Experiment overview:

Whether assessing the accuracy of expert forecasting, the pros and cons of group communication, or the value of evidence in diagnostic or predictive reasoning, dependencies between experts, group members, or evidence have traditionally been seen as a form of redundancy. We demonstrate that this conception of dependence conflates the structure of a dependency network, and the observations across this network. We want to discover whether there are cases where dependencies yield an informational advantage over independence. More precisely, when a structural dependency exists, but observations are either partial or contradicting, if these observations provide more support to a hypothesis than when this structural dependency does not exist, ceteris paribus. Furthermore, we want to see whether lay reasoners endorse sufficient assumptions underpinning these advantageous structures yet fail to appreciate their implications for probability judgments and belief revision.

Description of procedure:

A research containing two within-subjects experiments is conducted. Between the two experiments, I add a minesweeping game which is also a game using dependent information resources. The two experiments are both in the format of behavioural decision-making tasks and probability judgements tasks.

In experiment 1, Participants were presented with the plane crash. Critically, participants were provided with a prior probability of the plane having crashed due to sabotage (P (Sabotage) = 0.5), along with reliability statistics for the two independent investigators, Bailey and Campbell (error rates – both false positive and false negative – of 20%) when independent. The procedure started with participants providing basic demographics before reading through the plane crash scenario and providing conditional probabilities for their assumptions regarding the influence of a direct dependency on the reliability of a recipient source (Bailey). These conditional probability questions consisted of two 'if⋯ then' statements, wherein participants needed to provide a probability (0−100) of Bailey making an error given correct or

erroneous information from Campbell. Participants were provided with reminders that both Bailey and Campbell have the same 20% error rates when independent of each other when asked about the dependent case. Then they need to make judgements on which scenario (if either) provides more support for the plane having been sabotaged based on what they know at this point and make probability estimates of the independent scenarios and dependent scenarios. Then they need to make these processes again while provided that Bailey has reported that the plane was sabotaged.

In experiment 2, we further assessed the robustness of Experiment 1. First, to test the generalisability of elicited conditional probabilities, the primary hypothesis under investigation, which was previously always whether the crash was due to sabotage, the conditional probabilities elicited were expanded from two to four questions to reflect all possible states of the world. Previously, these were only concerned with changes in Bailey's chance of error when provided with correct/incorrect information from Campbell, but now this was separated also out by hypothesis (i.e., whether Campbell was correct/incorrect about the crash being due to an accident).

Experimenter's manual:

All the pictures needed are in the 'imgs' file and the sound is in the same working direction of the py file.

First, we could press the 'continue' button to enter the experiment (see Fig. 1).

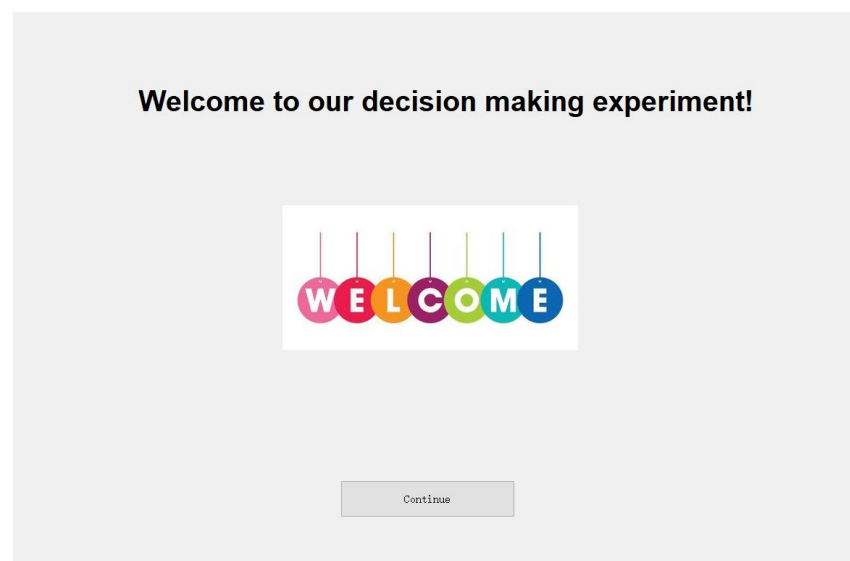**Welcome to our decision making experiment!**

Continue

Fig. 1

Then there is a statement of informed consent that the participants need to agree to proceed. You could change the content easily in the Designer. If not tickled, an error window will show and the participants need to press ok then tickle the button and press the 'continue' button to continue(see Fig. 2).

Statement of Informed Consent

Please consider this information carefully before deciding whether to participate in this research.

Purpose of the research:
To examine the way people make decisions under dependencies.

Confidentiality:
Your participation in this study will remain confidential. Your information will not be revealed.

Compensation:
You will get remuneration of £4 if you finish the experiment.

Agreement:
The nature and purpose of this research have been sufficiently explained and I agree to participate in this study. I understand that I am free to withdraw at any time without incurring any penalty.
Please consent by ticking the checkbox below to continue. Otherwise, please exit the study at this time.

☐ I have read the consent and agree to continue

Continue

Fig. 2

Then, they need to finish the demographic information table. The age should be between 18 and 90, which could be changed in line 125 in python. And other options can be changed in Designer. Participants need to finish them to continue, or there would be an error message(see Fig. 3).

Please fill in the form below to continue with the experiment. We will not reveal your information.

After you finish filling, please press the 'continue' button to go on to the experiment part. And you will be taking part in your experiment in another window

Age	1
Gender	
Education	
Native Language	
Current Location	
Contact	Please enter your contact information if you do not mind.

Error! Please choose the appropriate age then press the 'continue' button.

Continue

Fig. 3

Then they will see a new window open and it is experiment 1. They need to press the next button to continue(see Fig. 4).
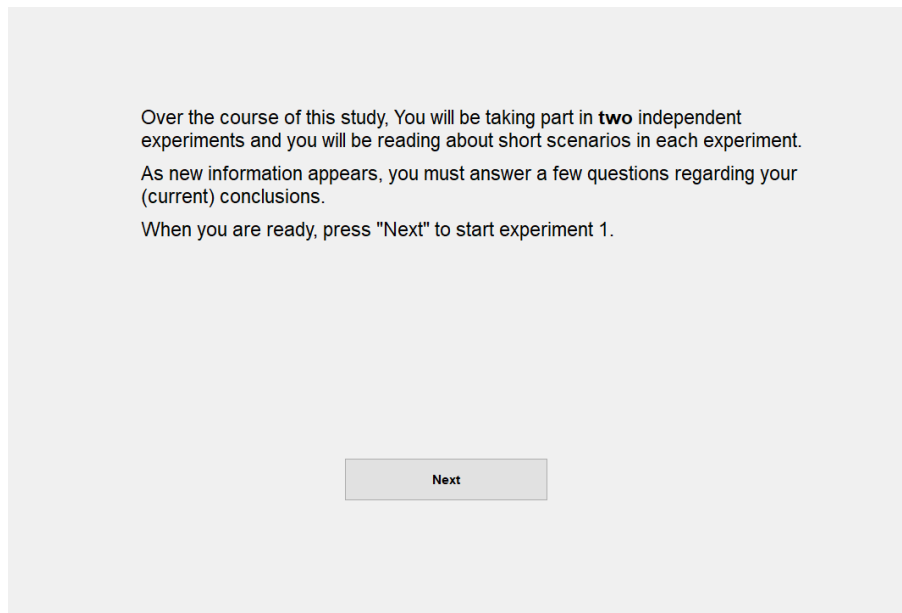

Over the course of this study, You will be taking part in **two** independent experiments and you will be reading about short scenarios in each experiment.

As new information appears, you must answer a few questions regarding your (current) conclusions.

When you are ready, press "Next" to start experiment 1.

Next

Fig. 4

Then they need to finish the conditional probability task. The baseline error rates (now 20%) can be changed in Designer by changing the text. And the probability value should be between 0-100 and it is set to -1 to avoid the default value. And the range could be changed in Designer(see Fig. 5).

Sabotage (Part 1a)

========== *BACKGROUND INFORMATION* ==========

Consider the following situation:

A small aircraft has crashed. Investigators were brought in to determine whether the plane was sabotaged.

Two experts, **Bailey** and **Campbell**, were brought in separately to assess the wreckage.

Prior to hearing their reports, you know three things:

Firstly, *prior to getting the reports*, it is safe to assume that there is a **50% probability of sabotage** (when a plane of this type crashes, half the time it is because of sabotage).

Secondly, although the analysis is notoriously difficult, *both Bailey and Campbell can be considered reasonably reliable*; it is safe to assume they each have a **20% probability** of mistakenly indicating that sabotage has occurred (and a 20% probability of mistakenly indicating sabotage has not occurred).

Finally, you know that Bailey and Campbell assessed the wreckage separately, and so had no opportunity to discuss it at the site. They then immediately left to go separately write their reports.

========== *END OF BACKGROUND INFORMATION* ==========

Campbell   **Bailey**

Consider the following situations, *clicking the spinbox below to indicate your estimate - between 0% and 100%, just to remind that the default value is -1.*

If Bailey, before making her report, has seen Campbell's completed report - **when that report is in fact CORRECT** - what do you estimate is the probability of Bailey making a mistake now?

Consider the following situations, *clicking the spinbox below to indicate your estimate - between 0% and 100%, just to remind that the default value is -1.*

If Bailey, before making her report, has seen Campbell's completed report - **when that report is in fact INCORRECT** - what do you estimate is the probability of Bailey making a mistake now?

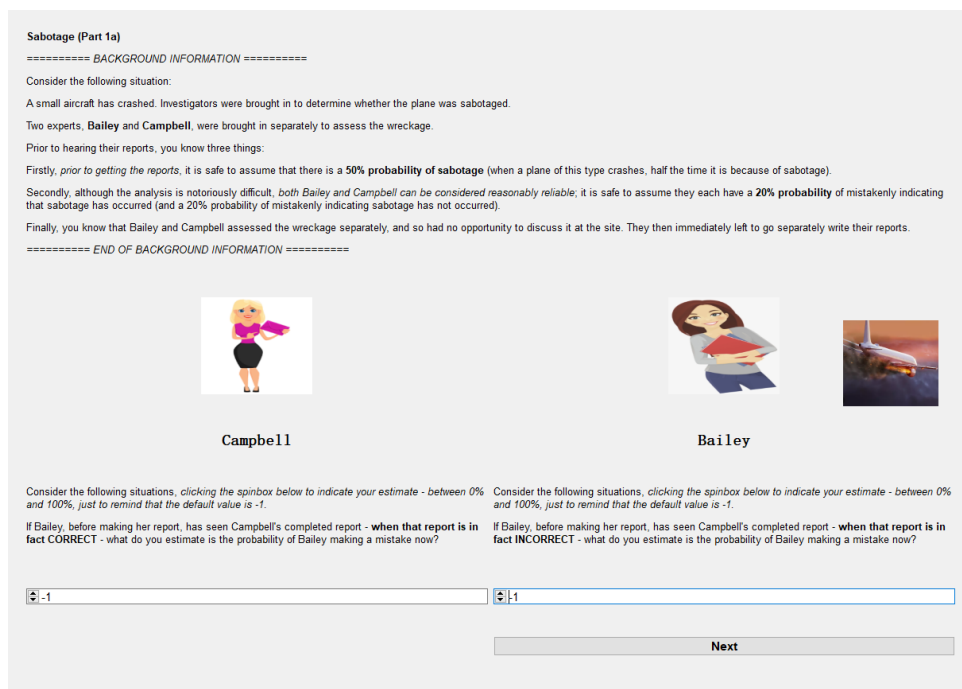-1   -1

Next

Fig. 5

Then they need to make judgements of the scenarios, input the confidence and the probability of two scenarios. The order of the choices of the judgements are randomly set and could be changed in python in line 168. The confidence and the probability value should be between 0-100 and it is set to -1 to avoid the default value. And the range could be changed in Designer(see Fig. 6).

Fig. 6

The error message sample is below(see Fig. 7).

Fig. 7

Then they need to provide some reasons of their latest estimates(see Fig. 8).

Please briefly provide some reasoning for your latest estimates in the text box below.

Please briefly provide some reasoning for your latest estimates.

Next

Fig. 8

Then they need to complete the second judgement task which is similar to the first(see Fig. 9).

Sabotage (Part 2)

=== *PREVIOUS BACKGROUND INFORMATION (SEE BELOW FOR NEW EVIDENCE)* ===
Consider the following situation:
A small aircraft has crashed. Investigators were brought in to determine whether the plane was sabotaged.
Two experts, **Bailey** and **Campbell**, were brought in separately to assess the wreckage.
Prior to hearing their reports, you know three things:
Firstly, *prior to getting the reports*, it is safe to assume that there is a **50% probability of sabotage** (when a plane of this type crashes, half the time it is because of sabotage).
Secondly, although the analysis is notoriously difficult, *both Bailey and Campbell can be considered reasonably reliable*; it is safe to assume they each have a **20% probability** of mistakenly indicating that sabotage has occurred (and a 20% probability of mistakenly indicating sabotage has not occurred).
Finally, you know that Bailey and Campbell assessed the wreckage at different times, and so had no opportunity to discuss it at the site. They then immediately left to go separately write their reports.
========== *END OF BACKGROUND INFORMATION* ==========

========== **NEW EVIDENCE**: BAILEY'S REPORT ==========
You are now handed Bailey's report:
*Bailey reports that the plane **was sabotaged**.*
========== *END OF BAILEY'S REPORT* ==========

NOTE: You *do not yet know what is contained in Campbell's report*.
Now, consider again the two scenarios:
Scenario 1:
You learn that Bailey, **prior to completing his/her report, was accidentally given access to Campbell's completed report** (which you have not seen yet). As such, Bailey's report may have been influenced by what Campbell has reported.
Scenario 2:
You learn that Bailey completed his/her report **without ever seeing Campbell's completed report** (which you have not seen yet). As such, Bailey's report was not influenced by what Campbell has reported.
========== ==========

Given the two scenarios above, and based solely on the information provided so far, please answer the following questions:

Based on what you know *at this point*, **which scenario (if either) provides more support for the plane having been sabotaged**?

Scenario 2 ○   They are the same ○   Scenario 1 ○

How **confident** are you that **your response is correct**?

Click the spinbox below to indicate your estimate - between 0% and 100%, just to remind that the default value is -1.

Confidence (%) [↕] -1

What is your **current probability estimate** of sabotage in each scenario, given what you know so far?

Click the spinbox below to indicate your estimate - between 0% and 100%, just to remind that the default value is -1.

Probability of Sabotage in **Scenario 1** (%) [↕] -1
Probability of Sabotage in **Scenario 2** (%) [↕] -1

Next

Fig. 9

Then they need to provide some reasons of their latest estimates(see Fig. 10).

Please briefly provide some reasoning for your latest estimates in the text box below.

```
Please briefly provide some reasoning for your latest estimates.
```

Next

Fig. 10

Then it is the end of experiment 1 and they need to press the button to continue. A window of MineSweeping game and a window of experiment 2 will be opened. They need to finish the game and continue with experiment 2(see Fig. 11).

Here is the end of experiment 1. Please press the 'Next' button below to continue with experiment 2.

However, after you press the button, you will have to play a MineSweeping game before entering experiment 2.

Please try your best to finish the game. Whether you win or lose the game, you need to press the face icon in the middle of the top of the game board to quit the game after finishing.

Next

Fig. 11

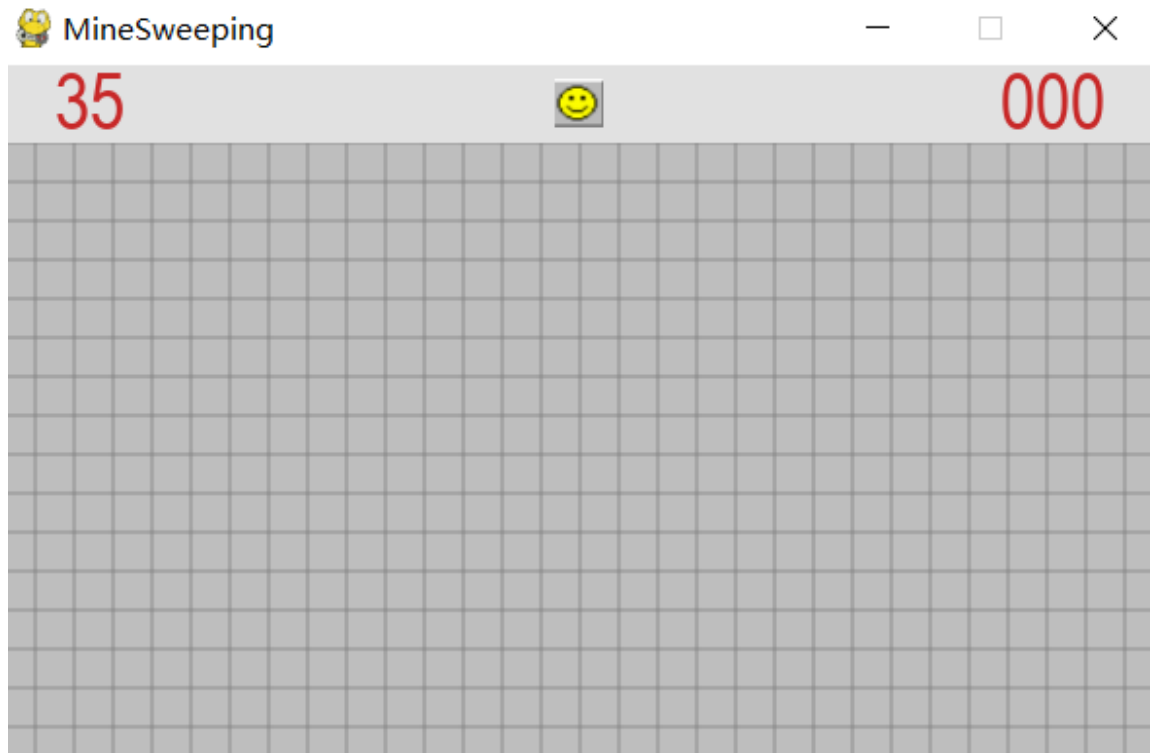MineSweeping Game (see Fig. 12).

Fig. 12

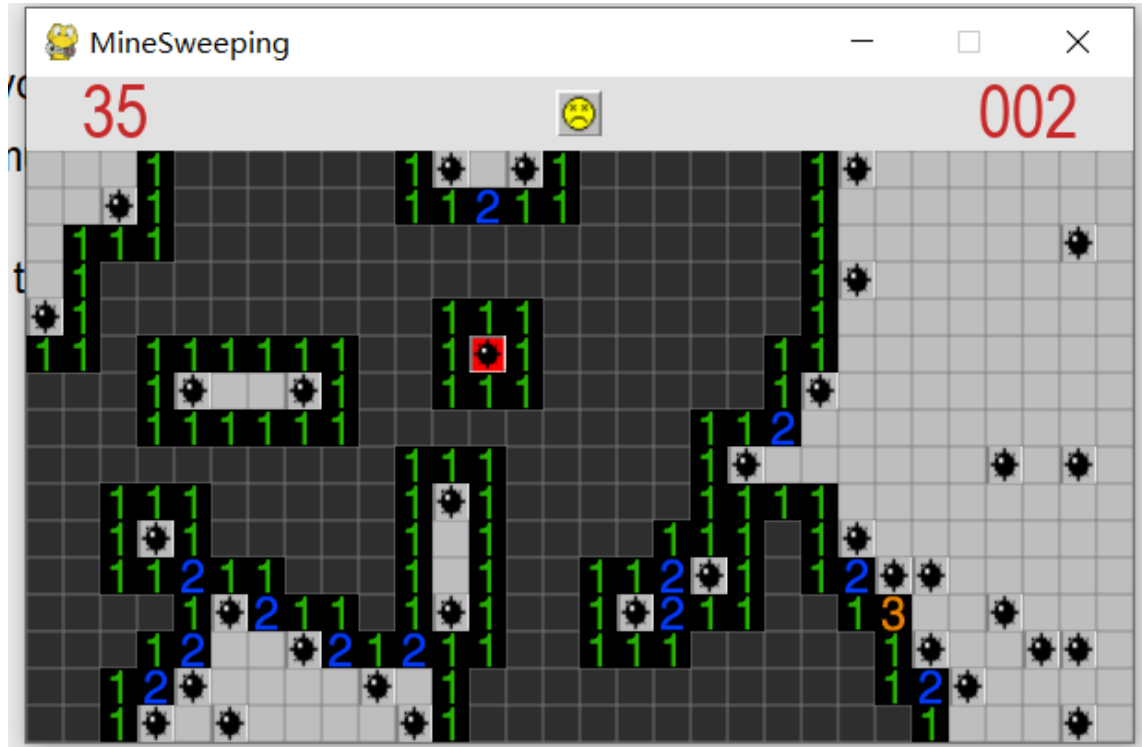End of the game (press the face icon to quit) (see Fig. 13).

Fig. 13

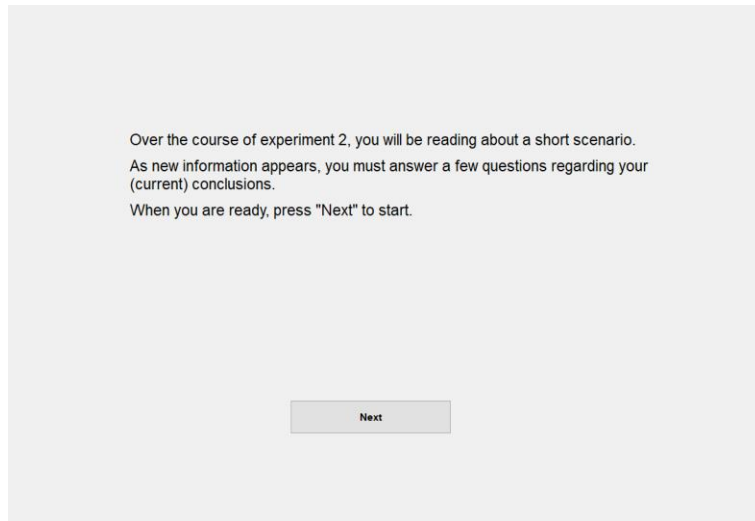Then they will enter experiment 2(see Fig. 14).

Fig. 14

For the conditional probability task in experiment 2, they need to finish all four questions including sabotage and accident. The baseline error rates (now 20%) can be changed in Designer by changing the text. And the probability value should be between 0-100 and it is set to -1 to avoid the default value. And the range could be changed in Designer (see Fig. 15).

Fig. 15

Then they need to finish a judgement task similar as experiment 1, but now they need to assess the probability of the accident instead of sabotage (see Fig. 16).

Sabotage (Part 1b)

========== *BACKGROUND INFORMATION* ==========
Consider the following situation:
A small aircraft has crashed. Investigators were brought in to determine whether the plane was sabotaged.
Two experts, **Bailey** and **Campbell**, were brought in separately to assess the wreckage.
Prior to hearing their reports, you know three things:
Firstly, *prior to getting the reports*, it is safe to assume that there is a **50% probability of sabotage** (when a plane of this type crashes, half the time it is because of sabotage).
Secondly, although the analysis is notoriously difficult, *both Bailey and Campbell can be considered reasonably reliable*; it is safe to assume they each have a **20% probability** of mistakenly indicating that sabotage has occurred (and a 20% probability of mistakenly indicating sabotage has not occurred).
Finally, you know that Bailey and Campbell assessed the wreckage at different times, and so had no opportunity to discuss it at the site. They then immediately left to go separately write their reports.
========== *END OF BACKGROUND INFORMATION* ==========

Now, consider the following two scenarios:
Scenario 1:
You learn that Bailey, **prior to completing his/her report, was accidentally given access to Campbell's completed report**. As such, Bailey's report may be influenced by what Campbell has reported.
Scenario 2:
You learn that Bailey completed his/her report **without ever seeing Campbell's completed report**. As such, Bailey's report is not influenced by what Campbell has reported.
NOTE: In both scenarios, *you have not yet seen the contents of either report*.
========== ==========

Given the two scenarios above, and based solely on the information provided so far, please answer the following questions:

Based on what you know *at this point*, which scenario (if either) provides more support for the plane having been IN AN ACCIDENT?

Scenario 2 ◉   Scenario 1 ○   They are the same ○

How **confident** are you that **your response is correct**?

Click the spinbox below to indicate your estimate - between 0% and 100%, just to remind that the default value is -1.

Confidence (%) | 99

What is your **current probability estimate** of accident in each scenario, given what you know so far?

Click the spinbox below to indicate your estimate - between 0% and 100%, just to remind that the default value is -1.

Probability of Accident in **Scenario 1** (%) | 43
Probability of Accident in **Scenario 2** (%) | 54

Next

Fig. 16

Then they need to provide some reasons of their latest estimates (see Fig. 17).

Please briefly provide some reasoning for your latest estimates in the text box below.

Please briefly provide some reasoning for your latest estimates.

Next

Fig. 17

Then there be a short debrief and the data would be collected(see Fig. 18).

Debrief

Here is the end of experiment 1 and also the end of the research. Thank you for your participation.

A very short debrief: We receive information from independent resources(mostly) and dependent resources(sometimes) in our daily life. Our research is trying to figure out how people making decisions facing information resources that are dependent.

Especially, these decisions are also made under uncertainty.

Thank you again!

Fig. 18

Data coding of experiment 1(see Fig. 19).

Q	Category of question & question content
1	Demographic Information – Age
2	Demographic Information – Gender
3	Demographic Information – Education
4	Demographic Information – Contact
5	Demographic Information – Native Language
6	Demographic Information – Location
7	Conditional Probability – If Bailey, before making her report, has seen Campbell's completed report – when that report is in fact CORRECT – what do you estimate is the probability of Bailey making a mistake now? [0-100%]
8	Conditional Probability – If Bailey, before making her report, has seen Campbell's completed report – when that report is in fact INCORRECT – what do you estimate is the probability of Bailey making a mistake now? [0-100%]
9	Conditional Probability – Reaction Time (ms)
10	Elicitation Stage 0 (Baseline) – Qualitative Judgment: Based on what you know at this point, which scenario (if either) provides more support for the plane having been sabotaged? [Dependent / Independent / Same]
11	Elicitation Stage 0 (Baseline) – Confidence in Qualitative Judgment: How confident are you that your response is correct? [0-100%]
12	Elicitation Stage 0 (Baseline) – Probability Estimate ("What is your current probability estimate of sabotage in each scenario, given what you know so far?"): Probability of Sabotage in Scenario 2 [0 – 100%] (Independent)
13	Elicitation Stage 0 (Baseline) – Probability Estimate ("What is your current probability estimate of sabotage in each scenario, given what you know so far?"): Probability of Sabotage in Scenario 1 [0 – 100%] (Dependent)
14	Elicitation Stage 0 (Baseline) – Reaction Time (ms)
15	Elicitation Stage 0 (Baseline) – Open text reasoning: Please briefly provide some reasoning for your latest estimates in the text box below.
16	Elicitation Stage 1 (First Report) – Qualitative Judgment: Based on what you know at this point, which scenario (if either) provides more support for the plane having been sabotaged? [Dependent / Independent / Same]
17	Elicitation Stage 1 (First Report) – Confidence in Qualitative Judgment: How confident are you that your response is correct? [0-100%]
18	Elicitation Stage 1 (First Report) – Probability Estimate ("What is your current probability estimate of sabotage in each scenario, given what you know so far?"): Probability of Sabotage in Scenario 2 [0 – 100%] (Independent)
19	Elicitation Stage 1 (First Report) – Probability Estimate ("What is your current probability estimate of sabotage in each scenario, given what you know so far?"): Probability of Sabotage in Scenario 1 [0 – 100%] (Dependent)
20	Elicitation Stage 1 (First Report) – Reaction Time
21	Elicitation Stage 1 (First Report) – Open text reasoning: Please briefly provide some reasoning for your latest estimates in the text box below.

Fig. 19

Data coding of experiment 2(see Fig. 20).

Q	Category of question & question content
1	Demographic Information – Age
2	Demographic Information – Gender
3	Demographic Information – Education
4	Demographic Information – Contact
5	Demographic Information – Native Language
6	Demographic Information – Location
7	Conditional Probability – If Bailey, before making her report, has seen Campbell's completed report stating sabotage – when that report is in fact CORRECT – what do you estimate is the probability of Bailey mistakenly reporting accident is now? [0-100%]
8	Conditional Probability – If Bailey, before making her report, has seen Campbell's completed report stating accident – when that report is in fact CORRECT – what do you estimate is the probability of Bailey mistakenly reporting sabotage now? [0-100%]
9	Conditional Probability – If Bailey, before making her report, has seen Campbell's completed report stating accident – when that report is in fact INCORRECT – what do you estimate is the probability of Bailey mistakenly reporting accident is now? [0-100%]
10	Conditional Probability – If Bailey, before making her report, has seen Campbell's completed report stating sabotage – when that report is in fact INCORRECT – what do you estimate is the probability of Bailey mistakenly reporting sabotage is now? [0-100%]
11	Conditional Probability – Reaction Time (ms)
12	Elicitation Stage 0 (Baseline) – Qualitative Judgment: Based on what you know at this point, which scenario (if either) provides more support for the plane having been sabotaged? [Dependent / Independent / Same]
13	Elicitation Stage 0 (Baseline) – Confidence in Qualitative Judgment: How confident are you that your response is correct? [0-100%]
14	Elicitation Stage 0 (Baseline) – Probability Estimate ("What is your current probability estimate of sabotage in each scenario, given what you know so far?"): Probability of Sabotage in Scenario 2 [0 – 100%] (Independent)
15	Elicitation Stage 0 (Baseline) – Probability Estimate ("What is your current probability estimate of sabotage in each scenario, given what you know so far?"): Probability of Sabotage in Scenario 1 [0 – 100%] (Dependent)
16	Elicitation Stage 0 (Baseline) – Open text reasoning: Please briefly provide some reasoning for your latest estimates in the text box below.
17	Elicitation Stage 0 (Baseline) – Reaction Time (ms)

Fig. 20

Program highlights:

I wrote a complicated minesweeping game with pygame and add it to the experiment. First of all, I love playing minesweeping. Second, playing minesweeping game is a process using dependent information resources to make decisions, which is corresponding to the research.

And I try to separate the experiment into three different windows, the demographic information window, experiment 1 window and experiment 2 window. Because I want to apply the interaction between windows in PyQt5 and we could split the experiments and run them separately if we separate the codes and we don't have to put everything in a huge main window.

Moreover, I try to collect the reaction time using the time package and I have made elegant animations. Though I use the within-subject design where assigning participants randomly is not need, but I include the random part in the choice of the scenario question. And the research is my research dissertation and it is novelly collaborated with my supervisor.