staw and Ross, 1989), the sunk cost effect (Arkes and Blumer, 1985) and task completion (Garland and Conlon, 1998).

Hitherto, people's reluctance to switch to an alternative course of action has generally been explained in terms of amount of investment. The sunk cost effect, for example, indicates that there is a greater tendency to pursue a course of action when investments are made, such as time, money or effort, even when these costs are irrelevant to the current decision (Arkes and Blumer, 1985). Thaler (1980) illustrates the sunk cost effect as follows: a family pays $40 for tickets to a basketball game to be played 60 miles from their home. On the day of the game there is a snowstorm. They decide to go anyway, but note in passing that had the tickets been given to them, they would have stayed home. Even though the correct trade-off should just
involves the costs of defying the snowstorm versus the pleasure of the game, people do take prior investments – the costs of the tickets – into account.

Several psychological mechanisms have been suggested for the sunk cost effect, either motivational – e.g. a desire not to appear wasteful (Arkes and Blumer, 1985) or cognitive – e.g. risk seeking behavior in the domain of losses (Whyte, 1986). Almost all mechanisms for behavioral entrapment focus on sunk costs. Recent findings, however, point to explanations in terms of termination of a course of action rather than prior investments.

Boehne and Paese (2000) pointed out that the degree of investments in a course of action is confounded with the degree of completion. Putting money or effort into a project not only implies that investments are made, but also that the project comes closer to completion. About the effects observed in studies on prior investments, the authors state, “were due to project completion rather than sunk costs and any attempt to explain these results in sunk-cost terms is therefore moot”(p.179).

Conlon and Garland (1993), Garland and Conlon (1998) and Boehne and Paese (2000) therefore conducted experiments in which they disentangled investment and completion. They crossed small versus large sunk costs with low versus high project completion and only found evidence for the completion factor, not for sunk costs. In addition, Moon (2001) found evidence for both task completion and sunk costs the latter being present only when the task was nearly completed. In all, it can be concluded that there is no agreement concerning the psychological mechanism underlying the tendency to stick to a course of action: sunk costs or task completion.

All studies on behavioral entrapment used scenarios that were highly hypothetical. As also noted by Boehne and Paese (2000), this seems to be a serious limitation. As they argue “real-world investment situations are likely
to be more involving*(p. 192) than decision scenarios where participants have to imagine a previous decision (for example, having invested 10 million dollars into a research project for constructing a plane) and to reconsider the decision after new information has come up (another firm can build a better plane)*. On the one hand, this involvement concerns the personal value of the decision, a motivational limitation inherent to laboratory studies. On the other hand, persons are also less involved in the decision process as they have to imagine the environmental change, rather than experiencing it.

The general procedure in experiments on behavioral entrapment is that participants are given a description of a project in which they have invested time, money or effort. At a certain point in time the situation changes. Based on new information participants have to make a decision whether to continue investing in the project or not. Although the scenario includes history information, the dynamics of the task are not taken into account explicitly. Participants have to provide a reaction to an environmental change, but the dynamic development of the situation has to be imagined, rather than experienced.

Research with dynamic tasks has also demonstrated people's tendency to stick to a course of action. An example of a dynamic environment is supervisory control. In supervisory control tasks an operator has to monitor a system and has to intervene whenever disturbances occur. The main conclusion from studies that have examined behavioral entrapment was that disturbances were handled in a strict sequential order (Kerstholt, Passenier, Houttuin and Schuffel, 1996; Kerstholt and Passenier, 2000 and Meij and Kerstholt, submitted). Only after a disturbance had been dealt with, participants assessed the situation again. As a consequence the overall state of the system was not noticed during fault handling which could result in
negative consequences. Most importantly, these studies show that participants reacted inadequately to environmental changes.

Whereas behavioral entrapment in decision making research has generally been explained in terms of sunk costs or, recently, task completion, in dynamic environments like process control, this tendency has mostly been explained by limited attention (Moray and Rotenberg, 1989). All resources are needed for handling the first fault. In a recent study, however, Mey and Kerstholt (submitted) showed that the tendency to deal with faults sequentially was not affected by workload, but rather by the anticipated cost of reassessing task priorities. This would suggest that operators make a deliberate trade-off between the costs and benefits of a reassessment. However, it still has to be examined which factors affect this trade-off. Perhaps in these supervisory control tasks factors like sunk costs or task completion do play a role as well. In the present chapter we will investigate behavioral entrapment in the dynamic environment of the fire control task.

The purpose of the fourth experiment was to investigate whether behavioral entrapment in a dynamic task environment can be explained by prior investments or by expectations about the future. The purpose of the fifth experiment was to investigate to what extent the inclusion of a real time component in a task attributes to behavioral entrapment. Is behavioral entrapment in a dynamic task environment stronger than in a static environment? And, can behavioral entrapment in a dynamic condition be ascribed to the same psychological mechanism as in a static environment?

**Experiment 4**

The aim of this experiment was to examine the influence of sunk costs and task completion on behavioral entrapment in a dynamic environment. We manipulated the degree of investment and task completion independently.
Method

Participants
Twenty-four participants voluntarily took part in the experiment. They were all first year students at the University of Utrecht. The experiment lasted about one hour and a half and participants were paid Dfl. 70 (approximately € 32).

Experimental task
The experimental task was identical to the fire control task used in the previous experiments with a few exceptions.

![Figure 4.1: An overview of the system at the moment two fires have been detected.](image)

As in the previous experiments, there were windows available in the subpart of the screen for the purpose of fire fighting (see figure 4.1). These windows
showed questions that could be asked in order to select the correct action. The number of questions that was presented in the lower part of the screen ranged from four to six. This number constituted the maximum number of questions. Participants had to work down the row of questions until a conclusive answer was provided. Participants didn’t know in advance how many questions had to be answered.

Maximum problem solving time was dependent on the number of questions that had to be requested. In case the maximum number was four, participants had 30 seconds to solve the fire, in case of five questions they had 35 seconds and in case of six questions they had 40 seconds. (Appendix C presents the tree structure to determine the appropriate action in case the maximum number of questions to be asked is four.) Answering a question closed down the system for 4 seconds.

At several points during fire handling a second fire symbol could pop out somewhere on the ship. This fire symbol could either be a rapid evolving fire (to be solved within 15 seconds) or it could be a false alarm. In case of a real fire, this fire always had priority meaning that this fire had to be dealt with first. To find out whether the symbol was a fast spreading fire or a false alarm, participants could click the symbol. If it represented a false alarm, the symbol simply disappeared from the screen. If it indeed represented a fire, a list of four questions was presented on the right part of the lower part of the screen. The structure of the question-and-answer tree was identical to the trees for the solving of the first fire in case of four questions, with the exception that the time delay was one instead of four seconds.

**Procedure**

Before the actual experiment, participants were trained in the selection of the correct treatment. Participants were handed out three trees of questions that could help them to ask the relevant questions and determine the correct
treatment. There was one tree in case of a maximum of four questions, a tree for a maximum of five questions and a tree for a maximum of six questions. Participants were allowed to use these trees throughout the experiment.

After the training-session, participants were given the instructions for the experimental task. Before the experiment started, participants received nine scenarios for practice purposes.

**Design**

Behavioral entrapment was operationalized as detecting the second fire after completion of the first fire. So, for each trial we recorded whether participants detected the second fire before or after completion of the first fire.

A 2 * 2 factorial was used. Both factors - investment and completion – were manipulated within subjects. The level of investment was equal to the number of questions that had been answered at the moment a second fire started. A second fire started after either one or two questions had been answered. The level of completion was equal to the maximum number of questions that still needed to be answered in order to select the correct action. Either three or four questions still needed to be answered when a second fire occurred. To accomplish sufficient uncertainty, we added some additional scenarios that did not fall in any condition of the experimental design. First, we added a number of scenarios without additional fires. Second, we included a number of scenarios in which the second fire occurred at different points in time.

In total, there were sixteen scenarios with two fires that we expanded with twenty-one filler scenarios. For the analysis we only used the sixteen scenarios that were part of the experimental design.
Results

Figure 4.2 shows the mean of scenarios in which percentage the second fire was detected after the first fire was completed.

![Graph showing the mean percentage of scenarios in which participants detected the second fire after completion of the first fire as a function of investment and completion.]

There was a main effect of investment, which was in the opposite direction as we expected (F(1,23) = 9.68, p < 0.01). This implies that the inclination to detect the second fire only after completion of the first fire, became less strong when more prior investment were done.

There was no effect of task completion (F(1,23) = 1.65, p > 0.1) nor an interaction between investment and task completion (F(1,23) = 1.79, p > 0.1).
**Discussion**

Results showed that - in a dynamic environment - participants do not seem to have a strong inclination for behavioral entrapment. In most cases they detected the second fire before determination of the first fire. Moreover, prior investments nor the degree of task completion can account for behavioral entrapment. For prior investments we even found an effect in the opposite direction, implying that people are more inclined to abandon an ongoing task when more investments have been made.

This reversed sunk cost effect may be explained by the perception of time pressure. It is a general characteristic of dynamic tasks that time is often limited and as the task develops there is less time available and time pressure increases. Although the available time to complete fires is equal for both conditions, participants in the high investment condition may perceive time pressure to be higher than in the low investment condition. This because the available time in relation to invested time is lower in the high investment condition than in the low investment condition. As a consequence, participants in the high investment condition may be more inclined to switch.

The present findings suggest that behavioral entrapment is less prominent in scenarios that include a real time component. However, a closer look at the data revealed that in 25.6% of the scenarios where there actually was a second fire, participants chose to solve the first fire first and then to switch to the second fire. In other words, in 74.4% of the cases participants made a switch to the fire symbol to check whether the symbol represented a fire or a false alarm. And, when there actually appeared to be a second fire, they did not always continue with that fire. It seems that at the moment they detected the fire symbol and knew the symbol indeed represented a fire, they made a new decision whether to continue with the first fire or not. In making this
decision they tended to finish the first fire, in spite of the fact that the second fire always had a higher priority.

Since problem solving was not independent of detection in this experiment, it was not possible to analyse the data from a problem solving perspective only. We therefore decided to conduct a fifth experiment in which participants had to decide whether to solve the first or the second fire. Detection of the second fire was no longer required.

**Experiment 5**

The purpose of this experiment was identical to the previous experiment, namely to examine which psychological mechanism behavioral entrapment could be ascribed: prior investments or task completion. The experiment was a replication of the fourth experiment but with a dependent variable that is more related to problem solving. Instead of recording whether participants detected the second fire before or after the first fire, we recorded whether participants solved the second fire before or after the first fire.

A second question of this experiment was to what extent the inclusion of a real time component in a task attributes to behavioral entrapment. Is behavioral entrapment in a dynamic task environment stronger than in a static environment? In order to investigate this question, we compared two conditions of the shipping control task: a dynamic condition and a static condition. In the dynamic condition participants had to solve the fires in real time whereas in the static condition they had to make a decision on the basis of snapshots of the dynamic developments.
Method

Participants
Sixty-nine first-year students from the University of Utrecht and the University of Amsterdam participated in the experiment. They were randomly assigned to an experimental condition and paid for participation.

Experimental task
We used the same experimental task as in the previous experiment. In addition, we introduced for each fire a time indication. From the onset of the fire(s), the available time to select the correct treatment for that fire was shown. For instance, if the maximum number of questions is equal to four, it is indicated that participants have 30 seconds of their disposal to solve that particular fire. Furthermore, the system is continuously updating for each fire how much time has elapsed so that participants always know how much time is left for the diagnosis process.

Procedure
The procedure was identical to the procedure of the previous experiment, with the exception that a second fire symbol always represented a high priority fire and never a false alarm. In addition, participants no longer needed to detect a second fire: at the moment a second fire started, the system automatically presented a list of four questions and five possible actions.

Participants in the dynamic condition were instructed in the same way as in the first experiment. Participants in the static condition where presented with snapshots of scenarios the moment the second fire started. For each snapshot they had to indicate which fire they would solve first: the first fire
or the second one. Participants received the same practice session as the participants in the dynamic condition.

**Design**

The design was identical to the previous experiment with the exception that the dependent variable was operationalized as solving the second fire after completion of the first fire. So, for each scenario we recorded whether participants solved the second fire before or after completion of the first fire.
Results

Figure 4.3 shows the number of times participants solved the second fire only after the first fire was completed for the dynamic condition (left panel) and for the static condition (right panel).

Figure 4.3: Mean percentage of scenarios in which participants solved the second fire after completion of the first fire as a function of investment and completion. This was done for the dynamic condition (left panel) and the static condition (right panel).

The tendency to complete the first fire first is stronger in the static than in the dynamic condition (F(1,68) = 11.25, p < 0.01). For each condition we conducted a separate analysis of variance.

In the dynamic condition there was a main effect of completion (F(1,23) = 4.29, p = 0.05), a main effect of investment (F(1,23) = 4.29, p = 0.05) and
an interaction between completion and investment \((F(1, 23) = 4.53, p = 0.05)\). The interaction implied that there was a reversed sunk cost effect only for the condition in which there was a relatively long time before the task would be completed \((F(1, 23) = 4.78, p < 0.05)\). For the condition in which the task was near completion there was no effect of sunk costs \((F(1, 23) = 1.93, p > 0.1)\). So, participants tend to abandon an ongoing task after high investments have been made but only when this task was not near completion.

For the static condition there was an effect of task completion \((F(1, 45) = 7.89, p < 0.01)\). The tendency to continue with the first fire became stronger when less questions still needed to be answered. There was no effect of investment \((F(1, 45) = 1.05, p > 0.1)\) nor an interaction between completion and investment \((F(1, 45) < 1)\).

**Discussion**

The main purpose of the present study was to examine behavioral entrapment in a dynamic task environment, that is, when individuals have to make decisions in a continuously changing environment.

The present data showed that even though behavioral entrapment was present for both the static and the dynamic condition, it was stronger for the static one. A plausible explanation for this result is that participants in the dynamic condition are in an interactive mode with the system and, in contrast to a static condition, received feedback concerning the consequences of their actions. When participants decided to stick to the first fire it almost always resulted in a shutdown of the system. As a consequence, participants had the opportunity to adjust their strategy in order to prevent shutdowns for subsequent scenarios. In the static condition, on the other hand, participants did not learn the consequences of their
choices and did probably not adjust their strategy accordingly. Over all trials, this resulted in more instances of behavioral entrapment in the static condition. Still, learning is not the sole explanation as there was still a bias in the dynamic condition as well.

In the dynamic condition we found a reversed sunk cost effect, but only for scenarios in which the first fire was not near completion. In the present task environment two different mechanisms seem to interact. On the one hand there are prior investments. As we argued earlier, prior investments may have increased subjective time pressure that induced participants to withdraw from the current fire. On the other hand there is an effect of task completion: participants continued with the task because it was near completion. The data suggest that participants tended to withdraw as subjective time pressure increased but only when the task was not near completion. The tendency to withdraw was reduced when the task came closer to completion.

The results of the static condition provided clear evidence for an explanation in terms of task completion and not for an explanation in terms of sunk costs. It seems that when sunk costs and task completion are disentangled more evidence is found for task completion as an explanation for behavioral entrapment than sunk costs (Boehne and Paese, 2000; Conlon and Garland, 1993; Garland and Conlon, 1998). So, it is plausible that, because prior investments and task completion have been confounded, previous findings that were ascribed to sunk costs were actually due to task completion.

In the first experiment behavioral entrapment was much less prominent than in the second experiment. A main difference between the experiments is the dependent variable that was used. In experiment four we focused on detection of the second fire and in second five on solving the second fire. The fact that participants’ inclination to abandon the first fire in experiment
four is much stronger implies that behavioral entrapment is not due to not
detecting a subsequent fault but rather to the decision not to invest time and
effort on it yet.

The difference in dependent variable can also explain the fact that no effect
of task completion was found in the fourth experiment. Taking task
completion into account is only relevant when there is an intention to
indeed invest time to complete the task at hand. Detection of the second
fire, however, does not necessarily imply that one is going to invest in it,
which may explain that task completion is not taken into account in the
fourth experiment. So, task completion is only relevant to problem solving
and not to detection.

In all, we can conclude that behavioral entrapment is a problem that is
mainly present during the phase of solving disturbances rather than during
the phase of detecting them. Furthermore, for a static task environment
behavioral entrapment can be entirely explained in terms of task
completion. For a dynamic environment the explanation is slightly more
complex. In a dynamic environment there is time pressure that accumulates
over time. After each investment (subjective) time pressure increases. On a
problem solving level, the effect of time pressure seems to be contingent on
the degree in which an ongoing task is completed. In high-pressure
situations where considerable investments are still required people are more
likely to abandon the ongoing task than in situations where this task is nearly
completed.