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In the face of uncertainty: The effects of presenting increased degrees of imprecise probabilities in risk descriptions in time critical decision-making situations

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Abstract: Effective C2 requires the ability to cope with uncertainty and to make timely decisions in situations often characterised by risk. This experimental study, with 56 participants, investigated how decision-makers handled these problems in a fictive time critical situation. More specifically, the study examined the effects of presenting two different degrees of uncertainty (low/high) on the choice to make a direct decision or to wait for additional information, in order to test if increased degrees of uncertainty lead to more people waiting for information and to longer waiting times. The overall purpose was to contribute to the debate regarding how uncertainty should be communicated to decision-makers, and to our knowledge concerning the practical consequences of presenting uncertainty to decision-makers in time critical situations. The study could not demonstrate any effect of increased degrees of uncertainty on the choice to make a direct decision or to wait for additional information. Neither could the study demonstrate any effect on the waiting time. However, the results show that almost all of the participants in both the experimental and the control group decided to wait for additional information, and that most of them showed little restraint regarding their waiting time. These results strengthen the conclusion from a previous study by Rydmark, Kuylenstierna, and Tehler (2020) - that presenting uncertainty in risk descriptions can be a practical problem in time critical decision-making situations, and that educating decision-makers in handing these problems may be required if uncertainty is to be presented in these kinds of situations.

Keywords: risk communication; uncertainty; decision-making

Introduction

Two interconnected problems in Command and Control (C2) are coping with uncertainty and making timely decisions (e.g. MCDP 6). These problems often have to be handled in situations characterised by risk. Uncertainty can be reduced by collecting and processing additional information, but collecting and processing information takes time. Thus, there is often a conflict between the possibility of reducing uncertainty and making timely decisions. Results from a previous study that explored how decision-makers deal with this conflict in a time critical decision-making situation have shown that presenting uncertainty in risk descriptions, by using imprecise probabilities in the form of ranges, may lead to unwanted delays in the decision-making process - with significant costs or losses as consequences (Rydmark, Kuylenstierna, and Tehler, 2020). The results show that nearly half of the participants in the study decided to delay their decisions and wait for additional information, despite the loss of lives and the relative low potential value of new information in the fictive time critical military scenario used. These results indicate that presenting uncertainty to decision-makers could be a practical problem in time critical decision-making situations.

However, that previous study was limited to only one degree of uncertainty, so these results do not tell us in what way higher or lower degrees of uncertainty affect the decision-making process. This limitation raises the question: *Do increased degrees of uncertainty lead to more people waiting and to longer waiting times?* Work by Becker and Brownson (1964) points in this direction, while results from other research show that it does not have to be this way (e.g. Viscusi and Chesson, 1999). The present study intends to provide an answer to the above question in a time critical decision-making situation, where delaying decisions leads to costs or losses. The overall purpose is to contribute to the debate regarding how uncertainty should be communicated to decision-makers, and to our knowledge concerning the practical consequences of presenting uncertainty to decision-makers in time critical situations.

Background

Effects of different degrees of uncertainty

That different degrees of uncertainty may affect a decision-maker has been shown in research about the effects of so called *ambiguity*. Several different uses of the concept ambiguity are found in the literature. In this article, following e.g. Ellsberg (1961), Frisch, and Baron (1988), and Trautmann, and van de Kuilen (2015), ambiguity is considered to be a situation where the probability judgement for an event to occur is uncertain, i.e. the probability value included in the judgement is imprecise.

The literature on the effects of different degrees of ambiguity has yielded mixed results over the years. First Becker and Brownson (1964) found that people were willing to pay more as the imprecise probability range of winning balls in an urn increased, to avoid choosing from an ambiguous urn. This result implied a general conclusion that increased degrees of ambiguity would lead to an increased desire to avoid these kinds of situations.

However, thereafter Yates and Zukowski (1976) and Larson (1980) found that people's degree of ambiguity aversion is not completely reducible to the size of the probability range. Instead, more recent work has uncovered a fourfold pattern, where both the specific domain (gains or losses) and the level of the single-valued probability (high or low) influence people's attitudes toward ambiguity (Kahn and Sarin, 1988; Viscusi and Chesson, 1999; Di Mauro and Maffioletti, 2004; Trautmann and van de Kuilen, 2015). This fourfold pattern implies that, in the domain of gains people are averse to ambiguity and to increased degrees of ambiguity for high probabilities (point estimates >50%) and prefer ambiguity and increased degrees of ambiguity for low probabilities (point estimates <50%). The opposite applies to the domain of losses, where people are averse to ambiguity and to increased degrees of ambiguity for low probabilities and prefer ambiguity and increased degrees of ambiguity for high probabilities. Viscusi and Chesson (1999) explain this fourfold relationship as an effect of hopes and fears. For example, if there is a high estimated probability of losing something of value, the presence of ambiguity about this estimation, stating that the correct probability can be both higher and lower, generates a hope effect by offering a chance that the lower probability is the correct one. The reverse applies to low probabilities in the loss domain, where ambiguity about a low probability generates a fear effect that the higher probability is correct (for a more detailed discussion of the hope and fear effects see Viscusi and Chesson, 1999).

However, even though this pattern for losses is established in the literature it has not yet been tested how increased degrees of uncertainty, in the form of ambiguous imprecise probability ranges, affect decision-making in time critical decision-making situations, where delaying decisions leads to costs or losses. The present study is part of a series of studies aiming at investigating how decision-makers handle uncertainty in time critical decision-making tasks.

The specific research questions for the study and the use of a fictitious situation to answer them

The effects of increased degrees of uncertainty have been broken down into three specific research questions:

(1) To what extent do decision-makers take the uncertainty information in the ranges into consideration when making their decision?

(2) To what extent do increased degrees of uncertainty affect the choice to make a direct decision or to wait for additional information?

(3) To what extent do increased degrees of uncertainty affect the waiting time and is the waiting time justifiable?

To provide an answer to these questions a fictitious situation, in the form of a simplified military scenario, was used. The approach was to focus on the four components in a time critical decision-making situation, i.e. risk, ambiguity, time and losses, and then design the fictitious situation based on them. Using this approach some realism is sacrificed, compared to a field study, in order to gain greater control of relevant variables. Moreover, it would have been practically difficult to interfere, manipulate and control a time critical decision-making situation in a field study, and it would therefore be difficult to discern the effects of increased degrees of uncertainty from the effects of other contextual factors. Instead, the aim of the approach used here was to capture some salient features of a real decision situation, while at the same time increasing the ability to control variables compared to a field study. However, regardless of approach, it is not possible to deliver conclusive answers to the questions in a single study. To achieve this, different forms of studies are required, in different time critical decision-making contexts. The present study constitutes one of the studies required to achieve this.

Material and method

The present study used the same material and method as were used in Rydmark, and Kuylenstierna (2020).

Participants

Participants were 56 students at Lund University's Faculty of Engineering (LTH) (20 women and 36 men). The participants mean age was 25 (min = 20, max = 38, SD = 3.4). They were recruited on a voluntary basis via e-mail, and they were given two movie tickets each for participating.

Scenario

The following description of the scenario is based on the description in Rydmark, and Kuylenstierna (2020). To make it possible to visualise the dynamic development of the situation in the scenario, the scenario was implemented into a computer.

In the scenario the participants were acting as the commander of a military force. Their task was to choose a route for the escort of a transport with necessities from the port, located in the north-western part of the country, to a region in the east with approximately 100.000 people in distress (Figure 1). The participants were informed that 20 people in the region died every hour due to starvation, disease and other hardships.

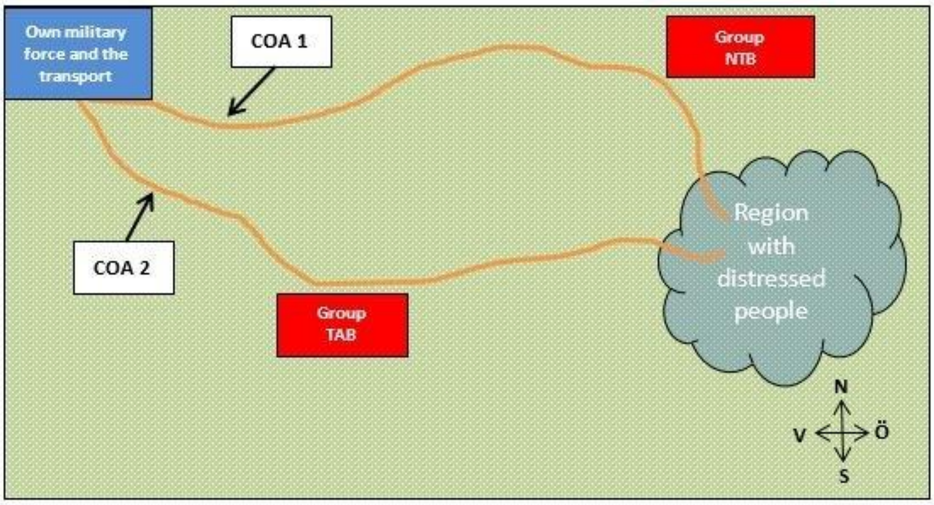

Figure 1. The map.

To reach the region, there were only two possible navigable roads, COA 1 and COA 2. Both of these roads were about 100 km long and passed through areas where the two hostile groupings “Northern Togan Liberation Front” (NTB) and “Togan Autonomous Population” (TAB) operated. The participants were informed that both of these groups wanted to appropriate the necessities transported, so regardless if COA 1 or COA 2 was selected there was a risk of an attack on the transport. Such an attack would not stop the transport, but the consequences would be the death of 1000 people due to delays and missed deliveries of some of the food and medicine.

The participants were also informed that the risk analysts in the military force had made a risk assessment regarding the probability of an attack along COA 1 and COA 2, and that there were uncertainties regarding these assessments. The estimated probabilities and uncertainties related to these risk assessments are presented below.

Design and procedure

The design of the experiment

The study was designed as an experiment with two different conditions regarding the degree of uncertainty for an attack along COA 1 and COA 2. The uncertainty was presented by using imprecise probabilities in the form of ranges. The probability ranges were overlapping throughout the development of the scenario to make it possible to study if the participants used the uncertainty information in the ranges and if the degree of uncertainty affected the waiting time.

In Condition 1 the initial estimated probability for an attack along COA 1 was 50% and the probability range was 40%-70%. This meant that the best estimation by the risk analysts for an attack along COA 1 was 50%, but the probability of an attack could be as low as 40% or as high as 70% or somewhere in between. Regarding COA 2 in condition 1 the initial estimated probability of an attack was 60% and the probability range was 45%-65%. Thus, the initial estimated probability of an attack along COA 1 was somewhat *lower* than the estimated probability of an attack along COA 2, but the probability range for COA 1 was slightly *wider* than the probability range for COA 2. The risk assessment for Condition 1 was summarised in a risk description (Figure 2).

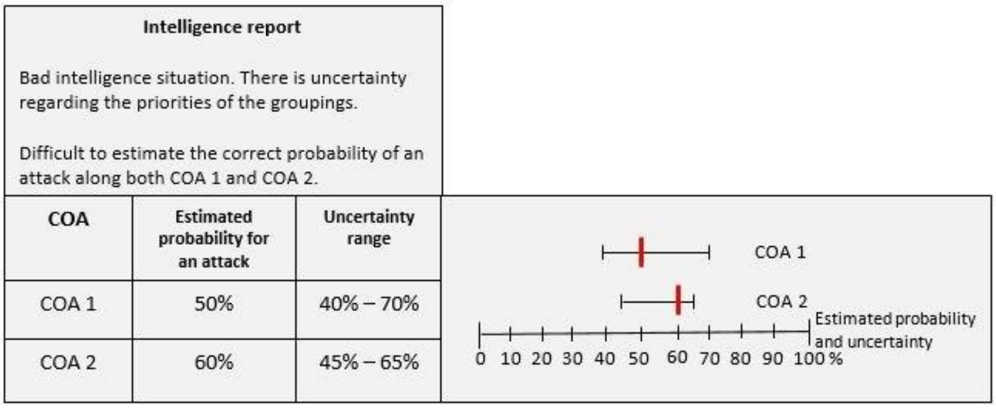

Figure 2. The risk description for Condition 1.

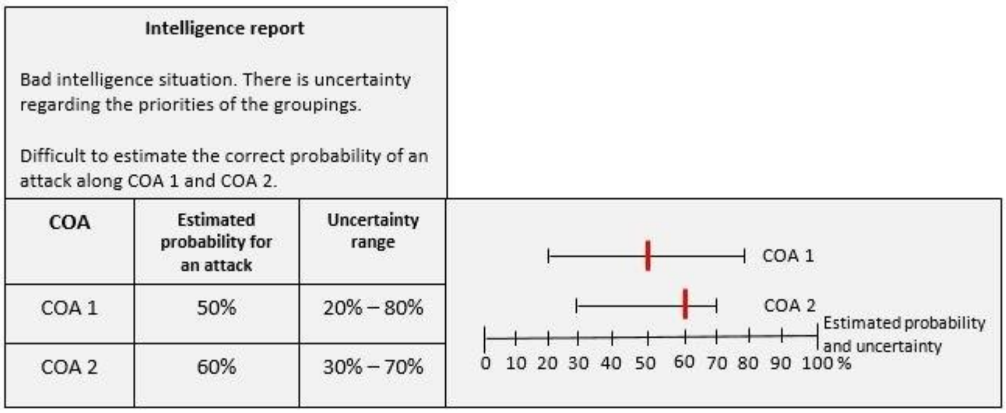

Figure 3. The risk description for Condition 2.

Regarding Condition 2 the initial estimated probability of an attack along COA 1 was 50% and the probability range was 20%-80%. Regarding COA 2 in Condition 2 the initial estimated probability of an attack was 60% and the probability range was 30%-70%. Thus, also in Condition 2 the initial estimated probability of an attack along COA 1 was somewhat *lower* than the estimated probability of an attack along COA 2, and the probability range for COA 1 was slightly *wider* than the probability range for COA 2. The risk assessment was summarised in a risk description (Figure 3).

Taken together, the difference between Condition 1 and Condition 2 was the initial degree of uncertainty, manifested by the width of the overlapping probability ranges, where Condition 2 had a higher degree of imprecise probabilities, and hence a higher degree of uncertainty, than Condition 1.

New intelligence information was presented on the computer screen every 30 seconds, which corresponded to 6 hour in real time. The new information could contain changed values regarding the estimated single-valued probability and/or the probability ranges. Condition 1 had a total of eight steps, from the first to the last intelligence report. The corresponding number of steps for Condition 2 was eleven. For a detailed presentation of each step in the animation, see Appendix.

The experimental procedure

The procedure for the experiment was as follows: First, the participants signed an informed consent. They were then randomly assigned to Condition 1 or Condition 2, 28 participants in each condition. Thereafter they read the scenario, including the risk assessment and the risk description. They were then informed that the intelligence report was updated every 30 seconds by the computer, meaning that the estimated probability for an attack could change and/or that the probability ranges could change. The participants were also informed that 30 seconds in the computer animation corresponded to 6 hours in real time. Thus, waiting for more information could perhaps provide a better picture regarding the probability of an attack, but waiting for additional information had the cost of 20 people dying every hour during the waiting time. Thereafter the participants interacted with the computer to make their decision of COA 1 or COA 2 as the route for the transport. The participants had the opportunity to make a direct decision or to wait for additional information before making their decision. The computer interface is shown in Figure 4. The number of dead people was updated every 10 seconds and displayed on the right hand side of the screen.

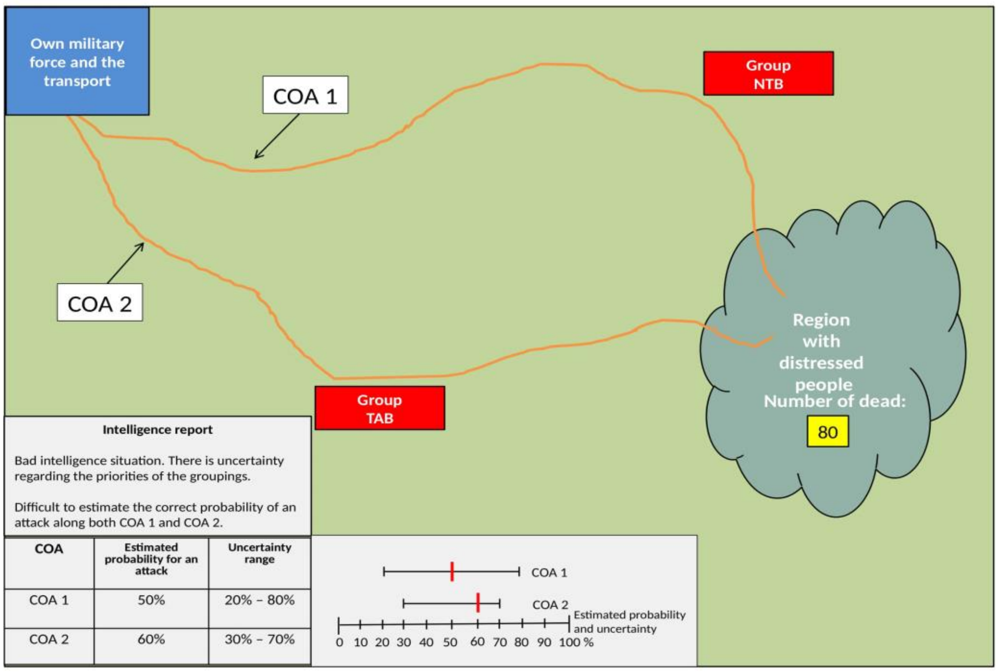

Figure 4. The computer interface.

After the participants made their decision about COA 1 or COA 2 in the computer animation, they then answered a questionnaire regarding their decision. The scenario and the questions were written in Swedish, and most of the participants completed the study in less than 30 minutes.

Data analysis

The participants' interaction with the animation in the computer generated numerical data in a direct way, concerning the decision time and the choice of COA. Regarding this data the following were calculated; frequencies, percentage distributions, Chi-square and t-tests. The questionnaire answered by the participants generated both numerical and free-text data. To analyse and synthesise the free-text data we first read the participants' motivations in order to identify main categories. We then coded each motivation to one or more of those categories. The presentation of the free-text data in the results and analysis section should be seen as a complement to the primary data, which consists of the directly generated numerical data.

Results and analysis

The data used to answer the questions asked in the present study is based on the data that was originally collected for Rydmark, and Kuylenstierna (2020).

The first question asked in the present study was: *To what extent do decision-makers take the uncertainty information in the ranges into consideration when making their decision?* To answer this question we will first look at how many of the participants in each condition chose COA 2, i.e. the alternative with the highest single-valued probability, but with the smallest probability range. Because, we can assume that if there is no uncertainty regarding a risky event a decision-maker would choose the alternative with the lowest estimated probability, e.g. COA 1. The results show that ten participants (n = 10) in Condition 1 and six participants (n = 6) in Condition 2 chose COA 2 (Table 1).

Table 1. Choice of COA.

	Condition 1 (n = 28)	Condition 2 (n = 28)
Choice COA 1 (n)	18	22
Choice COA 1 (%)	64	79
Choice COA 2 (n)	10	6
Choice COA 2 (%)	36	21
Choice COA 1 for its lowest range value (n)	2	6
Choice COA 1 for its lowest range value (%)	7	21

Another indicator that a participant took the uncertainty information presented in the ranges into consideration is the choice of COA 1, with reference to its lowest range value. The results show that two participants (n = 2) in Condition 1 and six participants (n = 6) in Condition 2 motivated their decision to choose COA 1 with its lowest range value (Table 1). Thus, there was no difference between the two conditions regarding how many participants took the uncertainty information presented in the ranges into consideration, i.e. 12 participants in Condition 1 and 12 participants in Condition 2. In total, 24 of 56 participants used the range information, which equals 43% (n = 56), 95% CI [0.30, 0.57] of all participants in the study. This is a slightly lower proportion than in the previous study by Rydmark, Kuylenstierna, and Tehler (2020), where the corresponding share was 48% (n = 106), 95% CI [0.38, 0.58]. However, both of these proportions are within each other´s confidence intervals, so we cannot determine any difference between the two studies. Thus, in both studies, more than 40% of the participants used the uncertainty information in the ranges to make their decision, and many of them referred to the smaller probability range in their motivations. Taken together these results strengthen the conclusions from earlier studies regarding the general value of using probability ranges to communicate uncertainty to decision-makers (Dieckmann, Mauro, and Slovic, 2010; Joslyn, and LeClerc, 2012; Budescu, Broomell, and Por, 2009).

The next question in the study was: *To what extent do increased degrees of uncertainty affect the choice to make a direct decision or to wait for additional information?* To answer this question we will look at how many of the participants in each condition made their decision without waiting for the first update on the screen regarding the number of dead people, i.e. how many of the participants made their decision within the first 10 seconds. 10 seconds was set as a generous limit for a direct decision, so that the participants would have enough time to press the stop button in the computer animation. 10 seconds corresponded to two hours in real time, and thus 40 dead people. So, if a participant wasn't willing to sacrifice any people at all to obtain additional information then one should expect that this participant made her/his decision before the first update concerning the number of dead people. The results show that only one participant (n = 1) in Condition 1 and none of the participants (n = 0) in Condition 2 made their decision within the first 10 seconds (Table 2).

Table 2. Decision time and EVPPI.

	Condition 1 (n = 28)	Condition 2 (n = 28)
Decision within the first 10 seconds (n)	1	0
Mean decision time (sec)	83	68
Mean decision time (h)	16.6	13.6
Maximum EVPPI (h)	5	12
Unjustified decision time (n)	25	17

Thus, there was no significant difference between Condition 1 and Condition 2 regarding the choice to make a direct decision or to wait for additional information. Nevertheless, Rydmark, Kuylenstierna, and Tehler (2020), using the same uncertainty levels as the initial levels in Condition 1 in the present study, found it troubling that 49% of the participants in that study decided to wait for additional information despite the relatively low potential value of new information. Furthermore, Rydmark, Kuylenstierna, and Tehler (2020) used a text-based version of the scenario where the participants had to estimate how long they were willing to wait for additional information. Therefore, the result in the present study is even more troubling, where almost all of the participants in both conditions waited for additional information in a more "lifelike" setting, where there was a dynamic development of the scenario and where new information was presented at specific times. These results strengthen the conclusion that presenting uncertainty to decision-makers, by using imprecise probabilities in the form of ranges, could be a practical problem in time critical decision-making situations.

However, it is not only whether the participants are waiting for additional information or not that is of interest here, but also how long they choose to wait and if the waiting time is reasonable. Hence, the third question in the study was: *To what extent do increased degrees of uncertainty affect the waiting time and is the waiting time justifiable?* On the one hand, if the waiting time is determined entirely by the degree of uncertainty it is expected that the waiting time of the two conditions would be different, because the time it takes to reach the same level of uncertainty is different in Condition 1 compared to Condition 2 (see Appendix). On the other hand, if the waiting time is determined by other factors than the degree of uncertainty, it is expected that the waiting time will be the same in the two conditions.

The results show that the mean decision time in Condition 1 was 83 seconds, which corresponds to 16.6 hours in real time, and that the mean decision time in Condition 2 was 68 seconds, which corresponds to 13.6 hours (Table 2). Thus, the mean decision time in Condition 2, with the higher degree of uncertainty, was slightly lower than the mean decision time in Condition 1. However, the difference between Condition 1 ($M = 82.93$, $SD = 44.68$) and Condition 2 ($M = 67.89$, $SD = 33.72$) was not significant, t (54) = 1.42, $p = 0.16$. These results suggest that there is no effect of increased degrees of uncertainty on the waiting time for additional information.

That the degree of uncertainty does not affect the waiting time is shown also by the significant difference regarding the level of uncertainty when the waiting ceases in Condition 1 ($M = 23.75$, $SD = 2.93$) and Condition 2 ($M = 41.25$, $SD = 8.99$), t (54) = -9.80, $p = 0.00$. The participants in Condition 2 stopped waiting on a significantly higher level of uncertainty than the participants in Condition 1. Also, the absence of a significant difference regarding the feeling of confidence to stop waiting between Condition 1 ($M = 68.21$, $SD = 17.49$) and Condition 2 ($M = 67.50$, $SD = 18.83$), t (54) = 0.15, $p = 0.88$ shows that the degree of uncertainty does not affect the waiting time. If this is so, one would expect the participants in Condition 2 to feel more insecure when stopping waiting, than the participants in Condition 1.

To summarise, the results from the study could not demonstrate any effect of increased degrees of uncertainty on the waiting time for additional information – but was the participants' waiting time justifiable?

One way to determine this is to use the concept Value of Information (VoI) and to calculate the Expected Value of Perfect Partial Information (EVPPI). The maximum

EVPPI for Condition 1 can be calculated as follows, where t is the number of hours one has to wait for additional information:

$$Maximum\ EVPPI = -400 – (-500) – 20 * t \qquad (Eq\ 1)$$

The analogous equation for Condition 2 is:

$$Maximum\ EVPPI = -260 – (-500) – 20 * t \qquad (Eq\ 2)$$

According to EVPPI the justifiable waiting time for Condition 1 is 5 hours, because the expected value of more information is then below zero (-400 – (-500) – 20 * 5). The corresponding justifiable waiting time for Condition 2 is 12 hours (Table 2).

The results show that there is a significant difference between Condition 1 (25 of 28 participants) and Condition 2 (17 of 28 participants) regarding the number of participants that had an unjustified waiting time, $X^2 = 6.10$ (p = 0.01), i.e. a waiting time longer than 5 hours in Condition 1 and a waiting time longer than 12 hours in Condition 2 (Table 2). However, the fact that more participants exceeded the justifiable waiting time in Condition 1 is a consequence of the results showing equivalent waiting times in both conditions, and the fact that the calculation of justifiable waiting times in the VoI concept are based on the degree of uncertainty, which in turn results in a longer justified waiting time in Condition 2 than in Condition 1. Nevertheless, the waiting times based on the VoI concept do not seem to have guided the participants to any significant extent. Instead, from a VoI perspective, and also to a greater extent than in Rydmark, Kuylentierna, and Tehler (2020), the participants in both Condition 1 and Condition 2 showed little restraint regarding their waiting times. In comparison, there is a significant difference regarding how many of all participants in the present study exceeded the justifiable waiting time, 75% (42/56), compared to the results in Rydmark, Kuylenstierna, and Tehler (2020), 32% (34/106), $X^2 = 27.11$ (p = 0.00). Thus, it seems as when the opportunity is given to obtain additional information by waiting in a dynamic setting, as in the present study, there are more people who use this opportunity, compared to when the decision-maker him-/herself has to estimate how long he/she is willing to wait for additional information, as in Rydmark, Kuylenstierna, and Tehler (2020).

Discussion

The results in this study could not demonstrate that presenting increased degrees of uncertainty had any effect on the choice to make a direct decision or to wait for additional information. Neither could the study demonstrate any effect of presenting increased degrees of uncertainty on the waiting time. These results imply that the difference in potential risk between the two conditions did not matter for the participants. How could this be? One possible explanation could be that the participants focused on the overlap between the alternatives, rather than the degree of uncertainty. The complete overlap between the alternatives was not changed by the increased degrees of uncertainty between the conditions, so perhaps this constant overlap affected the participants to a greater extent than the degree of uncertainty. It is not, however, possible to shed light on this question with the data collected in this study, so this is a question for future research to answer.

The results show, however, that almost all of the participants decided to wait for additional information and that most of the participants showed little restraint regarding their waiting time. From a practical point of view these results strengthen the conclusion in Rydmark, Kuylenstierna, and Tehler (2020) - that presenting uncertainty to decision-makers by using imprecise probabilities can be a problem in time critical decision-making situation if decision-makers are not taught to handle these problems. However, the results are not conclusive, and more studies of the presentation of uncertainty in time critical decision-making situations are needed.

From a theoretical point of view the results in this study are in line with the results obtained in previous research, stating that people are not averse to increased degrees of ambiguity if the probability of losing something is high (>50%), due to the so-called hope effect (Kahn and Sarin, 1988; Viscusi and Chesson, 1999; Di Mauro and Maffioletti, 2004; Trautmann and van de Kuilen, 2015). Just as in these previous studies, the results in this study could not demonstrate any increased aversion when the degrees of imprecise probabilities increased. However, as indicated above, perhaps it was the overlapping uncertainty ranges, rather than the so-called hope effect, that caused this lack of aversion in this study.

One possible limitation in this study is that the result obtained in Condition 1, where almost all participants decided to wait for additional information, could be a so-called *ceiling effect* that leaves no room for an increased share of participants waiting in Condition 2. Thus, the question that arises is if a decreased initial degree of uncertainty could lead to more people making a direct decision. What speaks against this, however, is that none of the participants in the study mentioned that they stopped waiting because the uncertainty had fallen enough.

This study is part of a series of studies investigating the effects of presenting uncertainty in risk descriptions to decision-makers in time critical decision making situations. However, all studies so far have used university students as participants. These participants do not have much experience in time critical decision-making. Therefore, a coming study in this series will investigate if the results obtained in these earlier studies are also valid for people who handle time critical decision-making situations in their profession. According to Heath, and Tversky (1991) people's beliefs regarding their general knowledge or understanding of a relevant context affects their attitude toward ambiguous situations. How will decision-makers facing time critical decision-making situations in their profession handle the trade-off between postponing decisions to receive additional information and avoid certain losses? A coming study in this series will aim to provide an answer to this question.

Conclusions

This study investigated the effects of presenting two different degrees of uncertainty (low/high) in a risk description to decision-makers in a fictive C2 time critical situation.

The aim was to test if increased degrees of uncertainty would lead to more people waiting for additional information and to longer waiting times. The overall purpose was to contribute to the debate regarding how uncertainty should be communicated to decision-makers, and to our knowledge concerning the practical consequences of presenting uncertainty to decision-makers in time critical situations.

The study could not demonstrate any effect of presenting increased degrees of uncertainty on the choice to make a direct decision or to wait for additional information. Neither could the study demonstrate any effect on the waiting time. However, the results show that almost all of the participants in the study decided to wait for additional information and that most of the participants showed little restraint regarding their waiting time. These results strengthen the conclusions from a previous study by Rydmark, Kuylenstierna, and Tehler (2020) - that presenting uncertainty to decision-makers by using imprecise probabilities can be a problem in time critical decision-making situations, and that educating the decision-makers to handle these problems is required if uncertainty is to be presented in risk descriptions in these kinds of situations.

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Appendix

The table shows each updating step and time sequence in the animation for Condition 1 and Condition 2. For example, during the second step and sequence (30 – 59 sec) regarding Condition 1 the estimated probability for COA 2 had changed from 60% in the first sequence to 55% in the second sequence (changes are marked in red in the table), and regarding Condition 2 the probability range for COA 1 had changed from 20%–80% to 20%-75%. Condition 1 had a total of eight updating steps, and Condition 2 had a total of eleven steps. From step four regarding Condition 2, this condition had the same estimated probability and the same probability ranges as Condition 1.

		Condition 1 (Low uncertainty)				Condition 2 (High uncertainty)				
		COA 1		COA 2		COA 1		COA 2		
Step	Time (sec)	Estimate (%)	Range (%)	Estimate (%)	Range (%)	Estimate (%)	Range (%)	Estimate (%)	Range (%)	Dead people (n)
1	0 – 29	50	40 - 70	60	45 - 65	50	20 - 80	60	30 - 70	0 - 119
2	30 – 59	50	40 - 70	55	45 - 65	50	20 - 75	60	30 - 70	120 - 239
3	60 – 89	50	40 - 70	55	45 - 65	50	30 - 75	60	40 - 70	240 - 359
4	90 – 119	55	40 - 70	60	45 - 65	50	40 - 70	60	45 - 65	360 - 479
5	120 – 149	55	45 - 70	60	50 -65	50	40 - 70	55	45 - 65	480 - 599
6	150 – 179	55	50 - 70	60	55 - 65	50	40 - 70	55	45 - 65	600 - 719
7	180 – 209	55	50 - 70	60	55 - 65	55	40 - 70	60	45 - 65	720 - 839
8	210 – 239	58	55 - 70	62	60 - 65	55	45 - 70	60	50 -65	840 - 959
9	240 – 269					55	50 - 70	60	55 - 65	960 - 1079
10	270 – 299					55	50 - 70	60	55 - 65	1080 - 1199
11	300 – 329					58	55 - 70	62	60 - 65	1200 - 1319