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# FRAMING-INDUCED EMOTIONS AFFECT PERFORMANCE IN SIMPLE COGNITIVE TASKS UNDER RISK

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# Framing-induced emotions affect performance in simple cognitive tasks under risk

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**Abstract:** In this study, we investigated how performance in a number of puzzles (decisions under risk) depended on the framing. The puzzles, drawn and adapted from existing literature, were designed to expose well-established cognitive biases could lead respondents to select intuitive yet incorrect answer. Subjects were randomly assigned to one of three treatments: a third of the sample saw puzzles framed in terms of COVID-19, another third about a common cold, and the remaining group about unemployment. Across five continents, we collected over 8,000 observations. We found that framing of the puzzles affected performance, prompting questions regarding the external validity of these puzzles. Treatments associated with more severe threats, such as COVID and Unemployment, elicited stronger (negative) emotions compared to the common cold. Moreover, these emotional reactions were also linked to performance, and their levels correlated negatively with the number of correctly solved puzzles.

**Keywords:** decision-making under risk, framing, emotions, cognitive biases, cognitive tasks, COVID-19

**JEL codes:** C91, C99, D01, D81, D91

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# 1. Introduction and literature review

Emotions have traditionally been seen as obstacles to rational decision making. Recent research, however, shows a more nuanced perspective. In this project, we contributed to this evolving understanding by running an experiment using puzzles known to frequently elicit normatively incorrect responses from a substantial fraction of subjects. We manipulated the framing of the puzzles: while the logical structure remained the same, we presented them in a more vs. less emotionally involving form. We did so in a large international sample to assess the robustness of our findings to languages and cultures.

The starting point for our design was the general observation that the ability to make normatively correct choices may strongly depend on the (broadly understood) framing of the problem. The existing evidence regarding the puzzles used in this study remains limited. For instance, Bar-Hillel (1980) found reduced base-rate neglect when – unlike in Tversky and Kahneman's taxicab problem – individuating information was framed as a feature of the type (see also Pennycook et al., 2022). Doyle (1997) found that strategies employed to judge cumulative risk depended on the problem being framed as a conjunction or a disjunction.

One form of framing involves manipulating the emotional load of task wording. This path is less explored in emotion research, which often relies on a separate task to induce emotions. (e.g., inducing affect in a preceding task by displaying happy vs. sad movie clips). However, this technique may be considered deceptive because it is either implied or explicitly said that the two tasks are unrelated. Furthermore, the question arises if findings concerning such *incidental* emotions are also valid for *integral* or *task-related* emotions. We are unaware of studies on the framing of cognitive biases that directly manipulate the emotional load in their wording. The COVID-19 pandemic inspired us to do just that.

We came up with a manipulation of the framing of the puzzles identified in the literature on decisions under risk, to see if it affected the prevalence of normatively correct answers to these puzzles. Given that COVID-19 was a potentially severe medical threat, framing logical puzzles in its terms might influence outcomes, given that fear and anxiety, widely experienced during crises (Jin, 2009; Pang et al., 2009), impact the quality of judgment and decision-making under risk. For example, in a study investigating the "Asian disease" (which we also used), Rachev et al. (2021) found that the risky-choice framing effect seemed to be especially high during the (early months of the) pandemic, particularly among respondents concerned about the virus. On top of that, some studies showed that longer (Forgas, 1989), more systematic

(Mohanty & Suar, 2014) processing of information was characteristic of negative mood more generally. There is also some evidence that the experience of a loss led to improved cognitive performance, which could be explained by increased arousal, attention, and consistency in judgments (Yechiam & Hochman, 2013b, 2013a).

The pandemic itself and especially the public health measures taken have also invoked high levels of *anger*. While being a negative affect (like fear or sadness), anger prompts different action tendencies; in particular, it leads to greater risk-taking (Lerner & Keltner, 2000). Still, like fear, it has been linked to more active information-seeking (Griffin et al., 2008) and more analytical processing (Moons & Mackie, 2007). Conversely, in the domain of political decision-making, induced anger (compared to fear) was shown to lead to more impulsive decisions (Parker & Isbell, 2010). Studies also found that it caused greater reliance on stereotypical thinking (Bodenhausen et al., 1994).

For comparison, our second treatments included another framing involving a severe (but not medical) threat: unemployment. Virgolino et al. (2022) reviewed literature that unambiguously showed its serious psychological consequences: a large majority of studies investigating a possible link between unemployment and phenomena such as anxiety and mood disorders found a positive association. Not only the actual job *loss* but mere job *insecurity* had adverse effects on psychological well-being; it even extended to the spouse, see Bünnings et al. (2017) and studies cited therein.

The third, sort of a control treatment, was one that, just like COVID-19 (and unlike unemployment), was a medical threat, but unlike either of the two was not severe – framing puzzles in terms of a common cold.

In the current paper, we reported two studies building upon the above. In both of them, we investigated how performance in a number of puzzles of decision-making under risk and uncertainty depended on framing treatment: COVID vs. unemployment vs. common cold. The main difference between them was that whereas Study 1 was conducted in Poland only, Study 2 was run in eight countries, allowing us to observe possible cultural differences. Additionally, the set of puzzles was streamlined. Both studies yielded consistent results, with the non-lethal, serious threat of unemployment tending to worsen performance slightly compared to the other two.

### *1.1. Hypotheses*

We formulate the following hypotheses:

H1: Puzzles framed in terms of a serious threat (COVID and Unemployment) will lead to more negative emotions compared to a less serious threat (Cold).

H2: Systematic differences in performance across treatments will be observed.

H3: Emotions and response times will mediate performance differences between treatments.

## 2. Study 1

### *2.1. Design and procedures*

Our study involved several demographic questions and a set of puzzles. The puzzles came in three different versions: for one-third of the sample, they concerned COVID-19, one-third saw those relating to the common cold, and the rest were about unemployment. In each case, the subjects were pre-warned that the puzzles involved possible simplified scenarios, not statistical facts. Note that all three domains involved threats (rather than chances). Whereas COVID represented a severe and medical threat, unemployment was a serious but nonmedical threat, and the common cold was a minor medical threat. We might thus hope to unravel which aspect of the threat of COVID (that it is a threat to one's health or that it is a major one) affected performance in our puzzles.

Notably, the logical structure of all the puzzles was identical in all treatments. For example, three versions of one of the questions (inspired by the cognitive reflection task (Frederick, 2005) are shown in Table 1.

Table 1. The 'lilypad' puzzle in the three treatments

| Covid | Common cold | Unemployment |
|---|---|---|
| In [a small town of] Braniewo, the percentage of residents infected with coronavirus doubles every day. After 12 days, everyone is infected. | In [a small town of] Braniewo, the percentage of residents with a cold doubles every day. After 12 days, everyone has a cold. | In [a small town of] Braniewo, among adult residents who are fit to work, the percentage of those unemployed doubles every month. After 12 months, everyone is unemployed. |
| After how many days was half of the population infected? | After how many days did half of the population have a cold? | After how many months were half of the adults unemployed? |

The puzzle has an intuitive answer (six), but the correct answer is different (11). It proved to be quite difficult, perhaps indicating that the concept of exponential growth is not easily grasped, which is of obvious relevance in pandemics (or: at its early stages at any rate). The puzzle is also brief, does not require special mathematical training to solve, and can be readily adapted to our three contexts. The same criteria were used to select the remaining puzzles in this study. The puzzles are summarized in Table 2, while the exact wording of all the questions can be found in Appendix A.

It should be noted that in some puzzles, arriving at an exact answer was challenging, such as 41.4% in the case of the Cab problem. To categorize answers as correct or incorrect, we adopted a more lenient approach. Any response recognizing that both the base rate information and the individuating information were valuable, i.e., any value higher than 15% and lower than 80% was considered as "correct" (see the last column of Table 2). Similarly, we took a lenient approach in the case of misestimation of compound probability and the inability to interpolate. Conversely, in the case of Asian disease, where framing was manipulated between subjects, it was impossible to establish correctness at the individual level at all.

Table 2: The puzzles

| Bias studied | Puzzle from the literature adapted | Bibliographic reference | Key elements of the narrative (COVID treatment) | Intuitive answer | Normative answer | Acceptable interval |
|---|---|---|---|---|---|---|
| Misperception of exponential growth* | *Lilypad* | (Frederick, 2005) | Doubles daily, in 12 days, all infected. When was half infected? | 6 | 11 | [11,11] |
| *Base rate* neglect/fallacy | Cab problem | (Tversky & Kahneman, 1980) | 15% really infected. Tests are 80% accurate. Prob. that a test-positive person is really infected. | 15%, 80% | 41.4% | (15%,80%) |
| Misestimation of *compound probability* | x | (Bar-Hillel, 1973; Kahneman et al., 1982) | 99.5% to stay healthy. Iterate 100 times. What is the prob. of being healthy after 100x. | 99.5% | 60.5% | (40%,80%) |
| Gain/loss framing effect in choice under risk | *Asian disease* | (Tversky & Kahneman, 1981) | Lives framed as gained vs. lost (between-subject). Choose risky vs. safe. | risky option in the loss frame only | Consistency between gain and loss framing | |
| *Loss aversion* | 50% for a greater gain, 50% for a (smaller) loss | (Kahneman et al., 1982; Tversky & Kahneman, 1991) | A new policy: 50/50 gamble, lives being lost/saved vs. do nothing | Loss aversion>1 | Loss aversion=1 | |
| Inability to interpolate: *death rate* | x | x | 51-60 0.5%<br>61-70 1.9%<br>Jan is 61. What is the prob. of Jan's death? | 1.9% | x | (0.5%,1.9%) |

| | | | | | |
|---|---|---|---|---|---|
| What you see is all there is – sample size neglect in *beliefs update* | x | (Kahneman, 2012) | 10 (1% of the sample) vs. 10.000 (1% of the sample) infected. Are the beliefs updated? | upward (downward) belief update when the absolute number of cases is high (low) | Consistency between the direction of belief update from large vs. small sample (within-subject) |

Variable names are *in italics.*
See Appendix A for all the questions.
* 12 changed to 8 in Study 2; see the design subsection of the Study 2 section for an explanation

After solving the puzzles, subjects were asked to state the intensity of feeling the basic emotions, namely fear, anger, disgust, sadness, surprise, and joy, on a scale of 1 to 10 (Ekman, 2005). They were also asked about the level (rated from 1 to 10) of fear regarding the labor market situation, the common cold, and the COVID-19 pandemic. We also asked about their willingness to take risks in general and in two specific domains (work and health); feeling informed about the issues of COVID-19, the labor market situation and unemployment, and the common cold; feeling in control regarding the risk of being infected with COVID-19, losing their job, catching a cold; beliefs in conspiracy theories; willingness to get vaccinated against COVID-19; mask-wearing habits, keeping physical distance from others, and meeting with the close elderly ones compared to before the pandemic.

### *2.2. Results*

Our sample consisted of 3105 adult Poles who were recruited from among approximately 110,000 individuals registered in the Ariadna panel. The identity of each panel member was verified, and their personal data was kept confidential to ensure anonymity. Ariadna's security measures prevent bot activity. Respondents earned virtual points for each survey they completed, which could later be redeemed in an online shop. The sample was nationally representative in terms of key demographic variables. Summary statistics are presented in Table 3.

Table 3. Summary statistics: Study 1

| Variable | Mean | SD | Min | Max |
|---|---|---|---|---|
| Female | 0.52 | 0.50 | 0 | 1 |
| Age | 43.72 | 15.89 | 18 | 95 |
| Education | 4.54 | 1.99 | 1 | 7 |
| Income | 3.12 | 0.77 | 1 | 5 |
| Health | 2.58 | 0.79 | 1 | 4 |
| Religious | 0.76 | 0.43 | 0 | 1 |
| Joy | 5.24 | 2.35 | 1 | 10 |
| Fear | 4.39 | 2.61 | 1 | 10 |

| | | | | |
|---|---|---|---|---|
| Anger | 4.45 | 2.75 | 1 | 10 |
| Disgust | 3.40 | 2.52 | 1 | 10 |
| Sadness | 4.54 | 2.76 | 1 | 10 |
| Surprise | 4.00 | 2.43 | 1 | 10 |
| Fear: covid | 5.84 | 2.52 | 1 | 10 |
| Fear: cold | 4.45 | 2.38 | 1 | 10 |
| Fear: unempl | 6.30 | 2.48 | 1 | 10 |
| Risk: overall | 5.60 | 2.26 | 1 | 10 |
| Risk: work | 5.59 | 2.42 | 1 | 10 |
| Risk: health | 4.73 | 2.48 | 1 | 10 |
| Mask wearing | 3.20 | 1.00 | 1 | 4 |
| Social distance | 7.03 | 2.49 | 1 | 10 |
| Elderly* | -0.54 | 0.59 | -1 | 1 |
| Informed: covid | 4.59 | 1.58 | 1 | 7 |
| Informed: cold | 4.17 | 1.52 | 1 | 7 |
| Informed: unempl | 3.88 | 1.58 | 1 | 7 |
| Control: covid | 4.03 | 1.74 | 1 | 7 |
| Control: cold | 3.41 | 1.86 | 1 | 7 |
| Control: unempl | 4.28 | 1.67 | 1 | 7 |
| Conspiracy score | 5.00 | 1.57 | 1 | 7 |
| Vaxx_yes | 0.56 | 0.50 | 0 | 1 |
| Performance | 0.43 | 0.18 | 0 | 1 |
| N | 3105 | | | |

**-1 means meeting with the elderly less often than before the pandemic, 1 more often*

### *2.2.1. Manipulation check*

We found significant differences in all emotions except joy; see Table 4. In the case of negative emotions, they were always most potent in the COVID treatment, as expected. In pairwise comparisons, COVID was found to induce significantly stronger feelings than Cold, except for the positive emotion of joy. Compared to Unemployment, COVID triggered significantly stronger anger and sadness (see Appendix B, Table B1 for the results of the Tukey's HSD pairwise comparison test).

Table 4. Study 1: Manipulation check

| Emotions | COVID | Unemployment | Cold | SD total sample | Kruskal-Wallis p-value |
|---|---|---|---|---|---|
| Fear | 4.72 | 4.50 | 3.93 | 2.61 | 0.0001 |
| Anger | 4.89 | 4.49 | 3.95 | 2.75 | 0.0001 |
| Disgust | 3.72 | 3.48 | 2.97 | 2.52 | 0.0002 |
| Sadness | 4.93 | 4.61 | 4.07 | 2.76 | 0.0003 |
| Surprise | 4.14 | 4.15 | 3.71 | 2.43 | 0.0004 |
| Joy | 5.30 | 5.16 | 5.25 | 2.35 | 0.4310 |

### *2.2.2. Performance in the puzzles*

Statistics of our performance measures by puzzle are presented in Tables 5 and 6. Although not substantial, the differences observed in each instance are statistically significant, owing to the large sample size. These differences are also puzzle-specific, although there is some tendency for the Unemployment treatment to do worse than the other treatments.

Table 5. Study 1: Performance by treatment and puzzle

| | COVID | Unemployment | Cold | Kruskal-Wallis p-value |
|---|---|---|---|---|
| Lilypad | 0.28 | 0.23 | 0.29 | 0.003 |
| Base rate | 0.77 | 0.81 | 0.78 | 0.0444 |
| Compound prob | 0.26 | 0.18 | 0.25 | 0.0001 |
| Loss aversion | 0.43 | 0.33 | 0.39 | 0.0001 |
| Death rate | 0.15 | 0.11 | 0.13 | 0.016 |
| Beliefs update | 0.73 | 0.67 | 0.76 | 0.0001 |

*Note: we show the fraction of subjects providing answers defined as "acceptable"; see the last column of Table 2.*

Table 6. Study 1: Prevalence of risky choices in the "Asian disease" puzzle, by treatment and framing

| | Treatment | | |
|---|---|---|---|
| Framing | COVID | Unemployment | Cold |
| Negative | 0.51 | 0.47 | 0.48 |
| Positive | 0.33 | 0.26 | 0.32 |

The response times did not differ between the treatments and they did not mediate the treatment effects. Neither the quantile regression of time on treatment nor the pairwise comparisons of means (Tukey's HSD) allowed us to reject the null hypothesis.

The correlations between variables indicating normatively correct answers to different puzzles were generally low, never exceeding 10% (see Table B2 in Appendix B).

Given the large and diversified sample, we were able to explore demographic effects. We computed the number of puzzles correctly solved by each individual, ranging from zero to six (while there were seven puzzles, recall that the Asian disease puzzle was run between-subject). Then, we took it as the dependent variable in an ordered logit model, see Table 7. In the basic specification (1) we only included treatment dummies. In (2) we added basic demographic variables, and in (3-7) also included self-reported experienced emotions. Findings from the regression confirmed that the Unemployment treatment had a small, negative impact on performance. Having completed higher education and living in a big city was associated with better performance. Interestingly, unemployed people did slightly better. Overall, the fit

of the model, judging by pseudo R2, was very poor. However, inclusion of any of the self-reported emotions markedly improved the fit (we did not include all of them simultaneously due to their high intercorrelation, as presented in Table B3 in Appendix B, which can lead to multicollinearity). Each of these emotions was negatively associated with performance.

Table 7. Study 1: Ordered logit model with *performance* as a dependent variable

| Variable | (1) Base | (2) Demo | (3) Fear | (4) Anger | (5) Disgust | (6) Sadness | (7) Surprise | (8) Joy |
|---|---|---|---|---|---|---|---|---|
| Treatment Cold | -0.070 | -0.100 | -0.145* | -0.140* | -0.146* | -0.131* | -0.124 | -0.103 |
| Tr_ Unemployment | -0.434*** | -0.457*** | -0.469*** | -0.476*** | -0.474*** | -0.472*** | -0.454*** | -0.461*** |
| Female | | -0.047 | -0.025 | -0.032 | -0.054 | -0.035 | -0.050 | -0.043 |
| Age | | 0.023 | 0.022 | 0.021 | 0.020 | 0.021 | 0.022 | 0.025* |
| $Age^2$ | | -0.000 | -0.000 | -0.000 | -0.000 | -0.000 | -0.000 | -0.000 |
| City Population: | | | | | | | | |
| *small (<20k)* | | -0.160 | -0.149 | -0.148 | -0.143 | -0.159 | -0.139 | -0.159 |
| *medium (<99k)* | | -0.050 | -0.045 | -0.041 | -0.041 | -0.044 | -0.039 | -0.054 |
| *big (<500k)* | | 0.060 | 0.065 | 0.072 | 0.073 | 0.069 | 0.073 | 0.048 |
| *large (>500k)* | | 0.169 | 0.179* | 0.178* | 0.184* | 0.181* | 0.171 | 0.164 |
| Edu: secondary | | 0.100 | 0.108 | 0.105 | 0.085 | 0.102 | 0.086 | 0.081 |
| Edu: higher | | 0.415*** | 0.425*** | 0.423*** | 0.398*** | 0.423*** | 0.399*** | 0.393*** |
| Wealth: low | | -0.221** | -0.203** | -0.202** | -0.183** | -0.196** | -0.191** | -0.225** |
| Wealth: high | | -0.082 | -0.097 | -0.093 | -0.093 | -0.094 | -0.077 | -0.064 |
| Health: poor | | 0.052 | 0.066 | 0.067 | 0.057 | 0.069 | 0.062 | 0.029 |
| Health: good | | 0.073 | 0.012 | 0.030 | 0.026 | 0.028 | 0.051 | 0.108 |
| Religious | | -0.160** | -0.127* | -0.159** | -0.150** | -0.148* | -0.131* | -0.133* |
| Unemployed | | 0.205* | 0.214* | 0.215* | 0.205* | 0.212* | 0.194* | 0.183 |
| Pensioner | | -0.050 | -0.041 | -0.051 | -0.066 | -0.041 | -0.052 | -0.040 |
| Student | | 0.170 | 0.171 | 0.143 | 0.138 | 0.174 | 0.125 | 0.151 |
| Fear | | | -0.060*** | | | | | |
| Anger | | | | -0.047*** | | | | |
| Disgust | | | | | -0.064*** | | | |
| Sadness | | | | | | -0.040*** | | |
| Surprise | | | | | | | -0.066*** | |
| Joy | | | | | | | | -0.045*** |
| Log-likelihood | -5096.547 | -5056.393 | -5045.643 | -5048.757 | -5044.367 | -5050.884 | -5044.238 | -5051.520 |
| Pseudo R2 | 0.003 | 0.011 | 0.013 | 0.013 | 0.014 | 0.012 | 0.014 | 0.012 |
| Observations | 3105 | 3105 | 3105 | 3105 | 3105 | 3105 | 3105 | 3105 |

*Legend: *p<.1; **p<.05; ***p<.01*

In Table B4 in Appendix B we also show the logistic regressions with acceptable answers to each of the puzzles as a dependent variable. These separate regressions increased the fit of the models considerably. However, they only emphasize what was already visible from the ordered logit model in Table 7.

# 3. Study 2

## *3.1. Design*

Study 2 followed the same pattern as Study 1, with analogous treatments and puzzles. The only change we implemented was that the number 12 was replaced with 8 in the Lilypad Puzzle. Twelve (and six) are prominent numbers of months but not prominent numbers of days. This could make the intuitive, incorrect answer especially tempting in the Unemployment treatment, which would be an undesirable artefact. Additionally, there were minor adjustments to the post-experimental questionnaire.

More importantly, Study 2 was conducted internationally. On top of the Polish version as used in Study 1, we deployed an English translation in Kenya, New Zealand, the UK, and the US, as well as a Spanish version in Argentina, Mexico, and Spain. This enabled us to investigate the robustness of our results with respect to language and, within English and Spanish versions, to substantial geographic and cultural differences. We collected a minimum of 400 observations in each country, except for the much larger, diverse US society, where we collected over 2000. The distribution of key variables in the US is presented in Table 8, while Table 9 provides this distribution for the other countries (referred to as the international dataset). Specific values for individual countries can be found in Table C5 in Appendix C.

Table 8. Study 2 (US sample): Summary statistics

| Variable | Mean | SD | Min | Max |
|---|---|---|---|---|
| Female | 0.56 | 0.5 | 0 | 1 |
| Age | 52.76 | 17 | 18 | 102 |
| Education | 2.51 | 0.55 | 1 | 3 |
| Income | 2.98 | 1.02 | 1 | 5 |
| Health | 2.86 | 0.89 | 1 | 4 |
| Religious | 1.11 | 0.71 | 0 | 2 |
| Joy | 4.93 | 2.88 | 1 | 10 |
| Fear | 3.55 | 2.89 | 1 | 10 |
| Anger | 3.57 | 2.89 | 1 | 10 |
| Disgust | 3.59 | 2.90 | 1 | 10 |
| Sadness | 3.90 | 2.94 | 1 | 10 |
| Surprise | 4.11 | 2.94 | 1 | 10 |
| Risk: overall | 5.72 | 2.56 | 1 | 10 |
| Risk: work | 5.07 | 2.84 | 1 | 10 |
| Risk: health | 5.00 | 2.92 | 1 | 10 |
| Mask wearing | 2.79 | 1.13 | 1 | 4 |
| Social distance | 7.37 | 2.57 | 1 | 10 |
| Performance | 0.49 | 0.18 | 0 | 1 |

| | |
|---|---|
| N | 2041 |

Table 9. Study 2 (international sample): Summary statistics

| Variable | Mean | SD | Min | Max |
|---|---|---|---|---|
| Female | 0.48 | 0.5 | 0 | 1 |
| Age | 42.46 | 16.01 | 18 | 97 |
| Education | 2.58 | 0.54 | 1 | 3 |
| Income | 2.91 | 0.84 | 1 | 5 |
| Health | 2.91 | 0.79 | 1 | 4 |
| Religious | 0.84 | 0.64 | 0 | 2 |
| Joy | 5.71 | 2.6 | 1 | 10 |
| Fear | 4.42 | 2.83 | 1 | 10 |
| Anger | 4.09 | 2.82 | 1 | 10 |
| Disgust | 4.11 | 2.77 | 1 | 10 |
| Sadness | 4.58 | 2.81 | 1 | 10 |
| Surprise | 4.76 | 2.68 | 1 | 10 |
| Risk: overall | 6.57 | 2.29 | 1 | 10 |
| Risk: work | 5.43 | 2.71 | 1 | 10 |
| Risk: health | 5.2 | 2.88 | 1 | 10 |
| Mask wearing | 3.52 | 0.83 | 1 | 4 |
| Social distance | 7.29 | 2.36 | 1 | 10 |
| Performance | 0.51 | 0.19 | 0 | 1 |
| N | 2949 | | | |

## 3.2. Results

### *3.2.1. Manipulation check*

Once more, treatments had a significant effect on all negative emotions, as seen in Table 10. Specifically, they were less pronounced in the cold treatment compared to the remaining two. Statistics from Tukey's HSD pairwise comparison test can be found in Table C1 of Appendix C.

Table 10. Study 2 (both samples): Manipulation check

| Emotions | COVID | Unemployment | Cold | SD total sample | Kruskal-Wallis p-value |
|---|---|---|---|---|---|
| Fear | 4.08 | 4.21 | 3.91 | 2.89 | 0.0089 |
| Anger | 3.96 | 3.98 | 3.69 | 2.86 | 0.0039 |
| Disgust | 4 | 4.01 | 3.68 | 2.84 | 0.0007 |
| Sadness | 4.38 | 4.44 | 4.09 | 2.88 | 0.0008 |
| Surprise | 4.44 | 4.63 | 4.41 | 2.81 | 0.0450 |
| Joy | 5.33 | 5.38 | 5.47 | 2.75 | 0.2537 |

### *3.2.2. Performance*

We now turn to the analysis of performance by puzzle. The differences between countries were limited (see Table 11); the results were thus analyzed jointly.

Table 11. Study 2: performance by country and puzzle

| | Lilypad | Base rate | Compound probability | Loss aversion | Death rate | Beliefs update |
|---|---|---|---|---|---|---|
| England | 0.34 | 0.84 | 0.18 | 0.33 | 0.78 | 0.73 |
| Kenya | 0.14 | 0.9 | 0.23 | 0.33 | 0.81 | 0.67 |
| New Zealand | 0.31 | 0.87 | 0.19 | 0.3 | 0.77 | 0.73 |
| USA | 0.19 | 0.88 | 0.17 | 0.22 | 0.71 | 0.77 |
| Spain | 0.23 | 0.86 | 0.2 | 0.25 | 0.76 | 0.76 |
| Argentina | 0.19 | 0.84 | 0.23 | 0.28 | 0.73 | 0.72 |
| Mexico | 0.15 | 0.89 | 0.24 | 0.2 | 0.73 | 0.69 |
| Poland | 0.28 | 0.81 | 0.22 | 0.2 | 0.62 | 0.71 |
| Total | 0.22 | 0.87 | 0.2 | 0.25 | 0.73 | 0.74 |

As shown in Table 12, the performance was similar to that of Study 1. In particular, making the incorrect answer less salient in the Unemployment framing of the Lilypad problem did not improve performance. Treatment effects from Study 1 are thus replicated: performance in the Unemployment treatment was lower not only in the Lilypad problem but also in the Compound probability and Loss aversion problems. Again, performance in the Loss aversion puzzle was slightly worse under Cold than under COVID treatment. As in Study 1, response times did not differ across treatment.

Table 12. Study 2: Performance by treatment and puzzle

| | COVID | Unemployment | Cold | Kruskal-Wallis p-value |
|---|---|---|---|---|
| Lilypad | 0.23 | 0.18 | 0.23 | 0.0004 |
| Base rate | 0.85 | 0.87 | 0.88 | 0.0071 |
| Compound probability | 0.24 | 0.14 | 0.21 | 0.0001 |
| Loss aversion | 0.31 | 0.21 | 0.23 | 0.0001 |
| Death rate | 0.09 | 0.06 | 0.04 | 0.0001 |
| Beliefs update | 0.74 | 0.70 | 0.77 | 0.0001 |

*Note: we show the fraction of subjects providing answers defined as "acceptable"; see the last column of Table 2.*

Choices in the "Asian disease" puzzle were also very similar (see Table 13), except that the fraction of participants choosing the risky option in the Unemployment treatment was higher. However, the positive-negative framing gap was very stable across studies and across treatments.

Table 13. Study 2: Prevalence of risky choices in the "Asian disease" puzzle, by treatment and framing

| | Treatment | | |
|---|---|---|---|
| Framing | COVID | Unemployment | Cold |

| | | | |
|---|---|---|---|
| negative | 0.51 | 0.56 | 0.52 |
| positive | 0.36 | 0.37 | 0.34 |

Again, the correlations between variables indicating normatively correct answers to different puzzles were low; see Table C2 in Appendix C.

In Table 14, we report ordered logit analyses analogous to those presented for Study 1 in Table 7 (whereas models for individual puzzles are displayed in Table C4). Once more, the Unemployment framing hindered performance; also, respondents with higher education did better. Likewise, self-reported economic status different from "we live very poorly" was associated with higher performance. As previously, the inclusion of any emotion (not included jointly due to multi-collinearity, see Table C3) improved the otherwise miniscule fraction of variance explained in the model: higher levels of emotions were associated with lower performance.

Table 14. Study 2: Ordered logit model with *performance* as a dependent variable

| Variable | (1) Base | (2) Demo | (3) Fear | (4) Anger | (5) Disgust | (6) Sadness | (7) Surprise | (8) Joy |
|---|---|---|---|---|---|---|---|---|
| Treatment Cold | -0.153* | -0.171** | -0.182** | -0.192** | -0.191** | -0.184** | -0.175** | -0.165** |
| Tr_Unemployed | -0.587*** | -0.606*** | -0.605*** | -0.609*** | -0.611*** | -0.608*** | -0.600*** | -0.608*** |
| Female | | -0.239*** | -0.232*** | -0.244*** | -0.250*** | -0.235*** | -0.274*** | -0.269*** |
| Age | | -0.008 | -0.009 | -0.007 | -0.006 | -0.008 | -0.009 | -0.009 |
| $Age^2$ | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| City population: | | | | | | | | |
| *Small city* | | 0.028 | 0.025 | 0.018 | 0.024 | 0.025 | 0.028 | 0.038 |
| *Medium city* | | -0.07 | -0.058 | -0.067 | -0.049 | -0.061 | -0.035 | -0.029 |
| *Large city/suburbs* | | -0.079 | -0.07 | -0.077 | -0.059 | -0.073 | -0.034 | -0.023 |
| Edu: secondary | | 0.288 | 0.268 | 0.253 | 0.244 | 0.274 | 0.272 | 0.267 |
| Edu: higher | | 0.690*** | 0.680*** | 0.665*** | 0.653*** | 0.682*** | 0.687*** | 0.669*** |
| Income: | | | | | | | | |
| *We live modestly* | | 0.289* | 0.253 | 0.246 | 0.238 | 0.259 | 0.251 | 0.294* |
| *We live an average life* | | 0.432*** | 0.376** | 0.359** | 0.352** | 0.385** | 0.385** | 0.457*** |
| *We live well* | | 0.487*** | 0.435** | 0.409** | 0.402** | 0.436** | 0.463** | 0.541*** |
| *We live very well* | | 0.461** | 0.425* | 0.402* | 0.392* | 0.413* | 0.495** | 0.578*** |
| Health: poor | | 0.103 | 0.122 | 0.131 | 0.121 | 0.122 | 0.08 | 0.007 |
| Health: good | | 0.069 | 0.066 | 0.068 | 0.069 | 0.068 | 0.069 | 0.07 |
| Religious | | -0.262*** | -0.248*** | -0.252*** | -0.247*** | -0.257*** | -0.218*** | -0.210*** |
| Unemployed | | -0.073 | -0.09 | -0.095 | -0.085 | -0.078 | -0.117 | -0.094 |
| Pensioner | | 0.178 | 0.174 | 0.187 | 0.184 | 0.179 | 0.18 | 0.167 |
| Student | | 0.167 | 0.147 | 0.142 | 0.164 | 0.159 | 0.097 | 0.15 |
| Fear | | | -0.044*** | | | | | |
| Anger | | | | -0.056*** | | | | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Disgust | | | | | -0.058*** | | | |
| Sadness | | | | | | -0.030** | | |
| Surprise | | | | | | | -0.077*** | |
| Joy | | | | | | | | -0.070*** |
| Log-likelihood | -6948.356 | -6850.57 | -6839.5 | -6832.84 | -6831.82 | -6845.61 | -6819.18 | -6827.42 |
| Pseudo R2 | 0.007 | 0.021 | 0.022 | 0.023 | 0.023 | 0.021 | 0.025 | 0.024 |
| Observations | 4990 | 4990 | 4990 | 4990 | 4990 | 4990 | 4990 | 4990 |

# 4. Discussion

As expected, we observed that the treatments involving more severe threats, namely COVID and Unemployment, triggered stronger (negative) emotions compared to Cold. These emotions were also linked to performance, with their levels correlating negatively with the number of correctly solved puzzles. This path cannot, however, fully explain treatment effects: while performance under Unemployment was worse than under Cold, this was not the case for COVID. Moreover, including emotions in the regression models did not substantially change estimates of direct treatment effects.

The remaining part of the treatment effect could, in principle, be related to differences in the clarity of the puzzles. Yet, there is, little evidence to support this explanation. First, nothing in the open-ended comments led us to believe that, for instance, the Unemployment treatment was more ambiguous than the other two. Treatment effects also exhibited remarkable stability across all three language versions. Lastly, while the initial formulation of the Lilypad puzzle might have made the incorrect answer particularly tempting in the Unemployment version, fixing the problem in Study 2 yielded no difference.

We thus observe very stable, systematic framing effects which are difficult to explain in terms of participants' emotional reactions. This observation calls for exploration of different possible wordings of the classic puzzles in the domain of decisions under risk, finding out how framing affects performance and seeking underlying mechanisms. The current practice of sticking to the canonical version can give a misleading picture of the cognitive biases these puzzles purportedly illustrate.

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# 6. Appendix A

## *Covid:*

**[P1]** Suppose that 15% of Polish citizens are infected with coronavirus, and 85% are healthy. A test to detect coronavirus at an early stage is 80% effective, i.e., when an actually infected person is examined, there is an 80% chance that the test will show that they are infected and 20% that they are healthy. When an actually healthy person is examined, there is an 80% chance that the test will show that they are healthy and 20% that they are infected.

**In a randomly selected citizen, the test indicated the presence of the virus. What is the probability (in percent) that this person is actually infected?**
[. . . .] %

**[P2]** Suppose that a random sample of [Poles] was tested, and it turned out that 10,000 of them were currently infected with the coronavirus. This represents 1% of the tested sample.

**Would this information make you more or less concerned about the pandemic than you currently are?**
More concerned
Less concerned

**[P3 - option 1]** Authorities in a certain city are preparing to confront a new wave of a coronavirus pandemic. It can be expected to kill approx. 600 residents. Two prevention programs are being considered. Epidemiologists estimate that their effects on these statistical 600 people will be as follows:
Program A: 200 people will be saved
Program B: with a probability of 1/3, 600 people will be saved; with a probability of 2/3, nobody will be saved
**Which program should be implemented?**
Program A
Program B
---
**[P3 - option 2]** Authorities in a certain city are preparing to confront a new wave of a coronavirus pandemic. It can be expected to kill approx. 600 residents. Two prevention programs are being considered. Epidemiologists estimate that their effects on these statistical 600 people will be as follows:
Program A: 200 people will die
Program B: with a probability of 1/3, no one will die; with a probability of 2/3, everyone will die

**Which program should be implemented?**
Program A
Program B

**[P4]** Mortality among patients with coronavirus depends on their age. Suppose that the estimated probability of death within one month of infection for men in specific age groups is as follows:

| Age group | Probability of death |
|---|---|
| 0-40 | 0.1% |
| 41-50 | 0.3% |
| 51-60 | 0.5% |
| 61-70 | 1.9% |
| 71+ | 4% |

**Jan is 61 years old. What do you think is the probability that Jan will die within one month of being infected?**
[……] %

**[P5]** Nationwide, around 20,000 more coronavirus deaths can be expected. A change in the procedure for handling patients in isolation hospitals has been proposed. The change may turn out to be good or bad.

**The expected outcomes and their probabilities are shown in the table. For each row, indicate whether you think such a change should be implemented in the given situation.**

| Outcomes if the change turns out to be bad (chance: 50%) | Outcomes if the change turns out to be good (chance: 50%) | **Should the proposed procedure change be implemented?** | |
|---|---|---|---|
| An additional 5000 people will die | 5000 people will be saved | Yes | No |
| An additional 5000 people will die | 6000 people will be saved | Yes | No |
| An additional 5000 people will die | 7000 people will be saved | Yes | No |
| An additional 5000 people will die | 8000 people will be saved | Yes | No |
| An additional 5000 people will die | 9000 people will be saved | Yes | No |
| An additional 5000 people will die | 10000 people will be saved | Yes | No |

**[P6]** Suppose you are now healthy-you have no coronavirus. You meet 100 people. For every meeting you start while being healthy, you have a 99.5% chance of remaining healthy (not being infected with coronavirus).

**What is the probability that you will remain healthy after the last of 100 meetings?**

[. . . . ]%

**[P7]** Suppose that a random sample of [Poles] was tested, and it turned out that 10 of them were currently infected with the coronavirus. This represents 1% of the tested sample.

**Would this information make you more or less concerned about the pandemic than you currently are?**
More concerned
Less concerned

**[P8]** In Braniewo, the percentage of residents infected with coronavirus doubles every day. After 12 days, everyone is infected.
**After how many days was half of the population infected?**
[. . . .]

## *Common cold:*

**[P1]** Suppose that 15% of [Polish] citizens have a cold and 85% are healthy. A test to diagnose a cold at an early stage is 80% effective, i.e., when a person with an actual cold is examined, there is an 80% chance that the test will show that they have a cold and 20% that they are healthy. When an actually healthy person is examined, there is an 80% chance that the test will show that they are healthy, 20% that they have a cold.
**In a randomly selected citizen, the test indicated the presence of a cold. What is the probability (in percent) that this person actually has a cold?**
[. . . .] %

**[P2]** Suppose that a random sample of [Poles'] saliva in a given week was tested, and it turned out that 10,000 of them had a common cold. This represents 1% of the tested sample.

**Would this information make you more or less concerned about catching a common cold than you currently are?**
More concerned
Less concerned

**[P3 - option 1]** The authorities of a certain city are preparing to confront a wave of seasonal cold. It can be expected that approx. 600 residents will have to go on sick leave because of it. Two prevention programs are being considered. Doctors estimate that their effects on these statistical 600 people will be as follows:
Program A: 200 people will be able to work
Program B: with a probability of 1/3, 600 people will be able to work; with a probability of 2/3, nobody will be able to work
**Which program should be implemented?**
Program A
Program B
---
**[P3 - option 2]** The authorities of a certain city are preparing to confront a wave of seasonal cold. It can be expected that approx. 600 residents will have to go on sick leave because of it. Two prevention programs are being considered. Doctors estimate that their effects on these statistical 600 people will be as follows:

Program A: 200 people will go on sick leave
Program B: with a probability of 1/3, nobody will go on sick leave; with a probability of 2/3, everyone will go on sick leave
**Which program should be implemented?**
Program A
Program B

**[P4]** The proportion of patients with complications due to the common cold depends on their age. Suppose that the estimated probability of complications for men in specific age groups is as follows:

| **age group** | **prob. of complications** |
|---|---|
| 0-40 | 0.1% |
| 41-50 | 0.3% |
| 51-60 | 0.5% |
| 61-70 | 1.9% |
| 71+ | 4% |

**Jan is 61 years old. What do you think is the probability that John will develop complications?**
[……] %

**[P5]** Nationwide, around 20,000 people can be expected to have health complications after having a cold. A change in the procedure for handling patients reporting to their family doctors has been proposed. The change may turn out to be good or bad.

**The expected outcomes and their probabilities are shown in the table. For each row, indicate whether you think such a change should be implemented in the given situation.**

| Outcomes if the change turns out to be bad (chance: 50%) | Outcomes if the change turns out to be good (chance: 50%) | **Should the proposed procedure change be implemented?** | |
|---|---|---|---|
| 5000 more people with complications | 5000 fewer people with complications | Yes | No |
| 5000 more people with complications | 6000 fewer people with complications | Yes | No |
| 5000 more people with complications | 7000 fewer people with complications | Yes | No |
| 5000 more people with complications | 8000 fewer people with complications | Yes | No |

| | | | |
|---|---|---|---|
| 5000 more people with complications | 9000 fewer people with complications | Yes | No |
| 5000 more people with complications | 10000 fewer people with complications | Yes | No |

**[P6]** Suppose you are now healthy - you do not have a cold. You meet 100 people. For every meeting you start while being healthy, you have a 99.5% chance of remaining healthy (not contracting a cold).
**What is the probability that you will remain healthy after the last of 100 meetings?**

[. . . . ]%

**[P7]** Suppose that a random sample of [Poles'] saliva in a given week was tested, and it turned out that 10 of them had a common cold. This represents 1% of the tested sample.

**Would this information make you more or less concerned about catching a common cold than you currently are?**
More concerned
Less concerned

**[P8]** In Braniewo, the percentage of residents with a cold doubles every day. After 12 days, everyone has a cold.
**After how many days did half of the population have a cold?**
[. . . .]

### *Unemployment*:

**[P1]** Suppose that 15% of [Polish] citizens are at risk of unemployment and 85% are not. A competency test to detect the threat of unemployment is 80% effective, i.e., when an actually threatened by an unemployment person takes the test, there is an 80% chance that the test will detect the threat of unemployment and 20% that it will not detect this threat. When a person who is not at risk of unemployment takes the test, there is an 80% chance that the test will indicate no risk of unemployment and 20% that it will indicate a threat.
**In a randomly selected citizen (from a group of working [Poles]), the test indicated that this person is at risk of unemployment. What is the probability (in percent) that this person is actually at risk of unemployment?**
[. . . .] %

**[P2]** Suppose that a random sample of employees in [Poland] was interviewed, and it turned out that 10,000 of them were afraid of losing their job within the next three months. This represents 10% of the tested sample.

**Would this information make you more or less concerned about the threat of unemployment than you currently are?**
More concerned

Less concerned

**[P3 - option 1]** The authorities of a certain city are preparing to confront a wave of layoffs. It is expected that around 600 people will permanently lose their jobs as a result. Two aid programs for the newly laid-off are being considered. The authors of these programs estimate that their effects on these statistical 600 people will be as follows:
Program A: 200 people will save their job
Program B: with a probability of 1/3, 600 people will save their job; with a probability of 2/3, nobody will keep their job

**Which program should be implemented?**
Program A
Program B
---
**[P3 - option 2]** The authorities of a certain city are preparing to confront a wave of layoffs. It is expected that around 600 people will permanently lose their jobs as a result. Two aid programs for the newly laid-off are being considered. The authors of these programs estimate that their effects on these statistical 600 people will be as follows:
Program A: 400 people will lose their jobs
Program B: with a probability of 1/3, nobody will lose their job; with a probability of 2/3, everyone will lose their job
**Which program should be implemented?**
Program A
Program B

**[P4]** The proportion of workers at risk of sudden job loss depends on their age. Suppose that the estimated probability of being fired for men in specific age groups is as follows:

| Age group | Probability of being fired |
|---|---|
| 0-40 | 0.1% |
| 41-50 | 0.3% |
| 51-60 | 0.5% |
| 61-70 | 1.9% |
| 71+ | 4% |

**Jan is 61 years old. What do you think is the probability that Jan will lose his job?**
[……] %

**[P5]** Nationwide, around 20,000 people can be expected to permanently lose their jobs as a result of the wave of layoffs. A change in the procedures for collective redundancies has been proposed. The change may turn out to be good or bad.

**The expected outcomes and their probabilities are shown in the table. For each row, indicate whether you think such a change should be implemented in the given situation.**

| Outcomes if the change turns out to be bad (chance: 50%) | Outcomes if the change turns out to be good (chance: 50%) | **Should the proposed procedure change be implemented?** | |
|---|---|---|---|
| 5000 more people laid off | 5000 fewer people laid off | Yes | No |
| 5000 more people laid off | 6000 fewer people laid off | Yes | No |
| 5000 more people laid off | 7000 fewer people laid off | Yes | No |
| 5000 more people laid off | 8000 fewer people laid off | Yes | No |
| 5000 more people laid off | 9000 fewer people laid off | Yes | No |
| 5000 more people laid off | 10000 fewer people laid off | Yes | No |

**[P6]** Suppose you have a job right now. Over 100 days, each day when you start work, you have a 99.5% chance of not being fired.

**What is the probability that you will remain employed after your 100th day on the job?**

[. . . . ]%

**[P7]** Suppose that a random sample of employees in [Poland] was interviewed, and it turned out that 10 of them were afraid of losing their job within the next three months. This represents 10% of the tested sample.

**Would this information make you more or less concerned about the threat of unemployment than you currently are?**
More concerned
Less concerned

**[P8]** In [Braniewo], among the adult residents that are fit to work, the percentage of those unemployed doubles every month. After 12 months, everyone is unemployed.
**After how many months were half of them unemployed?**
[. . . .]

# 7. Appendix B

Table B1. Study 1: Tukey's HSD pairwise comparisons test

Pairwise comparisons of means with equal variances
Over: treatment

| | | | Tukey | | Tukey | |
|---|---|---|---|---|---|---|
| Joy | Contrast | Std. err. | t | P>t | [95% conf. | interval] |
| Cold vs COVID | -.0508 | .1029 | -0.49 | 0.874 | -.2921 | .1905 |

| | | | | | | |
|---|---|---|---|---|---|---|
| Unempl vs COVID | -.1468 | .1029 | -1.43 | 0.327 | -.3881 | .0945 |
| Unempl vs Cold | -.0960 | .1046 | -0.92 | 0.629 | -.3412 | .1492 |
| Fear | | | | | | |
| Cold vs COVID | -.7897 | .1133 | -6.97 | -0.000 | -1.0555 | -.5240 |
| Unempl vs COVID | -.2161 | .1134 | -1.91 | 0.137 | -.4818 | .0495 |
| Unempl vs Cold | .5736 | .1151 | 4.98 | 0.000 | .3037 | .8436 |
| Anger | | | | | | |
| Cold vs COVID | -.9450 | .1193 | -7.92 | -0.000 | -1.2247 | -.6653 |
| Unempl vs COVID | -.4030 | .1193 | -3.38 | 0.002 | -.6827 | -.1234 |
| Unempl vs Cold | .5420 | .1212 | 4.47 | 0.000 | .2578 | .8262 |
| Disgust | | | | | | |
| Cold vs COVID | -.7453 | .1095 | -6.81 | -0.000 | -1.0020 | -.4886 |
| Unempl vs COVID | -.2359 | .1095 | -2.16 | 0.079 | -.4926 | .0207 |
| Unempl vs Cold | .5094 | .1112 | 4.58 | 0.000 | .2486 | .7702 |
| Sadness | | | | | | |
| Cold vs COVID | -.8556 | .1200 | -7.13 | -0.000 | -1.1369 | -.5743 |
| Unempl vs COVID | -.3236 | .1199 | -2.70 | 0.019 | -.6048 | -.0423 |
| Unempl vs Cold | .5320 | .1219 | 4.37 | 0.000 | .2462 | .8178 |
| Surprise | | | | | | |
| Cold vs COVID | -.4293 | .1060 | -4.05 | 0.000 | -.6778 | -.1808 |
| Unempl vs COVID | .01418 | .1059 | 0.13 | 0.990 | -.2342 | .2626 |
| Unempl vs Cold | .4435 | .1076 | 4.12 | 0.000 | .1911 | .6959 |

Table B2: Study 1: Pairwise correlations of performance between puzzles

| | Base rate neglect | Death rate | Beliefs update | Compound prob | Lilypad | Loss aversion |
|---|---|---|---|---|---|---|
| Base rate neglect | 1.0000 | | | | | |
| Death rate | -0.0686* | 1.0000 | | | | |
| | 0.0001 | | | | | |
| Beliefs update | -0.0212 | 0.0083 | 1.0000 | | | |
| | 0.2365 | 0.6453 | | | | |
| Compound prob | 0.0919* | -0.0011 | -0.0053 | 1.0000 | | |
| | 0.0000 | 0.9520 | 0.7693 | | | |
| Lilypad | 0.0971* | 0.0113 | 0.0546* | 0.0434* | 1.0000 | |
| | 0.0000 | 0.5302 | 0.0023 | 0.0155 | | |
| Loss aversion | 0.0438* | 0.0060 | 0.0190 | 0.0181 | 0.0706* | 1.0000 |
| | 0.0147 | 0.7364 | 0.2899 | 0.3140 | 0.0001 | |

Table B3: Study 1: Pairwise correlations of emotions

| | Joy | Fear | Anger | Disgust | Sadness | Surprise |
|---|---|---|---|---|---|---|
| Joy | 1.0000 | | | | | |
| Fear | -0.0156 | 1.0000 | | | | |
| | 0.3833 | | | | | |
| Anger | -0.1012* | 0.6346* | 1.0000 | | | |
| | 0.0000 | 0.0000 | | | | |
| Disgust | -0.0202 | 0.5581* | 0.7046* | 1.0000 | | |
| | 0.2595 | 0.0000 | 0.0000 | | | |
| Sadness | -0.2030* | 0.6689* | 0.7043* | 0.6152* | 1.0000 | |
| | 0.0000 | 0.0000 | 0.0000 | 0.0000 | | |
| Surprise | 0.1277* | 0.4555* | 0.4773* | 0.5290* | 0.4401* | 1.0000 |
| | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | |

Table B4. Study 1: Logistic regressions with acceptable answers in each of the puzzles as dependent variables

| **Logistic regression; Dependent variable: *Lilypad* (Acceptable interval from Table 2)** | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Variable | Base | Demo | Fear | Anger | Disgust | Sadness | Surprise | Joy |
| Treatment Cold | 0.067 | 0.035 | -0.050 | -0.054 | -0.062 | -0.020 | -0.017 | 0.029 |
| Tr_Unemployment | -0.270*** | -0.279*** | -0.317*** | -0.334*** | -0.324*** | -0.312*** | -0.289*** | -0.291*** |
| Female | | -0.448*** | -0.412*** | -0.428*** | -0.475*** | -0.432*** | -0.464*** | -0.446*** |
| Age | | -0.011 | -0.014 | -0.014 | -0.016 | -0.013 | -0.011 | -0.007 |
| $Age^2$ | | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| City Population | | | | | | | | |
| Small (<20k) | | -0.168 | -0.154 | -0.146 | -0.125 | -0.162 | -0.140 | -0.174 |
| Medium (<99k) | | -0.216* | -0.212* | -0.201* | -0.200 | -0.213* | -0.200* | -0.220* |
| Big (<500k) | | -0.064 | -0.052 | -0.036 | -0.032 | -0.046 | -0.043 | -0.083 |
| Large (>500k) | | 0.051 | 0.070 | 0.073 | 0.083 | 0.072 | 0.052 | 0.057 |
| Edu: secondary | | 0.420** | 0.452*** | 0.446*** | 0.418** | 0.439*** | 0.420** | 0.385** |
| Edu: higher | | 1.240*** | 1.285*** | 1.274*** | 1.241*** | 1.270*** | 1.238*** | 1.200*** |
| Wealth: low | | -0.556*** | -0.528*** | -0.501*** | -0.454*** | -0.512*** | -0.495*** | -0.563*** |
| Wealth: high | | 0.009 | -0.024 | -0.014 | -0.020 | -0.016 | 0.010 | 0.044 |
| Health: poor | | -0.028 | 0.003 | 0.006 | -0.014 | -0.001 | -0.008 | -0.066 |
| Health: good | | -0.011 | -0.124 | -0.101 | -0.114 | -0.084 | -0.056 | 0.063 |
| Religious | | -0.450*** | -0.388*** | -0.452*** | -0.435*** | -0.433*** | -0.395*** | -0.398*** |
| Unemployed | | -0.404** | -0.380** | -0.388** | -0.403** | -0.390** | -0.431** | -0.464*** |
| Pensioner | | -0.371** | -0.362** | -0.368** | -0.387** | -0.350** | -0.365** | -0.376** |
| Student | | 0.320 | 0.308 | 0.269 | 0.256 | 0.339* | 0.239 | 0.282 |
| Fear | | | -0.114*** | | | | | |
| Anger | | | | -0.097*** | | | | |
| Disgust | | | | | -0.147*** | | | |
| Sadness | | | | | | -0.067*** | | |
| Surprise | | | | | | | -0.127*** | |
| Joy | | | | | | | | -0.094*** |
| Log-likelihood | -1791.492 | -1664.030 | -1643.393 | -1646.522 | -1632.957 | -1655.595 | -1640.591 | -1652.060 |
| Pseudo R2 | 0.003 | 0.074 | 0.086 | 0.084 | 0.092 | 0.079 | 0.087 | 0.081 |
| N | 3105 | 3105 | 3105 | 3105 | 3105 | 3105 | 3105 | 3105 |

| **Logistic regression; Dependent variable: *Base rate neglect* (Acceptable interval from Table 2)** | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Variable | Base | Demo | Fear | Anger | Disgust | Sadness | Surprise | Joy |
| Treatment Cold | 0.052 | 0.059 | 0.041 | 0.048 | -0.001 | 0.051 | 0.041 | 0.058 |
| Tr_Unemployment | 0.258** | 0.275** | 0.269** | 0.271** | 0.254** | 0.272** | 0.276** | 0.274** |
| Female | | 0.189** | 0.198** | 0.192** | 0.183** | 0.192** | 0.189** | 0.190** |
| Age | | -0.035* | -0.036* | -0.036* | -0.039* | -0.036* | -0.036* | -0.034* |
| $Age^2$ | | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| City Population | | | | | | | | |
| Small (<20k) | | -0.057 | -0.051 | -0.053 | -0.027 | -0.056 | -0.044 | -0.056 |
| Medium (<99k) | | -0.066 | -0.063 | -0.064 | -0.051 | -0.065 | -0.057 | -0.066 |
| Big (<500k) | | 0.097 | 0.101 | 0.101 | 0.120 | 0.099 | 0.108 | 0.091 |
| Large (>500k) | | -0.046 | -0.043 | -0.044 | -0.030 | -0.045 | -0.045 | -0.047 |
| Edu: secondary | | 0.227* | 0.229* | 0.229* | 0.211 | 0.228* | 0.220 | 0.217 |
| Edu: higher | | 0.455*** | 0.456*** | 0.456*** | 0.432*** | 0.456*** | 0.444*** | 0.442*** |
| Wealth: low | | -0.285** | -0.279** | -0.280** | -0.234* | -0.280** | -0.266** | -0.285** |
| Wealth: high | | -0.349*** | -0.356*** | -0.352*** | -0.365*** | -0.352*** | -0.349*** | -0.340*** |
| Health: poor | | 0.005 | 0.009 | 0.008 | 0.004 | 0.007 | 0.008 | -0.005 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Health: good | | 0.141 | 0.120 | 0.132 | 0.092 | 0.132 | 0.130 | 0.159 |
| Religious | | -0.082 | -0.069 | -0.082 | -0.070 | -0.079 | -0.064 | -0.068 |
| Unemployed | | -0.048 | -0.044 | -0.046 | -0.046 | -0.046 | -0.054 | -0.059 |
| Pensioner | | -0.204 | -0.202 | -0.204 | -0.220 | -0.201 | -0.205 | -0.202 |
| Student | | 0.570** | 0.563** | 0.562** | 0.516* | 0.570** | 0.536* | 0.559** |
| Fear | | | -0.022 | | | | | |
| Anger | | | | -0.010 | | | | |
| Disgust | | | | | -0.073*** | | | |
| Sadness | | | | | | -0.008 | | |
| Surprise | | | | | | | -0.039** | |
| Joy | | | | | | | | -0.022 |
| Log-likelihood | -1614.855 | -1572.175 | -1571.425 | -1571.988 | -1563.963 | -1572.055 | -1569.933 | -1571.545 |
| Pseudo R2 | 0.002 | 0.028 | 0.029 | 0.028 | 0.033 | 0.028 | 0.030 | 0.029 |
| N | 3105 | 3105 | 3105 | 3105 | 3105 | 3105 | 3105 | 3105 |

**Logistic regression; Dependent variable: *Compound probability* (Acceptable interval from Table 2)**

| Variable | Base | Demo | Fear | Anger | Disgust | Sadness | Surprise | Joy |
|---|---|---|---|---|---|---|---|---|
| Treatment Cold | -0.099 | -0.112 | -0.103 | -0.104 | -0.101 | -0.106 | -0.099 | -0.112 |
| Tr_Unemployment | -0.464*** | -0.477*** | -0.474*** | -0.473*** | -0.473*** | -0.474*** | -0.478*** | -0.476*** |
| Female | | -0.167* | -0.172* | -0.170* | -0.165* | -0.169* | -0.165* | -0.167* |
| Age | | 0.001 | 0.002 | 0.002 | 0.002 | 0.002 | 0.001 | 0.001 |
| $Age^2$ | | -0.000 | -0.000 | -0.000 | -0.000 | -0.000 | -0.000 | -0.000 |
| City Population | | | | | | | | |
| Small (<20k) | | -0.027 | -0.029 | -0.030 | -0.032 | -0.027 | -0.036 | -0.027 |
| Medium (<99k) | | -0.065 | -0.067 | -0.067 | -0.068 | -0.066 | -0.071 | -0.065 |
| Big (<500k) | | -0.017 | -0.019 | -0.020 | -0.021 | -0.019 | -0.023 | -0.015 |
| Large (>500k) | | 0.191 | 0.189 | 0.190 | 0.188 | 0.189 | 0.190 | 0.191 |
| Edu: secondary | | -0.205 | -0.207 | -0.206 | -0.202 | -0.206 | -0.200 | -0.201 |
| Edu: higher | | -0.118 | -0.121 | -0.120 | -0.114 | -0.120 | -0.110 | -0.113 |
| Wealth: low | | -0.220* | -0.224* | -0.225* | -0.231* | -0.225* | -0.237* | -0.220* |
| Wealth: high | | -0.063 | -0.059 | -0.061 | -0.060 | -0.060 | -0.064 | -0.066 |
| Health: poor | | -0.242 | -0.244 | -0.244 | -0.242 | -0.244 | -0.246 | -0.238 |
| Health: good | | -0.105 | -0.093 | -0.097 | -0.095 | -0.097 | -0.096 | -0.113 |
| Religious | | -0.024 | -0.032 | -0.024 | -0.027 | -0.026 | -0.040 | -0.030 |
| Unemployed | | 0.215 | 0.212 | 0.213 | 0.215 | 0.214 | 0.221 | 0.220 |
| Pensioner | | 0.153 | 0.151 | 0.153 | 0.155 | 0.150 | 0.152 | 0.152 |
| Student | | 0.210 | 0.213 | 0.216 | 0.219 | 0.209 | 0.235 | 0.215 |
| Fear | | | 0.013 | | | | | |
| Anger | | | | 0.009 | | | | |
| Disgust | | | | | 0.015 | | | |
| Sadness | | | | | | 0.007 | | |
| Surprise | | | | | | | 0.032* | |
| Joy | | | | | | | | 0.009 |
| Log-likelihood | -1673.438 | -1664.235 | -1663.962 | -1664.074 | -1663.887 | -1664.131 | -1662.601 | -1664.123 |
| Pseudo R2 | 0.006 | 0.012 | 0.012 | 0.012 | 0.012 | 0.012 | 0.013 | 0.012 |
| N | 3105 | 3105 | 3105 | 3105 | 3105 | 3105 | 3105 | 3105 |

**Logistic regression; Dependent variable: *Loss aversion* (Acceptable interval from Table 2)**

| Variable | Base | Demo | Fear | Anger | Disgust | Sadness | Surprise | Joy |
|---|---|---|---|---|---|---|---|---|
| Treatment Cold | -0.147* | -0.156* | -0.157* | -0.178* | -0.181** | -0.165* | -0.171* | -0.157* |
| Tr_Unemployment | -0.436*** | -0.466*** | -0.467*** | -0.477*** | -0.476*** | -0.470*** | -0.467*** | -0.467*** |
| Female | | 0.129* | 0.130* | 0.136* | 0.125 | 0.132* | 0.128* | 0.130* |
| Age | | 0.036** | 0.036** | 0.036** | 0.035** | 0.036** | 0.036** | 0.037** |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| $Age^2$ | | -0.000 | -0.000 | -0.000 | -0.000 | -0.000 | -0.000 | -0.000 |
| City Population | | | | | | | | |
| Small (<20k) | | -0.105 | -0.104 | -0.097 | -0.092 | -0.104 | -0.094 | -0.104 |
| Medium (<99k) | | 0.029 | 0.029 | 0.034 | 0.035 | 0.030 | 0.036 | 0.029 |
| Big (<500k) | | 0.161 | 0.161 | 0.169 | 0.170 | 0.164 | 0.169 | 0.158 |
| Large (>500k) | | 0.348*** | 0.348*** | 0.353*** | 0.356*** | 0.351*** | 0.350*** | 0.348*** |
| Edu: secondary | | 0.152 | 0.153 | 0.156 | 0.145 | 0.154 | 0.146 | 0.148 |
| Edu: higher | | 0.227* | 0.227* | 0.231* | 0.217* | 0.230* | 0.218* | 0.221* |
| Wealth: low | | 0.007 | 0.007 | 0.019 | 0.030 | 0.014 | 0.025 | 0.007 |
| Wealth: high | | -0.007 | -0.007 | -0.012 | -0.013 | -0.010 | -0.005 | -0.002 |
| Health: poor | | 0.068 | 0.069 | 0.074 | 0.068 | 0.071 | 0.071 | 0.064 |
| Health: good | | -0.007 | -0.009 | -0.028 | -0.031 | -0.018 | -0.018 | 0.002 |
| Religious | | -0.005 | -0.003 | -0.004 | 0.001 | -0.002 | 0.012 | 0.002 |
| Unemployed | | 0.306** | 0.307** | 0.312** | 0.307** | 0.309** | 0.301** | 0.300** |
| Pensioner | | 0.301** | 0.301** | 0.301** | 0.295** | 0.304** | 0.301** | 0.302** |
| Student | | 0.340* | 0.340* | 0.327* | 0.322* | 0.342* | 0.316* | 0.336* |
| Fear | | | -0.002 | | | | | |
| Anger | | | | -0.023 | | | | |
| Disgust | | | | | -0.034** | | | |
| Sadness | | | | | | -0.010 | | |
| Surprise | | | | | | | -0.035** | |
| Joy | | | | | | | | -0.011 |
| Log-likelihood | -2054.436 | -2017.561 | -2017.553 | -2016.219 | -2015.201 | -2017.295 | -2015.046 | -2017.346 |
| Pseudo R2 | 0.006 | 0.024 | 0.024 | 0.024 | 0.025 | 0.024 | 0.025 | 0.024 |
| N | 3105 | 3105 | 3105 | 3105 | 3105 | 3105 | 3105 | 3105 |

**Logistic regression; Dependent variable: *Death rate* (Acceptable interval from Table 2)**

| Variable | Base | Demo | Fear | Anger | Disgust | Sadness | Surprise | Joy |
|---|---|---|---|---|---|---|---|---|
| Treatment Cold | -0.171 | -0.168 | -0.216* | -0.200 | -0.191 | -0.188 | -0.179 | -0.168 |
| Treatment Unemployment | -0.381*** | -0.370*** | -0.387*** | -0.384*** | -0.378*** | -0.379*** | -0.370*** | -0.370*** |
| Female | | 0.170 | 0.192* | 0.181 | 0.168 | 0.177 | 0.170 | 0.170 |
| Age | | 0.031 | 0.030 | 0.030 | 0.029 | 0.030 | 0.031 | 0.031 |
| $Age^2$ | | -0.000 | -0.000 | -0.000 | -0.000 | -0.000 | -0.000 | -0.000 |
| City Population | | | | | | | | |
| Small (<20k) | | 0.051 | 0.067 | 0.064 | 0.064 | 0.054 | 0.059 | 0.051 |
| Medium (<99k) | | 0.024 | 0.033 | 0.031 | 0.031 | 0.027 | 0.030 | 0.024 |
| Big (<500k) | | -0.076 | -0.066 | -0.063 | -0.067 | -0.070 | -0.070 | -0.077 |
| Large (>500k) | | 0.022 | 0.032 | 0.028 | 0.029 | 0.027 | 0.022 | 0.022 |
| Edu: secondary | | -0.027 | -0.021 | -0.022 | -0.035 | -0.025 | -0.031 | -0.029 |
| Edu: higher | | -0.184 | -0.181 | -0.181 | -0.197 | -0.181 | -0.192 | -0.186 |
| Wealth: low | | -0.306* | -0.296* | -0.293* | -0.287* | -0.295* | -0.295* | -0.306* |
| Wealth: high | | 0.109 | 0.092 | 0.100 | 0.104 | 0.101 | 0.109 | 0.110 |
| Health: poor | | 0.060 | 0.075 | 0.071 | 0.064 | 0.069 | 0.062 | 0.059 |
| Health: good | | 0.107 | 0.056 | 0.078 | 0.087 | 0.085 | 0.100 | 0.109 |
| Religious | | 0.108 | 0.140 | 0.107 | 0.112 | 0.113 | 0.118 | 0.109 |
| Unemployed | | -0.330 | -0.319 | -0.320 | -0.329 | -0.325 | -0.334 | -0.331 |
| Pensioner | | -0.314* | -0.312* | -0.314* | -0.320* | -0.308* | -0.314* | -0.314* |
| Student | | 0.137 | 0.127 | 0.116 | 0.117 | 0.139 | 0.120 | 0.136 |
| Fear | | | -0.054** | | | | | |
| Anger | | | | -0.033 | | | | |
| Disgust | | | | | -0.030 | | | |
| Sadness | | | | | | -0.021 | | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Surprise | | | | | | | -0.024 | |
| Joy | | | | | | | | -0.003 |
| Log-likelihood | -1192.393 | -1172.736 | -1169.729 | -1171.442 | -1171.862 | -1172.213 | -1172.185 | -1172.728 |
| Pseudo R2 | 0.004 | 0.020 | 0.022 | 0.021 | 0.021 | 0.020 | 0.020 | 0.020 |
| N | 3105 | 3105 | 3105 | 3105 | 3105 | 3105 | 3105 | 3105 |

**Logistic regression; Dependent variable: *Beliefs update* (Acceptable interval from Table 2)**

| Variable | Base | Demo | Fear | Anger | Disgust | Sadness | Surprise | Joy |
|---|---|---|---|---|---|---|---|---|
| Treatment Cold | 0.155 | 0.139 | 0.103 | 0.123 | 0.138 | 0.125 | 0.127 | 0.138 |
| Treatment Unemployment | -0.284*** | -0.293*** | -0.306*** | -0.301*** | -0.294*** | -0.300*** | -0.293*** | -0.296*** |
| Female | | -0.178** | -0.159* | -0.172** | -0.178** | -0.172** | -0.180** | -0.176** |
| Age | | -0.005 | -0.005 | -0.006 | -0.005 | -0.005 | -0.005 | -0.004 |
| $Age^2$ | | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| City Population | | | | | | | | |
| Small (<20k) | | -0.249* | -0.237* | -0.243* | -0.248* | -0.247* | -0.240* | -0.250* |
| Medium (<99k) | | 0.160 | 0.166 | 0.164 | 0.160 | 0.162 | 0.166 | 0.159 |
| Big (<500k) | | 0.092 | 0.099 | 0.097 | 0.092 | 0.097 | 0.098 | 0.084 |
| Large (>500k) | | -0.088 | -0.083 | -0.086 | -0.088 | -0.085 | -0.088 | -0.089 |
| Edu: secondary | | 0.037 | 0.044 | 0.039 | 0.036 | 0.039 | 0.031 | 0.024 |
| Edu: higher | | 0.343** | 0.350*** | 0.345*** | 0.343** | 0.347*** | 0.335** | 0.327** |
| Wealth: low | | 0.023 | 0.037 | 0.031 | 0.024 | 0.034 | 0.036 | 0.021 |
| Wealth: high | | -0.062 | -0.077 | -0.066 | -0.062 | -0.068 | -0.061 | -0.051 |
| Health: poor | | -0.049 | -0.039 | -0.043 | -0.049 | -0.043 | -0.046 | -0.061 |
| Health: good | | 0.057 | 0.009 | 0.040 | 0.056 | 0.037 | 0.047 | 0.080 |
| Religious | | -0.150 | -0.124 | -0.150 | -0.150 | -0.145 | -0.137 | -0.133 |
| Unemployed | | 0.325** | 0.336** | 0.329** | 0.325** | 0.329** | 0.320** | 0.310** |
| Pensioner | | -0.149 | -0.146 | -0.150 | -0.149 | -0.144 | -0.150 | -0.146 |
| Student | | -0.209 | -0.215 | -0.220 | -0.210 | -0.207 | -0.230 | -0.223 |
| Fear | | | -0.048*** | | | | | |
| Anger | | | | -0.018 | | | | |
| Disgust | | | | | -0.002 | | | |
| Sadness | | | | | | -0.018 | | |
| Surprise | | | | | | | -0.030* | |
| Joy | | | | | | | | -0.029 |
| Log-likelihood | -1825.788 | -1805.841 | -1801.356 | -1805.108 | -1805.837 | -1805.160 | -1804.258 | -1804.554 |
| Pseudo R2 | 0.006 | 0.016 | 0.019 | 0.017 | 0.016 | 0.017 | 0.017 | 0.017 |
| N | 3105 | 3105 | 3105 | 3105 | 3105 | 3105 | 3105 | 3105 |

# 8. Appendix C

Table C1. Study 2: Tukey's HSD pairwise comparisons test

Pairwise comparisons of means with equal variances

Over: treatment

| | | | Tukey | | Tukey | |
|---|---|---|---|---|---|---|
| Joy | Contrast | Std. err. | t | P>t | [95% conf. | interval] |
| Cold vs COVID | .1454 | .0951 | 1.53 | 0.277 | -.0776 | .3684 |
| Unempl vs COVID | .0493 | .0954 | 0.52 | 0.863 | -.1744 | .2731 |
| Unempl vs Cold | -.0961 | .0951 | -1.01 | 0.570 | -.3190 | .1268 |
| Fear | | | | | | |
| Cold vs COVID | -.1721 | .1000 | -1.72 | -0.197 | -.4066 | -.0623 |
| Unempl vs COVID | .1243 | .1003 | 1.24 | 0.430 | -.1109 | .3596 |
| Unempl vs Cold | .2965 | .1000 | 2.97 | 0.009 | .0621 | .5309 |
| Anger | | | | | | |
| Cold vs COVID | -.2686 | .0991 | -2.71 | 0.019 | -.5010 | -.0362 |
| Unempl vs COVID | .0236 | .0995 | 0.24 | 0.970 | -.2096 | .2568 |
| Unempl vs Cold | .2922 | .0991 | 2.95 | 0.009 | .0598 | .5245 |
| Disgust | | | | | | |
| Cold vs COVID | -.3240 | .0981 | -3.30 | -0.003 | -.5541 | -.0939 |
| Unempl vs COVID | .0078 | .0985 | 0.08 | 0.997 | -.2230 | .2387 |
| Unempl vs Cold | .3319 | .0981 | 3.38 | 0.002 | .1018 | .5619 |
| Sadness | | | | | | |
| Cold vs COVID | -.2817 | .0998 | -2.82 | 0.013 | -.5156 | -.0478 |
| Unempl vs COVID | .0668 | .1001 | 0.67 | 0.782 | -.1679 | -.3015 |
| Unempl vs Cold | .3845 | .0998 | 3.49 | 0. 001 | .1147 | .5824 |
| Surprise | | | | | | |
| Cold vs COVID | -.0332 | .0972 | -0.34 | 0.938 | -.2611 | -.1948 |
| Unempl vs COVID | .1857 | .0976 | 1.90 | 0.138 | -.0430 | .4145 |
| Unempl vs Cold | .2189 | .0972 | 2.25 | 0.063 | -.0090 | .4468 |

Table C2: Study 2: Pairwise correlations of performance between puzzles

| | Base rate neglect | Death rate | Beliefs update | Compound prob | Lilypad | Loss aversion |
|---|---|---|---|---|---|---|
| Base rate neglect | 1.0000 | | | | | |
| Beliefs update | -0.0111 | 1.0000 | | | | |
| | 0.4339 | | | | | |
| Death rate | -0.0231 | 0.0219 | 1.0000 | | | |
| | 0.1029 | 0.1219 | | | | |
| Compound prob | 0.0078 | -0.0206 | 0.0107 | 1.0000 | | |
| | 0.5827 | 0.1452 | 0.4509 | | | |
| Loss aversion | 0.0228 | 0.0060 | 0.0341 | 0.0041 | 1.0000 | |
| | 0.1079 | 0.6704 | 0.0160 | 0.7722 | | |
| Lilypad | -0.0123 | 0.0540 | 0.0544 | 0.0082 | 0.1819 | 1.0000 |
| | 0.2847 | 0.0001 | 0.001 | 0.5616 | 0 | |

Table C3: Study 2: Pairwise correlations of emotions

| | Joy | Fear | Anger | Disgust | Sadness | Surprise |
|---|---|---|---|---|---|---|
| Joy | 1.0000 | | | | | |
| Fear | 0.1509 | 1.0000 | | | | |
| | 0.000 | | | | | |
| Anger | 0.0773 | 0.6758 | 1.0000 | | | |
| | 0.0000 | 0.0000 | | | | |
| Disgust | 0.1157 | 0.6007 | 0.7525 | 1.0000 | | |
| | 0.0000 | 0.0000 | 0.0000 | | | |
| Sadness | 0.0343 | 0.7190 | 0.6920 | 0.6451 | 1.0000 | |
| | 0.0153 | 0.0000 | 0.0000 | 0.0000 | | |
| Surprise | 0.4503 | 0.4865 | 0.4226 | 0.4362 | 0.3848 | 1.0000 |
| | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | |

Table C4. Study 2: Logistic regressions with acceptable answers in each of the puzzles as dependent variables

| **Logistic regression; Dependent variable: *Lilypad* (Acceptable interval from Table 2)** | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Variable | Base | Demo | Fear | Anger | Disgust | Sadness | Surprise | Joy |
| Treatment Cold | -0.025 | -0.056 | -0.079 | -0.078 | -0.092 | -0.071 | -0.067 | -0.031 |
| Tr_Unemployment | -0.313*** | -0.342*** | -0.341*** | -0.343*** | -0.350*** | -0.343*** | -0.333*** | -0.346*** |
| Female | | -0.655*** | -0.645*** | -0.663*** | -0.674*** | -0.651*** | -0.720*** | -0.725*** |
| Age | | 0.017 | 0.014 | 0.018 | 0.019 | 0.017 | 0.016 | 0.015 |
| $Age^2$ | | 0.0000 | 0 | 0 | 0 | 0 | 0 | 0 |
| City Population | | | | | | | | |
| Small | | -0.003 | -0.007 | -0.01 | 0 | -0.007 | -0.001 | 0.022 |
| Medium | | -0.368** | -0.351** | -0.363** | -0.336* | -0.358** | -0.320* | -0.298* |
| Large city/suburbs | | -0.250* | -0.232* | -0.246* | -0.217* | -0.244* | -0.175 | -0.152 |
| Edu: secondary | | 0.112 | 0.071 | 0.07 | 0.042 | 0.091 | 0.053 | 0.066 |
| Edu: higher | | 0.814** | 0.789** | 0.778** | 0.751** | 0.799** | 0.778** | 0.758** |
| Wealth: low | | 0.650** | 0.583* | 0.597* | 0.579* | 0.607* | 0.576* | 0.639** |
| Wealth: high | | 0.685* | 0.694** | 0.712** | 0.685** | 0.736** | 0.714** | 0.824*** |
| Health: poor | | 0.201 | 0.226 | 0.238 | 0.225 | 0.227 | 0.176 | 0.026 |
| Health: good | | 0.031 | 0.03 | 0.034 | 0.041 | 0.03 | 0.04 | 0.045 |
| Religious | | -0.577*** | -0.551*** | -0.565*** | -0.555*** | -0.570*** | -0.514*** | -0.485*** |
| Unemployed | | 0.029 | -0.011 | -0.001 | -0.003 | 0.023 | -0.051 | -0.023 |
| Pensioner | | 0.184 | 0.167 | 0.188 | 0.176 | 0.178 | 0.158 | 0.133 |
| Student | | 0.143 | 0.097 | 0.114 | 0.135 | 0.13 | 0.04 | 0.106 |
| Fear | | | -0.088*** | | | | | |
| Anger | | | | -0.066*** | | | | |
| Disgust | | | | | -0.088*** | | | |
| Sadness | | | | | | -0.042** | | |
| Surprise | | | | | | | -0.125*** | |
| Joy | | | | | | | | -0.029 |
| Log-likelihood | -2594.57 | -2400.76 | -2380.27 | -2388.84 | -2380.35 | -2395.82 | -2361.2 | -2357.06 |
| Pseudo R2 | 0.003 | 0.078 | 0.085 | 0.082 | 0.085 | 0.079 | 0.093 | 0.094 |
| N | 4990 | 4990 | 4990 | 4990 | 4990 | 4990 | 4990 | 4990 |

| **Logistic regression; Dependent variable: *Basa rete neglect* (Acceptable interval from Table 2)** | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Variable | Base | Demo | Fear | Anger | Disgust | Sadness | Surprise | Joy |
| Treatment Cold | 0.315** | 0.315** | 0.308** | 0.298** | 0.301** | 0.299** | 0.314** | 0.321** |
| Treatment Unemployment | 0.189 | 0.204* | 0.207* | 0.203* | 0.203* | 0.206* | 0.209* | 0.205* |
| Female | | 0.286*** | 0.292*** | 0.284*** | 0.281*** | 0.293*** | 0.271** | 0.271** |
| Age | | 0.016 | 0.015 | 0.017 | 0.017 | 0.016 | 0.015 | 0.015 |
| $Age^2$ | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| City Population | | | | | | | | |
| Small | | -0.007 | -0.007 | -0.014 | -0.009 | -0.015 | -0.007 | 0 |
| Medium | | -0.092 | -0.078 | -0.085 | -0.075 | -0.076 | -0.075 | -0.071 |
| Large city/suburbs | | -0.035 | -0.025 | -0.031 | -0.019 | -0.026 | -0.011 | -0.007 |
| Edu: secondary | | 0.417 | 0.403 | 0.386 | 0.384 | 0.393 | 0.401 | 0.405 |
| Edu: higher | | 0.565* | 0.560* | 0.543* | 0.536* | 0.551* | 0.556* | 0.553* |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Wealth: low | | 0.458* | 0.432* | 0.423* | 0.427* | 0.412* | 0.436* | 0.456* |
| Wealth: high | | 0.582** | 0.538** | 0.515** | 0.528** | 0.506** | 0.556** | 0.590** |
| Health: poor | | -0.131 | -0.117 | -0.101 | -0.116 | -0.097 | -0.145 | -0.179 |
| Health: good | | 0.149 | 0.147 | 0.15 | 0.151 | 0.146 | 0.148 | 0.149 |
| Religious | | 0.008 | 0.02 | 0.02 | 0.021 | 0.019 | 0.029 | 0.034 |
| Unemployed | | -0.049 | -0.067 | -0.075 | -0.064 | -0.061 | -0.073 | -0.065 |
| Pensioner | | 0.298 | 0.295 | 0.304 | 0.295 | 0.299 | 0.295 | 0.289 |
| Student | | 0.288 | 0.271 | 0.255 | 0.283 | 0.272 | 0.254 | 0.28 |
| Fear | | | -0.036* | | | | | |
| Anger | | | | -0.053*** | | | | |
| Disgust | | | | | -0.041** | | | |
| Sadness | | | | | | -0.052*** | | |
| Surprise | | | | | | | -0.037* | |
| Joy | | | | | | | | -0.034* |
| Log-likelihood | -1961.39 | -1937.05 | -1934.15 | -1930.52 | -1933.32 | -1930.78 | -1934.31 | -1934.91 |
| Pseudo R2 | 0.002 | 0.015 | 0.016 | 0.018 | 0.017 | 0.018 | 0.016 | 0.016 |
| N | 4990 | 4990 | 4990 | 4990 | 4990 | 4990 | 4990 | 4990 |

**Logistic regression; Dependent variable: *Compound prob.* (Acceptable interval from Table 2)**

| Variable | Base | Demo | Fear | Anger | Disgust | Sadness | Surprise | Joy |
|---|---|---|---|---|---|---|---|---|
| Treatment Cold | -0.167* | -0.184* | -0.171* | -0.172* | -0.171* | -0.166* | -0.186* | -0.193* |
| Tr_Unemployment | -0.681*** | -0.722*** | -0.736*** | -0.723*** | -0.722*** | -0.728*** | -0.734*** | -0.725*** |
| Female | | -0.217** | -0.238** | -0.217** | -0.213** | -0.228** | -0.195** | -0.198** |
| Age | | -0.037* | -0.037* | -0.038** | -0.039** | -0.039** | -0.038** | -0.037* |
| $Age^2$ | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| City Population | | | | | | | | |
| Small | | 0.112 | 0.119 | 0.12 | 0.117 | 0.125 | 0.114 | 0.102 |
| Medium | | 0.234 | 0.21 | 0.231 | 0.218 | 0.215 | 0.209 | 0.204 |
| Large city/suburbs | | 0.191 | 0.172 | 0.19 | 0.177 | 0.181 | 0.154 | 0.152 |
| Edu: secondary | | -0.424 | -0.389 | -0.393 | -0.387 | -0.387 | -0.402 | -0.411 |
| Edu: higher | | -0.43 | -0.417 | -0.406 | -0.396 | -0.404 | -0.418 | -0.419 |
| Wealth: low | | -0.141 | -0.071 | -0.109 | -0.106 | -0.072 | -0.102 | -0.132 |
| Wealth: high | | -0.272 | -0.16 | -0.214 | -0.214 | -0.167 | -0.225 | -0.275 |
| Health: poor | | -0.17 | -0.211 | -0.196 | -0.186 | -0.22 | -0.15 | -0.1 |
| Health: good | | 0.001 | 0.005 | -0.001 | -0.001 | 0.004 | 0.002 | 0.002 |
| Religious | | 0.157** | 0.124* | 0.147** | 0.145** | 0.143** | 0.121* | 0.120* |
| Unemployed | | -0.196 | -0.146 | -0.176 | -0.18 | -0.182 | -0.153 | -0.174 |
| Pensioner | | -0.164 | -0.151 | -0.17 | -0.162 | -0.165 | -0.16 | -0.154 |
| Student | | 0.175 | 0.217 | 0.199 | 0.179 | 0.195 | 0.229 | 0.19 |
| Fear | | | 0.091*** | | | | | |
| Anger | | | | 0.044*** | | | | |
| Disgust | | | | | 0.042** | | | |
| Sadness | | | | | | 0.070*** | | |
| Surprise | | | | | | | 0.058*** | |
| Joy | | | | | | | | 0.048*** |
| Log-likelihood | -2440.22 | -2382.23 | -2357.56 | -2376.33 | -2376.93 | -2367.32 | -2373.06 | -2376.71 |
| Pseudo R2 | 0.012 | 0.036 | 0.046 | 0.038 | 0.038 | 0.042 | 0.039 | 0.038 |
| N | 4990 | 4990 | 4990 | 4990 | 4990 | 4990 | 4990 | 4990 |

| **Logistic regression; Dependent variable: *Loss aversion* (Acceptable interval from Table 2)** | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Variable | Base | Demo | Fear | Anger | Disgust | Sadness | Surprise | Joy |
| Treatment Cold | -0.430*** | -0.479*** | -0.504*** | -0.522*** | -0.522*** | -0.509*** | -0.497*** | -0.469*** |
| Tr_Unemployment | -0.522*** | -0.547*** | -0.544*** | -0.553*** | -0.555*** | -0.547*** | -0.537*** | -0.549*** |
| Female | | -0.158* | -0.142* | -0.167* | -0.174* | -0.148* | -0.215** | -0.196** |
| Age | | -0.029* | -0.032* | -0.029* | -0.028* | -0.030* | -0.032* | -0.031* |
| $Age^2$ | | 0.000* | 0.000* | 0.000* | 0.000* | 0.000* | 0.000* | 0.000* |
| City Population | | | | | | | | |
| Small | | 0.213 | 0.209 | 0.2 | 0.212 | 0.208 | 0.218 | 0.228 |
| Medium | | 0.031 | 0.052 | 0.042 | 0.07 | 0.053 | 0.085 | 0.082 |
| Large city/suburbs | | 0.006 | 0.024 | 0.011 | 0.042 | 0.02 | 0.082 | 0.072 |
| Edu: secondary | | 0.986** | 0.950** | 0.919** | 0.905** | 0.953** | 0.938** | 0.967** |
| Edu: higher | | 1.458*** | 1.440*** | 1.408*** | 1.387*** | 1.438*** | 1.435*** | 1.433*** |
| Wealth: low | | 0.386 | 0.325 | 0.304 | 0.308 | 0.319 | 0.317 | 0.377 |
| Wealth: high | | 0.647** | 0.546** | 0.505* | 0.515** | 0.541** | 0.566** | 0.661*** |
| Health: poor | | 0.133 | 0.161 | 0.195 | 0.168 | 0.18 | 0.103 | 0.016 |
| Health: good | | 0.093 | 0.095 | 0.101 | 0.107 | 0.095 | 0.102 | 0.099 |
| Religious | | -0.338*** | -0.317*** | -0.325*** | -0.319*** | -0.331*** | -0.276*** | -0.276*** |
| Unemployed | | 0.041 | 0.008 | 0 | 0.011 | 0.033 | -0.034 | 0.01 |
| Pensioner | | 0.109 | 0.094 | 0.119 | 0.106 | 0.103 | 0.086 | 0.081 |
| Student | | 0.129 | 0.093 | 0.079 | 0.121 | 0.111 | 0.023 | 0.105 |
| Fear | | | -0.086*** | | | | | |
| Anger | | | | -0.110*** | | | | |
| Disgust | | | | | -0.100*** | | | |
| Sadness | | | | | | -0.074*** | | |
| Surprise | | | | | | | -0.128*** | |
| Joy | | | | | | | | -0.086*** |
| Log-likelihood | -2768.53 | -2681.92 | -2658.65 | -2644.8 | -2651.88 | -2664.12 | -2633.13 | -2660.8 |
| Pseudo R2 | 0.009 | 0.04 | 0.048 | 0.053 | 0.051 | 0.046 | 0.057 | 0.047 |
| N | 4990 | 4990 | 4990 | 4990 | 4990 | 4990 | 4990 | 4990 |

| **Logistic regression; Dependent variable: *Death rate* (Acceptable interval from Table 2)** | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Variable | Base | Demo | Fear | Anger | Disgust | Sadness | Surprise | Joy |
| Treatment Cold | -0.391** | -0.387** | -0.398** | -0.404** | -0.410** | -0.389** | -0.393** | -0.380** |
| Tr_Unemployment | -0.889*** | -0.889*** | -0.887*** | -0.889*** | -0.892*** | -0.889*** | -0.882*** | -0.888*** |
| Female | | 0.249* | 0.254* | 0.245* | 0.239* | 0.249* | 0.228 | 0.229 |
| Age | | -0.002 | -0.004 | -0.002 | -0.002 | -0.002 | -0.004 | -0.003 |
| $Age^2$ | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| City Population | | | | | | | | |
| Small | | 0.054 | 0.052 | 0.048 | 0.047 | 0.054 | 0.053 | 0.063 |
| Medium | | 0.03 | 0.041 | 0.033 | 0.047 | 0.031 | 0.05 | 0.06 |
| Large city/suburbs | | -0.16 | -0.154 | -0.16 | -0.145 | -0.159 | -0.134 | -0.123 |
| Edu: secondary | | 0.814 | 0.792 | 0.77 | 0.749 | 0.811 | 0.784 | 0.796 |
| Edu: higher | | 0.527 | 0.51 | 0.486 | 0.464 | 0.524 | 0.504 | 0.504 |
| Wealth: low | | 0.371 | 0.348 | 0.34 | 0.329 | 0.367 | 0.349 | 0.372 |
| Wealth: high | | 0.652 | 0.612 | 0.594 | 0.58 | 0.645 | 0.624 | 0.665 |
| Health: poor | | 0.414 | 0.425 | 0.441* | 0.434 | 0.417 | 0.405 | 0.347 |
| Health: good | | 0.24 | 0.239 | 0.242* | 0.246* | 0.24 | 0.242* | 0.244* |
| Religious | | -0.133 | -0.127 | -0.128 | -0.123 | -0.133 | -0.112 | -0.101 |
| Unemployed | | -0.146 | -0.159 | -0.159 | -0.158 | -0.146 | -0.167 | -0.157 |
| Pensioner | | 0.054 | 0.047 | 0.059 | 0.053 | 0.054 | 0.049 | 0.044 |
| Student | | 0.221 | 0.205 | 0.197 | 0.218 | 0.22 | 0.181 | 0.205 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Fear | | | -0.035 | | | | | |
| Anger | | | | -0.046* | | | | |
| Disgust | | | | | -0.057* | | | |
| Sadness | | | | | | -0.005 | | |
| Surprise | | | | | | | -0.047* | |
| Joy | | | | | | | | -0.049* |
| Log-likelihood | -1196.27 | -1172.64 | -1171.37 | -1170.4 | -1169.36 | -1172.62 | -1170.4 | -1170.3 |
| Pseudo R2 | 0.016 | 0.035 | 0.036 | 0.037 | 0.038 | 0.035 | 0.037 | 0.037 |
| N | 4990 | 4990 | 4990 | 4990 | 4990 | 4990 | 4990 | 4990 |

**Logistic regression; Dependent variable: *Beliefs update* (Acceptable interval from Table 2)**

| Variable | Base | Demo | Fear | Anger | Disgust | Sadness | Surprise | Joy |
|---|---|---|---|---|---|---|---|---|
| Treatment Cold | 0.139 | 0.149 | 0.144 | 0.147 | 0.147 | 0.146 | 0.148 | 0.152 |
| Treatment Unemployment | -0.195* | -0.186* | -0.184* | -0.186* | -0.186* | -0.186* | -0.181* | -0.185* |
| Female | | -0.041 | -0.037 | -0.042 | -0.042 | -0.04 | -0.052 | -0.049 |
| Age | | 0.018 | 0.018 | 0.018 | 0.018 | 0.018 | 0.018 | 0.018 |
| $Age^2$ | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| City Population | | | | | | | | |
| Small | | -0.194 | -0.195 | -0.194 | -0.194 | -0.195 | -0.194 | -0.19 |
| Medium | | -0.104 | -0.097 | -0.104 | -0.103 | -0.102 | -0.093 | -0.093 |
| Large city/suburbs | | -0.048 | -0.042 | -0.048 | -0.046 | -0.046 | -0.032 | -0.033 |
| Edu: secondary | | 0.037 | 0.026 | 0.034 | 0.033 | 0.033 | 0.027 | 0.031 |
| Edu: higher | | 0.144 | 0.14 | 0.142 | 0.141 | 0.142 | 0.138 | 0.139 |
| Wealth: low | | -0.135 | -0.152 | -0.138 | -0.138 | -0.142 | -0.15 | -0.136 |
| Wealth: high | | -0.097 | -0.126 | -0.102 | -0.102 | -0.107 | -0.115 | -0.092 |
| Health: poor | | 0.053 | 0.063 | 0.055 | 0.055 | 0.058 | 0.043 | 0.027 |
| Health: good | | -0.063 | -0.064 | -0.063 | -0.062 | -0.063 | -0.063 | -0.063 |
| Religious | | -0.065 | -0.057 | -0.064 | -0.064 | -0.064 | -0.05 | -0.05 |
| Unemployed | | -0.011 | -0.02 | -0.013 | -0.012 | -0.012 | -0.026 | -0.018 |
| Pensioner | | 0.159 | 0.158 | 0.16 | 0.159 | 0.159 | 0.158 | 0.154 |
| Student | | -0.126 | -0.135 | -0.128 | -0.126 | -0.128 | -0.148 | -0.13 |
| Fear | | | -0.024* | | | | | |
| Anger | | | | -0.004 | | | | |
| Disgust | | | | | -0.004 | | | |
| Sadness | | | | | | -0.007 | | |
| Surprise | | | | | | | -0.026* | |
| Joy | | | | | | | | -0.019 |
| Log-likelihood | -2868.69 | -2845.26 | -2843.09 | -2845.18 | -2845.19 | -2845.05 | -2842.89 | -2844.17 |
| Pseudo R2 | 0.003 | 0.011 | 0.012 | 0.011 | 0.011 | 0.011 | 0.012 | 0.012 |
| N | 4990 | 4990 | 4990 | 4990 | 4990 | 4990 | 4990 | 4990 |

Table C5. Study 2: Specific values of variables for individual countries

| | England | Kenya | New Zealand | USA | Spain | Argentina | Mexico | Poland | Total |
|---|---|---|---|---|---|---|---|---|---|
| Female | 0.52 | 0.38 | 0.51 | 0.56 | 0.47 | 0.46 | 0.52 | 0.52 | 0.52 |
| Age | 49.62 | 30.99 | 46.87 | 52.76 | 47.33 | 41.4 | 39.49 | 42.86 | 46.67 |
| Education | 2.47 | 2.82 | 2.46 | 2.51 | 2.52 | 2.55 | 2.74 | 2.47 | 2.55 |
| Income | 2.9 | 2.68 | 2.82 | 2.98 | 2.99 | 2.82 | 3.04 | 3.13 | 2.94 |
| Health | 2.58 | 3.24 | 2.72 | 2.86 | 2.91 | 3.13 | 3.06 | 2.72 | 2.89 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Religious | 0.54 | 1.24 | 0.68 | 1.11 | 0.64 | 0.82 | 1.03 | 0.84 | 0.95 |
| Joy | 4.67 | 6.33 | 4.88 | 4.93 | 5.76 | 6.09 | 7.3 | 4.94 | 5.39 |
| Fear | 3.81 | 4.7 | 3.9 | 3.55 | 4.44 | 4.32 | 4.59 | 5.08 | 4.07 |
| Anger | 3.85 | 3.9 | 3.6 | 3.57 | 4.17 | 4.32 | 4.04 | 4.69 | 3.87 |
| Disgust | 3.42 | 3.68 | 3.54 | 3.59 | 4.8 | 4.99 | 4.66 | 3.72 | 3.9 |
| Sadness | 4.21 | 4.53 | 4.2 | 3.9 | 4.85 | 4.66 | 4.41 | 5.17 | 4.3 |
| Surprise | 3.95 | 4.61 | 3.99 | 4.11 | 5.02 | 5.2 | 6 | 4.58 | 4.5 |
| Risk: overall | 5.54 | 8.16 | 5.79 | 5.72 | 5.9 | 6.95 | 7.63 | 5.9 | 6.22 |
| Risk: work | 4.96 | 5.42 | 5.19 | 5.07 | 5.4 | 5.71 | 6.14 | 5.18 | 5.28 |
| Risk: health | 4.71 | 4.69 | 4.97 | 5 | 5.48 | 5.56 | 5.55 | 5.5 | 5.12 |
| Mask: wearing | 2.9 | 3.22 | 3.77 | 2.79 | 3.86 | 3.69 | 3.82 | 3.43 | 3.22 |
| Distance | 7.03 | 7.23 | 7.5 | 7.37 | 7.36 | 7.26 | 8.35 | 6.37 | 7.32 |
| Performance | 0.54 | 0.51 | 0.53 | 0.49 | 0.51 | 0.5 | 0.48 | 0.47 | 0.5 |

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