Epistemic vice predicts acceptance of Covid-19 misinformation

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Abstract

Why are mistaken beliefs about Covid-19 so prevalent? Political identity, education and other demographic variables explain only a part of individual differences in the susceptibility to Covid-19 misinformation. This paper focuses on another explanation: epistemic vice. Epistemic vices are character traits that interfere with acquiring, maintaining, and transmitting knowledge. If the basic assumption of vice epistemology is right, then people with epistemic vices such as indifference to the truth or rigidity in their belief structures will tend to be more susceptible to believing Covid-19 misinformation. We carried out an observational study (US sample, $n = 998$) in which we measured the level of epistemic vice of participants using a novel Epistemic Vice Scale. We also asked participants questions eliciting the extent to which they subscribe to myths and misinformation about Covid-19. We find overwhelming evidence to the effect that epistemic vice is associated with susceptibility to Covid-19 misinformation. In fact, the association turns out to be stronger than with political identity, educational attainment, scores on the Cognitive Reflection Test, personality, dogmatism, and need for closure. We conclude that this offers evidence in favor of the empirical presuppositions of vice epistemology.

Keywords: Covid-19, coronavirus, epistemic vice, virtue epistemology, Cognitive Reflection Test, misinformation, fake news

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1. Introduction

Are hand dryers effective in killing the novel coronavirus? Do houseflies transmit the disease? Should you spray your body with or drink bleach to make sure you don't get infected? Certainly not. But some people think so — in fact, sufficiently many people have believed these and other myths that the World Health Organization (WHO) decided to launch a campaign in order to make people aware of the dangerous and potentially lethal effects of believing them.[1] Yet 18% of US residents in our sample endorse the statement that hand dryers are effective in killing the novel coronavirus. Likewise, 15% endorse the claim that Covid-19 can be transmitted through houseflies. And 19% endorse the claim that that spraying and introducing disinfectant into your body will protect you against Covid-19.

Why would people believe that hand dryers kill the novel coronavirus? One reason is that social media are ripe with misinformation about Covid-19. Fact-checking organization *AFP Fact Check* says that the hand dryer myth can be traced back to a video, posted on Facebook on March 13, 2020, and shared hundred thousand of times.[2]

Yet the prevalence of misinformation does not provide a complete explanation for why people endorse myths about the novel coronavirus. Not everyone who is exposed to misinformation about Covid-19 ends up believing it. This raises the question whether we can identify differences

[1] https://www.who.int/emergencies/diseases/novel-coronavirus-2019/advice-for-public/myth-busters (accessed June 24, 2020).
[2] https://factcheck.afp.com/hot-air-saunas-hair-dryers-wont-prevent-or-treat-covid-19 (accessed June 24, 2020).

between people that explain why some are more susceptible to Covid-19 misinformation than others.

Emerging research suggests that someone's political identity is a key predictor of the extent to which they *believe* Covid-19 myths, with Republican-leaning US residents more likely and Democrat-leaning US residents less likely to believe them, as a Reuters/Ipsos poll suggests.[3] Moreover, it's not just about beliefs, but also about *behavior*. The poll showed, for instance, that Republicans had changed their daily lives less extensively in response to news about the spreading pandemic than Democrats.

But the partisan divide explains only a small part of individual differences in the susceptibility to Covid-19 myths and misinformation. In fact, our research suggests that demographic variables including political affiliation, educational achievement, age, gender, ethnicity, the importance of religion, income, and marital status together explain only about one third of variance in susceptibility to Covid-19 myths.

What explains the remaining differences in susceptibility to Covid-19 misinformation? This paper explores whether epistemic vice can explain why people believe Covid-19 myths. Epistemic vices are character traits and other dispositions that interfere with acquiring, maintaining, and transmitting knowledge. An epistemically vicious person might be fooled by a video about hand dryers and Covid-19 to believe that hot air protects against the disease, without

[3] https://www.reuters.com/article/us-health-coronavirus-usa-polarization/americans-divided-on-party-lines-over-risk-from-coronavirus-reuters-ipsos-poll-idUSKBN20T2O3 (accessed June 24, 2020).

evaluating the evidence and counter-evidence, or without getting a second opinion. Vice epistemology explores to what extent people's beliefs are determined by epistemic vices such as indifference to the truth or rigidity in their belief structures.

The philosophical literature on virtue and vice epistemology is wide, including theoretical work as well as applications to such domains as medical and business ethics, education, and law. Until recently, most of this work has focused more on virtue than vice. The empirical literature on epistemic virtue and vice is much smaller, and almost none of it focuses on vice. But without empirical corroboration, this theoretical work remains uncertain and its relevance to applied fields such as education dubious.

The motivation of the present paper is that the Covid-19 pandemic offers an opportunity to study the role of epistemic vice in belief formation. More speculatively, we think that this type of research may be relevant to policymakers: if epistemic vice turns out to be relevant to health beliefs and behaviors, and if epistemic vice can be countered using educational or other interventions, then the public health response to Covid-19 may be bolstered by this line of research.

If the basic assumption of vice epistemology is right, then people with higher degrees of epistemic vice will tend to be more susceptible to Covid-19 myths. This is what we set out to study. We carried out an observational study (US sample, $n = 998$) in which we measured the level of epistemic vice of participants using a novel Epistemic Vice Scale that we developed and validated (anonymized, working paper). We also asked participants questions eliciting whether

they subscribe to myths and misinformation about the coronavirus disease that were sufficiently widespread at the moment of data gathering (8-10 May 2020).

We find overwhelming evidence to the effect that a person's degree of epistemic vice is associated with the extent to which they believe such myths and misinformation. In fact, the association turns out to be stronger than with political identity, educational attainment, and the other demographic factors mentioned above. Adding our short measure of epistemic vice to the mentioned demographic variables increases the variance explained in individual differences in susceptibility to Covid-19 misinformation from about one third to two thirds. Epistemic vice is also more strongly associated with endorsement of Covid-19 misinformation than other psychological measures, including personality, dogmatism, the Cognitive Reflection Test or need for closure. We conclude that this offers evidence in favor of the empirical presuppositions of vice epistemology.

Sections 2 and 3 present some relevant background on Covid-19 myths and vice epistemology. Section 4 presents our results. Section 5 discusses these results and concludes.

2. Prior work relevant to Covid-19 and belief formation

Covid-19 is a respiratory disease caused by one type of coronavirus first identified in China in December 2019. Formally known as the *severe acute respiratory syndrome coronavirus 2* (SARS-CoV-2), it is most often referred to by the name Covid-19 (coronavirus disease 2019) that the World Health Organization (WHO) gave to it in February 2020. While in the beginning it seemed that it would be restricted to China, it started spreading globally in March 2020, and

seems to have reached all but a dozen (mostly small) countries worldwide at the moment of writing.

Covid-19 leads to mild or moderate respiratory symptoms in most patients. In older people and people with cardiovascular diseases, diabetes, and other underlying conditions it is significantly more likely to develop into a serious illness. The disease is thought to have spread from animals to human beings in China in the second half of 2019. It is transmitted through the air via small droplets emitted when an infected person coughs or sneezes. It is estimated that a person who has the disease infects about two to four people, but that this infection rate can be and has been reduced when people take particular hygienic measures and keep physical distance from others. While infection rates have indeed gone down in some countries, at the time of writing this paper the global death toll is nearly half a million people, about 25% of whom were in the US. Over a hundred candidate vaccines are in clinical or preclinical evaluation, but so far no prevention or treatment is available or is expected to be available anytime soon. The most prominent strategies that governments have chosen include extensive restrictions on national and international travel, closing schools and universities, distance learning, restricting access to medical services, mandatory hygiene routines for shops and restaurants, curfews, and social or physical distancing (maintaining a distance from other people of at least 6 feet).

The success of many of these measures depends on the ability and willingness of residents to conform to them, which in turn depends on whether they understand and appreciate the rationale behind the measures. A person who believes that the coronavirus doesn’t spread in warmer climates, as 22% of our respondents do, may see no reason for social distancing. False beliefs

can also gratuitously increase the burden of the disease. If you think that Covid-19 can be transmitted by houseflies, as 15% of respondents in our sample do, you may unnecessarily worry and possibly protect yourself against contact with houseflies.

We find that myths about Covid-19 are prevalent at all educational levels and levels of income. Yet believing myths about Covid-19 is most harmful for people who are impoverished or otherwise vulnerable. Many people in the US may stand to lose their jobs if they refuse to work contact-intensive service jobs, and, lacking employment insurance, they may consequently have to choose between risking infection, on the one hand, and poverty or homelessness on the other.

Before we continue our survey of relevant work, a disclaimer is in place to the effect that most of the studies we survey report very recent research and consequently have not gone through peer-review yet, and we should avoid drawing overly hasty conclusions. We strongly believe that it is imperative that researchers attempt to learn as much as is necessary to contain the spread of Covid-19 misinformation, but research ethics and methodology should not be compromised. To our knowledge, the studies referenced here satisfy these criteria.

Media scholars and other researchers have started studying the determinants of Covid-19 beliefs in various populations. As we mentioned in the Introduction, one key element seems to be political orientation. In a meticulously designed study, Allcott et al. (2020) compare the extent to which US residents follow social distancing measures in regions with higher versus lower proportions of Republican voters. Using geo-localized cell phone data they show that residents in regions with greater Republican support engage less in social distancing as compared with

regions with greater Democratic support. Barrios and Hochberg (2020) found that in counties with high support for President Trump the average resident searches less for information about the coronavirus on the internet than in counties with low support. While much of the extant research concerns the US, similarly polarized countries witness similar effect. In a study on Brazil, Ajzenman, Cavalcanti, and Da Mata (2020), for instance, found evidence to the effect that after public statements in which President Bolsonaro downplayed the severity of the coronavirus pandemic and came close to ridiculing the need for social distancing, residents in regions with greater governmental support engaged less in social distancing than those in regions with less support for the government. These findings are corroborated by numerous further studies (see, e.g., Grossman, Kim, Rexer, & Thirumurthy, 2020; Kushner Gadarian, Wallace Goodman, & Pepinsky, 2020; Painter & Qiu, 2020).

Research on misinformation and the Covid-19 pandemic is scarcer. Some research tries to estimate the impact that various media have on the beliefs and behaviors of residents. Simonov, Sacher, Dubé, and Biswas (2020), for instance, show that the propensity of staying home as part of the measures to combat the spread of Covid-19 is negatively correlated with Fox News cable viewership. As Fox News hosts differed notoriously about the dangers of Covid-19, Bursztyn, Rao, Roth, and Yanagizawa-Drott (2020) refined these findings: they show that counties with larger viewership of the *Sean Hannity Show* have greater numbers of Covid-19 cases and deaths than counties with larger *Tucker Carlson Tonight* viewership. The authors attribute the difference to the fact that while Tucker Carlson already started warning his viewers in early February 2020, Sean Hannity at first dismissed the risks.

Further noteworthy studies concern the effects of Covid-19 media on such things as panic buying (hoarding) (Kuruppu & De Zoysa, 2020), the intentional provision of misinformation globally (Milanovic & Schmitt, 2020), the use of suboptimal communication strategies by governments and policymakers (Romano, Sotis, Dominioni, & Guidi, 2020), and the incidence of misleading information about Covid-19 on YouTube (Li, Bailey, Huyhn, & Chan, 2020).

Stanley, Barr, Peters, and Dr Paul Seli (2020) find that people who tend to be less willing to engage in effortful cognitive processes and inquiry are more likely to believe that Covid-19 is a hoax and less likely to engage in hygienic behaviors such as distancing and hand-washing. The instrument used to test willingness to engage in such cognitive processes was the well-known Cognitive Reflection Test (Sirota & Juanchich, 2018), which we discuss at further length below. Second, Pennycook, McPhetres, Zhang, Lu, and Rand (2020) examined willingness to share misinformation about Covid-19. Like Stanley et al. (2020), they found that participants who scored higher on the Cognitive Reflection Test had more accurate beliefs about the disease and how to avoid contracting it; in addition, such participants were less inclined to share misinformation.

Most philosophical work on Covid-19 comes from applied ethics and political philosophy, and concerns such topics as the allocation of scarce medical resources (Emanuel et al., 2020), the hidden costs incurred by children and young people (Larcher & Brierley, 2020), the ethics of clinical trials (Bompart, 2020), utilitarian approaches to pandemics (Savulescu, Persson, &

Wilkinson, 2020), and the use of triage procedures (Herreros, Gella, & Real de Asua, 2020).[4] Rahimi and Talebi Bezmin Abadi (2020), in a letter to the editor of *The American Journal of Bioethics*, consider potential issues to do with peer review, publication, and dissemination of scientific results about Covid-19.

Yet, to our knowledge hardly any philosophical work on Covid-19 and *epistemic* topics has been published. A thorough bibliographic search (June 9, 2020) delivered only three English-language publications.[5] Metz (2020) discusses in general the role of philosophy and philosophers during the pandemic. In an editorial for the journal *Educational Philosophy and Theory*, Neilson (2020) takes a critical theory perspective and considers epistemic violence in times of corona. And Coeckelbergh (2020) considers political epistemology.

3. Epistemic vices

Epistemic vices are character traits that interfere with gaining, keeping, or sharing knowledge. They include close-mindedness, intellectual arrogance, and prejudice. Research on epistemic vices and their correlative epistemic virtues has mainly been conducted in philosophy, which has led to an emphasis on conceptual and theoretical matters (Battaly, 2008; Montmarquet, 1993;

[4] A more general statement from the Covid-19 task force of the Association of Bioethics Program is (McGuire et al., 2020)

[5] Search terms: (coronavirus OR covid-19) AND epistem*, June 9, 2020. *Philosopher's Index* retrieves no references. *PhilPaper* besides the mentioned reference two non-English publications. *Google Scholar* gives 26 references, of which none to a philosophy paper. Online outlets not indexed by *PhilPapers* and *Google Scholar* retrieved by a Google search include the online *Social Epistemology Review and Reply Collective*, which a range of contributions on Covid-19 at https://social-epistemology.com/in-and-beyond-the-era-of-covid-19/ (accessed June 9, 2020), and incidental blogs, of which a contribution by Erik Angner https://behavioralscientist.org/epistemic-humility-coronavirus-knowing-your-limits-in-a-pandemic/ (accessed June 9, 2020) is most relevant to our concerns as he discusses the virtue of epistemic humility.

Roberts & Wood, 2007; Zagzebski, 1996). Epistemic virtue and vice are thought to be associated with educational achievement (Baehr, 2013), business and financial decision-making (de Bruin, 2014), and susceptibility to conspiracy theories (Cassam, 2016).

Epistemic vices differ from cognitive defects such as lowered IQ as a result of prenatal exposure to lead in that epistemic vices are always reprehensible, and sometimes blameworthy (Cassam, 2019). Unlike those who have a lower IQ as a result of lead poisoning, say, the bearers of epistemic vices are open to criticism for displaying epistemically vicious traits, because they are responsible either for acquiring these vices or for continuing to embody them.

Epistemic vice also differs from cognitive biases, understood in a certain way (Cassam, 2019). Consider the availability heuristic as an example of a cognitive bias. The availability heuristic is the tendency to overestimate the likelihood of events with greater "availability" in memory. More recent and more emotionally charged memories tend to be more readily available to people. The availability heuristic gets in the way of knowledge because how recent or emotionally charged a memory is does not predict the likelihood of similar events well. In contrast to epistemic vices, cognitive biases such as the availability heuristic are universal in the sense that almost everyone can be led astray by them.[6] Cognitive biases are sometimes resistant to revision because they operate largely unconsciously.

[6] Note that, in a suitably-constructed environment, the availability heuristic and its close counterpart, the recognition heuristic, can be quite reliable. However, in environments where exposure does not systematically track prevalence, the heuristic goes haywire. For an empirical investigation of this phenomenon, see Alfano and Skorburg (2018)

Yet there are other cognitive biases that are either modulated by epistemic vice or can even be regarded as epistemic vices in their own right. Consider confirmation bias, the tendency to search for information that confirms your preconceptions (Klayman, 1995). Confirmation bias can be checked by conscious effort. Genuinely curious and open-minded people should therefore be less likely to undermine knowledge by falling into confirmation bias.

Only recently have researchers started to interrogate the empirical underpinnings of epistemic virtues and vices (Fairweather & Flanagan, 2014). There has also been interest by psychologists, experimental philosophers, and researchers on education in notions closely related to epistemic virtue (Peterson & Seligman, 2004; Tetlock, 1983, 2005; Tetlock, Kristel, Beth, Green, & Lerner, 2000). Some measures for individual virtues and vices have been proposed in the literature, for instance by Alfano et al. (2017) and Krumrei-Mancuso and Rouse (2016).

In this paper, we use the newly-developed Epistemic Vice Scale (EVS) to predict acceptance of Covid-19 misinformation. The EVS has two subscales, indifference and rigidity. Indifference manifests itself in a lack of motivation to find the truth. Rigidity manifests itself in being insensitive to evidence. These two subscales relate a range of traits that the philosophical literature suggests form the core of epistemic vice, such as arrogance, imperviousness to evidence, and gullibility. To our knowledge, the resulting ten-item scale is the first instrument to measure such a broad range of epistemic vices.

4. Study

4.1 Method

Data

998 participants were recruited and compensated using Amazon's Mechanical Turk platform. The data collection was part of a pre-registered observational study.[7] The eligibility criteria were living in the United States and being 18 years or older. Ages ranged from the bracket 18-29 years to the bracket 74 years and up, with the median respondent falling in the age bracket 30-39 years, consistent with the most recent US census data. 63% of participants were male, as compared with 49% in the general population. 68% had a bachelor's or higher level of education, as compared with 32% in the general population. Median household income was in the bracket between $50,000 and $74,999 per year, consistent with the median income of $63,000 in the general population. 55% of respondents were married; 34% had never married; 7% were divorced; 2% separated; and 2% widowed. 38% of respondents identified as Republican to various degrees; 47% as Democrats; and 15% as Independent. 74% of respondents were White/Caucasian; 12% were Black or African American; 5% Hispanic; 7% Asian or Pacific Islander; and 2% American Indian or Alaskan Native. 49% of respondents rated religion as not at all important or not very important; 18% as moderately important, and 33% as important or extremely important.

Our sample is more male and more educated than the US as a whole, and probably also slightly less religious and less Republican, although different ways of eliciting this information make comparisons difficult. In order to check the robustness of our results, we conducted the correlation and regression analyses described below on several split samples: only female

[7] Pre-registered with <anonymized for peer-review>.

respondents; only Republicans; only respondents with less formal education than a bachelor's degree; only respondents in whose life religion plays an important role. All results are qualitatively the same as reported below.

Measures

Epistemic Vice Scale. To study potential epistemically vicious tendencies of respondents, we administered the Epistemic Vice Scale (EVS), a ten-item instrument to measure epistemic vice. The scale has two subscales, Indifference and Rigidity. Indifference manifests itself in a lack of motivation to find the truth. Rigidity manifests itself in being insensitive to evidence.

The scale has been rigorously validated and has good psychometric properties. Structural equation modelling meets Hu and Bentler's standards of fit (Hu and Bentler, 1999) ($\chi^2(34) = 150$, CFI = .98, RMSEA = .06, SRMR = .03). Cronbach's Alpha is .90 for the whole scale, .90 for the Indifference subscale, and .83 for the Rigidity subscale.

Here we focus on showing the relationship between the EVS and endorsement of Covid-19 misinformation. Table 1 shows the items, which were administered to participants in random order. Participants were asked to respond to the items on a five-point, fully-anchored Likert scale (1 = "strongly disagree," 2 = "somewhat disagree," 3 = "neither agree nor disagree," 4 = "somewhat agree," 5 = "strongly agree"). The indifference score is calculated as the mean of items 1-4; the rigidity score as a mean of items 5-10.

[Table 1 about here]

Covid-19 Misinformation. To study the propensity of respondents to endorse Covid-19 related misinformation, we administered a 12-item measure of Covid-19-related misinformation based on the "myth-busting" page of the World Health Organization (Table 2).[8] Examples of the myths included in the study are: "Being able to hold your breath for 10 seconds or more without coughing or feeling discomfort means you are free from the coronavirus disease," "Spraying and introducing disinfectant into your body will protect you against COVID-19," and "Regularly rinsing your nose with saline helps prevent infection with the new coronavirus." Items were administered in random order. Participants were asked to respond on a fully anchored five-point Likert scale (1 = "Definity false," 2 = "Probably false," 3 = "Don't know," 4 = "Probably true," 5 = "Definitely true"). We randomly inserted two control items with claims about Covid-19 that were common knowledge at the moment of conducting the survey to check whether respondents read the items attentively and gave their best answers. The high endorsement scores of 90% for the item "Some people infected with coronavirus experience no symptoms" and 91% for "Older people are more likely to die due to an infection with Covid-19" suggest that responses are of high quality. The Covid-19 misinformation score is calculated as the mean of the responses to the first ten items, excluding the control items. "Don't know" responses were excluded from the analysis on a per-item basis; that is, if a respondent replied "Don't know" on one or more items, the Covid-19 misinformation score was calculated on the basis of the remaining items.

[8] https://www.who.int/emergencies/diseases/novel-coronavirus-2019/advice-for-public/myth-busters (accessed May 8, 2020).

[Table 2 about here]

Demographic information and other scales. In order to evaluate to what extent epistemic vice explains variation in the tendency to endorse misinformation, we elicited demographic information and other relevant psychological constructs.

We elicited demographic information about age, educational attainment, income, gender, ethnicity, the importance of religion, and marital status. In addition, we measured political partisanship by asking participants whether respondents "consider themselves a Republican, a Democrat, an Independent, or what?" Responses were "Strong Democrat," "Moderate Democrat," "Lean Democrat," "Lean Republican," "Moderate Republican," "Strong Republican," "Independent," "Other," and "Prefer not to say". We replaced "Independent" with missing rather than placing Independents in-between Republican and Democratic responses. For robustness we also ran analyses with dummies for Democrats, Republicans, and Independents respectively, which did not affect our results.

We elicited related psychological constructs by administering nine scales. First, we measured all dimensions of the Big Six personality model using the 24-item QB6, measuring Honesty, Emotionality, Extraversion, Agreeableness, Conscientiousness, and Openness to Experience (Thalmayer and Saucier 2014). Second, we administered a seven-item version of the Cognitive Reflection Test, measuring the tendency to override an incorrect "gut" response and engage in further reflection to find a correct answer (Sirota & Juanchich, 2018). Third, we administered Rosenberg's 10-item self-esteem scale, measuring feelings of self-worth (Rosenberg, 1965).

Fourth, we administered a 15-item scale of need for closure, measuring aversion toward ambiguity (Roets & Van Hiel, 2011). Fifth, we administered an 18-item scale of need for cognition, measuring tendency to engage in and enjoy activities that require thinking (Cacioppo, Petty, & Kao, 1984). Sixth, we administered a 15-item scale of faith in intuition, measuring the tendency to rely on intuitive information processing (Alós-Ferrer & Hügelschäfer, 2012). Seventh, we administered the general version of a 6-item scale of open-minded cognition, measuring willingness to consider a variety of intellectual perspectives (Price, Ottati, Wilson, & Kim, 2015). Eighth, we administered a 20-item dogmatism scale, measuring the tendency to consider views as undeniably true (Altemeyer, 2002). Ninth and finally, we administered a 6-item scale of trust in experts, measuring the tendency to trust experts over lay people, adapted from Imhoff, Lamberty, and Klein (2018).

Hypotheses. Before conducting the study, we recorded our hypotheses in the process of pre-registration. We expected EVS and its subscales to be 1) strongly positively correlated with endorsement of Covid-19 misinformation; 2) positively correlated with the scales measuring faith in intuition, dogmatism, and need for closure; and 3) negatively correlated with all other scales: personality, cognitive reflection, self-esteem, need for cognition, open-minded cognition, and trust in experts. In addition, we expected 4) religiosity to be positively correlated with endorsement of Covid-19 misinformation; and 5) Republican political identity to be positively correlated with endorsement of Covid-19 misinformation. Our most important hypothesis was, however, this:

Epistemic vice explains susceptibility to Covid-19 misinformation, over and above the demographic information and the other psychological scales.

The type of explanation we are after is operationalized by accounting for variance in individual differences in Covid-19 misinformation using regression models. Note that this notion of explanation falls short of, but is consistent with, establishing causation. Given the observational data we have collected, we can only establish association between variables.

4.2 Analysis and Results

The analysis proceeded in three steps. First, in order to test whether more epistemically vicious respondents are more likely to endorse Covid-19 misinformation, we analyzed the relationship between their scores on the Epistemic Vice Scale, as well as on the rigidity and indifference subscales, and the Covid-19 misinformation score. Second, to put the strength of the associations between epistemic vice and misinformation in context, we analyzed correlations of misinformation with epistemic vice, demographic variables, and other psychological scales. Third, to understand whether epistemic vice explains variance in endorsement of Covid-19 misinformation over and above that explained by demographic variables and other psychological measures, we conducted a hierarchical regression.

Epistemic vice and Covid-19 misinformation. Table 3 gives an overview of how well the EVS score works as a predictor of susceptibility to Covid-19 misinformation. Respondents are classified according to their mean EVS score and their Covid-19 misinformation score. 751

respondents had an EVS score of 3 or less. We categorized these respondents in the low epistemic vice group, as they strongly disagreed, disagreed, or responded "neither agree nor disagree" on average across the ten EVS items. 89% of respondents in this group have a low Covid-19 misinformation score, indicating that they endorsed at most one of the coronavirus myths. Just 11% of respondents in this group had higher misinformation scores, with the overwhelming majority in the "medium" group, endorsing 2-5 Covid-19 myths.

169 respondents fell into the medium epistemic vice category, defined by an EVS score between 3 ("neither agree or disagree") and 4 ("somewhat agree"). 43% of respondents in this group fell into the medium category on Covid-19 misinformation, 30% into the high category endorsing 5-10 Covid-19 myths. 27% of respondents had low susceptibility to Covid-19 misinformation despite their medium EVS score.

78 respondents had an EVS score greater than 4. 80% or respondents in this group were highly susceptible to Covid-19 misinformation. That leaves just 20% with lower misinformation scores, which the overwhelming majority in the medium, rather than the low, category.

[Table 3 about here]

[Figure 1 about here]

Figure 1 illustrates the strength of the relationship between epistemic vice and susceptibility to Covid-19 misinformation. The position of the tiles on the heatmap is determined by the indifference score (*y*-axis) and the rigidity score (*x*-axis). For instance, tiles representing respondents scoring high on indifference and rigidity are situated in the top-right quadrant. The color of each tile is determined by the average Covid-19 misinformation score for respondents with the respective scores. Red coloring means that respondents endorsed misinformation items on average as true. Blue coloring means that respondents rejected misinformation items on average.

The top-right quadrant of the graph represents 184 individuals whose indifference and rigidity scores are both greater than or equal to 3. This part of the graph is overwhelmingly red and orange, indicating that high scores on both dimensions of epistemic vice are associated with endorsement of misinformation (mean Covid-19 misinformation score = 3.48, SD = 1.1). By contrast, the lower-left quadrant of the graph is overwhelmingly blue (536 observations), indicating rejection of misinformation (mean Covid-19 misinformation score = 1.31, SD = 0.4). To determine whether the difference is significant, we performed a two-sided, two-sample Welch's t test, testing against the alternative hypothesis that the true mean Covid-19 misinformation score by respondents in the lower-left quadrant is not different from the true mean Covid-19 misinformation score in the top-right quadrant. The result strongly suggests to reject the alternative hypothesis, indicating that the Covid-19 misinformation mean for responses in the bottom-left quarter is indeed lower than for responses in the top-right quarter ($t(196) = -26.0$, $p < 0.0001$, Welch-Satterthwaite).

Respondents represented in the bottom-right quadrant of the graph are motivated to gain knowledge but are also rigid in their thinking (264 observations). They have on average lower Covid-19 misinformation scores than in the top-right quadrant, but higher scores than respondents in the bottom-left quadrant (mean Covid-19 misinformation score = 1.94, SD = .9). Differences between the Covid-19 misinformation scores of respondents in the bottom-right quadrant to misinformation scores both of respondents in the top-right quadrant and in the bottom-left quadrant are highly significant ($t(335) = -15.6$, $p < 0.0001$, and $t(311) = -10.7$, $p < 0.0001$, respectively). We speculate that respondents in the bottom-right quadrant might be particularly open to interventions to address rigidity in their thinking, because they are already properly motivated.

The top-left quadrant of the graph has few observations (18). This indicates that few respondents indicated that they were indifferent to knowledge yet were not rigid in their thinking.

[Table 4 about here]

Table 4 summarizes the epistemic vice scores of respondents "at risk" of endorsing Covid-19 misinformation, compared to respondents with a low susceptibility to Covid-19 misinformation. 71% of respondents showed low susceptibility to misinformation. That leaves 29% of respondents in our sample susceptible, almost half of whom are highly susceptible.

EVS scores as well as scores for the indifference and rigidity subscales increase with rising susceptibility. Two-sided Welch's t tests for each of the differences suggest that each is highly statistically significant ($p < 0.0001$).

On the EVS as well as rigidity subscale, medium or highly susceptible respondents scored above 3 on average. Mean indifference scores were somewhat lower across the board, indicating that people are more reluctant to describe themselves as indifferent than as rigid.

Correlation analysis. Figure 2 shows correlation coefficients between the Covid-19 misinformation score (column 1) and all other measures (rows). The correlations between the EVS and Covid-19 misinformation is strongest, at .76 (all correlations are pairwise Pearson correlations). Correlations of misinformation with the two subscales are similarly strong: 72 for indifference and .68 for rigidity. These high correlations hold as well on subsamples that we selected to test the robustness of our results (see "Data" section above on the representativeness of our sample for the US population). On these subsamples, we find: among female respondents, the correlation between the EVS and Covid-19 misinformation is .75 ($n = 371$); among republicans it is .75 ($n = 343$); on the subsample containing only respondents with less formal education than a bachelor's degree it is .48 ($n = 288$); among respondents in whose life religion plays an important role it is .76 ($n = 505$). The further results reported below are qualitatively the same for the split samples.

[Figure 2 about here]

Measures for competing explanations such as political affiliation and the Cognitive Reflection Test are less strongly associated with Covid-19 misinformation. The measure with the next-highest correlation, dogmatism, shows a substantially lower correlation with Covid-19 misinformation than epistemic vice. The correlation of political affiliation with Covid-19 misinformation is less than a third of the correlation between epistemic vice and Covid-19 misinformation (note that in our measure of political affiliations, higher values indicate greater identification with Republican positions).

We conceptually replicate the findings of Stanley et al. (2020) and Pennycook et al. (2020) that the Cognitive Reflection Test predicts acceptance of Covid-19 misinformation (their outcome variable was measured slightly different, but the headline result is the same). Yet the absolute value of the correlation coefficient of cognitive reflection with Covid-19 misinformation (-.39) is only about half of the correlation coefficient of epistemic vice with Covid-19 misinformation (.76). This gives epistemic vice a fairly strong lead over alternative measures.

The associations between the EVS subscales and other measures all have the expected sign, with the exception of education. We would have expected that higher levels of formal education are associated with lower readiness to endorse fake news. Yet the opposite is the case. We could only speculate as to the explanation of this finding.

None of the correlations between the epistemic vice subscales and other measures is so high to suggest that the EVS is tapping into a construct for which a measure already exists. Indeed, the

correlation of epistemic vice with Covid-19 misinformation is stronger than the association of any of the other measures with either of the epistemic vice subscales. The closest correlates of epistemic vice are dogmatism, faith in intuition, and open-mindedness, each with coefficient absolute values above .5. Yet none of these measures is as closely associated with Covid-19 misinformation as epistemic vice is. This lends support to the vice epistemological supposition that epistemic vice is a distinct theoretical and empirical construct.

Regression analysis. The results so far indicate that epistemic vice is more strongly associated with Covid-19 misinformation than other measures, and that epistemic vice is a distinct construct from all of the other measures considered. Yet our central hypothesis remains to be tested. Does the EVS predict endorsement of Covid-19 misinformation above and beyond what already established measures can predict? So far, while we have found that the EVS correlates more strongly than other individual measures with Covid-19 misinformation, we have not yet shown that the force of the EVS is little more than that of a combination of other measures, which, if it were the case, would affect its usefulness. Hence our last task is to examine what EVS adds to the other scales.

[Table 5 about here]

We performed a hierarchical regression with the Covid-19 misinformation score as dependent variable. We tested how much variance in the Covid-19 misinformation scores the indifference and rigidity subscales predicted above and beyond other measures individually, and other

measures combined. Table 5 summarizes the results. Each row compares two ordinary least squares regression models with the Covid-19 misinformation score as dependent variable. The first model includes the measure(s) listed in the "Measures" column. The second model includes additionally the indifference and rigidity scores of the Epistemic Vice Scale. The columns "R^2 without EVS" and "R^2 with EVS" show the amount of variance the respective models explain; the column "ΔR^2" is the difference between the two columns. Positive values for ΔR^2 indicate that the model with the epistemic vice subscales predicts more variance as measured by R^2 than the corresponding model without the epistemic vice scores.[9] The difference that adding the epistemic vice subscales makes is substantial. For each individual measure, adding epistemic vice to the regression at least doubles the variance explained, increasing R^2 in every case to above .5.

Importantly, epistemic vice explains additional variance of .09 even when *all* other measures are included in the regression. Table 6 in the appendix provides the detailed results of this final hierarchical regression. Both models are ordinary least square regressions with the Covid-19 misinformation score as dependent variable. All continuous predictors as well as the dependent variable are mean-centered and scaled by 1 standard deviation. The two epistemic vice subscales have the largest coefficients (.39 for indifference and .19 for rigidity) and are significant at the 1% level. This result strongly supports our hypothesis that the EVS explains additional variance with regard to Covid-19 misinformation, over and above the demographic information and the other psychological scales.

[9] R^2 is a statistical measure that represents the proportion of the variance for a variable — in our case the Covid-19 misinformation score — that is explained by the variables included in the regression model. It ranges between 0 (no variance explained) and 1 (all variance explained).

5. Conclusion

This paper demonstrates that a compact and easily administered self-report questionnaire — the Epistemic Vice Scale — greatly outperforms existing measures, including the Cognitive Reflection Test, in predicting susceptibility to Covid-19 misinformation.

People who accept Covid-19 misinformation may be more likely to put themselves and others at risk, to strain already overburdened medical systems and infrastructures, and to spread misinformation to others. Of particular concern is the prospect that a vaccine for the novel coronavirus will be rejected by a sizeable proportion of the population because they have been taken in by misinformation about the safety or effectiveness of the vaccine. Conspiracy theories about possible treatments have already spread online and even led to protests calling for the arrest of Bill Gates, whose foundation is funding research into potential vaccines.[10] Sullivan et al. (2020) have found that anti-vaccine accounts on Twitter have both greater reach and greater receptivity than pro-vaccine accounts, which should make public health officials and policymakers alert to the possibility that, even if a vaccine for the novel coronavirus is found, herd immunity may remain out of reach due to vaccine hesitancy and resistance.

We believe that the results reported in this paper show that policymakers may benefit from paying attention to the role epistemic virtue and vice play in the uptake of information and

[10] https://www.theguardian.com/media/2020/may/12/vaccines-5g-bill-gates-why-are-australians-gathering-to-spread-coronavirus-conspiracy-theories (accessed June 24, 2020).

misinformation. Policy might be developed to help people boost virtue or depress vice, and we believe that emerging research may be useful here. Pennycook et al. (2020), for instance, found that simply nudging people to think about accuracy led to their accepting and sharing less misinformation about Covid-19, so it may be possible to contain the spread of misinformation with relatively anodyne interventions rather than, for instance, censorship. More ambitiously, we might hope to develop interventions that help people overcome their epistemic rigidity or indifference. Whether such interventions would need to be longitudinal and embedded in elementary and higher education, or could be one-off trainings for adults, remains to be seen. Future research should investigate the extent to which epistemic vice can be prevented or overcome.

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Item	Description
Indifference	
1	I am not very interested in understanding things.
2	I am not so interested in the reasons why.
3	I am not particularly curious to learn new things.
4	I do not much enjoy gaining knowledge.
Rigidity	
5	It's more important to have a stable worldview than to be open-minded.
6	I make up my mind without much fuss about the many factors that may affect an issue.
7	I tend to make decisions based on my gut feeling.
8	I tend to be too confident in my opinions.
9	I often have strong opinions about issues I don't know much about.
10	I tend to feel sure about my views even if I don't have much evidence.

Table 1: Items of the Epistemic Vice Scale

Item	Description	Endorsement
1	Adding pepper to your meals prevents COVID-19.	16%
2	COVID-19 can be transmitted through houseflies.	15%
3	Spraying and introducing disinfectant into your body will protect you against COVID-19.	19%
4	Drinking methanol, ethanol or bleach prevents COVID-19.	13%
5	5G mobile networks spread COVID-19.	11%
6	Exposing yourself to the sun or to temperatures higher than 77°F prevents the coronavirus disease.	22%
7	Catching Covid-19 means you will have it for life.	15%
8	Being able to hold your breath for 10 seconds or more without coughing or feeling discomfort means you are free from the Coronavirus disease.	23%
9	Hand dryers are effective in killing coronavirus.	18%
10	Regularly rinsing your nose with saline helps prevent infection with Covid-19.	22%
11*	Some people infected with coronavirus experience no symptoms.	91%
12*	Older people are more likely to die due to an infection with Covid-19.	90%

Endorsement: if respondents replied “probably true” or “definitely true”.

* control items not included in calculation of mean score

Table 2: Items of the Covid-19 misinformation instrument

	Covid-19 misinformation score			
EVS score	*Low (0-1)*	*Medium (2-5)*	*High (5-10)*	*Observations*
Low (≤ 3)	89%	9%	2%	751
Medium (> 3, ≤ 4)	27%	43%	30%	169
High (> 4)	5%	15%	80%	78

Table 3: Accuracy of classification based on EVS score

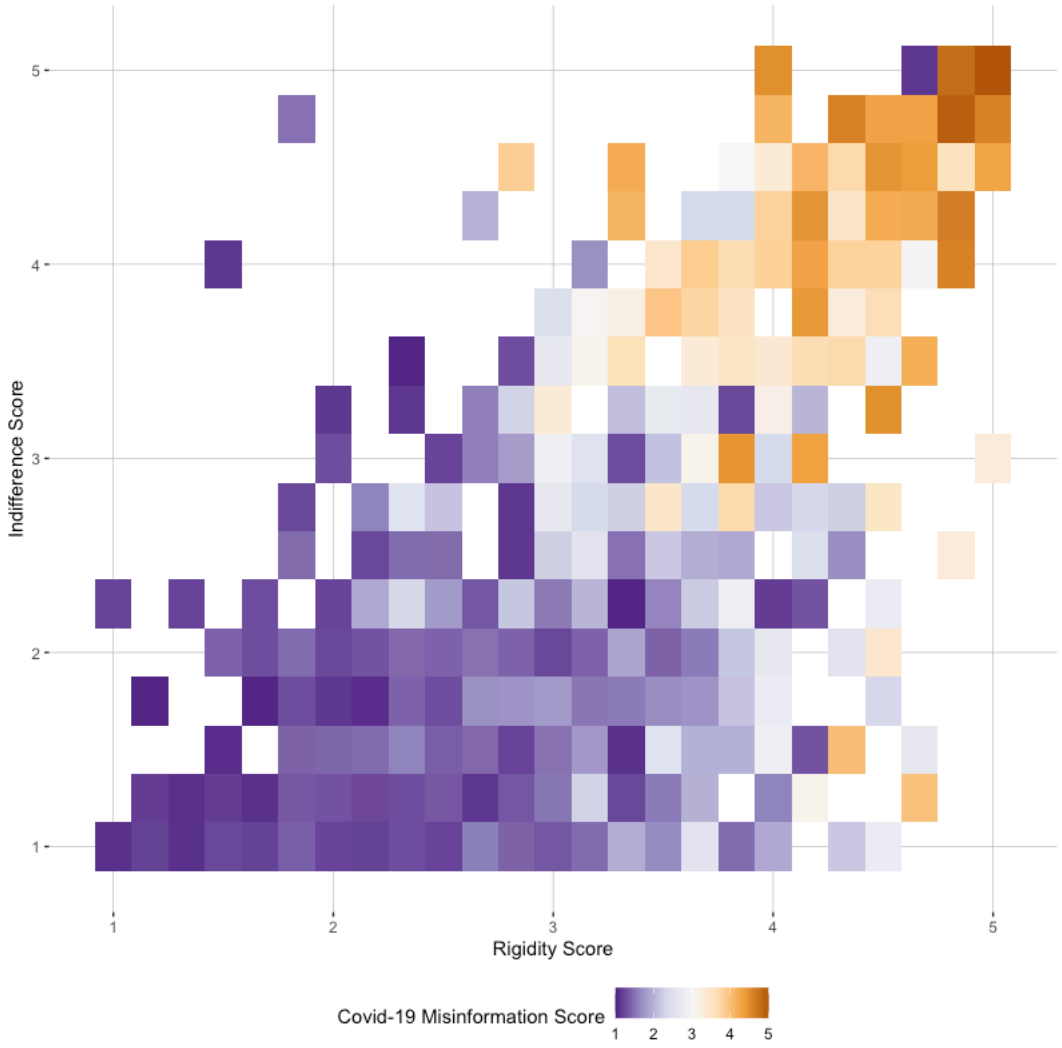

Figure 1: Heatmap of Covid-19 misinformation score in relation to the Indifference and Rigidity dimensions of the Epistemic Vice Scale, based on 998 observations. Higher indifference and rigidity scores are both associated with a higher misinformation score.

Covid-19 misinformation score	Observations (%)	EVS score (SD)	Rigidity score (SD)	Indifference score (SD)
Low (0-1)	714 (71%)	2.11 (0.62)	2.47 (0.73)	1.57 (0.68)
Medium (2-5)	153 (16%)	3.07 (0.68)	3.46 (0.69)	2.48 (1.01)
High (5-10)	131 (13%)	3.87 (0.66)	4.06 (0.57)	3.59 (1.06)

Table 4: Epistemic vice scores by Covid-19 misinformation score

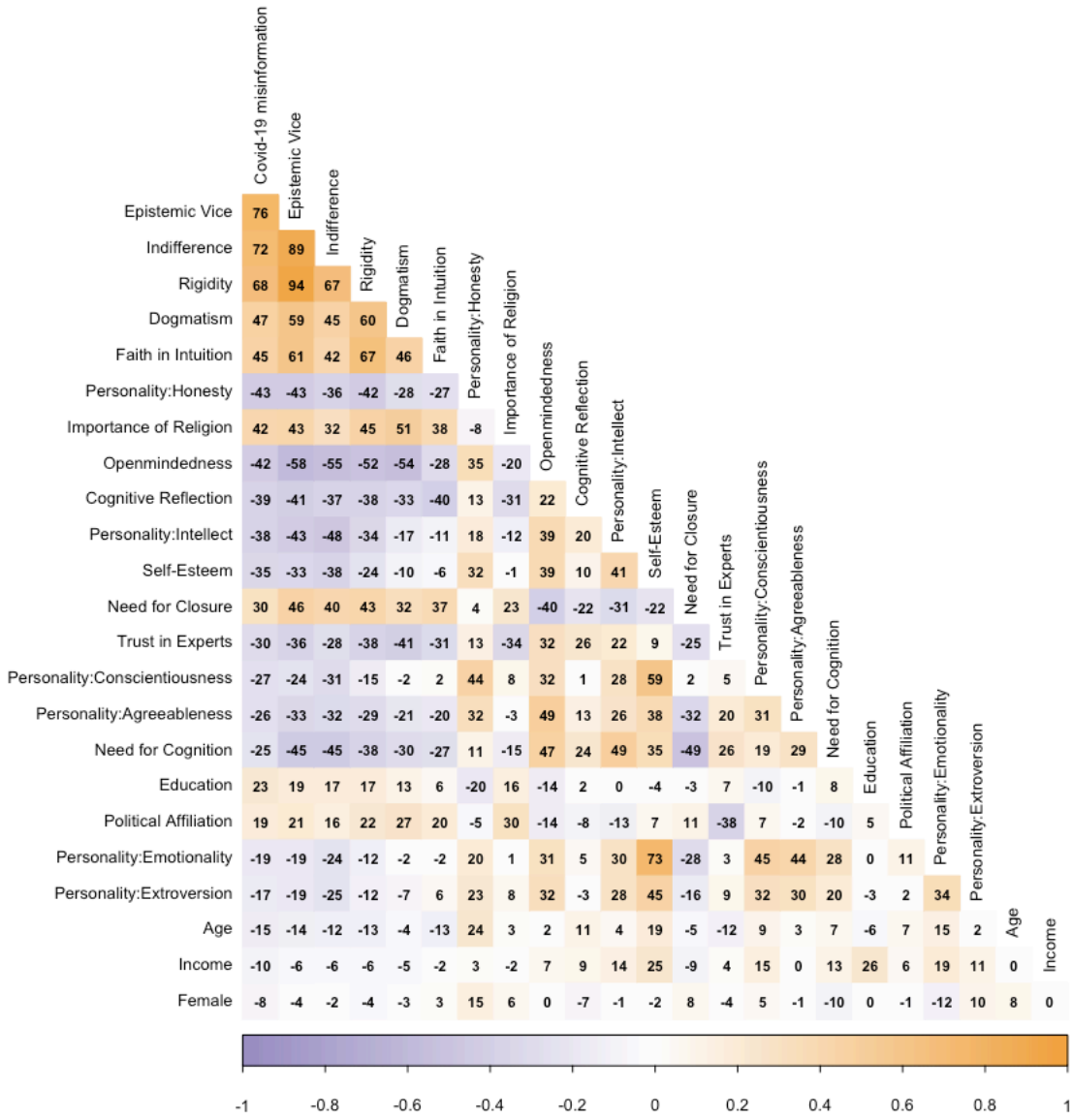

Figure 2: The table shows correlations between covariates in percentages (pairwise Pearson correlations). Purple indicates negative correlations, orange indicates positive correlations. The shade captures the size of the correlation (absolute value).

Measures	R^2 without EVS	R^2 with EVS	ΔR^2
All demographic variables*	0.37	0.63	0.26
Dogmatism	0.22	0.59	0.37
Faith in intuition	0.21	0.59	0.38
All six personality traits	0.29	0.60	0.31
Importance of religion	0.17	0.60	0.43
Open-mindedness	0.18	0.59	0.41
Cognitive reflection	0.15	0.59	0.44
Self-esteem	0.12	0.59	0.47
Need for closure	0.09	0.59	0.50
Trust in experts	0.09	0.59	0.50
Need for cognition	0.06	0.60	0.54
Political affiliation	0.09	0.60	0.51
All of the above	0.58	0.67	0.09

Table 5: Results of hierarchical regression analysis.

* Included demographic variables: Education, political affiliation, importance of religion, age, gender, income, marital status, ethnicity

	Model 1	*Model 2*
Epistemic vice: Indifference		0.39***
		(0.03)
Epistemic vice: Rigidity		0.19***
		(0.04)
Education	0.11***	0.08***
	(0.02)	(0.02)
Religion	0.12***	0.08***
	(0.03)	(0.02)
Age	-0.07**	-0.05*
	(0.03)	(0.02)
Female	-0.14**	-0.10*
	(0.05)	(0.04)
Income	-0.08**	-0.08***
	(0.03)	(0.02)
Political Affiliation		
Strong Democrat (Dummy)	0.27	0.10
	(0.17)	(0.15)
Modertate Democrat (Dummy)	0.16	0.00
	(0.17)	(0.15)
Lean Democrat (Dummy)	0.13	-0.02
	(0.17)	(0.15)
Independent (Dummy)	0.13	0.00
	(0.17)	(0.15)
Lean Republican (Dummy)	0.16	0.03
	(0.18)	(0.15)
Moderate Republican (Dummy)	0.11	0.00
	(0.17)	(0.15)
Strong Republican (Dummy)	0.38*	0.14
	(0.17)	(0.15)
Maritial Status		
Married (Dummy)	0.50*	0.35
	(0.24)	(0.21)
Widowed (Dummy)	0.46	0.36
	(0.29)	(0.26)
Divorced (Dummy)	0.28	0.15
	(0.26)	(0.23)
Separated (Dummy)	0.50	0.43
	(0.29)	(0.25)
Never Married (Dummy)	0.15	0.12
	(0.24)	(0.21)
Ethnicity		
American Indian or Alaskan Native (Dummy)	0.33	-0.04
	(0.24)	(0.22)
Asian or Pacific Islander (Dummy)	0.06	-0.06
	(0.19)	(0.17)

Black or African American (Dummy)	0.20	0.09
	(0.18)	(0.16)
Hispanic (Dummy)	0.09	-0.01
	(0.20)	(0.17)
White / Caucasian (Dummy)	-0.05	-0.08
	(0.17)	(0.15)
Personality		
Honesty	-0.16***	-0.09***
	(0.03)	(0.03)
Agreeableness	-0.01	-0.02
	(0.03)	(0.02)
Emotionality	0.10**	0.05
	(0.03)	(0.03)
Extroversion	-0.01	0.01
	(0.03)	(0.02)
Conscientiousness	-0.08**	-0.03
	(0.03)	(0.03)
Intellect	-0.15***	-0.06**
	(0.03)	(0.02)
Need for cognition	0.11***	0.15***
	(0.03)	(0.03)
Selfesteem	-0.20***	-0.14***
	(0.04)	(0.03)
Cognitive reflection	-0.12***	-0.07**
	(0.02)	(0.02)
Need for closure	0.09**	0.02
	(0.03)	(0.03)
Faith in intuition	0.12***	0.02
	(0.03)	(0.03)
Open-mindedness	-0.04	0.06*
	(0.03)	(0.03)
Dogmatism	0.08**	0.03
	(0.03)	(0.03)
Trust in experts	-0.04	-0.04
	(0.03)	(0.02)
Constant	-0.51	-0.20
	(0.33)	(0.29)
Observations	973	973
R2	0.58	0.67
ΔR2		**0.09**

Table 6: Detailed regression results with the corona misinformation score as dependent variable, comparing the full model without epistemic vice (Model 1) to the full model including epistemic

vice (Model 2). Numbers in brackets are standard errors. All continuous predictors are mean-centered and scaled by 1 standard deviation. *** $p < 0.001$; ** $p < 0.01$; * $p < 0.05$.