Fighting COVID-19 misinformation on social media: Experimental evidence for a scalable accuracy nudge intervention

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Misinformation can amplify humanity's greatest challenges. A salient recent example of this is the COVID-19 pandemic, which has bred a multitude of falsehoods even as truth has increasingly become a matter of life-and-death. Here we investigate why people believe and spread false (and true) news content about COVID-19, and test an intervention intended to increase the truthfulness of the content people share on social media. Across two studies with over 1,600 participants (quota-matched to the American public on age, gender, ethnicity and geographic region), we find support for the idea that people share false claims about COVID-19 in part because they simply fail to think sufficiently about whether or not content is accurate when deciding what to share. In Study 1, participants were far worse at discerning between true and false content when deciding what they would share on social media relative to when they are asked directly about accuracy. Furthermore, participants who engaged in more analytic thinking and had greater science knowledge were more discerning in their belief and sharing. In Study 2, we found that a simple accuracy reminder at the beginning of the study – i.e., asking people to judge the accuracy of a non-COVID-19-related headline – more than doubled the level of truth discernment in participants' sharing intentions. In the control, participants were equally like to say they would share false versus true headlines at COVID-19 whereas, in the treatment, sharing of true headlines was significantly higher than false headlines. Our results – which mirror those found previously for political fake news – suggest that nudging people to think about accuracy is a simple way to improve choices about what to share on social media. Accuracy nudges are straightforward for social media platforms to implement on top of the other approaches they are currently employing, and could have an immediate positive impact on stemming the tide of misinformation about the COVID-19 outbreak.

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The COVID-19 pandemic represents a substantial challenge to the maintenance of global human wellbeing. Not unlike other global challenges, such as anthropogenic global warming, much depends on the actions of individual citizens and, therefore, the quality of the information to which people are exposed. Unfortunately, however, misinformation about COVID-19 has proliferated on social media (Frenkel, Alba, & Zhong, 2020; Russonello, 2020). In the case of COVID-19, this misinformation comes in many forms - from conspiracy theories about the virus being created as a biological weapon in China to claims that coconut oil kills the virus. At its worst, misinformation of this sort may cause people to turn to ineffective (and potentially directly harmful) remedies, as well as to either overreact (e.g., by hoarding goods) or, more dangerously, underreact (e.g., by deliberately engaging in risky behavior and inadvertently spreading the virus). As a consequence, it is important to better understand why people both believe and share false (and true) information related to COVID-19 – and to develop interventions to reduce the spread of misinformation.

Here we apply a cognitive science lens to this problem. In particular, we test whether previous findings from the domain of political "fake news" (fabricated political news stories presented as if from legitimate sources, Lazer et al., 2018) extend to misinformation related to COVID-19. One vein of prior research suggests that engaging in reasoning helps people to identify political misinformation (Pennycook & Rand, 2019a) – in contrast to theories that focus more on partisanship (Van Bavel & Pereira, 2018) or argue that reasoning is often hijacked by partisan bias (Kahan, 2017; Kahan, Peters, Dawson, & Slovic, 2017). Survey experiments show, for example, that people who believe and consider sharing more political false (Pennycook, Cannon, & Rand, 2018; Pennycook & Rand, 2019a, 2019b) and misleading hyperpartisan (Ross, Rand, & Pennycook, 2019) news headlines score lower on the Cognitive Reflection Test (CRT; Frederick, 2005) – a test of one's willingness and ability to engage in analytic or reflective thinking (as opposed to relying on one's intuitions; (Pennycook, Cheyne, Koehler, & Fugelsang, 2016; Toplak, West, & Stanovich, 2011). Belief in fake news is also associated with lower scores on the Actively Open-minded Thinking about Evidence scale (Bronstein, Pennycook, Bear, Rand, & Cannon, 2019), a self-report measure of the extent to which people believe that beliefs ought to change according to evidence (Pennycook, Cheyne, Koehler, & Fugelsang, 2019). Similarly, analysis of sharing behavior on Twitter shows that people who score lower on the CRT share news from sources deemed to be less trustworthy by professional fact-checkers (Mosleh, Pennycook, Arechar, & Rand, 2020). Finally, experimentally increasing reliance on emotion (Martel, Pennycook, & Rand, 2019) and decreasing reflective thinking (Bago, Rand, & Pennycook, 2019) leads to an increase in belief in false (but not true) news content.

In Study 1 of the present paper, we presented participants with a set of true and false news headlines about COVID-19 to test the prediction that their level of discernment between false and true headlines will be positively related to their tendency to engage in analytic thinking (indexed by the CRT); and, relatedly, to their level of scientific knowledge. We also examined (in exploratory analyses) the relationship between discernment and various other measures, including

partisanship (Russonello, 2020), geographic proximity to COVID-19 diagnoses, and the tendency to over- versus under-use medical services (the medical maximizer-minimizer scale; Scherer et al., 2016). We also examine how these constructs relate to participants' level of concern regarding COVID-19 and their attention to news regarding COVID-19.

In addition, we gain insight into the spread of COVID-19 misinformation by drawing on recent research that focuses specifically on the *sharing* of fake and misleading news (again in the political realm; Pennycook et al., 2020). This work introduced an attention-based account of misinformation sharing on social media. By this account, most people are reasonably good at telling truth from falsehood and generally want to avoid spreading misinformation – that is, the primary problem in the United States is neither media/digital literacy (Cooke, 2018; Lee, 2018) nor a "post-truth" lack of concern for the truth (Davies, 2016; Lewandowsky, 2020). Instead, the problem is that the social media context focuses their attention on factors other than accuracy (e.g., amount of positive social feedback they will receive). As a result, users get distracted from even *considering* accuracy when deciding whether to share – leading them to not implement their preference for accuracy and instead share misleading content. In support of this argument, Pennycook et al. (2020) found that most participants were surprisingly good at discerning between true and false political news when asked to assess the headlines' accuracy – yet headline veracity had very little impact on the choices of participants who were asked if they would consider sharing the headlines on social media. Crucially, subtle nudges that helped make the concept of accuracy top-of-mind decreased subsequent sharing of false content. For example, rating the accuracy of a single headline at the beginning of a study (ostensibly as a part of an unrelated pretest) more than doubled participants' level of sharing discernment between true and false headlines in survey experiments; and a similar message improved the quality of news shared by Twitter users in a digital field experiment.

Here, we ask if the same is true of misinformation related to COVID-19. In Study 1, we compare participants' level of discernment (i.e., differentiation between true from false headlines) when judging headlines' accuracy versus when considering what to share online. Our prediction is that discernment will be high for accuracy judgments, but much lower for sharing intentions. In Study 2, we then test the prediction that subtly inducing people to consider the concept of accuracy reduces their likelihood to consider sharing false headlines related to COVID-19.

We report how we determined our sample size, all data exclusions, all manipulations, and all measures in the study. Our data, materials, and preregistration are available online (https://osf.io/7d3xh/). At the end of both surveys, participants were told which of the headlines were accurate (by representing the true headlines).

Study 1

Methods

Participants

We recruited 1000 participants using Lucid, an online recruiting source that aggregates survey respondents from many respondent providers (Coppock & McClellan, 2019). Lucid uses quota sampling to provide a sample that is matched to the American public on age, gender, ethnicity and geographic region. In total, 1143 participants began the study. However, 192 did not indicate using Facebook or Twitter and therefore did not complete the survey. A further 98 participants did not finish the study and were removed. The final sample of 853 (Mean age = 46) included 357 males, 482 females, and 14 other/prefer not to answer (although only 55.3% passed a majority of the attention check questions; see below). This study was run on March 12th, 2020.

Materials and Procedure

News evaluation/sharing task. Through a partnership with Harvard Global Health Institute, we derived a list of 15 false and 15 true news headlines relating to COVID-19 (available online: https://osf.io/7d3xh/). The false headlines were deemed to be false by authoritative sources such as fact-checking sites like snopes.com and factcheck.org, health experts such as mayoclinic.com, and credible science websites such as www.livescience.com. The true headlines came from reliable mainstream media sources. Headlines were presented in the format of Facebook posts: a picture accompanied by a headline and lede sentence. Participants were randomized into two conditions. In the Accuracy Condition, they were asked: "To the best of your knowledge, is the claim in the above headline accurate" (yes, no). In the Sharing Condition, they were asked: "Would you consider sharing this story online (for example, through Facebook or Twitter)" (yes, no); some evidence in support of the validity of this self-report sharing measure comes from the observation that news headlines which MTurkers report a higher likelihood of sharing do indeed receive more shares on Twitter (Mosleh, Pennycook, & Rand, 2020). We also counterbalanced the order of the yes/no options (No/Yes v. Yes/No) across participants. Headlines were presented in a random order.

COVID-19 questions. Prior to the news evaluation task, participants were asked two questions specific to the COVID-19 pandemic. First, they were asked "How concerned are you about COVID-19 (the new coronavirus)", which they answered using a sliding scale from 0 (not concerned at all) to 100 (extremely concerned). Second, they were asked "How often do you proactively check the news regarding COVID-19 (the new coronavirus)", which they answered on a scale from 1 (never) to 5 (very often).

Additional correlates. We gave participants a 6-item Cognitive Reflection Test (CRT; Frederick, 2005) that consisted of a reworded version of the original 3-item test (Shenhav, Rand, & Greene, 2012) and 3 items from a non-numeric version (we excluded the "hole" item; Thomson & Oppenheimer, 2016). The CRT had acceptable reliability (Cronbach's $\alpha = .69$). Participants also completed a general science knowledge quiz that consisted of 17 questions about basic science facts (e.g., "Antibiotics kill viruses as well as bacteria", "Lasers work by focusing sound waves") (McPhetres & Pennycook, 2020; Miller, 1998). The scale had acceptable reliability (Cronbach's $\alpha = .77$). We also administered the Medical Maximizing-Minimizing Scale (Scherer et al., 2016), which indexes the extent to which people are either "medical maximizers" who tend to seek health care even if for minor issues or, rather, "medical minimizers" who tend to avoid health care unless absolutely necessary. The MMS scale also had acceptable reliability (Cronbach's $\alpha = .86$). Finally, in addition to various demographic questions, we indexed political ideology on both social and fiscal issues, in addition to Democrat v. Republican party alignment.

Attention checks. Following the recommendations of Berinsky, Margolis, and Sances (2014) we added three screener questions that put a subtle instruction in the middle of a block of text. For example, in a block of text ostensibly about which news sources people prefer, we asked participants to select two specific options ("FoxNews.com and NBC.com") if they were reading the text. Full text for the screener questions is available online (along with the full materials for the study; https://osf.io/7d3xh/). Screeners were placed just prior to the news evaluation/sharing task, after the CRT, and after the science knowledge and MMS scales. Although we did not preregister any exclusions based on inattentiveness, performance on the screener questions was substantially worse than we expected: 44.7% of participants failed the majority of the screener questions. Thus, we deviate from our preregistration and restrict our main analyses to participants who answered the majority of screener questions. The results are qualitatively equivalent when following the preregistered plan of analyzing all participants (see Supplementary Information).

Analysis

All analyses of headline ratings are conducted at the level of the rating, using linear regression with robust standard errors clustered on participants and headline (note that our preregistration erroneously indicated that we would cluster standard errors only on participant; doing so does not qualitatively change the results). Ratings are z-scored, all individual difference measures are z-scored, and experimentally manipulated variables (headline veracity and condition) are coded as -0.5 and 0.5. Our main analyses use linear probability models instead of logistic regression because the coefficients are more readily interpretable. However, qualitatively equivalent results are obtained using logistic regression.

Results

We begin by comparing discernment – the difference between responses to true versus false headlines – across conditions. As predicted, we observed a significant interaction between headline veracity and condition, $F(1,14156)=46.28$, $p<0.0001$, such that veracity had a much bigger impact on accuracy judgments than sharing intentions (Figure 1; equivalent results are obtained when z-scoring ratings within condition). In particular, for false headlines, 50% more people considered sharing the headlines than rated them as accurate. Thus, we observe a similar pattern when using false headlines about COVID-19 as what has been observed previously using false political headlines (Pennycook et al., 2020). In Study 2, we build on this observation to test the impact of experimentally inducing participants to think about accuracy when making sharing decisions.

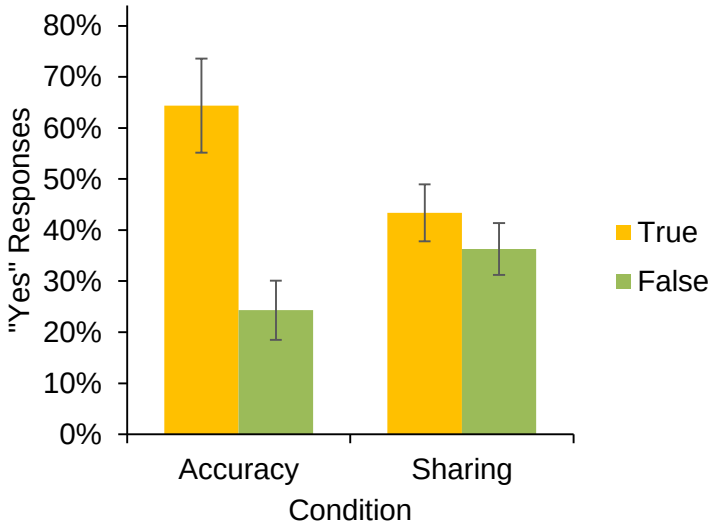

Figure 1. *Percentage of "yes" responses by headline veracity (true vs false) and condition (accuracy = "To the best of your knowledge, is the claim in the above headline accurate?"; sharing = "Would you consider sharing this story online (for example, through Facebook or Twitter)?"). Error bars indicate 95% confidence intervals.*

Before turning to Study 2, we examine how various individual difference measures correlate with truth discernment and sharing discernment (i.e., how the individual differences interact with headline veracity). We also note that all relationships reported below are robust to including controls for age, gender, education (college degree or higher), and ethnicity (white versus non-white) and all interactions between controls, veracity, and condition.

We begin with cognitive reflection. We found an overall positive relationship between CRT and discernment ($F(1,14152)=11.37$, $p<.001$), which did not significantly differ for accuracy versus sharing (3-way interaction between CRT, veracity, and condition; $F(1,14152)=2.44$, $p=.12$). In particular, CRT was negatively correlated with belief in false headlines and uncorrelated with

belief in true headlines; whereas CRT was negatively correlated with sharing of *both* types of headlines (albeit more negatively with sharing of false headlines compared to true; see Table 1). The pattern of CRT correlations we see here for COVID-19 misinformation therefore replicates what has been seen previously with political headlines (e.g., Pennycook & Rand, 2019a).

Condition:	**Accuracy**		**Sharing**	
Headline Veracity:	**False**	**True**	**False**	**True**
Cognitive Reflection Test	-0.086** (-0.086**)	0.003 (-0.001)	-0.156*** (-0.170***)	-0.120** (-0.115**)
Science Knowledge	-0.025 (-0.032)	0.120*** (0.112***)	-0.088* (-0.107*)	-0.005 (-0.026)
Distance to closest disease epicenter	0.004 (0.026)	-0.002 (-0.015)	-0.028 (-0.020)	-0.015 (0.009)
Medical Maximizer-Minimizer Scale	0.101*** (0.102***)	-0.003 (-0.003)	0.236*** (0.213***)	0.259*** (0.233***)
Preference for Republican Party	0.027 (0.035)	-0.034 (-0.034)	-0.050 (-0.022)	-0.118** (-0.086†)

Table 1. *Regression coefficients (β) for simple effects of each individual difference measure within each combination of condition and headline veracity. Values in parentheses show the results when including controls for age, gender, education (college degree or higher), and ethnicity (white versus non-white) and all interactions between controls, veracity, and condition. †p<0.1, *p<0.05, **p<0.01, ***p<0.001.*

Next we consider science knowledge. Like CRT, we found an overall positive relationship between science knowledge and discernment ($F(1,14152)=26.81$, $p<.0001$) that did not significantly differ for accuracy versus sharing (3-way interaction between science knowledge, veracity, and condition; $F(1,14152)=2.26$, $p=.13$). Science knowledge was positively correlated with belief in true headlines and uncorrelated with belief in false headlines, but negatively correlated with sharing of false headlines and uncorrelated with sharing of true headlines (see Table 1).

We now turn to the relationship between discernment and our exploratory measures (see Table 1). Distance from the nearest COVID-19 epicenter (defined as a county with at least 10 confirmed coronavirus cases; log-transformed because of right-skew) was not significantly related to any of the belief or sharing measures. The medical maximizer-minimizer scale was negatively correlated with discernment for accuracy ($F(1,14152)=12.02$, $p=.0005$), such that medical maximizers show

greater belief in false but not true headlines; but, in contrast, there is no such correlation with discernment for sharing ($F(1,14152)=0.98$, $p=.32$) such that medical maximizers were more likely to consider sharing *both* true and false headlines to the same degree (the 3-way interaction between maximizer-minimizer, veracity, and condition was significant; $F(1,14152)=10.97$, $p<.001$). Preference for the Republican party over the Democratic party (partisanship) was not significantly related belief in false or true headlines or to sharing of false headlines, but was significantly negative correlated with sharing of true headlines. However, the 3-way interaction between partisanship, veracity, and condition was not significant, $F(1,14092)=0.02$, $p=.88$; instead, there was a significant overall relationship between partisanship and discernment ($F(1,14092)=5.03$, $p=.025$) such that Democrats were better at discerning between true and false content.

Finally, in Table 2 we report how all of the above variables relate to concern about COVID-19 and how often people proactively check COVID-19 related news (self-reported). Both measures were negatively correlated with CRT and preference for the Republican party over the Democratic Party; uncorrelated with science knowledge and distance from closest disease epicenter; and positively correlated with being a medical maximizer. The results are qualitatively equivalent when using a regression model where all of the individual difference measures were included simultaneously, along with age, gender, ethnicity (white vs non-white) and education (less than college degree vs college degree or more). The only exception is that CRT is no longer a significant predictor of checking COVID-19 related news.

	COVID-19 Concern	COVID-19 News-Checking	CRT	Science Knowledge	Partisanship (Republican)	Distance to epicenter	Medical Maximizing
COVID-19 Concern	-						
COVID-19 News-Checking	.65***	-					
Cognitive Reflection Test (CRT)	-.20***	-.12*	-				
Science Knowledge	-.001	.010	.37***	-			
Partisanship (Republican)	-.29***	-.23***	.08	-.14**	-		
Distance to epicenter	-.02	-.03	-.01	.01	.09*	-	
Medical Maximizing	.39***	.33***	-.24***	-.20***	-.12*	-.02	-

Table 2. *Pairwise correlations between concern about COVID-19, proactively checking news about COVID-19, and the individual difference measures. *p<0.05, **p<0.01, ***p<0.001.*

Study 2

Methods

Participants

We recruited 1000 participants using Lucid. In total, 1145 participants began the study. However, 177 did not indicate using Facebook or Twitter and therefore did not complete the survey. A further 112 participants did not complete the study. The final sample of 856 (Mean age = 47) included 385 males, 468 females, and 8 other/prefer not to answer (although only 58.3% passed a majority of the attention check questions; see below). This study was run on March 13-15th, 2020.

Materials and Procedure

Accuracy induction. Participants were randomized into one of two conditions. In the Control Condition they began the news sharing task, as in Study 1. In the Treatment Condition they rated the accuracy of a single headline (that did not relate to COVID-19) at the beginning of the survey (this was framed as being for a pretest, as in Pennycook et al., 2020). An advantage of this design is that the manipulation is subtle and not explicitly linked to the main task. Thus, although social desirability bias may lead people to underreport their likelihood of sharing misinformation *overall*, it is unlikely that any *between-condition* difference is driven by participants believing that the accuracy question at the beginning of the treatment condition was designed to make them take accuracy into account when making sharing decisions during the main experiment. It is therefore relatively unlikely that any treatment effect would be due demand characteristics or social desirability.

News sharing task. Participants were presented the same headlines as for Study 1 and (as in the sharing condition of Study 1) were asked about their willingness to share the headlines on social media. In this case, however, we asked: "If you were to see the above on social media, how likely would you be to share it", which they answered on a 6-point scale from 1 (extremely unlikely) to 6 (extremely likely). As described above, some evidence in support of the validity of this self-report sharing intentions measure comes from (Mosleh, Pennycook, & Rand, 2020). Further support for the specific paradigm used in this experiment – where participants are asked to rate the accuracy of a headline and then go on to indicate sharing intentions – comes from Pennycook et al. (2020), who find similar results using this paradigm on MTurk and in a field experiment on Twitter measuring actual (rather than hypothetical) sharing.

Other measures. All of the additional measures that were included in Study 1 were also included for Study 2.

Attention checks. The same screeners included in Study 1 were also included in Study 2. Once again, performance on the screener questions was very poor, with 41.7% of participants failing the majority of the screener questions. Thus, as in Study 1, we deviate from our preregistration and restrict our main analyses to participants who answered the majority of screener questions; and once again the results are qualitatively equivalent when following the pre-registered plan of analyzing all participants (see Supplementary Information). [We did not notice the high level of inattention in Study 1 until after launching Study 2, hence the lack of discussion of excluding inattentive participants in the Study 2 preregistration.]

Analysis.

All analyses of are conducted at the level of the rating, using linear regression with robust standard errors clustered on participants and headline. Sharing intentions are rescaled such that 1 on the 6-point Likert scale is 0 and 6 on the 6-point Likert scale is 1.

Results

As predicted, we observe a significant positive interaction between headline veracity and treatment, $F(1,14928)=13.28$, $p=.0003$, such that the treatment increased sharing discernment (Figure 2). Participants were not significantly more likely to say they would share true headlines compared to false headlines in the control, $F(1,14928)=2.31$, $p=0.13$, whereas sharing intentions for true headlines were significantly higher than for false headlines in the treatment, $F(1,14928)=12.35$, $p=0.0004$. Quantitatively, sharing discernment was 2.5 times higher in the treatment compared to the control. Furthermore, the treatment effect on sharing discernment was not significantly moderated by CRT score, science knowledge, distance to nearest infection epicenter, or the medical maximizer-minimizer scale ($p>0.10$ for all 3-way interactions between headline veracity, treatment, and individual difference); and although there was a significant negative 3-way interactions between headline veracity, treatment, and partisanship, $F(1,14864)=8.16$, $p=0.004$, the treatment still significantly increased discernment for both Democrats, $F(1,14864)=15.77$, $p=0.0001$, and Republicans, $F(1,14864)=6.14$, $p=0.013$.

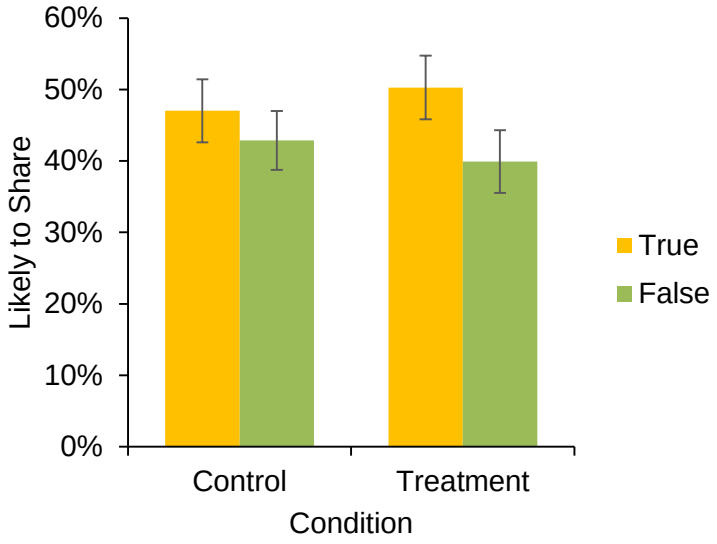

Figure 2. *Percentage of headlines participants said they would be likely to share by headline veracity (true vs false) and condition. For this visualization, we discretize sharing intentions using the scale midpoint (i.e. 1-3=0, 4-6=1) in give a more easily interpretable measurement; all analyses are conducted using the full (non-discretized) scale, and plotting the average (non-discretized) sharing intentions looks qualitatively similar. Error bars indicate 95% confidence intervals.*

Our interpretation of the mechanism underlying the treatment effect is that the treatment makes participants more likely to consider accuracy when deciding whether to share. Based on this mechanism, the extent to which the treatment increases or decreases sharing of a given headline should reflect the underlying perceptions of the headline's accuracy. To provide evidence for such a relationship, we perform an item-level analysis. For each headline, we examine how the effect of the treatment on sharing (i.e. average sharing intention in treatment minus average sharing intention in the control) varies based on the average accuracy rating given to that headline by participants in the Accuracy condition of Study 1. Because participants in Study 2 did not rate the accuracy of the COIVD-19 related headlines, we use average Study 1 ratings as a proxy for how accurate individual participants in Study 2 would likely deem the headlines to be. As shown in Figure 3, there is indeed a strong positive correlation between a headline's perceived accuracy and the impact of the treatment, $r(28)=0.77$, $p<.0001$.

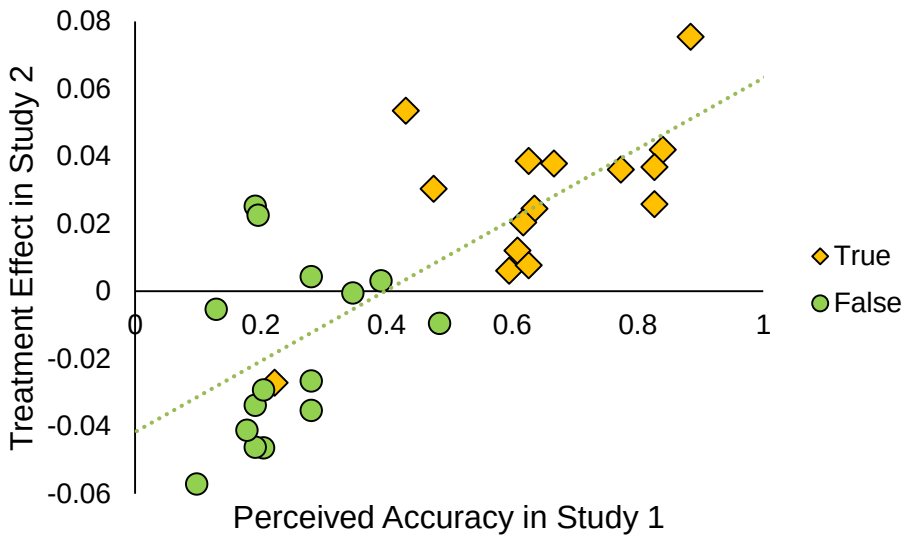

Figure 3. *Relationship across headlines between the effect of the treatment in Study 2 and the average accuracy rating from participants in the Accuracy condition of Study 1.*

Discussion

Our results are consistent with an attention-based account (Pennycook et al., 2020) of COVID-19 misinformation transmission on social media. In Study 1, participants were willing to share fake news about COVID-19 that they would have apparently been able to identify as being untrue if they were asked directly about accuracy. Put differently, participants were far less discerning if they were asked about whether they would share it on social media than if they were asked about its accuracy. Furthermore, individuals who are less likely to rely on their intuitions and who are lower in basic scientific knowledge were worse at discerning between true and false content (in terms of both accuracy and sharing decisions). In Study 2, we demonstrated the promise of a behavioral intervention informed by this attention-based account. Prior to deciding which headlines they would share on social media, participants were subtly primed to think about accuracy by being asked to rate the accuracy of a single news headline. This minimal, content-neutral intervention was sufficient to more than double participants' level of discernment between sharing true versus false headlines.

This research has implications for both public policy and theory. Misinformation is a particularly significant problem in uncertain news environments (e.g., immediately following a major news event; Starbird, 2019; Starbird, Maddock, Orand, Achterman, & Mason, 2014). In cases where high quality information may literally be life-and-death (for some) – such as for COVID-19 – the impetus to develop interventions to fight misinformation become even more dire. Consistent with recent work on political misinformation (Pennycook et al., 2020), here we find that simple and subtle reminders about the concept of accuracy may be sufficient to improve people's sharing decisions regarding information about COVID-19, and therefore reduce the amount of

misinformation of COVID-19 seen on social media. Although our treatment was far from eliminating all intentions to share misinformation, the intervention may nonetheless have important downstream effects on the overall quality of information shared online (e.g. due to network effects; for an extended discussion, see Pennycook et al., 2020). Furthermore, when misinformation is particularly high risk – as is the case for COVID-19 – even modest improvements can have meaningful consequences.

In terms of theoretical impact, our findings relate to recent debates in the social science of misinformation. A lot has been made of the potential role of political ideology and partisan identity in the context of fake news (Beck, 2017; Kahan, 2017; Taub, 2017; Van Bavel & Pereira, 2018). Although there has certainly been some political polarization in the context of COVID-19 (Bruce, Nguyen, Ballad, & Sanders, 2020) – which we find evidence for here as well; Republicans tended to be less concerned about COVID-19 and less likely to share true COVID-19 news content than Democrats – believing and spreading health misinformation seems (based on our data) more similar to the type of poor intuitive or emotional thinking that is typically linked with conspiratorial (Pennycook, Cheyne, Barr, Koehler, & Fugelsang, 2015; Swami, Voracek, Stieger, Tran, & Furnham, 2014; Vitriol & Marsh, 2018) and superstitious (Elk, 2013; Lindeman & Svedholm, 2012; Pennycook, Cheyne, Seli, Koehler, & Fugelsang, 2012; Risen, 2015) belief. Furthermore, recent work has shown that, even in the context of politically polarized false (Pennycook & Rand, 2019a) and misleading (Ross et al., 2019) news, the actual truth or falsity of the content plays a larger role than political valence. Relatedly, in an investigation of a American opinions about a wide range of scientific topics, McPhetres and Pennycook (2020) found that political ideology was a weak and inconsistent predictor relative to cognitive sophistication (i.e., basic science knowledge, analytic thinking, etc.). Collectively, these findings highlight the importance of reflecting on incorrect intuitions and avoiding the traps of cognitive miserliness for a variety of psychological outcomes (Pennycook, Fugelsang, & Koehler, 2015; Stanovich, 2005).

Our research is not without several important implications. Perhaps most importantly, our evidence is restricted to the United States and therefore needs to be tested elsewhere in the world. Although our sample was quota-matched to the U.S. population on age, gender, ethnicity, and region, it was also not obtained via probability sampling and therefore should not be considered nationally representative. We also used a particular set of true and false headlines about COVID-19. It is important for future work to test the generalizability of our findings to other headlines, and to (mis)information about COVID-19 that comes in forms other than headlines (e.g. emails/text posts/memes about supposed disease cures). Finally, our sharing intentions were hypothetical and our experimental accuracy induction was performed in a "lab" context. Thus, one may be concerned about whether our results will extend to naturalistic social media contexts. We see two reasons to expect that our results will in fact generalize to real sharing. First, our manipulation was quite subtle and thus we believe it is unlikely that differences in sharing intentions between the treatment and control (as opposed to overall sharing levels) are driven by demand effects or social

desirability bias. Second, Pennycook et al. (2020) targeted the same accuracy reminder intervention at political misinformation and found that the results from the survey experiments replicated when they delivered the intervention via direct message on Twitter, significantly improving the quality of subsequent tweets from individuals who are prone to sharing misleading political news content.

In sum, our results shed light on why people believe and share misinformation related to COVID-19 and points to a suite of interventions based on accuracy nudges that social media platforms could easily implement. Such interventions are easily scalable, avoid issues related to implied truth that can arise with warning flags (Pennycook, Bear, Collins, & Rand, 2019), and do not require platforms to make decision about what content to censor. We hope that social media platforms will consider this approach in their efforts to combat the spread of health misinformation.

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Competing interests

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Supplementary Materials

Study 1 Results When Including Inattentive Participants

As predicted, we observe a significant interaction between headline veracity and condition, $F(1,25586)=42.24$, $p<0.0001$, such that veracity has a much bigger impact on accuracy judgments than sharing intentions (Figure 1; equivalent results are obtained when z-scoring ratings within condition). In particular, for false headlines, ⅓ more people considered sharing the headlines than rated them as accurate. Thus, we observe a similar pattern when using false headlines about COVID-19 as what has been observed previously using false political headlines (Pennycook et al., 2020).

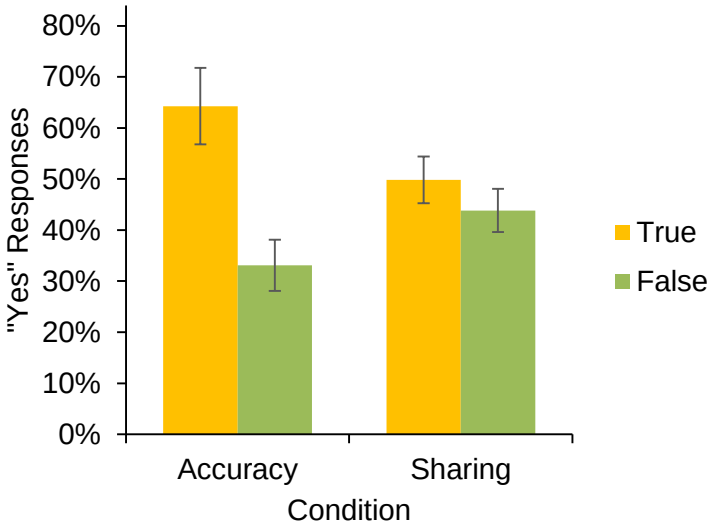

Figure S1. *Percentage of "yes" responses by headline veracity (true vs false) and condition (accuracy = "To the best of your knowledge, is the claim in the above headline accurate?"; sharing = "Would you consider sharing this story online (for example, through Facebook or Twitter)?"). Error bars indicate 95% confidence intervals.*

We find that CRT is positively related to discernment for both accuracy ($F(1,25582)=34.95$, $p<.0001$) and sharing ($F(1,25582)=4.98$, $p=.026$), but much more so for accuracy (3-way interaction between CRT, veracity, and condition; $F(1,25582)=14.68$, $p=.0001$). In particular, CRT is negatively correlated with belief in false headlines and uncorrelated with belief in true headlines; whereas CRT is negatively correlated with sharing of *both* types of headlines (albeit more negatively with sharing of false headlines compared to true; see Table S1).

Condition:	**Accuracy**		**Sharing**	
Headline Veracity:	**False**	**True**	**False**	**True**
Cognitive Reflection Test	-0.148***	0.008	-0.177***	-0.134***
Science Knowledge	-0.080**	0.079**	-0.082*	-0.011
Preference for Republican Party	0.003	-0.016	-0.070*	-0.128***
Distance to closest disease epicenter	-0.046†	-0.021	-0.099**	-0.099**
Medical Maximizer-Minimizer Scale	0.130***	0.047*	0.236***	0.233***

Table S1. *Regression coefficients for simple effects of each individual difference measure within each combination of condition and headline veracity. †p<0.1, *p<0.05, **p<0.01, ***p<0.001.*

Next we consider science knowledge. Like CRT, science knowledge is positively correlated with discernment for both accuracy ($F(1,25552)=32.80$, $p<.0001$) and sharing ($F(1,25552)=10.02$, $p=.002$), but much more so for accuracy (3-way interaction between science knowledge, veracity, and condition; $F(1,25552)=7.59$, $p=.006$). In particular, science knowledge is negatively correlated with belief in false headlines and positively with belief in true headlines; whereas science knowledge is negatively correlated with sharing of false headlines and *uncorrelated* with sharing of true headlines (see Table S1).

We now turn to the relationship between discernment and our exploratory measures (see Table S1). Distance from the nearest COVID-19 epicenter (defined as a county with at least 10 confirmed coronavirus cases; log-transformed because of right-skew) is not significantly related to belief in either true or false headlines, but negatively correlated with sharing intentions for both true and false headlines (no significant interactions with veracity, $p>0.2$; interaction between distance and condition was marginal, $F(1, 25522)=3.07$, $p=0.080$). The medical maximizer-minimizer scale is negatively correlated with discernment for accuracy ($F(1,25582)=11.26$, $p=.0008$), such that medical maximizers show greater belief in both true and false headlines (this pattern is more strongly positive for belief in false headlines); but, in contrast, there is no such correlation with discernment for sharing ($F(1,25582)=0.03$, $p=.87$). Thus, medical maximizers are more likely to consider sharing *both* true and false headlines to the same degree (the 3-way interaction between

maximizer-minimizer, veracity, and condition was significant; $F(1,25582)=7.58$, $p=.006$). Preference for the Republican party over the Democratic party (partisanship) was not significantly related to discernment for accuracy ($F(1,25402)=0.45$, $p=.50$) but was significantly negatively related to discernment for sharing ($F(1,25402)=8.28$, $p=.004$), such that stronger Republicans were *less* likely to share both true and false headlines, but were particularly less likely (relative to Democrats) to share *true* headlines (however, the 3-way interaction between partisanship, veracity, and condition was not significant, $F(1,25402)=1.62$, $p=.20$).

Finally, in Table S2 we report how all of the above variables relate to concern about COVID-19 and how often people proactively check COVID-19 related news (self-reported). Both measures are negatively correlated with CRT score and preference for the Republican party over the Democratic Party; uncorrelated with science knowledge; and positively correlated with being a medical maximizer. Distance to the nearest county with at least 50 COVID-19 diagnoses was uncorrelated with concern but negatively correlated with news-checking. The results are qualitatively equivalent when using a regression model where all of the individual difference measures were included simultaneously, along with age, gender, ethnicity (white vs non-white) and education (less than college degree vs college degree or more) - except that in the regression models, a significant positive relationship emerges between science knowledge and both COVID-19 measures ($p<0.01$ for both); and the negative relationship between distance to epicenter and news seeking is no longer significant.

	COVID-19 Concern	COVID-19 News-Checking	CRT	Science Knowledge	Partisanship (Republican)	Distance to epicenter	Medical Maximizing
COVID-19 Concern	-						
COVID-19 News-Checking	.64***	-					
Cognitive Reflection Test (CRT)	-.22***	-.10**	-				
Science Knowledge	-.001	.06†	.40***	-			
Partisanship (Republican)	-.27***	-.21***	.09**	-.08*	-		
Distance to epicenter	-.05	-.07*	.01	-.03	.10*	-	
Medical Maximizing	.41***	.36***	-.23***	-.16***	-.15***	-.05	-

Table S2. *Pairwise correlations between concern about COVID-19, proactively checking news about COVID-19, and the individual difference measures. †p<0.1, *p<0.05, **p<0.01, ***p<0.001.*

Study 2 Results When Including Inattentive Participants

As predicted, we observe a significant positive interaction between headline veracity and treatment, $F(1,25623)=17.88$, $p<.0001$, such that the treatment increased sharing discernment (Figure S2). Participants were no more likely to say they would share true headlines compared to false headlines in the control, $F(1,25623)=1.41$, $p=0.24$, whereas sharing intentions for true headlines were significantly higher than for false headlines in the treatment, $F(1,25623)=8.89$, $p=0.003$. Quantitatively, sharing discernment was 2.8 times higher in the treatment compared to the control. Furthermore, the treatment effect on sharing discernment was not significantly moderated by CRT score, science knowledge, partisanship, distance to nearest infection epicenter, or the medical maximizer-minimizer scale ($p>0.10$ for all 3-way interactions between headline veracity, treatment, and individual difference).

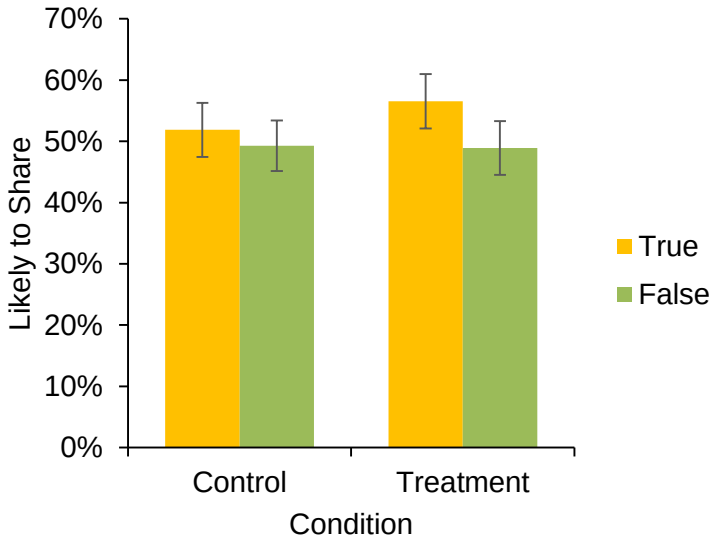

Figure S2. *Percentage of headlines participants said they would be likely to share by headline veracity (true vs false) and condition. For this visualization, we discretize sharing intentions using the scale midpoint (i.e. 1-3=0, 4-6=1) in give a more easily interpretable measurement; all analyses are conducted using the full (non-discretized) scale, and plotting the average (non-discretized) sharing intentions looks qualitatively similar. Error bars indicate 95% confidence intervals.*

Our interpretation of the treatment effect is that it makes participants more likely to take accuracy into account when deciding what to share. Thus, the extent to which the treatment increases or decreases sharing of a given headline should depend on how accurate they perceive the headline to be. To provide evidence for such a relationship, we perform an item-level analysis. For each headline, we examine how the effect of the treatment on sharing (i.e. average sharing intention in treatment minus average sharing intention in the control) varies based on the average accuracy rating given to that headline by participants in the Accuracy condition of Study

1. (Recall that we must use Study 1 ratings because participants in Study 2 did not rate the accuracy of the COIVD-19 related headlines.) As shown in Figure S3, there is indeed a strong positive correlation between a headline's perceived accuracy and the impact of the treatment ($r(28)=0.76$, $p<.0001$).

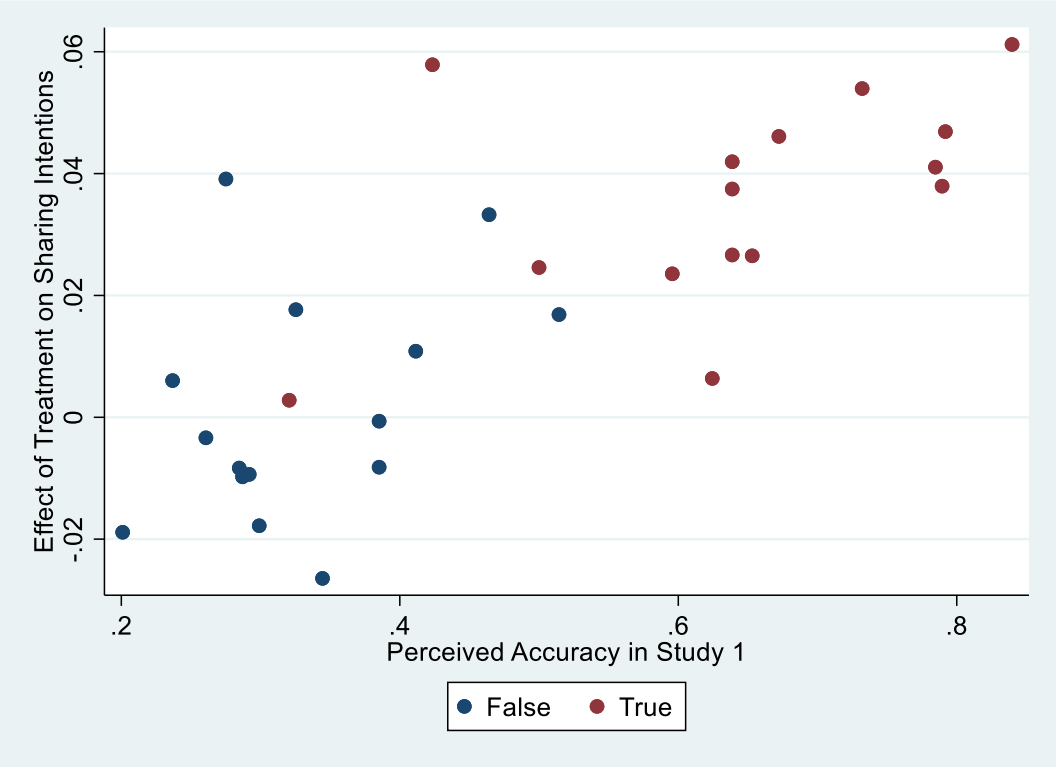

Figure S3. *Relationship between the effect of the treatment in Study 2 (y-axis) for each headline and the average accuracy rating that headline received from participants in the Accuracy condition of Study 1 (x-axis).*