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Thinking Concretely Increases the Perceived Likelihood of Risks: The Effect of Construal Level on Risk Estimation.

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ABSTRACT

Recent findings on construal level theory (CLT) suggest that abstract thinking leads to a lower estimated probability of an event occurring compared to concrete thinking. We applied this idea to the risk context and explored the influence of construal level (CL) on the overestimation of small and underestimation of large probabilities for risk estimates concerning a vague target person (Study 1 & 3) and personal risk estimates (Study 2). We were specifically interested in whether the often found overestimation of small probabilities could be reduced with abstract thinking, and the often found underestimation of large probabilities was reduced with concrete thinking. The results showed that CL influenced risk estimates. In particular, a concrete mind-set led to higher risk estimates compared to an abstract mind-set for several adverse events, including events with small and large probabilities. This suggests that CL manipulation can indeed be used for improving the accuracy of lay people's estimates of small and large probabilities. Moreover, the results suggest that professional risk managers' risk estimates of common events (thus with a relatively high probability) could be improved by adopting a concrete mind-set. However, the abstract manipulation did not lead managers to estimate extremely unlikely events more accurately. Potential reasons for different CL manipulation effects on risk estimates' accuracy between lay people and risk managers are discussed.

KEYWORDS

Construal level; risk estimates; accuracy; biases

1. INTRODUCTION

Although people are confronted with risks and uncertainty everyday, there is a lack of risk savvy.[1, 2] Moreover, it would increasingly appear that we do not become better risk experts with time. Research shows that humans are not good intuitive statisticians. In fact, Daniel Kahneman goes as far as to claim that even statisticians are not good intuitive statisticians.[3] A large body of research, much of which stems from prospect theory[4], reveals that probability estimation is influenced and systematically biased by many different factors (e.g., heuristics, affect, gain vs. loss frames). A rather new perspective for investigating how people mentally represent future events that influence their decisions is Construal Level Theory (CLT).[5] The present research investigates the influence of construal level (CL) on risk estimation, particularly with regard to whether CL could be useful in improving lay people's and professional risk managers' risk estimation.

1.1 Construal level theory and probability estimates

The core idea of CLT is that psychological distance ("the subjective experience that something is close or far away from self, here and now"[5] to a target (e.g., event) influences and is influenced by the respective level of mental construal. People apply a more abstract (high CL) thinking when judging a psychologically distal target, and assess more abstract targets to be more psychologically distal.[6] Psychological distance can be perceived in different dimensions: e.g., time, space, socially or probability. For instance, events happening far away (in time or space) are construed more abstractly than nearby events.

Todorov, Goren and Trope[7] demonstrated that probability/hypotheticality (as well as temporal, spatial and social distance) instantiates psychological distance (see also Trope and Liberman[5]). This means, that likely events may seem more close than unlikely events and may, therefore, be construed at a relatively low CL.[7] Also, Wakslak, Trope, Liberman and Alony[8] suggested that unlikely events are associated with abstract construals (high CL)

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whereas more likely events are related to concrete construals (low CL). Recent findings provided empirical evidence that there is a bi-directional relationship between psychological distance and CL.[9-11] Drawing on findings of Liberman *et al.*[10], who argued that abstract construals promote greater psychological distance, Wakslak *et al.*[8] supposed that abstract thinking should lead to lower probability estimates for the occurrence of events compared to concrete thinking.

Subsequent studies by Wakslak and Trope[12] showed that manipulating the cognitive processes (i.e., letting participants adopt an abstract or concrete mind-set via priming; e.g., by either specifying subordinate or superordinate categories of an item[13]) influences participants' probability estimates for the occurrence of neutral future events (e.g., "Jack is looking through his mail. How likely is he to get a credit-card offer in the mail?"[12]). Their findings revealed that participants who adopted a concrete mind-set have higher probability estimates than those who adopted an abstract mind-set. As an explanation for the link between probability and CL, Wakslak and Trope argued that in order to transcend direct experience and to consider unlikely options, it could be useful to adopt a more abstract kind of thinking. Since people typically have not much detailed information on unlikely events, abstraction appears to be useful (e.g., negative consequences due to nanotechnology). Thinking abstractly means that central aspects are captured that are constant across psychological distance (i.e., unlikely to vary as soon as concrete information is added; e.g., the increasing amount of nano-coated products). Thus, the authors argued that people's uncertainty about improbable events leads them to construe unlikely events in an abstract manner. On this basis, they showed that an activated abstract mind-set makes an event's unlikelihood salient, i.e. probability estimates for the perceived likelihood of the occurrence of events are reduced. In other words, they refer to the logic that because people use an abstract mind-set to transcend direct experience (i.e., consider the improbable; e.g., being intoxicated by chemical agents), abstraction may serve as

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a cue for unlikelihood and greater distance.

However, current knowledge on the impact of different construal level on the perception of risks remains sketchy. Building on the research of Wakslak and Trope[(12)] that showed that CL influences the probability estimates for neutral events, we assume in our research that CL influences risk estimates. Accordingly, the influence of different CL mind-sets is applied to the risk context.

1.2 Utility of construal level influence on risk estimates

Transferring the CL findings on probability estimates of neutral events to risk assessment, adapting a concrete or abstract mind-set should counteract biases. A lot of research on people's correct perception of deadly risks that face them personally, revealed that people have the tendency to overestimate extremely unlikely events, and to underestimate the frequency of common events.[(14-17)] Although the general conjecture that people have systematic biases in their perception of deadly risks has been challenged at times by some researchers[(18, 19)], we share the opinion that these systematic biases (i.e., overestimation of the probability of infrequent events and underestimation of the likelihood of more frequent events) are a quite stable phenomenon. Recently, Armantier[(14)] re-examined the subject of biased risk perceptions and found supportive evidence for these traditional biases.

We assume that if CL biases risk estimates, then these biases could be used in a flexible way to mitigate, or even eliminate, risk estimate biases that are more stable, for instance due to the given context. In other words, we assume risk estimates, which are biased so that they are generally overestimated (i.e., infrequent deadly risks) to be more accurate when estimated with an abstract mind-set (biasing the perceived probability downwards). Conversely, we suppose risk estimates for more frequent events, which in general are underestimated, to be more correct with a concrete mind-set (biasing risk estimates upwards).

Since safety, the counterpart to risk, can be assumed to be the world's largest

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industry,[20] people's risk perceptions and specifically their accuracy are of enormous importance, in particular in insurance industries, politics and economics, as well as in our everyday life. Therefore, we investigated whether these biases (i.e. overestimation of infrequent events; underestimation of more frequent events) occur and if so, how different mind-sets may contribute (by biasing biases) to a higher risk estimate accuracy given by lay people and professional risk managers.

1.3 Hypothesis and Research Questions

The present research comprises three studies, the purpose of which was three-fold. Our first goal was to investigate whether people with abstract and concrete construal levels differ in their risk estimates (Studies 1 - 3). In line with previous research,[12] we assumed that concrete thinking leads to higher risk estimates compared to abstract thinking. Thus, as a first step, we investigated the influence of CL on risk estimates. The second, related goal was to investigate whether CL can improve the accuracy of risk estimates (Studies 1 & 3). Since CL is assumed here to influence risk estimates, this is particularly applicable to bias reduction in terms of the traditional over- and underestimation biases.

It has been shown that strong emotional reactions to a risk can increase risk perception. This notion is stated in the affect heuristic, which proposes that people rely on quick and automatic affective responses that occur when they encounter a risk.[21-23] It has been further suggested that an increase in psychological distance, which results in a higher construal level [5], can lead to a decrease in emotional reactions to a risk.[24, 25] In conclusion, we argue that an increase in the level of construal reduces emotional reactions to a risk and thus results in lower risk estimates. Thus, our hypothesis reads:

Hypothesis 1: Participants who adopt a concrete mind-set estimate risk to be higher than participants with an abstract mind-set.

Hypothesis 1 implies that the over- and underestimation bias can be de-biased by

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manipulating the CL. The reduction of these biases is significant as the underestimate bias, in particular, can have dramatic consequences (i.e. subjectively perceived safety is greater than objective facts). Assuming that abstract thinking leads to lower risk estimates, and a concrete mind-set to higher estimates, the following research questions (RQ) were formulated:

RQ 1: Does an abstract mind-set increase risk estimate accuracy for extremely unlikely risks (which, in general, are overestimated)?

RQ 2: Does a concrete mind-set increase risk estimate accuracy for common risks (which, in general, are underestimated)?

The third major point of interest was the impact of CL on risk estimates across different risk perspectives (in Study 1 & 3 risks were related to a vague target; in Study 2 participants were asked to estimate personal risks). Past research explored the idea that unrealistic optimism (UO; i.e., lower risk estimates for oneself compared to risk estimates for another person) strongly influences risk estimates.[(26)] Thus, we were interested in exploring whether the CL effect can be found across different perspectives, and formulated the corresponding research question accordingly:

RQ 3: Is the CL effect risk perspective independent?

Furthermore, we were interested in the question as to whether professional risk managers (Study 3) show the same CL effect as lay people (Studies 1 & 2). Therefore, we explored whether the accuracy of professional risk managers' risk estimates can be improved by using an appropriate CL. Accordingly, in Study 3, we tested Hypothesis 1 using a professional sample. The corresponding research question reads:

RQ 4: Can the accuracy of risk managers' risk estimates be improved by using an appropriate CL?

In all three studies, participants were primed to adopt a concrete vs. abstract mind-set before they were asked to estimate the probability of the occurrence of different negative

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events. In Study 1, risks were related to a vague target person (i.e. *another person*). Study 2 replicates Study 1, but here risks were related to oneself. As mentioned above, Study 3 replicates Study 1, but the sample consists of professional risk managers.

2. STUDY 1

2.1 Method

2.1.1 Participants and design

A total of 93 students and alumni (54 female; M_{age} = 32.60, SD_{age} = 10.96) of a Bavarian university were recruited for Study 1. Participants were not rewarded, and were randomly assigned to one of three experimental conditions (CL: abstract vs. concrete vs. no priming). The dependent variables were estimates of 12 different risks for a distant target.

2.1.2 Materials and procedure

Participants were approached via email (using mailing lists of experimental subject pools), via links on Facebook and student forums, and asked to take part in an online survey on risk assessment. The email contained a hypertext link, which enabled access to the online survey. On entering the survey homepage, participants were randomly assigned to one of three conditions. CL was manipulated using a categorization priming task (adapted from Fujita, Trope, Liberman, and Levin-Sagi[(13)]). Participants were asked to name either a superordinate (*abstract CL* condition; e.g., plant) or subordinate (*concrete CL* condition; e.g., rose) category for 30 different items (e.g., flower). Hereafter, participants estimated the probability of occurrence of 12 negative events (risks). Participants that were assigned to the control group did not receive any additional task, and estimated risk events directly after starting the study.

A set of items was developed in order to meet the following demands: A) variation in domain (e.g., health, accidents); B) variation in the probability of occurrence (from common to extremely unlikely); and, C) accuracy in participants' estimate of risks with known probabilities, i.e. risk estimates were compared with existing statistics from the Federal

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Statistical Office of Germany[28]. Participants were given the odds in the top line and answered each risk probability item below. A closed frequency scale (ranging from *1:1* to *1:100,000,000*) was used to measure risk estimates. This scale was used for three reasons: Firstly, the closed frequency scale is a quantitative measurement that allows comparison of participants risk estimates with existing statistics. Secondly, this scale seems to be easier to answer for participants relative to other quantitative approaches (e.g., percentage scale) that require more statistical or numerical skills.[26] Thirdly, previous research showed that the closed frequency scale is very robust to risk perspective influences.[26] The latter is particularly appropriate in determining whether the CL effect appears across different perspectives. The chosen risks were related to Germany within a time frame of one year ("*What do you think: How big is the risk for a person in Germany to die during the period of one year from the following events?*"), and then presented in a list (see Table I for a detailed list of all items including the associated official statistics).

****Please insert Table I here****

2.2 Results

Due to the exponential character of the closed frequency scale, estimates were logarithmized to base 10 (participants saw the odds, which corresponded to hidden integer numbers in the dataset). On the logarithmic scale, all risks ranged between -6 (1:1,000,000) and -2 (1:100). As in other recent studies,[26] events were grouped according to their probability of occurrence. Scenarios with a probability of 1 in 100,000 or less (i.e., -5 or -6 on the log scale) were grouped into extremely unlikely risks (EUR). Events with a probability of around 1 in 10,000 (i.e., -4 on the log scale) were assigned as unlikely risks (UR) and events having a probability of 1 in 1,000 or higher (i.e., -3 or -2 on the log scale) were grouped into common risks (CR).

After all risks on the exponential closed frequency scale were logarithmized, the

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following risk estimate indices were calculated: mean risk index (RI) across all 12 risks, extremely unlikely risk index (EURI), unlikely risk index (URI), and common risk index (CRI). Furthermore, in order to investigate the risk estimate accuracy, each event (risk estimate item) was matched to the best possible answer of the questionnaire. That means for instance, the risk of a person in Germany dying of a concussion within one year (related to the German population) is 1 in 1,049,282. Accordingly, the item concussion was allocated to the answer 1:1,000,000 (i.e., log(-6)).

2.2.1 Construal level and risk estimates

One-way ANOVAs were conducted for each item and risk index to test Hypothesis 1, i.e., whether participants with a concrete mind-set estimate risk to be higher than those with an abstract mind-set.

The ANOVA results for the risk indices showed a significant main effect for condition (except EURI where the main effect was only marginally significant; for results see Table II). Post hoc tests (LSD) revealed that, across all risk indices, risk estimates given by participants with an abstract mind-set were lower than those given by participants who adopted a concrete mind-set. Furthermore, results across almost all risk indices (except EURI) showed that risk estimates given by the concrete thinkers were also significantly higher than those of the control group. Single item analyses showed that, qualitatively, each probability was assessed lower by abstract thinkers compared to concrete thinkers. Significant differences in half of the single items, and marginal significant differences in three further items, supported this finding.

Thus, the results confirmed Hypothesis 1, i.e., participants with a concrete mind-set estimate risk to be higher than those with an abstract mind-set.

****Please insert Table II here****

2.2.2 Construal level and risk estimate accuracy

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The existing risk statistics were examined and risk estimates were then compared with the best possible answer from the questionnaire in order to investigate the potential de-biasing effect of CL priming on the underestimation of common risks and the overestimation of unlikely risks (i.e., research questions (RQ) 1 and 2). As in Study 1, different events were considered separately and then grouped into EURI and CRI (see Table III).

****Please insert Table III here****

Results descriptively showed that all participants overestimated the likelihood of EUR. However, the risk estimates by participants with an abstract mind-set were more similar (i.e. higher accuracy) to the published statistics for most of the EUR (see Table III), than estimates by both the control group (except for the item *flu* where the the control group and abstract CL are comparable) and participants with a concrete mind-set. Although ANOVA results for the mean EURI differences showed only a marginally significant main effect for condition (CL: abstract vs. concrete vs. no priming), post hoc tests (LSD) for differences in the mean EURI, *accident as pedestrian* and *complications due to medical treatment,* demonstrated that estimates from abstractly thinking participants were significantly closer to zero (which means less overestimation) than concrete thinkers. One sample *t*-test against zero revealed that even the abstractly thinking group (albeit less than the other groups) tend to overestimate extremely unlikely risks (except regarding the item *complications due to medical treatment* where risk estimates matched the existing statistics). Thus, RQ 1 could be answered with *yes*: Participants with an abstract mind-set estimated extremely unlikely risks more accurately than those with a concrete mind-set, who overestimated risk.

Research question 2, which queries the accuracy of common risk estimation by concrete versus abstract thinkers, was explored in the same way as RQ 1. Results descriptively showed that almost all participants underestimated CR (except concrete thinkers on the item *heart attack*). However, most of the CR estimates by participants with a concrete

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mind-set were more similar (higher accuracy) to the published statistics (see Table III) than the estimates by both the control group (except item *pneumonia* where the control group and concrete thinkers are comparable) and participants with an abstract mind-set. Here ANOVA results for *mean CRI*, and the difference score for the items *to die at all* and the actual existing statistics showed significant main effects for condition (CL: abstract vs. concrete vs. no priming). Furthermore, post hoc tests (LSD) for *mean CRI*, *pneumonia*, *heart attack* and *to die at all* showed that estimates by concrete thinking participants were significantly closer to zero (which means less underestimation) than abstract thinkers. However, one sample *t*-test against zero revealed that even the concretely thinking group (albeit less) tend to underestimate most of the common risks (except regarding the item *heart attack* where risk estimates matched the existing statistics). Thus, RQ 2 could be answered with *yes*: participants with a concrete mind-set estimated common risks more accurately than participants with an abstract mind-set, who underestimated these risks.

In summary, results of Study 1 showed that an abstract thinking leads to lower risk estimates than concrete thinking. Furthermore, this effect appears to be useful in counteracting systematic biases in risk estimation (i.e., overestimation of infrequent events and underestimation of more frequent events).

3. STUDY 2

The aim of Study 2 was two-fold. In addition to replicating the results of Study 1, it was intended to explore whether the CL effect on risk estimates is apparent when people estimate personal risks. People generally have an optimistically biased view regarding personal risk. This phenomenon is called *unrealistic optimism* (UO)[29-33] and means that personal risks are often perceived as less likely than other peoples' risks. Thus, it might be that the CL effect (due to UO) would not apply when personal risk has to be estimated. Study 2 explored risk estimates for oneself in both experimental CL groups (CL: abstract vs.

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concrete) and a control group, as well as investigating the effect that CL priming has on personal risk estimates.

3.1 Method

3.1.1 Participants and design

A total of 115 students and alumni of a Bavarian university participated (84 female; M_{age} = 29.83, SD_{age} = 8.80). As in Study 1, participants were not rewarded, and were randomly assigned to one of three conditions (CL: abstract vs. concrete vs. no priming).

3.1.2 Materials and procedure

The recruitment, procedure and priming for Study 2 were basically the same as for Study 1, with the exception that participants in Study 2 were asked to estimate their own subjective risks. The scenarios were also similar to those in Study 1 (see Table I), except that the item *suicide* was removed due to ethical reasons. The instruction text read: *What do you think: How big is your personal risk in Germany to die during the period of one year from the following events?*

3.2 Results

As in Study 1, risk estimates were logarithmized before mean risk indices (RI, EURI, URI, and CRI) were calculated and one-way ANOVAs were conducted for both each event and risk index were conducted.

3.2.1 Construal level and personal risk estimates

One-way ANOVAs were conducted for each item as well as risk indices for dependent variables in order to explore Hypothesis 1, which predicts that people with a concrete mind-set estimate higher risks than those with an abstract mind-set. The results showed only a significant main effect for condition (CL: abstract vs. concrete vs. no priming) for EURI and the item *flu*, and marginally significant main effects for URI and the items *concussion* and *fall* (see Table IV). The other ANOVA results were not significant. However, as in Study 1, most

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of the risk estimates and indices descriptively showed that participants who adopted an abstract mind-set gave the lowest risk estimates, while concrete thinkers gave the highest. Estimates given by the control group were between the concrete and abstract groups (except for the items *alcohol related liver disease, cancer* and *to die at all*). Furthermore, post hoc tests (LSD) revealed significant differences between abstract and concrete thinkers across almost all of the risk indices (except for CRI), showing that concrete thinkers gave higher risk estimates than abstract thinkers (see Table IV). Single item analyses showed significant differences for the items *concussion* and *fall*, and marginally significant differences for *accident as pedestrian* and *traffic*, which support our assumptions. Thus, CL manipulation also seems to affect personal risk estimates. Hence, Hypothesis 1 was partially confirmed, and RQ 3 could be answered wit *yes* as the CL effect is shown to be risk perspective independent.

****Please insert Table IV here****

However, the CL effects were of Study 2 was weaker than those from Study 1. Therefore, it could be concluded that the UO (i.e., self-enhancement) may contribute overriding the CL effect on risk estimates.

4. STUDY 3

The purpose of Study 3 was two-fold: Firstly, to investigate whether professional risk managers' risk estimates are affected by CL manipulation. Secondly, to explore whether it is possible to improve risk managers' risk estimates by an appropriate CL manipulation. This question is not trivial as risk managers are experienced in dealing with quantitative risk assessments. Supposing that risk managers' risk estimates are biased (i.e., overestimate the likelihood of very infrequent events or underestimate the probability of more frequent events[(14)]), then the answer to this research question will have major implications for the practical application of CL manipulation. Since it is a risk manager's job to assess risks as accurately as possible, any bias reduction is desirable.

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4.1 Method

4.1.1 Participants and design

A total of 85 risk managers from a reinsurance company participated. Information on gender, age and tenure was not accessible due to work council restrictions. As in Studies 1 and 2, participants were not rewarded, and were randomly assigned to one of three conditions (CL: abstract vs. concrete vs. control).

4.1.2 Materials and procedure

Participants were approached via email through the company's intranet. As in Studies 1 and 2, participants were invited to take part in an online survey on risk assessment as part of a university research project. Random assignment to one of three conditions and CL manipulation followed the same pattern as in Studies 1 and 2. The questionnaire was the same as that used in Study 1.

4.2 Results and Discussion

Hypothesis 1 was tested by comparing risk estimates by risk managers who received a concrete priming and those with an abstract priming. As in Study 1, risk estimates that were assessed with the closed frequency scale, were logarithmized and mean risk indices (RI, EURI, URI, and CRI), ANOVAs for each item and risk indices as dependent variables were calculated.

The risk indices showed a main effect for the factor CL, for RI and EURI, but not for URI and CRI (see Table V). ANOVAs of single items showed a significant main effect for *accident as pedestrian* and *pneumonia* and a marginally significant main effect for five other items. However, post hoc tests (LSD) revealed that across all risk indices, risk estimates did not differ between the abstract and concrete thinking groups. However, there was a difference in most of the estimates between the two experimental groups and the control group. Thus, Hypothesis 1, stating that participants with a concrete mind-set estimate risk to be higher than

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those with an abstract mind-set, could not be confirmed with the risk manager sample set. However, the results showed that risk estimates given by the concrete group were significantly higher than those of the control group across almost all risk indices, except for URI. Here the difference was marginally significant. Interestingly, the abstract and control groups differed to the control group in a similar manner. The similarity in the abstract and concrete primed groups could indicate that the abstract priming did not work properly. Potential reasons for this outcome are discussed below.

****Please insert Table V here****

To explore research question 4 that asks whether the accuracy of risk managers' risk estimates can be improved by the appropriate CL, risk managers' estimates (CL: abstract vs. concrete vs. control) were compared with existing statistics and one way ANOVAs were conducted for the differences in the risk indices (EURI, URI, and CRI) and existing statistics. Since the abstract manipulation failed, we excluded the abstract priming group from this analysis. Therefore, only the risk estimates from the concrete priming group and the control group could be compared. However, this comparison still allowed assessment of the effect of a concrete mind-set on the accuracy of the risk managers' risk estimates'.

All estimates for EUR by the control group were consistently closer to zero (indicating higher accuracy) and differed significantly from those of the concrete CL group (see Table VI). While the concrete thinkers overestimated all EUR, which was indicated by *t*-tests against zero, the control group correctly estimated EUR (except for the item *flu*, which was also overestimated by the control group). Thus, risk managers' risk estimates of EUR were already optimal.

This pattern changes for CR. The results showed that both groups significantly underestimated almost all CR (except item *heart attack,* which was correctly estimated by the concrete CL group), which was indicated by *t*-tests against zero. Furthermore, estimates given

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by the concrete group in this study were consistently closer to zero. *T*-test results showed significant differences between both groups for the item *pneumonia* and *CRI-existing*, and marginally significant differences for *heart attack* and *cancer*.

****Please insert Table VI here****

Thus, RQ 4, that asks whether the accuracy of risk managers' risk estimates can be improved with an adequate CL, could be answered with *yes* for CR estimation and a concrete mind-set. Priming does not seem to enhance risk managers estimates for EUR, but does seem to effect the CR estimates. Mean differences of CR estimates showed that risk managers also tend to underestimate frequent events. Here a concrete CL manipulation increased the accuracy (compared to no priming), as shown by less underestimation. Thus, RQ 2 (*Does a concrete mind-set increase risk estimates' accuracy regarding common risks (which in general are underestimated)?*) could also be answered with *yes* for risk managers.

In summary, results of Study 3 showed that the abstract CL manipulation did not work as expected. Instead, it led risk managers to think the same way as participants who received the concrete CL manipulation. This explains why there was no difference between the two experimental CL groups. Study 3 failed to replicate findings of Studies 1 and 2 for Hypothesis 1, i.e. participants with a concrete mind-set estimate risk to be higher than those with an abstract mind-set. One explanation as to why risk managers reacted differently to abstract priming compared to students and alumni might be that this population is not familiar with such research tasks particularly those like the categorizations task. Post-Study 3-debriefing talks revealed that many of the risk managers were fairly puzzled by the relevance of the priming task within a questionnaire that was intended to assess risk estimates. When people are surprised, their attention increases and their cognitive processes become more deliberate.[(3)] In the words of Daniel Kahneman[(3)], more deliberate processes (System 2) are "activated when an event is detected that violates the model of the world that" the automatic

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system (System 1) maintains. The same effect (switch from System 1 to System 2) appears when people are confronted with difficulties. Thereby, the failure of the abstract manipulation is in line with action identification theory[34] that suggests that "individuals are likely to respond to difficulties encountered in executing a task by thinking about the task at an even more specific level".[35] This would explain why both manipulations resulted in responses consistent with the expectations for concrete priming.

Another explanation might be that due to the fact that risk managers are surrounded by risk and hazards on a daily basis, they probably adapt a different view to risk compared to lay people. After all, it is their job to estimate risks as correctly as possible and thus, they should have a clear idea of different probabilities of hazards. Therefore, risk managers (due to their higher knowledge-level) are not as susceptible to CL priming as lay people, independent of the manipulation method. However, further research is necessary to clarify this issue. Nonetheless, the concrete priming group estimates differed from those of the control group by reduced underestimates. Thus, CL manipulation appears to be a promising approach to reduce even professionals' risk estimate biases regarding common risks.

Furthermore, it should be noted that there is an ongoing debate regarding the replication problem of priming effects (see, for instance, Cesario[36]). These controversies led to the demand that researchers should replicate their own findings/effects.[36] By doing so, researchers should further show their effects by using conceptual replications, which comprises at least some variance within either the manipulation or the measures that were applied in the original study.[37] The use of conceptual replications is particularly important for Type I error probability reduction. Moreover, conceptual replications are of theoretical relevance because the replications' confirmatory power increases with every variation from the previous study.[38]

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Our three studies followed these recommendations in that we used the same manipulation in all three studies, but changed both risk perspective (Studies 1 & 3: person; Study 2: self) and sample (Studies 1& 2: Students and alumni; Study 3: risk managers). In line with the widely discussed problem of replicating priming effects, the results of Study 3 indicate that the CL effect seems to be prone to even putative small changes. With the exception of the abstract condition in Study 3, our results showed that the CL effect occurred across all studies in the expected direction.

5. GENERAL DISCUSSION

In our Studies, we have explored the influence of CL on risk estimates. Three important findings emerge: First, manipulation of CL influences risk estimates in that a concrete mind-set leads to higher risk estimates (Studies 1 & 2) compared to an abstract mind-set. Second, CL manipulation can be used to increase accuracy of risk estimates by reducing systematic biases (Studies 1 & 3). Study 1 showed that an abstract mind-set is advantageous for estimating extremely unlikely events (which are typically overestimated) and a concrete mind-set works better for common events (which are often underestimated). Study 3 showed that by inducing a concrete mind-set, even the accuracy in estimating common events by professional risk managers' can be improved. Third, CL can affect risk estimates for both another person and for oneself.

5.1 CL and Risk Estimates

The findings of our research are in line with CLT assumptions for the influence of the mind-set on probability estimates. Our studies are consistent with previous research that showed that even probability estimates, which are linked to the occurrence of negative events, vary subjectively with the current mind-set. Previous research focusing on the influence of CL on mental representations of potentially negative outcomes, demonstrates, for example, that increased psychological distance (PD) decreases loss aversion[39] and "increases people's

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interest in risky choices”[40]. Furthermore, our results are in line with findings of Chandron and Menon[41], who showed that temporal distance (a dimension of PD) influences risk estimates. The authors found that in a day frame (e.g., “every day”), presented risks were perceived as more probable, proximal, threatening and concrete when compared to risks which were presented in a year frame. However, to the best of our knowledge, our research is the first to show the influence of CL, after manipulation of the mind-set (vs. psychological distance), on the perceived likelihood of negative occurrences by focussing on risk estimates. For future research, it would be interesting to widen the probability spectrum and to explore at which degrees of event-likelihood CL manipulations appear most useful, and to detect its limits. Furthermore, focusing on another dimension (next to probability) could be promising, particularly different degrees of risk severity. Additionally, further studies involving different population samples (just as we explored risk assessment in lay people and risk managers), for instance physicians or statisticians (who are used to dealing with probabilities) would be of interest.

5.2 Implications of CL Influence on Risk Estimates Findings

Another important aspect arising from our findings concerns the useful implications of CL manipulation for risk estimation. Research has shown that people have the tendency to systematically over- and underestimate risk probabilities.[14] Based on theoretical assumptions and empirical findings, we assumed that a certain level of construal could be used to counteract these tendencies. In particular, this means counteracting overestimations of infrequent events with an abstract mind-set and underestimations of more frequent events with concrete thinking. Our results support these assumptions. However, in practice, different methods for CL priming should be considered (see Burgoon and et al.[42] for a review). Specifically, the method of mental simulations (process or goal simulation for adopting concrete and abstract thinking) has been shown to successfully influence participants kind of

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thinking.[43] We propose that these findings are relevant for practical use in different contexts. For instance, risk managers assessing emerging risks (i.e., new risks) are reliant on their subjective probability estimates since there are no existing statistics to serve as a guide. However, further research is needed to explore which kind of sample needs bias reduction in order to increase accuracy by CL manipulation. CL manipulation could also be useful in risk perception in everyday life. Concrete thinking may contribute to people's motivation to show precautionary behaviour. For instance, CL manipulation may help reduce *environmental numbness* when faced with natural hazards.[44] This concept implies that people can intentionally think about "climate change but choose not to".[45] Research has shown that a key characteristic of risks associated with climate change is that these are psychologically distant for many people.[46] Concrete thinking about climate change risks may increase environmentally friendly behaviours.

Furthermore, it has been suggested that overweighting of low probability risks increases when the risk is affect-rich.[47] Several studies have demonstrated the important role of the affect heuristic in the judgment of risks.[21, 48, 22, 23] The affect heuristic is based on a two-systems approach of thinking, which proposes an experiential system and an analytical system to process information. For example, it was shown in a study on risk communication that people judge the risk of flooding as higher when they had experienced the risk before and when they were presented with affect-laden pictures of floods.[21] Thus, risks that have not been experienced before should evoke less emotional reaction and are assumed to be represented in a more abstract mind-set. Further research should investigate whether affect mediates the relationship between the level of construal and risk estimates.

In Study 3, the abstract mind-set manipulation did not lead to the expected results. This might be due to the sample per se and/or due to failed manipulation. Nevertheless, we demonstrated a bias reduction in the risk manager sample set for the concrete mind-set

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(regarding common risks). However, since results showed that risk managers predominantly did not overestimate infrequent events anyway (i.e., control group showed highest risk estimate accuracy), it might be assumed that an abstract mind-set would not have much additional value for professional risk managers in this probability spectrum. The question as to why the abstract manipulation failed remains unanswered. Further research is needed to clarify the relevant conditions (e.g., sample, briefing) under which CL manipulations in different contexts work reliably. Only recently, Burgoon et al.[42] reviewed different methods of studying abstraction. However, there is no reference in the CL literature to the questions of why and when CL manipulation works effectively.

We propose that our results contribute to the field of CL research by showing that the same manipulation method does not necessarily lead to the same effects across different samples. Cesario[36] criticised the desire from critics to have invariant priming effects that can always be obtained. Moreover, he argued that critics often too quickly interpret failed replication attempts as Type 1 errors or as being too fickle to be of interest.[36] Cesario further argued that researchers have the responsibility to also present work that did not meet their expectations. Only by doing so (by honestly reporting all findings), real knowledge can be gained and contributions made to a better understanding of the borders of generalizability.

Furthermore, especially the findings where replications failed (e.g., due to sample changes) are valuable for future research: they prevent researchers from blind repetition without due consideration of other influences. Also Stroebe and Strack[37] argued: “we should publish more null findings”. Although, results of Study 3 are not null findings, they indicate that different samples can react differently to the same CL priming method.

5.3 Limitations

Some limitations of the study have to be mentioned. We are well aware that each person’s risk is different. There are many different variables influencing each person’s

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probability to be affected by negative events (e.g., age, gender, social and educational background, leisure behaviour). Therefore, it is not possible to determine a real risk value for any one person or group. Nevertheless, we did address the question of accuracy of risk estimates. Our approach could be criticized in terms of accuracy. However, our aim was to explore the influence of CL manipulation on risk estimates and, in doing so, identify CL advantages for typical biases in estimating probabilities of events (i.e., overestimating infrequent events and underestimating frequent events). Although we used approximate values to compare estimates with reality, they are correct in their characteristic and order. Furthermore, there was a surplus of women to men in the Studies 1 and 2 (and in Study 3 information on gender was not accessible due to work council restrictions), which has to be noted. However, we made no assumptions regarding differences in the CL impact due to gender. Another aspect that should be considered is that the recruitment in these studies was done via internet or intranet. Online studies are not as representative as laboratory (or field) studies, because there is no control over the context and situation in which participants fill out the questionnaire. Furthermore, future research should contemplate a larger sample size.

6. CONCLUSION

People have to make decisions involving risk every day and in doing so, they have to assess probabilities. In most cases, such decisions lead to better or worse outcomes which are of more or less relevance. Hence, estimating risks are part of our everyday life. Although the focus of this study is predominantly on serious risks, the inherent pattern of the findings could be transferred to other decision-making contexts that involve risk, for instance, committees who have to assess risks. Our results showed that people’s risk estimates are biased, consistent with traditional biases (e.g., underestimations of frequent events). Furthermore, they revealed that people’s actual mind-sets have a significant impact on their estimates. This should be considered when risks are assessed, because results might be distorted inter alia by both

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traditional biases and the currently activated mind-set, which may also have an adverse affect. Every judgment is integral to the respective decision making process. Thus, there are always environmental conditions that influence the way people think about an issue (e.g., working hard on a difficult problem may lead to a detailed analysis). In this way, the respective context may trigger either an abstract or concrete mind-set, which influences the risk estimator's assessment, although it is not related to the issue.

Our findings also showed that the biases arising from the mind-set can be used to counter-bias traditional biases in order to increase accuracy. However, it is important to have an idea of the probability spectrum for the respective scenario in advance. It would be useful to think about how these mind-set effects could be utilized in different risk assessment contexts (e.g., via trainings, workshops). Less riskiness is advantageous in most situations in our daily life and, therefore, a concrete mind-set might be a good advisor.

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Table I. Risk items for Studies 1-3 with corresponding official federal statistics for Germany in 2011

Risk (to die because of)	Deceased persons in Germany in 2011	Ratio: one out of X Germans	Corresponding value used for answer in questionnaire	Corresponding value in closed frequency scale	Logarithmized value	Risk index for data analysis
Concussion	47	1,741,362	1:1,000,000	7	-6	EUR
Flu	78	1,049,282	1:1,000,000	7	-6	EUR
Accident as pedestrian	679	120,536	1:100,000	6	-5	EUR
Complications during medical treatment	1,165	70,252	1:100,000	6	-5	EUR
Traffic	4,199	19,491	1:10,000	5	-4	UR
Alcohol related liver disease	8,459	9,675	1:10,000	5	-4	UR
Fall	9,722	8,418	1:10,000	5	-4	UR
Suicide *	10,144	8,068	1:10,000	5	-4	UR
Pneumonia	19,337	4,233	1:1,000	4	-3	CR
Heart attack	55,286	1,480	1:1,000	4	-3	CR
Cancer	228,220	359	1:100	3	-2	CR
To die at all	852,328	96	1:100	3	-2	CR

Note. Numbers for deceased persons are according to the Federal Statistical Office of Germany (Destatis, 2011). Ratios were calculated on the basis of 81,844,000 inhabitants. Since the presented possible answers (i.e. *corresponding value used for answer in questionnaire*; from *1:1* to *1:100,000,000*) did not match the actual risk ratio, participants' answers could not match the actual statistics accurately. In a first step, participants' answers were transformed into a 9-step closed frequency scale (i.e. *corresponding value in closed frequency scale*; from *1 = 1:1* to *9 = 1:100,000,000*). In a second step, values of the closed frequency scale were logarithmized to the basis 10, because of the exponential character of the dataset. * The item "suicide" was deleted in Study 2 for ethical reasons. EUR = extremely unlikely risk, UR = unlikely risk, CR = common risk.

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Table II. CL influence on risk estimates (Study 1)

	Mind-set								
	Abstract CL (n = 33)		Control group (n = 30)		Concrete CL (n = 30)				
Risk items and indices	*M*	*SD*	*M*	*SD*	*M*	*SD*	*F*	*p*	η^2
RI	-4.23_a	1.15	-4.19_b	0.85	-3.54_{ab}	1.24	3.78	.026	.078
EURI	-4.64_a	1.35	-4.43	0.97	-3.87_a	1.56	2.80	.066	.059
Concussion	-5.24	1.79	-5.10	1.56	-4.60	2.13	1.04	.357	.023
Flu	-4.03	1.89	-4.10^a	1.71	-3.37^a	1.75	1.72	.185	.037
Accident as pedestrian	-4.48_a	1.37	-4.27	1.48	-3.63_a	1.97	2.29	.106	.049
Complications during medical treatment	-4.82_a	1.72	-4.27	1.17	-3.90_a	1.84	2.61	.080	.055
URI	-4.20_a	1.12	-4.21_b	1.02	-3.53_{ab}	1.39	3.29	.042	.068
Traffic	-3.97_a	1.13	-3.83_b	1.26	-3.07_{ab}	1.46	4.40	.015	.089
Alcohol related liver disease	-4.30	1.42	-4.40	1.22	-3.90	1.49	1.11	.335	.024
Fall	-4.03^a	1.83	-4.10^b	1.67	-3.27^{ab}	1.91	1.99	.143	.042
Suicide	-4.52^a	1.42	-4.53^b	1.38	-3.90^{ab}	1.56	1.87	.160	.040
CRI	-3.86_a	1.34	-3.92_b	0.86	-3.22_{ab}	1.15	3.45	.036	.071
Pneumonia	-4.48^a	1.33	-4.53^b	1.14	-3.87^{ab}	1.46	2.43	.093	.051
Heart attack	-3.36	1.48	-3.63_a	1.10	-2.87_a	1.46	2.46	.091	.052
Cancer	-3.52	1.58	-3.90	1.03	-3.50	1.43	0.83	.441	.018
To die at all	-4.09_a	1.89	-3.63_b	1.58	-2.67_{ab}	1.49	5.86	.004	.115

Note: RI = Risk index across all risk items; EURI = extremely unlikely risk index, includes mean risk estimates with actual statistics between log(-6) and log(-5); URI = unlikely risk index, includes mean risk estimates with actual statistics of log(-4); CRI = common risk index, includes mean risk estimates with actual statistics between log(-3) and log(-2). Means with same subscripts differ significantly, $p < .05$ (LSD). Means with same superscripts have a marginally significant difference, $p < .10$ (LSD).

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Table III. Differences between EUR and CR items and indices and existing statistics for experimental groups and the control group (Study 1)

	Mind-set														
	Abstract CL				Control group				Concrete CL						
Estimate minus existing	*M*	*SD*	t_{zero}	*p*	*M*	*SD*	t_{zero}	*P*	*M*	*SD*	t_{zero}	*p*	*F*	*p*	η^2
Extremely unlikely risks (EUR)															
Concussion	0.76	1.79	2.43	.021	0.90	1.56	3.15	.004	1.40	2.13	3.60	.001	1.04	.357	.023
Flu	1.97	1.90	5.97	.000	1.90^a	1.39	7.44	.000	2.63^a	1.75	8.23	.000	1.71	.185	.037
Accident as pedestrian	0.52_a	1.37	2.15	.039	0.73	1.48	2.70	.011	1.37_a	1.97	3.79	.001	2.29	.106	.049
Complications due to a medical treatment	0.18_a	1.72	0.60	.548	0.73	1.17	3.42	.002	1.10_a	1.84	3.26	.003	2.60	.080	.055
EURI minus mean existing	0.90_a	1.35	3.83	.000	1.11	0.98	6.25	.000	1.67_a	1.56	5.87	.000	2.80	.066	.059
Common risks (CR)															
Pneumonia	-1.48^a	1.33	-6.43	.003	-1.53^b	1.13	-7.38	.000	-0.87^{ab}	1.46	-3.26	.003	2.43	.093	.051
Heart attack	-0.36	1.45	-1.41	.166	-0.63_a	1.09	-3.15	.004	0.13_a	1.46	0.50	.620	2.46	.091	.052
Cancer	-1.52	1.43	-5.49	.000	-1.90	1.02	-10.11	.000	-1.50	1.43	-5.73	.000	0.82	.441	.018
Die	-2.09_a	1.49	-6.34	.000	-1.63_b	1.58	-5.64	.000	-0.67_{ab}	1.49	-2.44	.021	5.86	.004	.115
CRI minus mean existing	-1.36_a	1.35	-5.81	.000	-1.43_b	0.87	-8.98	.000	-0.73_{ab}	1.16	-3.43	.002	3.46	.036	.071

Note: Positive means indicate overestimation whereas negative means indicate underestimation. Close to zero means indicate a higher accuracy. Means with the same subscripts differ significantly, $p < .05$ (LSD). Means with the same superscripts have a marginally significant difference, $p < .10$ (LSD). T_{zero} values are the results of one sample *t*-tests against zero; non-significant differences indicate accurate risk assessment. EURI = EUR index; CRI = CR index. It should be noted that there is an overlap between Tables 2 and 3 due to fact that the values of Table 3 are difference scores between risk estimates (Table 2) and existing statistics.

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Table IV. CL influence on risk estimates (Study 2)

Risk index	Mind-set: Abstract CL (n = 40) *M*	*SD*	Control group (n = 36) *M*	*SD*	Concrete CL (n = 40) *M*	*SD*	*F*	*p*	η^2
RI	-4.92_a	1.46	-4.55	1.80	-4.22_a	1.04	2.26	.109	.039
EURI	-5.06_a	1.58	-4.58	1.88	-4.14_a	1.26	3.28	.041	.055
Concussion	-5.69_a	2.02	-5.11	2.24	-4.60_a	2.06	2.67	.074	.045
Flu	-5.44	2.22	-4.89^a	2.78	-4.15^a	2.01	3.33	.040	.056
Accident as pedestrian	-4.36^a	1.95	-4.17	1.81	-3.63^a	1.46	1.87	.160	.032
Complications during medical treatment	-4.74	2.01	-4.64	2.19	-4.20	1.71	0.84	.434	.015
URI	-5.00_a	1.38	-4.51	1.87	-4.25_a	1.00	2.71	.070	.046
Traffic	-4.13^a	1.63	-3.92	1.83	-3.45^a	1.11	2.01	.139	.035
Alcohol related liver disease	-6.49	1.75	-5.92	2.43	-5.95	2.01	0.92	.401	.016
Fall	-4.38_a	2.06	-3.69	2.32	-3.35_a	1.72	2.62	.077	.045
CRI	-4.69	1.80	-4.56	2.03	-4.26	1.47	0.59	.555	.010
Pneumonia	-5.13	2.17	-4.81	2.07	-4.40	1.75	1.32	.272	.023
Heart attack	-4.72	2.19	-4.56	2.53	-3.98	1.69	1.30	.276	.023
Cancer	-4.13	2.31	-4.22	2.28	-4.03	1.80	0.08	.922	.001
To die at all	-4.79	2.12	-4.67	2.61	-4.68	2.08	0.03	.962	.001

Note: RI = Risk index across all risk items; EURI = extremely unlikely risk index, includes mean risk estimates with actual statistics between log(-6) and log(-5); URI = unlikely risk index, includes mean risk estimates with actual statistics of log(-4); CRI = common risk index, includes mean risk estimates with actual statistics between log(-3) and log(-2). Means with the same subscripts differ significantly, $p < .05$ (LSD). Means with same superscripts have a marginally significant difference, $p < .10$ (LSD).

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Table V. CL influence on risk estimates (Study 3)

	Mind-set								
	Abstract CL (*n* = 25)		Control group (*n* = 26)		Concrete CL (*n* = 34)				
Risk index	*M*	*SD*	*M*	*SD*	*M*	*SD*	*F*	*p*	η^2
RI	-4.09_{a}	1.15	-4.72_{ab}	1.15	-4.07_{b}	0.79	3.36	.040	.076
EURI	-4.61_{a}	1.43	-5.41_{ab}	1.19	-4.57_{b}	-1.02	4.23	.018	.093
Concussion	-5.04_{a}	2.09	-6.08_{a}^{b}	1.44	-5.26^{b}	1.50	2.76	.069	.063
Flu	-4.56	1.73	-5.27_{a}	1.69	-4.32_{a}	1.63	2.44	.094	.056
Accident as pedestrian	-4.36_{a}	1.58	-5.27_{ab}	1.37	-4.38_{b}	1.21	3.84	.025	.086
Complications during medical treatment	-4.48	1.58	-5.04_{a}	1.22	-4.25_{a}	1.22	2.57	.083	.060
URI	-4.21^{a}	1.29	-4.79^{ab}	1.27	-4.27^{b}	0.93	2.01	.141	.047
Traffic	-3.80^{a}	1.22	-4.42^{a}_{b}	1.58	-3.76_{b}	0.95	2.39	.098	.055
Alcohol related liver disease	-4.24	1.67	-4.85	1.54	-4.27	1.18	1.48	.235	.035
Fall	-4.28_{a}	1.77	-5.27_{a}^{b}	1.43	-4.56^{b}	1.56	2.68	.074	.061
Suicide	-4.52	1.33	-4.62	1.33	-4.50	1.26	0.06	.939	.002
CRI	-3.45	1.24	-3.96_{a}	1.38	-3.35_{a}	0.85	2.24	.112	.052
Pneumonia	-4.32_{a}	1.63	-5.19_{ab}	1.52	-4.29_{b}	1.22	3.42	.038	.077
Heart attack	-3.16	1.52	-3.73^{a}	1.56	-3.09^{a}	1.11	1.78	.175	.042
Cancer	-3.20	1.29	-3.69^{a}	1.54	-3.06^{a}	1.07	1.86	.163	.043
To die at all	-3.12	1.72	-3.23	1.80	-2.97	1.17	0.21	.808	.005

Note: RI = Risk index across all risk items; EURI = extremely unlikely risk index, includes mean risk estimates with actual statistics between log(-6) and log(-5); URI = unlikely risk index, includes mean risk estimates with actual statistics of log(-4); CRI = common risk index, includes mean risk estimates with actual statistics between log(-3) and log(-2). Mean values with the same subscripts differ significantly, $p < .05$ (LSD). Means with the same superscripts have a marginally significant difference, $p < .10$ (LSD).

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Table VI. Differences between EUR and CR items and indices and actual statistics for experimental groups and control group (Study 3)

	Mind-set														
	Abstract CL				Control group				Concrete CL				*T*-test		
Estimate minus actual	*M*	*SD*	t_{zero}	*p*	*M*	*SD*	t_{zero}	*P*	*M*	*SD*	t_{zero}	*p*	*t*	*p*	*r*
Extremely unlikely risks															
Concussion	0.96	2.09	2.30	.031	-0.08	1.44	-0.27	.788	0.74	1.50	2.85	.007	2.11	.039	.267
Flu	1.44	1.73	4.15	.000	0.73	1.89	2.20	.037	1.68	1.63	6.00	.000	2.20	.032	.278
Accident as pedestrian	0.64	1.58	2.02	.054	-0.27	1.37	-1.00	.327	0.62	1.21	2.97	.005	2.66	.010	.330
Complications due to a medical treatment	0.52	1.58	1.64	.114	-0.04	1.22	-0.16	.873	0.75	1.22	3.48	.002	2.45	.017	.306
EURI minus mean actual	0.94	1.43	3.28	.003	0.13	1.19	0.57	.572	0.98	1.02	5.55	.000	2.93	.005	.359
Common risks															
Pneumonia	-1.32	1.63	-4.06	.000	-2.19	1.52	-7.34	.000	-1.29	1.22	-6.19	.000	2.54	.014	.316
Heart attack	-0.16	1.52	-.053	.060	-0.73	1.56	-2.38	.025	-0.09	1.11	-0.53	.646	1.86	.068	.237
Cancer	-1.20	1.29	-4.64	.000	-1.69	1.54	-5.59	.000	-1.06	1.07	-5.76	.000	1.87	.066	.238
Die	-1.12	1.72	-3.26	.003	-1.23	1.80	-3.50	.002	-0.97	1.17	-4.84	.000	0.68	.500	.089
CRI - mean actual	-0.95	1.25	-3.81	.001	-1.46	1.38	-5.41	.000	-0.85	0.85	-5.85	.000	2.11	.040	.267

Note: Positive means indicate overestimation, whereas negative means indicate underestimation. T_{zero} values are results of one sample *t*-tests against zero; non-significant differences indicate accurate risk assessments. *T*-test results are related to control group and concrete CL group.

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