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Time pressure in risky decision-making: effect on risk defusing

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Abstract

In an experiment with 40 participants, the effect of time pressure on the search for risk defusing operators was investigated as the central research question. A *risk defusing operator* (*RDO*) is an action intended by the decision maker to be performed *in addition* to an otherwise attractive alternative and expected to decrease the risk. Examples in daily life are insurances or vaccinations. Decision-makers in experiments with quasi-realistic risky scenarios instead of gambles often search actively for RDOs. In the presented experiment, participants had to search for information they considered to be essential for reaching a decision. As expected, under time pressure search for information on RDOs and negative consequences increased, whereas search for positive consequences and probability decreased. Furthermore, the initially risky alternative was chosen more often under time pressure. As in other experiments on time pressure, the total amount of inspected information decreased.

Key words: risky decision-making, risk defusing, time pressure, risk, decision process, information search

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Most people have probably experienced time pressure when making a decision. One consequence of time pressure, for example, is that we often cannot take all the information we would like to into account. Our experiment investigates decision behavior in risky decision situations under time pressure. We study risky scenarios that are not pre-structured like gambles by the experimenter. In such scenarios, decision-makers often do not only passively assess the involved risk, but, they also actively search for additional factors that eliminate or reduce the risk associated with an otherwise attractive alternative. We investigate whether under time pressure people continue to search for risk-defusing operators or if they fall back onto risk avoiding heuristics.

In experiments on (single-stage) risky decision-making, gambles are usually used as alternatives or the alternatives are pre-structured like gambles by the experimenter. In such experiments, two variables are central for the decision: (a) the subjective values (utilities) of the consequences, and (b) the subjective probabilities of obtaining the consequences. The most prominent current theory founded on these variables is the Prospect theory (Kahneman & Tversky, 1979; Tversky & Kahneman, 1992). A recent analysis of such models is presented by Fox and See (2003) and Wu, Zhang and Gonzales (2004).

In the last decade, however, a number of experiments have been published that question the generalizability of the value × probability approach to all decision situations: Huber, Wider & Huber 1997; Huber, Beutter, Montoya & Huber, 2001; Huber & Huber, 2003; Huber & Macho, 2001; Ranyard, Williamson & Cuthbert, 1999; Ranyard, Hinkley & Williamson, 2001; Schulte-Mecklenbeck & Huber, 2003; Tyszka & Zaleskiewicz, 2006; Williamson, Ranyard & Cuthbert, 2000a,b.

These experiments work with quasi-realistic scenarios that are *not* pre-structured as gambles by an experimenter. One example is the situation of a businesswoman who is confronted with two options: She can travel to a country where an epidemic disease rages in order to negotiate an important contract or she can postpone the meeting with the risk of not reaching a satisfying agreement (Bär & Huber, in press).

Decision behavior in quasi-realistic scenarios differs in two main respects from that in gambling tasks: (a) in a great variety of tasks, most decision-makers are not interested in probability information as much as one would expect and (b) often, risk-defusing behavior is a central component of the decision process. If decision-makers realize that an otherwise attractive alternative may produce a negative outcome, they search for a risk-defusing operator. Shiloh, Gerad and Goldman (2006) replicated these main results in a study with real decisions in the context of genetic counseling.

A *risk-defusing operator* (*RDO*) is an action intended by the decision-maker to be performed *in addition* to a specific existing alternative and expected to decrease the risk. Consider the situation in the example above: our businesswoman may not only reflect on the probability of becoming infected, but may inquire whether a vaccination exists or look for possibilities to prevent an infection (e.g., by cooking water before drinking it). All these additional actions are RDOs. RDOs are quite common in everyday risky decision situations. Typical examples are: Buying auto theft insurance, wearing protective gear to avoid contact with a toxic substance, or copying important documents. If an RDO is detected with a promising alternative, it is usually chosen (Bär & Huber, in press).

It should be noted that incorporating an RDO is not the same as looking for a new alternative.[2] The concept of RDOs is closely related to the concept of control: An RDO provides the decision-maker with at least some control over the risk and as we know from research on risk perception, controllable risks are experienced as less grave than uncontrollable ones (e.g., Lion, 2001; Weinstein, 1984; Vlek and Stallen, 1981).

Huber (2007) summarizes the results of experiments which investigated factors influencing the search for RDOs (e.g., attractiveness of the alternative, expectation of finding relevant information) and the factors affecting the acceptance of an RDO (e.g., cost, effect). Different types of RDOs are distinguished in Huber (2007), Huber and Huber (2003) and Huber & Wicki (2004). There is a great variability between scenarios in the search for RDOs as well as for probabilities. Huber and Huber (in press) identify background knowledge and local expectations to get useful information as two factors determining the search.

Decisions in everyday life are often made under time limits. For example, a person who is offered a job position has three days from the time of the offer as a deadline to decide whether to accept the offer or not. *Time pressure* exists when there is a deadline *and* the decision maker realizes that the available time may be too short to make a decision (Ariely & Zakay, 2001; Benson, Groth & Beach, 1998; Maule & Hockey, 1993; Svenson & Benson, 1993). Instead of an explicit deadline, the decision situation may induce a pressure to make a quick decision. An example is the search for a house where an attractive offer may be taken away by another buyer if one waits too long. The effect of time pressure on choices has been investigated in a variety of studies, for example, Betsch, Fiedler and Brinkmann (1998), Diederich (2003), Dror, Busemeyer and Basola (1999) or Payne, Bettman and Luce (1996).

The presented study is especially interested in the effect of time pressure on risk defusing behavior as one component of the decision process. Few studies exist, which concern the process of decision-making and information search behavior. An overview is presented by Maule and Edland (1997). Maule and Hockey (1993) distinguish two main strategies used by decision-makers to cope with time pressure: micro-strategy changes (acceleration and selectivity) and macro-strategy changes (change of the decision strategy). Payne, Bettman & Johnson (1993) and Payne, Bettman and Luce (1996) combine these two general strategies in the context of their effort-accuracy framework.

Acceleration means that the decision-maker increases the speed of information processing and in this way needs less time to execute a specific information process. This behavior was observed, for example, in Ben Zur and Breznitz (1981) or in Maule et al. (2000). *Selectivity* means that the decision-maker processes less information under time pressure. The selection of information may not only concern the total amount of used information but also the type of information chosen. The decision maker may, for example, specifically select negative information (Wright, 1974) or concentrate on information that is more important and ignore the less relevant information (Edland, 1993). Selectivity may also result as a consequence of the change of heuristics, for example, from a compensatory heuristic to the Lexicographic one (Payne, Bettman & Luce, 1996; Rieskamp & Hoffrage, 1999).

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[2] *Formally*, the incorporation of an RDO into an alternative can be considered as creating a new alternative (a new gamble) consisting of the original action *and* the RDO, see Huber (2007). With standard methods of decision analysis (e.g., a decision tree), the utility of the cost of RDO application, of the effect of an RDO and its success probability can be incorporated into the computation of the overall utility of this composed new alternative.

Whereas time pressure has been investigated in different types of risky decisions (see above), in the context of RDOs, time limits have not yet been studied. In our experiment, we are investigating the problem of how time pressure affects risk defusing behavior in the decision process.

We are especially interested in the question of whether or not decision-makers under time pressure search for RDOs or switch to choosing the safe alternative. If RDOs are as central to the decision process as they appear to be in many previous experiments, the search for RDOs should even increase under time pressure. There are two possible reasons for an increase: Under time pressure, the decision-maker becomes aware that he or she cannot inspect and process all of the information that would usually be taken into account. Therefore, a part of the information must be selected. In such a situation decision-makers are expected to aim at not overlooking potential dangers. As a result, the perceived dangers and risks become more salient and therefore the pressure to defuse the risk increases. As a consequence, the threshold for an RDO search (Ranyard et al., 2001) is more likely surpassed. Time pressure may furthermore induce a more negative emotional state (Maule, Hockey & Bdzola, 2000). A negative emotional state results in more controlled and less automatic cognitive processes (e.g., Dunegan, 1993). A more controlled process should draw the decision-maker's attention to the construction of the mental representation of the alternatives and lead to a higher likelihood of changing the initial cognitive representation, for example, by introducing an RDO as an action defusing risk. As a further consequence of the higher salience of potential dangers we expect an increase in the search for information about negative outcomes. We assume that this type of information becomes more important to the decision-maker if she knows that she can probably not process all the information she would like to. This prediction is also consistent with the expected effects of a negative emotional state.

Method

Participants

40 students and non-students of different professions (22 f, 18 m; mean age 28.5 years) took part as voluntary participants. None of them had partaken in a similar experiment before.

Decision scenarios

We used two quasi-realistic risky decision scenarios from Bär and Huber (in press): Virus infection and Breeding turtles. A third scenario – Post office (Huber, Wider & Huber, 1997) – served as a warm-up. The *Breeding turtles* scenario is described in more detail below. In the *Virus infection* scenario, the participant takes on the role of a vacationer on a tropical island, who is infected with a dangerous virus and has to decide on his or her treatment. In the Post office scenario, the participant acts as the manager who has to decide whether or not to rent additional space.

In all scenarios, two alternatives were presented: a non-risky alternative with certain positive *and* negative consequences and a risky one. The alternatives were constructed so that initially no alternative dominated and that the detection of an RDO could be expected to result in a choice of the (initially) risky alternative. We selected scenarios from our former experiments in which usually only a minority of decision-makers searched for an RDO because we also wanted to leave room for an increase in the RDO search.

The Breeding turtles scenario

The participant takes on the role of the head of an international program to protect an endangered species of ocean turtles. The last of the remaining turtles are kept in a nature reserve. Unfortunately, the turtles do not breed in the reserve. Now, biologists have found two possible breeding places.

Alternative A: Beach (non-risky alternative). A beach situated close to the reserve would be suitable for breeding. On this beach, the turtles are not at risk because there aren't any predators. However, the water is only of moderate quality. Therefore, the reproduction rate of the turtles is low.

Alternative B: Island (risky alternative). A little island provides a perfect environment for breeding. It is also free of predators. Unfortunately, an epidemic of salt water mites can occasionally occur. If the epidemic occurs, the mites attack the turtles' eggs thereby killing the offspring.

Note that this description is not the instructions which were presented to the participants. The instructions for the two main scenarios are provided in the appendix.

Method of Active Information Search

In order to test our hypotheses we have to determine which information decision-makers are *actively* searching for (e.g. information about the existence of an RDO or about the probability of a negative outcome,). With the *Method of Active Information Search* (Huber et al., 1997), the participant is given a short description of the decision situation first. Then, he or she can ask questions in order to obtain more information from the experimenter. The question is recorded, and the answer is given from a list of standardized answers. Elaborate pre-experiments are necessary in order to optimize the short description and to standardize the answers. Note that the *participant* asks the questions, not the experimenter.

Different variations of the basic version of the AIS-method have been developed. An overview is presented in Huber, Schulte-Mecklenbeck and Huber (2006), where detailed instructions for the application of the method are given.

In our experiment, we use the list-version of AIS: Here, the decision-maker is presented with a list of questions and may select as many as wanted and as often as wanted but only one question at a time. Table 1 contains the questions on the list. These questions cover all categories of questions that are usually put forward by decision-makers (Huber et al., 2001; Schulte-Mecklenbeck & Huber, 2003). In each scenario, the terms "alternative A" and "alternative B" were replaced by the names of the respective alternative (e.g., "beach" and "island"). The sequence of questions was the same in all scenarios, in order to avoid time loss by searching for a specific question.

Table 1:
List of questions

Question	Type of information requested
Can I learn more about the situation?	general situation
What are the positive consequences of alternative A?[b)]	positive outcomes
What are the negative consequences of alternative A?[b)]	negative outcomes
What is the probability that the negative consequences will occur with alternative A?[b)]	probability
Can I do something to prevent the negative consequences of alternative A?[b)]	RDO
Are there other options besides A and B?[c)]	new alternative

b The same question was included for alternative B
c The answer to this question was always "no"

We chose the list version because otherwise the participant would need too much time to come up with a question and formulate it and therefore time pressure could not be controlled. The list version provokes a higher number of all types of questions (Huber et al., 2001). For our research question, this increase is no disadvantage because we are interested is a *comparison* of the frequencies of specific types of questions (e.g., RDO) in different experimental conditions and not in the absolute frequencies (cf. also Huber et al., 2006).

Design and procedure

There were two main independent variables that were varied *within* participants: *Time pressure* and *Scenarios*. The independent variable Scenarios had two levels: Virus infection and Breeding turtles. The independent variable Time pressure also had two levels: with and without time pressure.

Participants were run individually. They started with the Post office scenario as a warm-up task. Then the Virus infection and the Breeding turtles scenarios were administered. The sequence of the two scenarios and the time pressure conditions were counterbalanced.

Time pressure was operationalized according to Benson and Beach (1996). In a pre-experiment, the mean time participants needed to make their decisions in the two scenarios was determined. In the time pressure conditions of the experiment, participants had to make their decision within a time limit that was one standard deviation below the mean of the pre-experiment: 195 sec in the Breeding turtles scenario, 180 sec in the Virus scenario. In the condition with time pressure, a clock counting backwards was placed in the participant's field of vision, so that he or she always knew how much time was left.

Results

The following question types were analyzed as dependent variables: total number of all types of questions, questions for negative consequences, positive consequences, RDOs and probability. Table 2 summarizes the mean values.

Table 2:
Mean number of questions, percentage of participants with at least one question and choices as a function of time pressure condition and scenario

	No Time pressure			Time pressure		
Dependent variable	**Turtles** (N=20)	**Virus** (N=20)	**Total** (N=40)	**Turtles** (N=20)	**Virus** (N=20)	**Total** (N=40)
Mean number of questions						
all types	4.10	5.00	**4.55**	3.45	3.10	**3.28**
negative consequences	0.85	0.85	**0.85**	1.60	1.30	**1.45**
positive consequences	1.45	1.70	**1.58**	0.45	0.45	**0.45**
RDO	0.25	0.45	**0.35**	1.15	0.75	**0.95**
probability	0.55	0.85	**0.70**	0.20	0.40	**0.30**
Percentage of participants with at least one question						
negative consequences	55%	55%	**55%**	85%	70%	**77.5%**
positive consequences	80%	90%	**85%**	35%	40%	**37.5%**
RDO	25%	45%	**35%**	65%	60%	**62.5%**
probability	50%	65%	**57.5%**	30%	25%	**27.5%**
Number of participants and percentage who chose the initially risky alternative						
	9 (45%)	8 (40%)	**17 (43%)**	15 (75%)	13 (65%)	**28 (70%)**

The mean total number of questions is lower under time pressure. A repeated measures ANOVA (repeated factor: time pressure, other factors: sequence of scenarios and time-pressure in which scenario) confirms this impression, with time pressure as the sole significant factor: $F(1,36)=24.72$, $p<.001$, effect size f=.83 (large effect according to Cohen, 1977).

Search questions for negative consequences, positive consequences, RDOs and probability have only very few observed values and are not normally distributed. Therefore, the Wilcoxon matched-pairs signed rank-test was used as test statistic.

The search for information on negative consequences and on RDOs increased under time pressure. For the negative consequences, $z=2.86$ (N=40), $p<.05$. For the RDO questions, $z=2.92$ (N=40), $p<.01$. Therefore, we conclude that the increase is significant. Effect size r was computed by transforming the z-value into a correlation coefficient r (Rosenthal, 1991). $r = .45$ for negative consequences and .46 for RDOs, both values indicating a medium effect.

Search for information on positive consequences and on probabilities decreased under time pressure. The Wilcoxon matched-pairs signed rank-test was significant in both variables. For the positive consequences, $z=4.65$ (N=40), $p<.001$, effect size $r = .74$; and for the probability questions, $z=3.58$ (N=40), $p<.001$, $r = 57$. In both variables, effect size indicates a large effect.

As in other experiments, the means of the number of questions might be biased because some participants ask the same category of questions several times, whereas others do not ask at all. Therefore, we additionally analyzed the percentage of participants who asked the respective question category at least once as a dependent variable. These data are also included in Table 2. The results confirm those with mean numbers as dependent variables. The search for negative consequences and for RDOs increased under time pressure; McNemar test: $\chi^2(1) = 5.4$, N=40, p<.01, w=0.38, medium effect, and $\chi^2(1) = 7.35$, N=40, p<.01, w=0.43, medium effect. The search for information on positive consequences and on probabilities decreased under time pressure; McNemar test: $\chi^2(1) = 19.0$, N=40, p<.001, w=0.69, large effect, and $\chi^2(1) = 9.94$, N=40, p<.001, w=0.50, large effect.

The first question concerning outcomes was about the positive outcome in 83% of cases without time pressure and in 22% of cases with time pressure. In both scenarios, the difference is significant; Turtles: χ^2 (1)=14.29, *p*<.00001, effect size w=.65, large effect; Virus: χ^2 (1)=7.16, *p*<.01, effect size w=.46, medium effect.

Additionally, we analyzed the proportion of people who chose the initially risky alternative; these data are also included in Table 2. Under time pressure, the initially risky alternative was chosen more often (McNemar test: $\chi^2(1) = 6.37$, N=40, p<.01, w=0.40, medium effect).

Discussion

Under time pressure, less information was searched for in general. This result is consistent with the usual result in research on time pressure and confirms the hypothesis of selectivity. Most questions that were asked concerned positive or negative consequences in both conditions. This result is common in experiments with quasi-realistic scenarios and reflects the fact that consequences are the basic information necessary to construct a mental representation of the alternatives. Usually an RDO – as an elaboration of a representation – is only searched for when the decision maker knows that a negative consequence may occur.

The relation between the search for positive and negative consequences changes as a consequence of time pressure: Whereas without time pressure more positive consequences are explored, under time pressure decision-makers search distinctly more for negative consequences. The switch from a search for positive information to a negative one is in accordance with Ben-Zur and Breznitz (1981) and Wright (1974), but seems to contradict the results of Maule et al. (2000). The latter experiment is especially relevant for us because these authors also used risky scenarios. The difference may be attributed to their different operationalization: they used the relative proportion of time spent with the negative information as dependent variable. This time decreased under time pressure. One explanation for this shorter time is that the decision-maker used simpler and, therefore, faster mental operations to process negative information. For example, they could use a coarser subjective scale for the evaluation or place thresholds in such a way that faster processing was possible. In this respect, further research is necessary. The results concerning the search for positive and negative consequences are also relevant for the Priority heuristic (Brandstätter, Gigerenzer & Hertwig, 2006) which predicts that negative consequences are searched for first. Our results confirm this prediction only for the time pressure condition, but disconfirms it for the condition without time pressure.

The most important results of our experiment concern the search for RDOs and probability. While many subjects posed probability questions without time pressure (especially in the Virus scenario) only a minority did in the time pressure condition. In contrast, under time pressure more decision-makers invested their limited time in a search for RDOs. Under time pressure, 73% of all questions concerned negative outcomes or RDOs, in comparison to only 27% without time pressure.

Our results do not further support the conclusion that risk taking is increased under time pressure, this result being in accordance to Maule et al. (2000). Even if more of our participants choose the initially risky alternative under time pressure, one has to take into account that also a higher number searched for RDOs. Finding an RDO transforms an initially risky alternative into a non-risky one.

The most relevant finding for risk defusing is that the search for RDOs even increased in a condition with limited time. Additional research should investigate whether the saliency of the risk dimensions or the effect of the induced negative emotional state is more relevant under time pressure.

Together with the decrease of interest in probability information, the increase of RDO search under time pressure demonstrates the importance of risk defusing in non-gambling risky decision situations. Further research should investigate the preferences for different types of RDOs under time pressure, for example, the preferences for Pre-event RDOs and Post-event RDOs (Huber & Huber, 2003).

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Authors' note

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Appendix: Scenarios

Below the instructions for the two main scenarios are provided (our translation). It should be noted that the participant learned about the different risks connected with the alternatives when they received the answers to questions concerning the negative outcomes. For the risky alternative, the answer contained the information that the negative consequence *may* occur. This formulation provided basic information about uncertainty, but no probability was presented. The participant, however, knew from the available question list that he or she could get information about probability.

The Breeding turtles scenario

The ocean turtle named *Parrot hawksbill turtle* is well-known because of its richly-colored shell. It lives in the Southern Pacific but is in danger of extinction. The last of the remaining turtles are held in a nature reserve which belongs to the WWF on a small island. Here, they are safe but do not breed. They only breed in their natural habitat with the right water and beach conditions.

You are the head of the program to save the *Parrot hawksbill turtle* and responsible for the survival of the species. Regretfully your means for the program are limited.

Now, sea biologists have found two possible breeding places. You have to decide which place the turtles should be transported to. Because the animals do not breed when their group is too small, all animals have to be transported to the same breeding place.

Alternative A: a beach situated close to the reserve.

Alternative B: a small island.

Virus infection scenario

During a journey on a tropical island you have been infected with a life-threatening virus. You have a high fever and cannot be transported. The disease has to be treated immediately because otherwise death is imminent within one week.

There are only two possibilities for treatment, from which you have to chose:

Alternative A: the traditional medication of Relox, a tropical medicine.

Alternative B: the newly developed medication Nexin.