EXEX Online Appendix for Do People Really Want to Be Informed?

Romain Espinosa, Jan Stoop

November 2020

Appendix A: A theoretical model of cognitive dissonance for the spectrum of knowledge

In this section we develop a theoretical model based on cognitive dissonance theory that would account for the beliefs reported in the spectrum of knowledge (see Figure 1).

General framework. We consider a situation where agents can consume a private good that may generate negative externalities for society. In the good state of the world ($s = 0$), private consumption c does not generate negative externalities, while it does in the bad state ($s = 1$). We assume here that the true state of the world is $s = 1$. In the following, we take our inspiration from the models of memory management in Bénabou & Tirole (2002) and Hestermann et al. (2018) and assume that individuals are made up of two agents (Self 0 and Self 1).[4] The true state of the world is not directly observable by either Self 0 or Self 1.

Self 0 receives a number of signals over time about the state of the world and constructs a belief, δ_0, about the probability that the current state of the world is bad ($\delta_0 = Pr[s = 1]$). Self 0 can fully or partially reveal its knowledge to Self 1, but hiding knowledge is costly (that means, there is a *self-deception costThe self-deception costs might vary across individuals, across topics, and can regroup several psychological factors relative to information acquisition such as the preference for the truth.*). This process mimics motivated reasoning in cognitive-dissonance theory, where individuals try to underestimate the negative externalities of their behavior to justify their consumption of the private good. The resulting belief of Self 1 is denoted β.

The timing of the game is as follows: (i) Based on its belief δ_0, Self 0 decides on the information to transmits to Self 1, which generates beliefs β, and (ii) based on its beliefs β, Self 1 chooses consumption of the potentially-harmful private good. In the following, we consider an equilibrium for this game where both Self 0 and Self 1 maximize their utility, and where Self 1 naively trusts the information provided by Self 0.[5] The equilibrium is calculated

[4] In Bénabou & Tirole (2002), individuals have two distinct time horizons, which we model here as two Selves, as in Hestermann et al. (2018).

[5] We consider Self 1 here as a naive non-Bayesian agent. There are two reasons for doing so. First, our objective is to develop a model that accounts for non-Bayesian behaviors (i.e. cognitive dissonance). Specifying a model with a Bayesian agent to account for non-Bayesian behaviors is as debatable as specifying a naive agent. Second, Hestermann et al. (2018) show that modeling Self 1 as a Bayesian agent still leaves room for Self 0 to manipulate the beliefs of Self 1 at some cost. As the two models (naive agent and Bayesian agents) yield the same type of results (manipulating beliefs is effective, but at some cost), we choose simplicity here

by backward induction: Self 1 maximizes its utility given the beliefs transmitted by Self 0, and Self 0 chooses the optimal level of motivated reasoning anticipating Self 1's choice.

The left-hand side of Figure A1 illustrates Self 1's utility depending on its consumption of the private good and its belief β. This depicts the utility functions of Self 1 for four types of beliefs: $\beta = 1 > \beta_1 > \beta_2 > \beta = 0$. These curves reflect a number of fundamental assumptions about agent preferences. First, the concavity of the utility curves reflects the tradeoff between decreasing marginal utility and the fixed price of consuming the private good ($\frac{\partial^2 U(c|\beta)}{\partial c^2} < 0$). Second, all utilities are equal (and normalized to 0) when the individual consumes nothing, as zero consumption generates no externalities whatever the state of the world ($\forall \beta, U(0|\beta) = 0$).

Third, for each given level of consumption of the private good, utility is larger when the individual believes that the bad state of the world (i.e. generating negative externalities) is less likely. More formally, we have that $\forall (\beta_1, \beta_2) \in (0,1)^2$, such that $\beta_1 > \beta_2, \forall c \geq 0 : U(c|\beta_1) < U(c|\beta_2)$. We then define the convex function $V_1(\beta)$ as the maximum utility reached by Self 1 for a given belief β ($V_1(\beta) = \max_c \hat{\text{A}} \;\; U(c|\beta)$). At $\delta = 0$ and $\delta = 1$, the state of the world is certain, and Self 1 derives utility $V_1(0)$ and $V_1(1)$ respectively. See the left-hand side of Figure A1.

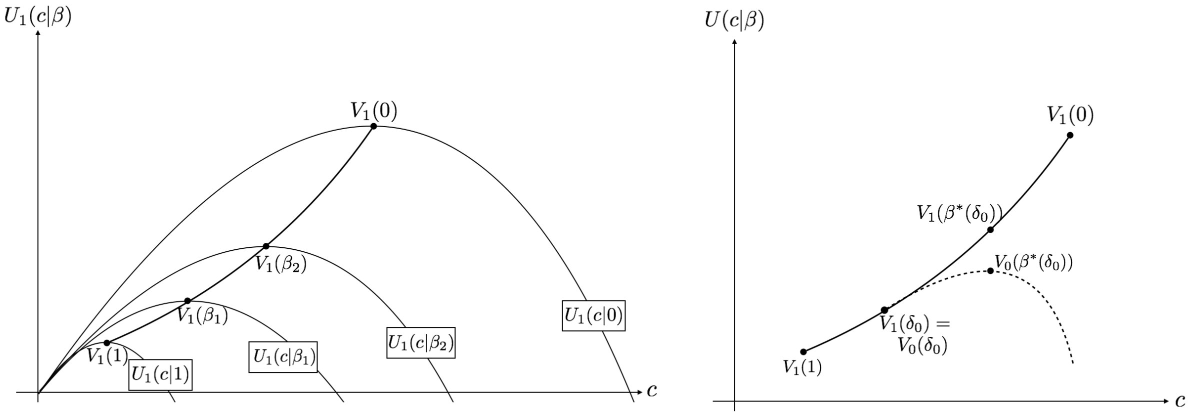
The right hand-side of Figure A1 shows how Self 0 can manipulate Self 1's beliefs. Following Hestermann et al. (2018), we assume that Self 0's utility is equal to Self 1's utility minus a cognitive cost that rises with the degree of belief manipulation ($V_0(\delta_0, \beta) = V_1(\beta) - \phi(\delta_0, \beta)$, $\frac{\partial \phi(\delta_0, \beta)}{\partial \beta} \leq 0$ for $\beta < \delta_0$). The graph starts with the utility of agent Self 0 if Self 1's beliefs are equal to Self 0's beliefs ($\beta = \delta_0$) (i.e. no manipulation). The dashed line represents the utility of Self 0 given his original belief δ_0. When Self 0 does not manipulate beliefs (i.e. $\beta = \delta_0$) and, therefore does not bear any cognitive costs, the utilities of Self 1 and Self 0 are the same.

If Self 0 does manipulate beliefs, Self 1 will underestimate the probability of the bad state of the world, which will increase his utility (V_1 increases), and, by definition, Self 0's utility as well. However, Self 0 will also incur a growing cognitive cost associated with this belief manipulation ($\phi(\delta, \beta)$ increases). The optimal manipulated belief $\beta^*(\delta_0)$ corresponds to the argument that maximizes the utility of Self 0 ($\beta^*(\delta_0) = \text{argmax}_\beta V_0(\beta, \delta_0)$). We characterize below the types of beliefs in the equilibrium where Self 0's strategy is $\beta^*(\delta_0)$ and Self 1's strategy is $c^* = \text{argmax}_c \hat{\text{A}} \;\; U(c|\beta^*(\delta_0))$.

We now consider the case where individuals are asked by an interviewer to report the state of the world. We assume a general strategy where Self 1 will report $s = 1$ if his belief is above a threshold $\overline{\delta}$, and $s = 0$ if his belief is below a threshold $\underline{\delta}$. We allow individuals to report 'I don't know' when their beliefs take values between $\underline{\delta}$ and $\overline{\delta}$.

and model Self 1 as a naive agent.

Figure A1 Utility curves and motivated reasoning



Definition: *Accepted knowledge* in the population corresponds to the share of individuals who correctly and spontaneously report the state of the world ($s = 1$). This is equal to: $Pr[\delta_0 \geq \overline{\delta}; \beta^*(\delta_0) \geq \overline{\delta}]$, which simplifies to $Pr[\beta^*(\delta_0) \geq \overline{\delta}]$.

The proportion of *Accepted knowledge* in society depends on the distribution of original beliefs δ_0 and the cost of self-deception. Note that in the definition, the first condition is always fulfilled when the second condition is met, since $\beta^*(\delta_0) \leq \delta_0$. First, the more the distribution is concentrated close to $\delta = 1$ (left-skewed), i.e. the more the population truly believes that $s = 1$ is likely, the greater the share of *accepted knowledge*. Second, a higher cost of self-deception is associated with a greater share of *accepted knowledge*. Higher cognitive self-deception costs reduce the incentives to lie, reducing the proportion of individuals whose true beliefs are above $\overline{\delta}$ but whose manipulated beliefs are below $\overline{\delta}$.

Definition : *Pretended ignorance* in the population corresponds to the proportion of individuals whose original beliefs produce $s = 1$ but whose manipulated beliefs lead them to report either ‘I don’t know’ or $s = 0$. The proportion of fake ‘I don’t knows’ is $Pr[\delta_0 \geq \overline{\delta}; \beta^*(\delta_0) \in [\underline{\delta}, \overline{\delta})]$, and the proportion of fake incorrect reporting ($s = 0$) is $Pr[\delta_0 \geq \overline{\delta}; \beta^*(\delta_0) < \underline{\delta}]$. The total amount of *pretended ignorance* is $Pr[\delta_0 \geq \overline{\delta_0}; \beta^*(\delta_0) < \overline{\delta}]$.

The amount of *pretended ignorance* in society is positively correlated with the amount of evidence supporting $s = 1$ and negatively associated with self-deception costs. For the former, pretended ignorance can only occur when original beliefs support $s = 1$. Individuals do not need motivated reasoning if most of the evidence supports $s = 0$, as their original belief δ_0 is already below $\overline{\delta}$. This reduces the likelihood that the first condition is met. For the latter, higher costs make self-deception less attractive for individuals. Individuals whose original beliefs are above $\overline{\delta}$ are less likely to manipulate their beliefs such that $\beta^*(\delta_0) < \overline{\delta}$.

Higher self-deception costs therefore reduce the likelihood that the second condition is met.

Definition : Accepted ignorance in the population corresponds to the proportion of individuals whose original and manipulated beliefs lead them to report 'I don't know'. This is equal to $Pr[\beta^*(\delta_0) \in [\underline{\delta}, \overline{\delta}); \delta_0 \in [\underline{\delta}, \overline{\delta})]$.

The share of *accepted ignorance* also depends on the distribution of original beliefs and self-deception costs. On the one hand, relatively-undocumented questions, or topics with contradictory evidence, will produce a greater mass of individuals between the two thresholds $\underline{\delta}$ and $\overline{\delta}$. This will increase the probability that the first condition is met. On the other hand, greater self-deception costs reduce the incentives to engage in motivated reasoning, and so the distortion between δ_0 and $\beta^*(\delta_0)$. This will increase the probability of the second condition, given that the first condition is fulfilled.

Imagine now that we provide participants with the possibility to access information revealing the correct state of the world. We assume that information access has an opportunity cost k. This opportunity cost might vary across individuals, depending on various psychological factors such as curiosity or entertainment. Individuals who acknowledge that they are ignorant might be willing to access this information if the benefits of doing so outweigh the associated costs. Access has two opposite effects on individual utility. The first effect is that utility may rise if the signal reveals a good state of the world ($\forall \delta_0 \in (0, 1) : V_0(0) \geq V_0(\beta^*(\delta_0))$).

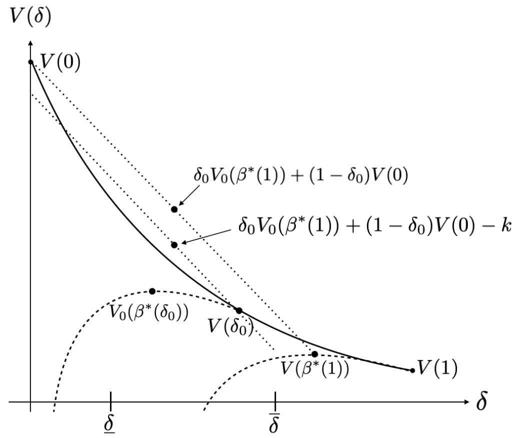
Alternatively individuals may discover a bad state of the world, which will force them to reduce their level of consumption and engage in cognitive dissonance ($\forall \delta_0 \in (0, 1) : V_0(\beta^*(1)) \leq V_0(\beta^*(\delta_0))$). Self 0 expects to discover a bad state of the world with probability δ_0 and a good state of the world with probability $1 - \delta_0$. The expected utility of information access is then $(1 - \delta_0)V_0(0) + \delta_0 V_0(\beta^*(1)) - k$. Individuals who acknowledge that they are ignorant will access the information if $(1 - \delta_0)V_0(0) + \delta_0 V_0(\beta^*(1)) - k > V_0(\beta^*(\delta_0))$. This is summarized in Figure A2, which illustrates the case where individuals are willing to become informed.

Definition : Population Information-seeking accepted ignorance is the share of individuals whose original and manipulated beliefs lead them to report 'I don't know', but who would actively access information about the true state of the world. This is $Pr[\beta^*(\delta_0) \in [\underline{\delta}, \overline{\delta}); \delta_0 \in [\underline{\delta}, \overline{\delta}); (1 - \delta_0)V_0(0) + \delta_0 V_0(\beta^*(1)) - k \geq V_0(\beta^*(\delta_0))]$.

Definition : Population Information-passive accepted ignorance is the share of individuals whose original and manipulated beliefs lead them to report 'I don't know', and who would not actively access information about the true state of the world. This is $Pr[\beta^*(\delta_0) \in [\underline{\delta}, \overline{\delta}); \delta_0 \in [\underline{\delta}, \overline{\delta}); (1 - \delta_0)V_0(0) + \delta_0 V_0(\beta^*(1) - k < V_0(\beta^*(\delta_0))]$.

Both types of *accepted ignorance* depend on the distribution of original beliefs and self-deception costs, as discussed above. The decomposition of *accepted ignorance* into *information-seeking* and *information-passive* categories depends on the costs of information access and the convexity of the maximum utility function. Higher information costs will naturally discourage access. The condition $(1-\delta_0)V_0(0)+\delta_0 V_0(\beta^*(1))-k > V_0(\beta^*(\delta_0))$ is less likely to hold for larger k. In addition, the convexity of $V(.)$ will reduce the second term of the equation $V_0(\beta^*(\delta_0))$, so that revealing the state of the world will become more attractive and $(1-\delta_0)V_0(0)+\delta_0 V_0(\beta^*(1))$ will be more likely to be above $V_0(\beta^*(\delta_0))$. Overall, *information-seeking accepted ignorance* is expected to rise with the convexity of $V(.)$.

Figure A2 Information Access: information-seeking accepted ignorance



Definition : <u>*Selective ignorance*</u> corresponds to the share of individuals whose manipulated beliefs lead them to report $s=0$, and who, therefore, do not want to become informed, but would have accessed informed in the absence of cognitive dissonance. The proportion of *selective ignorance* in society is $Pr[\beta^*(\delta_0) < \underline{\delta}; \delta_0 \in [\underline{\delta}, \overline{\delta}); (1-\delta_0)V_0(0)+\delta_0 V_0(1)-k \geq V_0(\delta_0)]$.

The population frequency of *selective ignorance* depends on the distribution of original beliefs, the cost of self-deception, the cost of information, and the convexity of the maximum utility function. This frequency first rises with the proportion of individuals whose original beliefs lie between $\underline{\delta}$ and $\overline{\delta}$. The less well-known is the topic for the general population, the more likely is *selective ignorance*. Second, we expect a negative relationship between *selective ignorance* and the costs of self-deception: these latter reduce the distortion between δ_0 and $\beta^*(\delta_0)$, which makes $\beta^*(\delta_0) < \underline{\delta}$ less likely to hold.

Third, it is straightforward to see that higher costs of information access reduce the willingness to be informed. This reduces the likelihood that the last condition holds, leading to a negative relationship between information costs and *selective ignorance*. Last, we noted above that greater convexity in the utility function makes information more attractive. We therefore expect a positive relationship between *selective ignorance* and the convexity of the maximum utility function.

Definition : *Unconscious ignorance* refers to the population share whose original and manipulated beliefs support $s = 0$. This proportion of individuals is $Pr[\beta^*(\delta_0) < \underline{\delta}; \delta_0 < \underline{\delta}]$, which simplifies to $Pr[\delta_0 < \underline{\delta}]$.

The proportion of *unconscious ignorance* in society depends only on the distribution of original beliefs: the more evidence there is for $s = 0$, the more the distribution of beliefs will be concentrated towards $\delta = 0$, leading to higher shares of *unconscious ignorance*. Note that *unconscious ignorance* does not depend on self-deception costs, as individuals in this category would also support $s = 0$ if they did not engage in motivated reasoning. Finally, we consider here that individuals who are unconsciously ignorant are sufficiently sure that $s = 0$ that the opportunity costs of information access outweigh the associated benefits.

Appendix B: The questions in the questionnaire

Table B1 Statements in the online questionnaire: Meat consumption in the UK

Order	Question (as statements)	Correct answer
1	Eating meat and fish is essential for the healthy growth of children. link: https://www.ncbi.nlm.nih.gov/pubmed/19562864	False
2	Processed meat is a carcinogen (i.e., food that causes cancer). link: http://www.who.int/features/qa/cancer-red-meat/en/	True
3	Should everyone erase meat from their diets, greenhouse gas emissions would decrease by 10% at most. link: https://www.drawdown.org/solutions/food/plant-rich-diet	False
4	The vast majority of soy production (which is the most important factor for deforestation) is used to produce vegan food items (like tofu). link: http://wwf.panda.org/wwf_news/?247051	False
5	For a cow to give milk independently, the most important requirement is that she eats grass. link: https://www.theguardian.com/commentisfree/2017/mar/30/dairy-scary-public-farming-calves-pens-alternatives	False
6	Unlike caged production, organic eggs do not involve the killing of young male chicks (inappropriate for egg-laying). link: https://www.independent.co.uk/life-style/food-and-drink/hatched-discarded-gassed-what-happens-to-male-chicks-in-the-uk-10088509.html	False

Table B2 Statements in the online questionnaire: Alcohol consumption in the UK

Order	Question (as statements)	Correct answer
1	Frequent drinking is more common among low income earners than among high income earners (earning Â£40,000 and above annually). www.ons.gov.uk/peoplepopulationandcommunity/healthandsocialcare/druguse alcoholandsmoking/bulletins/opinionsandlifestylesurveyadultdrinkinghabits ingreatbritain/2005to2016	False
2	Alcohol causes extra risk of heart attacks in men only when they drink more than 10 pints of average strength beer a week. link: https://www.nhs.uk/news/lifestyle-and-exercise/people-who-drink-above-uk-alcohol-guidelines-lose-one-two-years-life/	False
3	Alcohol dependency occurs more than twice as much in the UK as in the rest of Europe. link: http://www.who.int/substance_abuse/publications/global_alcohol_report profiles/gbr.pdf	True
4	Alcohol is a carcinogen (i.e. consumption of it causes cancer). link: https://www.cancer.gov/about-cancer/causes-prevention/risk/alcohol/alcohol-fact-sheet#q2	True
5	People who use alcohol before age 15 are as likely to become alcohol dependent as adults who begin drinking at age 21. link: https://www.cdc.gov/alcohol/faqs.htm#young	False
6	Less than 5% of the traffic accidents in the UK involve at least one driver being over the drink-drive limit. link: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/402698/rrcgb-drink-drive-2013-prov.pdf	False

Table B3 Statements in the online questionnaire: Immigration

Order	Question (as statements)	Correct answer
1	The UK's visa entry requirements for skilled workers have been lowered in the past ten years. link: https://ichef.bbci.co.uk/news/624/cpsprodpb/7E95/production/_101150423_chart-imm-entry_v2-nc.png	False
2	Foreign-born women in the UK on average give birth to about twice as many children as UK-born women. link: https://www.ons.gov.uk/peoplepopulationandcommunity/birthsdeathsandmarriages/livebirths/bulletins/parentscountryofbirthenglandandwales/2017	False
3	About 8% of the workers in the UK's construction sector are non-UK nationals. link: https://www.ons.gov.uk/peoplepopulationandcommunity/populationandmigration/internationalmigration/articles/migrantlabourforcewithintheconstructionindustry/august2018	True
4	Asylum seekers in the UK receive at least £10 per day for food, sanitation and clothing. link: https://www.unhcr.org/asylum-in-the-uk.html	False
5	Most of the Non-EU immigrants that come to the UK, come to look for a job. link: https://ichef.bbci.co.uk/news/624/cpsprodpb/002B/production/_101134000_reasonsforcoming-nc.png	False
6	The UK forms the second-largest receiver of asylum applications in the EU (with Germany being first). link: https://www.bbc.com/news/world-europe-44660699	False

Table B4 Statements in the online questionnaire: Control questions that should trigger no information resistance

Order	Question (as statements)	Correct answer
1	The first shuttle to the moon had three persons on board.	True
2	This soccer stadium is located in France. [Picture of Allianz Arena]	False
3	Toyota belongs to the top 10 largest companies in the world (ranked by revenue).	True
4	In 1990, the UK had between 56 and 58 million inhabitants.	True
5	In 2011, the UK's main source of generating electricity was coal.	False
6	The company Google receives more income from licences than from other sources (e.g. advertisements).	False

Appendix C: Statistics table

Table C1 Demographics

	Main treatments			Infographics		
	Diet	Alcohol	Immigration	Diet	Alcohol	Immigration
Student						
Yes (%)	15	17.8	17.8	23.4	23.4	25.8
No (%)	82.3	78.2	79.1	74.6	74.6	72.2
Missing (%)	2.7	4.1	3.1	2	2	2
Gender						
Male (%)	35.2	29.4	35.9	31.8	25.4	29.3
Female (%)	64	68.3	62.4	67.2	73.1	70.2
Missing (%)	0.9	2.2	1.7	1	1.5	0.5
Age						
Mean	38.1	38	36.5	32.6	34.5	33.5
Std Dev.	(12.1)	(13.2)	(12.3)	(10.4)	(11.2)	
Missing (%)	2.6	5.1	3.8	2.5	2.5	2.5
Employment						
Start next month (%)	0.8	0.9	1.3	0	1.5	0
Full-time (%)	49.5	47.1	49.6	48.8	48.8	48
Unemployed - not seeking (%)	15.4	14.7	11.4	13.4	12.4	11.1
Other (%)	4.1	4.7	5.2	4.5	2	4
Part-time (%)	23.2	21.8	22.6	25.9	23.4	27.3
Unemployed - seeking (%)	4.5	5.9	6.6	6	10	6.6
Missing (%)	2.6	4.9	3.3	1.5	2	3
Observations	1,795	1,800	1,800	201	201	198

Table C2 Number of participants in each treatment

Treatment	Diet	Alcohol	Immigration
Main			
H-NL	199	200	197
H-NL-3	201	188	200
H-L	200	206	199
I10-NL	199	200	201
I10-L	198	201	200
I30-NL	198	208	200
I30-L	199	199	200
I50-NL	200	205	198
I50-L	201	193	200
Pilot			
H-NL	191	-	-
H-L	211	-	-
I10-NL	217	-	-
I10-L	181	-	-
Heavy Drinkers			
H-NL	-	200	-
I10-NL	-	200	-
Infographics			
H-NL	201	201	198
No cognitive dissonance			
H-NL		201	

Table C3 Summary statistics

	Diet		Alcohol		Immigration	
	Mean	St. Dev.	Mean	St. Dev.	Mean	St. Dev.
	Percentage of correct answers					
H-NL	.499	.253	.585	.199	.519	.218
H-L	.547	.274	.638	.214	.669	.266
I10-NL	.572	.235	.579	.212	.496	.216
I10-L	.603	.276	.634	.209	.668	.255
I30-NL	.54	.25	.576	.205	.516	.208
I30-L	.595	.273	.631	.204	.658	.260
I50-NL	.544	.259	.586	.215	.516	.209
I50-L	.61	.267	.600	.187	.647	.270
H-NL-3	.361	.253	.467	.227	.298	.216
	Percentage of 'I don't know' answers					
H-NL-3	.334	.241	.224	.224	.352	.275

Table C4 Regression of the percentage of correct answers for the pilote sessions on the order of the screen.

	Percentage of correct answers	
	Diet	
Link	0.0724***	0.0673***
	(0.0192)	(0.0184)
I10	0.0826***	0.0779***
	(0.0191)	(0.0183)
Ask diet first	-0.00316	0.000221
	(0.0191)	(0.0184)
Constant	0.337***	0.667***
	(0.0188)	(0.0464)
Diet	No	Yes
Observations	800	800
R-squared	0.037	0.117

Robust standard errors appear in parentheses. ***/**/*: significant at the 1%/5%/10% levels.

Table C5 MLE estimates of the knowledge spectrum for daily meat eaters (Diet), heavy drinkers (Alcohol) and extreme-right voters (Immigration)

	Diet	Alcohol	Immigration
Accepted Knowledge	0.257***	0.431***	0.214***
	(0.018)	(0.036)	(0.029)
Information Seeking	0.095	0.209***	0.310***
	(0.060)	(0.045)	(0.059)
Information Passive	0.061	0.001	0.001
	(0.075)	(0.008)	(0.01)
Unconscious Ignorance	0.442***	0.329***	0.425***
	(0.014)	(0.021)	(0.024)
Fake IDK	0.144***	0.015	0.046
	(0.053)	(0.031)	(0.052)
Fake Incorrect	0	0.015	0.002
	(0)	(0.02)	(0.008)
Selective Ignorance	0	0.001	0
	(0)	(0.006)	(0.001)
Information Resistance	0.144***	0.031	0.048
	(0.053)	(0.034)	(0.052)
ICEI	0.598***	0.539***	0.736***
	(0.052)	(0.046)	(0.057)
N	977	214	289

Bootstrap estimates. Standard errors appear in parentheses. ***/**/*: significant at the 1%/5%/10% levels.

Appendix D: The infographics

Figure D1 Infographic for the diet treatment

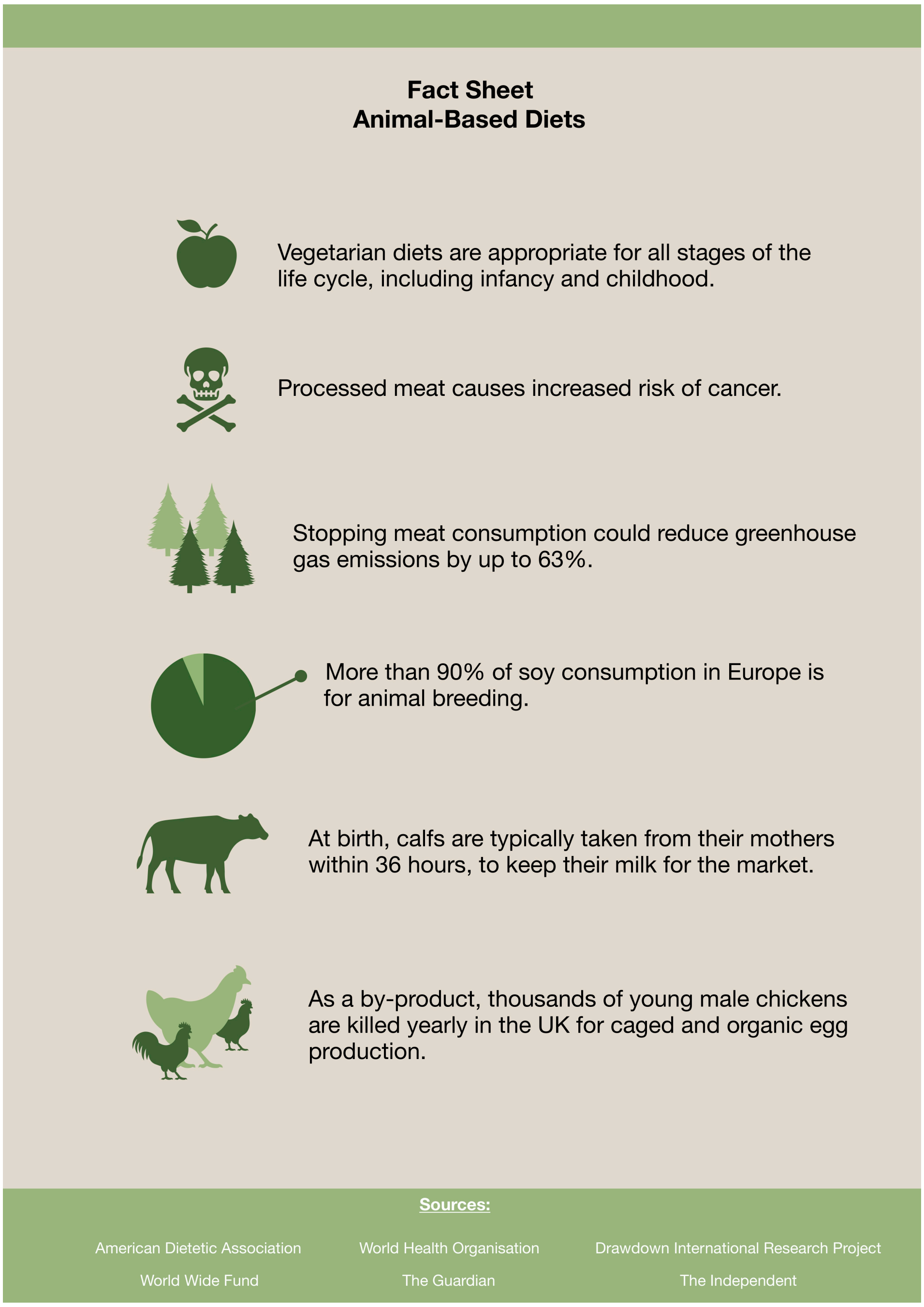
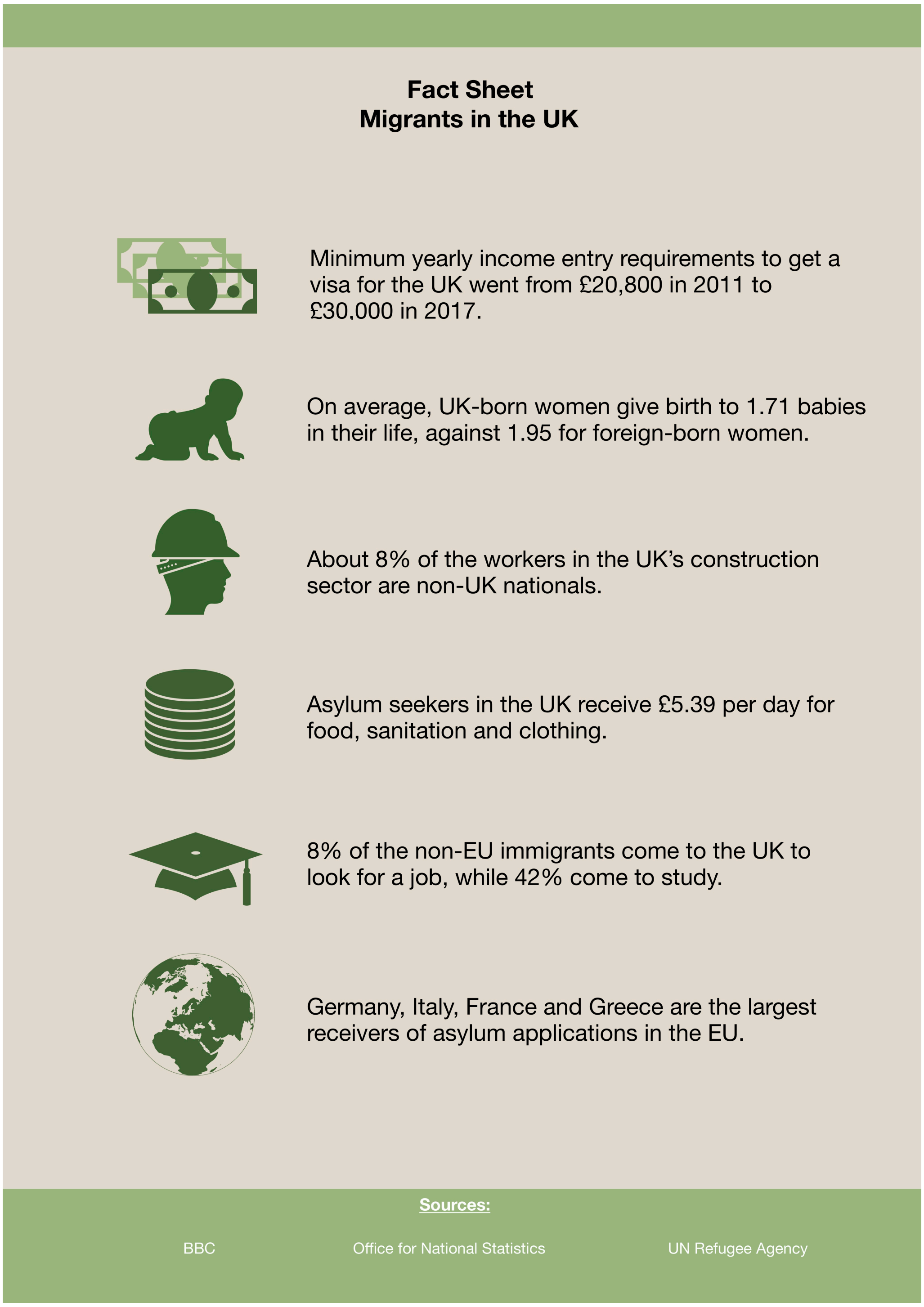


Figure D2 Infographic for the alcohol treatment

Figure D3 Infographic for the immigrant treatment



Appendix E: Maximum Likelihood Estimation

Table 2 summarizes how each type of belief is expressed as a correct, incorrect, or 'I don't know' answer. Let us note ϕ_k the proportion of each type of belief in the knowledge spectrum. Table 2 can be rewritten in forms of equations:

$$
\begin{aligned}
P(\text{Correct}|\text{H-NL-3}) &= \phi_{AK} \\
P(\text{IDK}|\text{H-NL-3}) &= \phi_{IS} + \phi_{IP} + \phi_{FIDK} \\
P(\text{Incorrect}|\text{H-NL-3}) &= \phi_{UI} + \phi_{FI} + \phi_{SI} \\
P(\text{Correct}|\text{H-NL}) &= \phi_{AK} + s(\phi_{IS} + \phi_{IP}) + (1 - s')\phi_{FIDK} + \phi_{FI} \\
P(\text{Incorrect}|\text{H-NL}) &= (1 - s)(\phi_{IS} + \phi_{IP}) + (1 - s')\phi_{FIDK} + \phi_{FI} + \phi_{UI} + \phi_{SI} \\
P(\text{Correct}|\text{I-NL}) &= \phi_{AK} + s(\phi_{IS} + \phi_{IP}) + \phi_{FIDK} + \phi_{FI} \\
P(\text{Incorrect}|\text{I-NL}) &= (1 - s)(\phi_{IS} + \phi_{IP}) + \phi_{UI} + \phi_{SI} \\
P(\text{Correct}|\text{H-L}) &= \phi_{AK} + \phi_{IS} + s\phi_{IP} + s'\phi_{FIDK} \\
P(\text{Incorrect}|\text{H-L}) &= (1 - s)\phi_{IP} + (1 - s')\phi_{FIDK} + \phi_{FI} + \phi_{UI} + \phi_{SI} \\
P(\text{Correct}|\text{I-L}) &= \phi_{AK} + \phi_{IS} + \phi_{IP} + \phi_{UI} + \phi_{FIDK} + \phi_{FI} + \phi_{SI} \\
P(\text{Incorrect}|\text{I-L}) &= \phi_{UI}
\end{aligned}
$$

Let us note y_i the proportion of correct, incorrect, or 'I don't know' answers given to the questionnaire by individual i. For each treatment j, we assume that the answers are normally distributed with mean μ_j ($y \sim N(\mu_j, \sigma)$). The contribution to the likelihood for the proportion of correct answers of individual i in treatment j is $f(\frac{y_i - \mu_j}{\sigma_j})$ with $f(.)$ the pdf of a normal distribution.