Making up your mind about a complex technology : an investigation into factors that help or hinder the achievement of cognitive closure about CCS

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Appendix

Design, Stimulus Materials, and Results of the Two Distinct Data Collection Waves (Study 2)

Data Collection Wave I

In the first data collection wave we explored whether communicating an analogy of CCS would reduce participants' risk perception of and negative emotional reactions to the implementation of CCS, and whether this would lead to an increase in the level of cognitive closure they achieved on the topic. To ensure that the effects would not differ depending on CCS-component, we counterbalanced whether participants were prompted to think about CO_2 storage or about CO_2 transport.

Method

Participants and design. Participants were 97 students (33 men and 64 women; M_{age} = 20.32, SD = 2.99) who were randomly assigned to either one of the conditions of the 2 (CCS-component: CO_2 transport vs. CO_2 storage) × 2 (analogy use: analogy vs. no-analogy) design. They received either a monetary reward or course credit in return for their participation.

Procedure. The study was the first in a set of unrelated studies. The procedure and measures of this data collection wave were as described in the main text of Chapter 2. Depending on CCS-component condition, participants read information about CO_2 transport or CO_2 storage, and depending on analogy condition, this information did or did not include an analogy of the relevant CCS-component. Participants in the CO_2 transport condition (analogy and no-analogy) read the following information:

> CO_2 can be transported via pipelines, ships, or tanker trucks. The manner of transport that is selected depends on many aspects, such as the amount of CO_2 and the transport distance to the location where the CO_2 can be stored. Transport via pipelines is the most likely method in the Netherlands. These pipelines can be located below as well as above the ground. The CO_2 is compressed after it has been captured. Next, the CO_2 can be transported via the pipelines to the storage location.

Those in the CO_2 transport-analogy condition then also read:

> CO_2 transport via pipelines is comparable to transport of natural gas, where natural gas is transported via pipelines to provide households and businesses with gas.

Participants in the CO_2 storage condition (analogy and no-analogy) read the following information about the CCS-component:

> CO_2 can be stored in depleted natural gas fields, in depleted oil fields, and in so-called aquifers (water-bearing layers). Prior to the selection of CO_2 storage locations, investigations are carried out, after which the most suitable location is selected. Depleted natural gas fields are the most likely storage location for CO_2 in the Netherlands. To be able to store

> the CO_2 that has been captured, it is first compressed. The CO_2 is then inserted into the depleted natural gas field via an injection well where it is stored.

In the CO_2 storage-analogy condition participants then also read:

> CO_2 storage in depleted natural gas fields is comparable to storage of natural gas in these kinds of fields. Storage of natural gas in depleted natural gas fields takes place to enable effective responses to peaks in gas demand.

Results

To explore whether participants´ general risk perception, specific risk perceptions, negative emotional reactions, and their achievement of cognitive closure were affected by the use of an analogy or differed depending on CCS-component (CO_2 transport or CO_2 storage), we conducted Analysis of Variance (ANOVA) with analogy use and CCS-component as independent variables.

Results revealed no significant main or interaction effects of analogy use and CCS-component on general risk perception, $Fs(1, 93) \leq 3.08$, $ps \geq .083$, or on any of the specific risk perception dimensions (catastrophic potential, lack of control, and lack of familiarity), $Fs(1, 93) \leq 3.22$, $ps \geq .076$. Participants' negative emotional reactions to CCS also remained largely unaffected by analogy use and CCS-component. Analogy use and CCS-component had neither main nor interaction effects on outcome uncertainty-related emotions, $Fs(1, 93) \leq 1.59$, $ps \geq .210$. Results showed only a main effect of analogy use on outcome certainty-related emotions; participants who learned about a natural gas analogue of CCS experienced these emotions more intensely ($M = 2.45$, $SD = 1.36$) than those who did not learn about an analogous technology ($M = 1.91$, $SD = 0.92$), $F(1, 93) = 5.19$, $p = .025$, $\eta_p^2 = .05$. There was no main effect of CCS-component or interaction effect of analogy use and CCS-component on outcome certainty-related emotions, $Fs(1, 93) < 1$, $ps \geq .585$. Finally, the level of cognitive closure that participants achieved did differ depending on the CCS-component under consideration; participants who were asked to form an attitude on CO_2 transport achieved more cognitive closure ($M = 3.94$, $SD = 1.13$) than those who formed an attitude on CO_2 storage ($M = 3.50$, $SD = 1.05$), $F(1, 93) = 4.02$, $p = .048$, $\eta_p^2 = .04$. There was no main effect of analogy use or an interaction effect of analogy use and CCS-component on cognitive closure achieved, $Fs(1, 93) \leq 1$, $ps \geq .319$.

Data Collection Wave II

In the second data collection wave we focused on CO_2 storage only. In this wave, we did not only systematically vary whether participants learned about an analogous technology of CO_2 storage, but also whether this analogy contained information that alluded to the safety of the analogous technology. In this way, we aimed to explore whether communicating information that contained an analogy of CO_2 storage as well as safety-related information about the analogue would reduce participants' risk perception and negative emotional reactions to the implementation of the technology. Such reductions would then possibly lead to an increase in the level of cognitive closure that people achieved on the topic. Contrary to the first data collection wave, participants in the analogy conditions first learned about the analogy, and then read further information on the CCS-component.

Method

Participants and design. Participants were 122 students (24 men and 98 women; M_{age} = 20.00, SD = 2.69) who were randomly assigned to either one of three experimental conditions (analogy with safety information vs. analogy without safety information vs. no analogy). They received either a monetary reward or course credit in return for their participation.

Procedure. The study was the first in a set of unrelated studies. The procedure and measures of this data collection wave were as described in the main text of Chapter 2. Depending on experimental condition, participants read information about CO_2 storage that did or did not include an analogy. Specifically, participants in the "analogy with safety information" condition and the "analogy without safety information" condition first learned about a technology that is analogous to CO_2 storage in depleted natural gas fields; storage of natural gas in depleted natural gas fields. The text on the analogy in the "analogy with safety information" condition additionally contained information that alluded to the safety of the analogous technology. Participants in the "no analogy" condition did not learn about an analogy. Thus, the complete text on CO_2 storage in depleted natural gas fields in the "analogy with safety information" read as follows:

> Some parts of the CO_2 capture, transport, and storage technology are comparable to already existing technologies. For instance, storage of CO_2 in depleted natural gas fields is comparable to the storage of natural gas in these types of fields. Storage of natural gas in depleted natural gas fields takes place to enable effective responses to peaks in gas demand in winter. Underground storage of natural gas is a tried and tested method and has been taking place since the 1990s on several locations in the Netherlands. To store the natural gas, it is inserted in depleted

> natural gas fields via wells that were originally used for gas extraction. It has been demonstrated that the chance is virtually zero that natural gas will escape from the natural gas field in which it has been stored.
>
> CO_2 can be stored in different ways. Depleted natural gas fields are the most likely storage location for CO_2 in the Netherlands. Prior to the selection of CO_2 storage locations, investigations are carried out, after which the most suitable location for storage of the CO_2 is selected. To be able to store the CO_2 it is gathered at the depleted natural gas field. The CO_2 is then inserted into the depleted natural gas field via an existing well where it is stored. In this way, storage of CO_2 in depleted natural gas fields is comparable to the storage of natural gas in depleted natural gas fields.

Participants in the "analogy without safety information" read the following text:

> Some parts of the CO_2 capture, transport, and storage technology are comparable to already existing technologies. For instance, storage of CO_2 in depleted natural gas fields is comparable to the storage of natural gas in these types of fields. Storage of natural gas in depleted natural gas fields takes place to enable effective responses to peaks in gas demand in winter. To store the natural gas, it is inserted in depleted natural gas fields via wells that were originally used for gas extraction.
>
> CO_2 can be stored in different ways. Depleted natural gas fields are the most likely storage location for CO_2 in the Netherlands. Prior to the selection of CO_2 storage locations, investigations are carried out, after which the most suitable location for storage of the CO_2 is selected. To be able to store the CO_2 it is gathered at the depleted natural gas field. The CO_2 is then inserted into the depleted natural gas field via an existing well where it is stored. In this way, storage of CO_2 in depleted natural gas fields is comparable to the storage of natural gas in depleted natural gas fields.

And, finally, the information on CO_2 storage in depleted natural gas fields in the "no analogy" condition read:

> CO_2 can be stored in different ways. Depleted natural gas fields are the most likely storage location for CO_2 in the Netherlands. Prior to the selection of CO_2 storage locations, investigations are carried out, after which the most suitable location for storage of the CO_2 is selected. To be able to store the CO_2 it is gathered at the depleted natural gas field. The CO_2 is then inserted into the depleted natural gas field via an existing well where it is stored.

Results

To explore whether participants´ general risk perception, specific risk perceptions, negative emotional reactions, and achievement of cognitive closure were affected by the use of an analogy that either did or did not include safety-related information, we conducted Analysis of Variance (ANOVA). Results revealed no significant differences between the three experimental conditions on general risk perception, the three risk perception dimensions, negative outcome uncertainty-related emotions, or level of cognitive closure achieved Fs(1, 119) ≤ 2.54, ps ≥ .083. Thus, communication about a natural gas analogue of CO_2 storage (including or excluding safety information) did not affect these measures. Participants in the three conditions, however, did differ in the extent to which they experienced outcome certainty-related emotions, $F(1, 119) = 3.85$, $p = .024$, $\eta_p^2 = .06$. Bonferroni post hoc tests revealed that participants in the "analogy without safety information" condition experienced less outcome certainty-related emotions (e.g., anger, disappointment) ($M = 1.77$, $SD = 0.86$), than participants in the "analogy with safety information" condition ($M = 2.33$, $SD = 1.09$, $p = .051$) or the "no analogy" condition ($M = 2.32$, $SD = 1.14$, $p = .054$).

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