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Intellectual humility is associated with greater misinformation discernment and metacognitive insight but not response bias

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There is growing evidence that intellectual humility is associated with reduced misinformation susceptibility. However, a key aspect of intellectual humility is awareness of one's own limitations, which may increase cautious responding (e.g., tendency to label headlines false or withhold responses, regardless of headline veracity or response accuracy). Therefore, the present study used signal detection theory to disentangle discernment and response bias, and examine the relationships between intellectual humility, misinformation discernment, and metacognitive discernment (i.e., ability to discern between one's own correct and incorrect responses). Participants ($N = 246$) assessed the truthfulness of 60 news headlines (30 true, 30 false; misinformation discernment) and decided whether to report or withhold each truthfulness judgment (metacognitive discernment). Participants also completed three intellectual-humility scales. Intellectual humility was related to greater misinformation discernment and metacognitive discernment, but not to response bias. These findings suggest intellectual humility is associated with reduced misinformation susceptibility due to improved discernment of true and false claims and not response bias. Moreover, the finding that self-reported intellectual humility positively related to metacognitive discernment supports the validity of the intellectual-humility scales. Cumulatively, results highlight the benefits of intellectual humility and suggest future research should examine whether interventions that increase intellectual humility are an effective approach for countering misinformation.

Keywords: misinformation, intellectual humility, metacognition, signal detection theory

1. INTRODUCTION

The spread of misinformation (any information that is false or misleading) and fake news (a subset of misinformation in which false news is presented as true) poses serious challenges, undermining global health, trust in science, and democratic stability (Ecker et al., 2022, 2024; Loomba et al., 2021; Lorenz-Spreen et al., 2023; Tay et al., 2024). Given this context, identifying individual differences that might reduce misinformation susceptibility has become increasingly important. One key individual difference that may reduce susceptibility to misinformation is intellectual humility. Defined broadly, intellectual humility is the recognition and acceptance of the limitations of one's own knowledge, and promotes a readiness to scrutinize information critically, reconsider beliefs in light of credible evidence, and be receptive to diverse viewpoints, all of which may reduce susceptibility to misinformation (Alfano et al., 2017; Deffler et al., 2016; Krumrei-Mancuso et al., 2020; Krumrei-Mancuso & Rouse, 2016; Leary et al., 2017; Porter et al., 2022; Zmigrod et al., 2019).

Another aspect of intellectual humility that may reduce susceptibility to misinformation is enhanced metacognitive insight (Deffler et al., 2016; Leary et al., 2017; Porter et al., 2022). Specifically, if those higher in intellectual humility are better able to distinguish between their own accurate and inaccurate judgments about the truth (or falsity) of information, then they may be less prone to sharing that information with others, more likely to seek out additional information, and/or more receptive to updating their beliefs. Therefore, in this study we examined the relationship between intellectual humility and people's ability to discern between true and false headlines, as well as whether intellectual humility is associated with greater metacognitive insight into those truthfulness judgments.

1.1 Intellectual Humility

There are multiple definitions and measures of intellectual humility; however, metacognitive

awareness of one's own thinking and limitations, is common to most definitions (Alfano et al., 2017; Krumrei-Mancuso & Rouse, 2016; Leary et al., 2017; McElroy et al., 2014; for a review see Porter et al., 2022). Many definitions also emphasize related aspects, such as openness to conflicting ideas, acceptance of the potential to be wrong, and a willingness to update beliefs in response to evidence (Alfano et al., 2017; Krumrei-Mancuso & Rouse, 2016). Some researchers have also highlighted the importance of other facets of intellectual humility, such as respecting others' viewpoints even if they differ from one's own, and acknowledging the worth and value of others' intellectual contributions (Porter et al., 2022).

Several recent studies have investigated the relationship between intellectual humility and susceptibility to both misinformation and conspiracy theories. Although misinformation and conspiracy theories are distinct constructs, they are interrelated because many conspiracy theories are based on misinformation and some, but not all, misinformation is conspiratorial in nature (Lewandowsky et al., 2017; Tay et al., 2024). These studies have found that intellectual humility is associated with reduced endorsement of conspiracy theories, more positive vaccination attitudes and intentions, reduced endorsement of pseudoscience, and reduced susceptibility to misinformation (Bowes et al., 2021; Bowes & Tasimi, 2022; Huynh & Bayles, 2022; Huynh & Senger, 2021; Koetke et al., 2022, 2023; Senger & Huynh, 2021). Relatedly, the actively open-minded thinking about evidence scale (AOT-E; Pennycook et al., 2020), has also been found to be associated with reduced endorsement of conspiracy theories, paranormal beliefs, moralistic thinking, and anti-science attitudes. Although actively open-minded thinking is not generally defined as a facet of intellectual humility, there is considerable overlap between actively open-minded thinking about evidence and some aspects of intellectual humility, although actively open-minded thinking places an even greater emphasis on

willingness to consider evidence and update one's beliefs.

The above findings are promising in terms of establishing intellectual humility and actively open-minded thinking about evidence as individual differences that may reduce susceptibility to misinformation. However, one important limitation is that prior research does not distinguish between ability to discern misinformation and response bias. In the context of misinformation, discernment is defined as accurately identifying false information as false, and true information as true, whereas response bias is the overall tendency to label information as true or false, regardless of veracity (Batailler et al., 2022; Gawronski et al., 2023). Disentangling discernment from response bias is particularly important because a key component of intellectual humility is an awareness of one's own limitations (Krumrei-Mancuso & Rouse, 2016; Leary et al., 2017; Porter et al., 2022). Therefore, it is possible that what appears to be reduced susceptibility to misinformation is actually driven by a conservative response bias (Batailler et al., 2022; Modirrousta-Galian & Higham, 2023). That is, individuals higher in intellectual humility might be excessively cautious or skeptical, and therefore may be more prone to label even true information as false. This is potentially problematic because, just as belief in misinformation can have negative consequences for both individuals and society, failure to accept true information can have potential negative consequences, and may lead people to be underinformed, reducing their ability to form beliefs based on evidence, and to follow advice or support policies that are based on accurate information.

1.2 Signal Detection Theory and Metacognition

Signal detection theory (SDT) is a longstanding and well-established approach for separating discernment from response bias, and recently it has increasingly been applied to misinformation research (Batailler et al., 2022; Gawronski et al., 2023; Modirrousta-Galian &

Higham, 2023; Modirrousta-Galian et al., 2023; Wixted, 2020). The application of a SDT framework to misinformation has already provided important insights, revealing that cognitive reflection is associated with improved misinformation discernment, whereas partisan bias is associated with changes in response bias (lower threshold to judge politically aligned information as true; Batailler et al., 2022; Gawronski et al., 2023); SDT has also proven useful in examinations of the efficacy of some existing misinformation interventions (Modirrousta-Galian & Higham, 2023; Modirrousta-Galian et al., 2023).

Despite the strong emphasis on metacognition as a key component of intellectual humility, there is surprisingly little research on the relationship between intellectual humility and performance on metacognitive tasks (Porter et al., 2022). That said, some prior research has investigated the relationship between intellectual humility and overclaiming, producing mixed evidence. Both Alfano et al. (2017) and Krumrei-Mancuso et al. (2020) found that lower intellectual humility was associated with overclaiming of knowledge one did not have. However, Deffler et al. (2016) applied SDT and found that intellectual humility was related to improved discernment on an overclaiming task, but was unrelated to response bias (i.e., unrelated to a tendency to overclaim). Bowes et al. (2023) found that for both college and community samples, intellectual humility was associated with greater discernment on an overclaiming task, but an association with response bias (i.e., tendency to overclaim) was only found for the general community sample. Bowes et al. (2023) also found that intellectual humility was associated with better discernment on the bullshit receptivity scale but not response bias, with prior research also finding that bullshit receptivity is associated with poorer fake news discernment (Pennycook & Rand, 2020). Both Bowes et al. (2023) and Leman et al. (2023) found that lower intellectual humility was associated with greater overestimation of one's

abilities, although the strength and significance of these relationships varied across measures; both studies also found some limited evidence that intellectual humility was negatively related to overconfidence, but again the strength and significance of these relationships varied across measures.

These previous applications of SDT to misinformation and intellectual humility have focused on SDT for so-called type-1 tasks, which are tasks requiring participants to distinguish between signal and noise trials, such as when discerning true claims (signal) from false ones (noise). However, SDT can also be applied to metacognitive judgments or decisions, using what is known as type-2 SDT (Higham, 2011). Like type-1 SDT, type-2 SDT also produces two separate measures, discernment and response bias. However, in the case of type-2 SDT these measures index metacognitive discernment (i.e., ability to discern one's own correct and incorrect responses) and metacognitive response bias (e.g., tendency to report or withhold one's type-1 judgments). Given the central role of metacognition in intellectual humility, the present study included a type-2 task to allow for examination of the relationship between intellectual humility and metacognitive discernment and response bias. This enables us to expand upon previous work on intellectual humility and metacognition, which has primarily focused on type-1 discernment, response bias, and confidence, by examining whether greater intellectual humility is also associated with being better able to distinguish one's own correct and incorrect responses. Given an awareness of the limitations of one's knowledge is a core component of intellectual humility, finding a positive association between intellectual humility and metacognitive discernment would also provide convergent validity for the intellectual-humility measures.

1.3 The Present Study

The present study used a standard misinformation-detection task, in which participants

were presented with a series of news headlines (Pennycook et al., 2021). Participants were provided with a cover story instructing them to imagine they were part of a non-partisan online group who tried to promote true news and debunk misinformation. Therefore, their task was to evaluate the truthfulness of each headline and then decide whether to share these truthfulness ratings with others (see Procedure for more detail; full instructions details are provided in Supplementary Materials at <https://osf.io/brh83/>).

For each headline, participants judged the truthfulness of the headline, with type-1 SDT used to gain measures of misinformation discernment (d'), response bias (C ; overall tendency to respond true or false), and area under the curve (AUC). Following each truthfulness judgment, participants then decided whether to share (report) that truthfulness rating or withhold it, with type-2 SDT used to determine measures of metacognitive discernment (d'), response bias (C ; overall tendency to report or withhold truthfulness judgments), and AUC. Additionally, to capture the multi-dimensional nature of intellectual humility and examine which dimensions are most strongly related to misinformation susceptibility and metacognition, we included three measures that focused on awareness of one's own limitations (Leary et al., 2017), open mindedness (Alfano et al., 2017), and attitudes towards evidence and belief updating (Pennycook et al., 2020).

We had two key hypotheses regarding the relationships between intellectual humility, misinformation susceptibility, and metacognition. (1) Consistent with prior research, we predicted that individuals higher in intellectual humility would be better able to discern between true and false news (type-1 d' and AUC; Bowes & Tasimi, 2022; Koetke et al., 2022, 2023); (2) because metacognition, specifically an awareness of the limitations of one's knowledge, is a core component of intellectual humility, we predicted that individuals higher in intellectual

humility would be better able to discern between their own accurate and inaccurate truthfulness judgments (type-2 d' and AUC; Alfano et al., 2017; Krumrei-Mancuso & Rouse, 2016; Leary et al., 2017; Zmigrod et al., 2019). We did not make any specific predictions regarding the relationship between intellectual humility and either type-1 or type-2 response bias.

2. METHODS

This study used a correlational design, with intellectual humility as the independent variable, and the six SDT measures (type-1 d' , type-1 C, type-1 AUC, type-2 d' , type-2 C, type-2 AUC) as the dependent variables. More detailed explanations of the SDT measures and how they were calculated are presented in the Results section.

2.1 Participants

An a-priori power analysis for a correlation was conducted using G*Power 3 (Faul et al., 2007) and suggested a minimum sample size of 191 participants to detect a small effect size of $r = 0.20$ ($\alpha = 0.05$, $1 - \beta = 0.80$). This effect size was chosen based on our reading of prior literature and because it is the median effect size for individual differences research (Gignac & Szodorai, 2016). To ensure sufficient power even after potential exclusions, 246 U.S.-based participants were recruited via the online platform Prolific. Participants were reimbursed \$4.75 USD for completing the study. Prolific was used to collect a more diverse and demographically representative sample than could be obtained from a standard university cohort (Palan & Schitter, 2018). The a-priori exclusion criteria were: self-reporting only 'fair' or 'poor' English proficiency (score of 0 or 1 on a 0-4 scale; $n = 0$); self-reported lack of effort ($n = 0$); self-reporting residing outside the U.S. ($n = 2$). This resulted in a final sample size of $N = 244$. The sample included 126 men, 113 women, 4 non-binary participants, and 1 who opted not to disclose their gender; 36 participants identified as Republicans, 115 as Democrats, and 93 as Independents; mean age was 39.82 years ($SD = 12.33$, age

range 19-73).

2.2 Materials

2.2.1 News Headlines

Sixty headlines (30 true, 30 false) were selected for inclusion from an initial pool of 120 headlines. Headlines were selected based on two independent pilot studies, in which the headlines were rated on shareability and current relevance (Pilot 1) and believability and political leaning (Pilot 2; see Supplementary Materials <https://osf.io/brh83/> for more details). The most currently relevant and shareable headlines were chosen to increase participant engagement and maximize external validity; political leaning of both true and false headlines was balanced to minimize the impact of political ideology.

For each headline, participants were asked "Do you believe this news headline is true or false?" and responded on a 6-point scale from "*certainly false*" (0) to "*certainly true*" (5). Participants were then immediately shown their truthfulness judgment and asked to make a metacognitive report/withhold judgment. Specifically, participants were asked "Would you be willing to report this judgment?" and responded on a 6-point scale ranging from "*certainly withhold*" (0) to "*certainly report*" (5). Figure 1 contains an example trial.

2.2.2 General Intellectual Humility Scale (GIH)

The GIH was used to measure awareness of one's own limitations and belief flexibility (Leary et al., 2017). The GIH is a six-item measure that includes items such as "I question my own opinions, positions, and viewpoints because they could be wrong". Items are answered on a 5-point scale anchored by "*not at all true or characteristic of me*" (0) and "*extremely true or characteristic of me*" (4). Previous research has found the GIH exhibits robust construct and criterion validity, and good internal consistency (Leary et al., 2017).

2.2.3 Open-Mindedness Subscale (OM)

The OM subscale from the multi-dimensional measure of intellectual humility developed by Alfano et al. (2017) is a six-item measure designed to capture willingness to learn and to listen to other people's perspectives or viewpoints. It includes items such as "I feel no shame learning from someone who knows more than me" and is answered on a 7-point scale, from "strongly disagree" (0) to "strongly

agree" (6). This scale has shown good convergent and discriminant validity, and good reliability, including from an informant-report replication whereby associates of participants were asked to separately rate them on the same scales (Alfano et al., 2017).

2.2.4 Actively Open-Minded Thinking About Evidence Scale (AOT-E)

We also measured attitudes towards considering evidence and belief updating using the

Figure 1

Example Trial for a False Headline

HEADLINE:

Michigan house passes human microchipping legislation

Do you believe this news headline is true or false?

Certainly False	Probably False	Somewhat more likely to be False than True	Somewhat more likely to be True than False	Probably True	Certainly True
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You rated the headline: **Michigan house passes human microchipping legislation** as **Probably False**

Would you be willing to report this judgment?

Certainly Withhold	Probably Withhold	Somewhat more likely to Withhold than Report	Somewhat more likely to Report than Withhold	Probably Report	Certainly Report
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Note. The figure shows the initial truthfulness judgment (above) and the metacognitive report/withhold judgment (below). The metacognitive judgment was presented on the screen immediately following the truthfulness judgment.

AOT-E (Pennycook et al., 2020). Although not commonly referred to as an intellectual-humility measure, the AOT-E focuses on openness to changing one's beliefs or opinions according to evidence, which are relevant dimensions of intellectual humility. The AOT-E is an eight-item measure that includes items such as "People should always take into consideration evidence that goes against their opinions." Participants respond on a 6-point scale, from "strongly disagree" (0) to "strongly agree" (5). This scale has previously shown strong internal reliability and is related to reduced endorsement of non-evidence based beliefs and increased agreement with scientific claims (Pennycook et al., 2020).

2.2.5 Composite Intellectual Humility Measure (CIH)

In addition to measuring intellectual humility using the GIH, AOT-E, and OM, we also created a composite measure by combining the scores from the three scales. This was done to provide a measure that encompassed multiple dimensions of the concept of intellectual humility. The GIH focuses on acknowledging one's own fallibility and belief flexibility. The AOT-E focuses on openness to evidence and updating one's beliefs. The OM adds to these scales by

measuring willingness to learn from others and open mindedness. The three scales were centered and scaled using the *scale* function from base R (R Core Team, 2023) before being combined; we labelled the composite measure CIH. Correlations between all three scales and the composite scale are reported in Table 1, along with Cronbach's α .

2.3 Procedure

The study was approved by the Human Research Ethics Office at the University of Western Australia (RA/4/20/6423). The study was run using Qualtrics software (Qualtrics, Provo, UT). Participants first received an ethics-approved information sheet and provided informed consent. They were then shown a narrative explaining their role in the study (see Supplementary Materials at <https://osf.io/brh83/>), namely that their tasks were to rate the truthfulness of news headlines on social media and then report these ratings as a member of a non-partisan online group. To clarify that "reporting" referred to sharing their truthfulness rating, rather than sharing the headline itself, participants were told "After deciding whether you think a headline is true or false, you also need to decide

Table 1

Correlations and Cronbach's α for the Intellectual Humility Scales

Intellectual Humility Scale	1.	2.	3.	4.
1. General Intellectual Humility Scale	(.89)			
2. Open-Mindedness Subscale	.43 [.32, .53]	(.75)		
3. Actively Open-Minded Thinking About Evidence Scale	.56 [.47, .64]	.61 [.53, .69]	(.84)	
4. Composite Intellectual Humility Measure	.80 [.75, .84]	.82 [.77, .86]	.87 [.84, .90]	(.77)

Note. 95% CIs shown in brackets. Cronbach's α for each scale are listed in parentheses along the major diagonal.

whether to tell others about your judgment — which is basically adding a comment like 'I believe this headline is True' or 'I believe this headline is False', to give others some guidance.". Following the instructions, participants were exposed to the 60 true and false news headlines, each displayed individually and in a randomized sequence. For each headline, participants initially judged its truthfulness and then chose whether to report or withhold that truthfulness judgment. After evaluating all headlines, participants completed the three intellectual-humility measures in a randomized order. Participants then provided basic demographic information: English proficiency, age, gender, country of residence, political group identity (Republican, Democrat, Independent), and political leaning (5-point scale from "very liberal" to

"very conservative"). Finally, participants were asked whether their data should be excluded from analyses due to distraction or insufficient effort and were then fully debriefed, including explicitly informing them about the veracity of all headlines (Greene et al., 2023). The study took approximately 25 minutes to complete.

3. RESULTS

All data cleaning and analyses were conducted using R statistical software version 4.3.1 (R Core Team, 2023) and RStudio version 2023.6.1.524 (Posit team, 2023). The *tidyverse* was used for data cleaning (Wickham et al., 2019) and *ggplot2* was used for data visualization (Wickham, 2016). Materials, data, and analysis scripts are available at <https://osf.io/brh83/>.

3.1 Misinformation Discernment

To test our hypothesis that intellectual humility was positively associated with misinformation discernment, we first calculated type-1 SDT indices, with d' as a measure of discernment and C as a measure of response bias. To calculate

hits and false alarms, we binarized participants' truthfulness judgments, with values ≤ 2 coded as "false" judgments, and values ≥ 3 coded as "true" judgments. Trials on which participants judged a true headline as true were classified as hits, whereas trials on which a false headline was judged as true were classified as false alarms.¹ Hits and false alarms were in turn used to calculate d' and C using the *dprime* function from the *psycho* package (Makowski, 2018). The formulas used to calculate d' and C are based on the Z values of the hit and false alarm rate, with the specific formulas shown below:

$$d' = z(H) - z(FA)$$

$$C = -0.5 \times [z(H) + z(FA)]$$

Higher d' scores indicate greater discernment between true and false headlines. Higher C scores indicate a higher acceptance threshold for judging headlines as true, suggesting a more conservative response bias. Conversely, lower C scores imply a more liberal response strategy, where a participant is more inclined to label a headline as true (Wickens, 2001). Descriptive statistics are presented in Table 2.

In addition to d' and C , we also computed receiver operating characteristic (ROC) curves to further examine discernment (Higham & Higham, 2019). This was done by calculating cumulative hit and false alarm rates for each participant at each response point (i.e., 6 hit and 6 false alarm rates per participant). These cumulative hit and false alarm rates treat each response level as the cut-off point (e.g., when 2 is the response level, all true claims rated at 2 or above are classified as hits and all false claims rated at 2 or above are classified as false alarms; Mandrekar, 2010). AUC was then calculated for each participant using the trapezoidal rule (Pollack & Hsieh, 1969). Perfect discernment between true and false items is represented by an AUC of 1, whereas an AUC of 0.5 represents

¹ Standard SDT formulas cannot handle hit or false-alarm rates of exactly 0 or 1. Therefore, for both type-1 and type-2 SDT, we used the log-linear rule in which 0.5 is added to all hits, false alarms, misses, and correct rejections (Hautus, 1995).

Table 2*Type-1 Signal Detection Theory Descriptive Statistics*

SDT Measure	<i>M</i>	<i>SD</i>	Minimum	Maximum
Hits	23.29	4.57	5	30
False Alarms	9.00	5.36	0	27
<i>d'</i>	1.40	0.65	-0.52	3.20
AUC	0.79	0.11	0.32	0.97
<i>C</i>	-0.13	0.43	-1.32	1.16

Note. Hits, number of true headlines correctly identified as true. False Alarms, number of false headlines incorrectly identified as true. *d'*, a measure of ability to discern between true and false headlines; positive *d'* values suggest better discernment, negative values suggest below-chance performance. *C*, an index of response bias; positive values indicate a bias towards saying “false”, negative values indicate a bias towards saying “true”.

chance level performance.

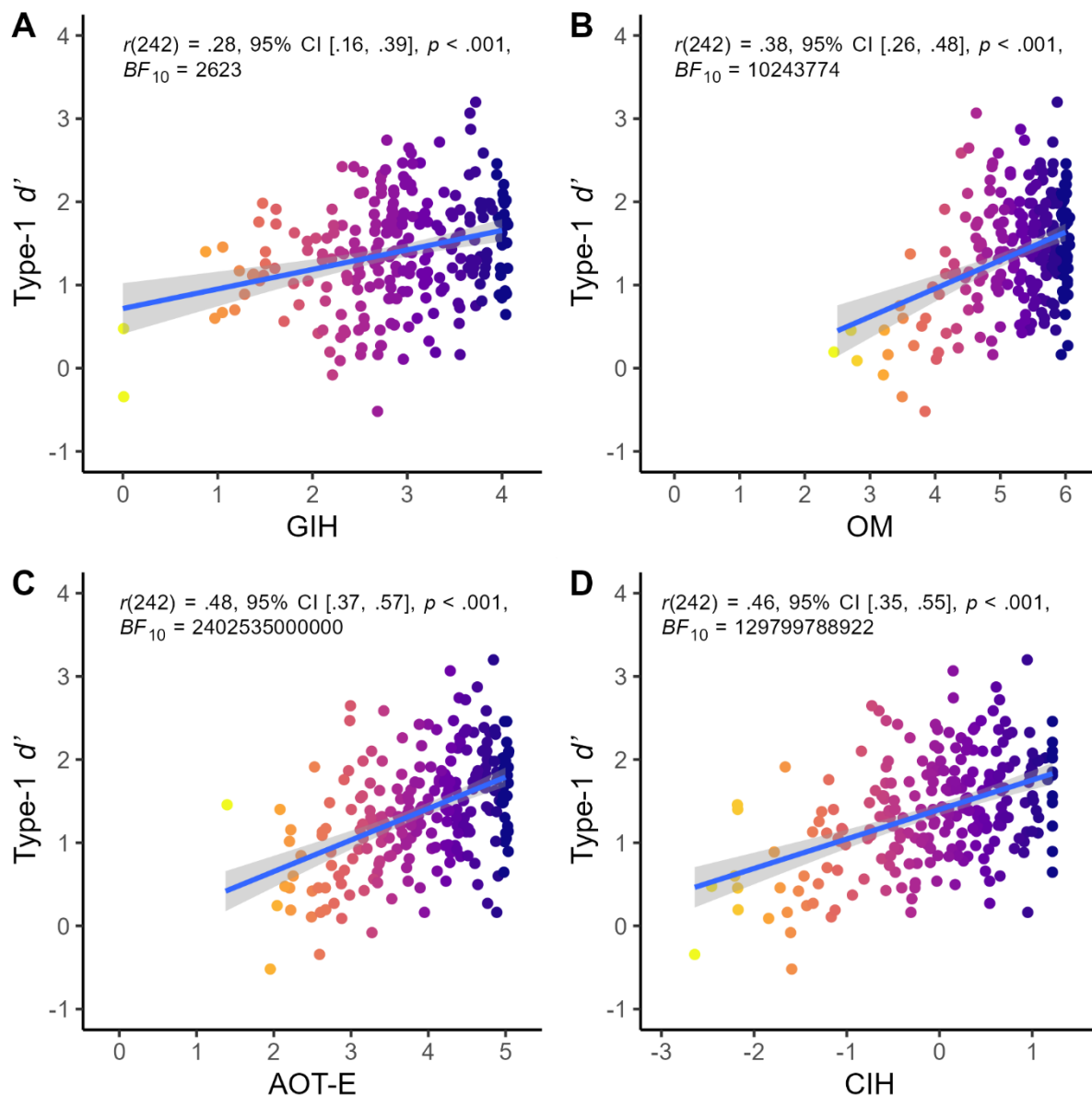
The relationship between intellectual humility and misinformation discernment was then analyzed by correlating each of the intellectual-humility measures with *d'*, AUC, and *C*. Consistent with our hypothesis, there were statistically significant positive correlations between all the intellectual-humility measures and type-1 *d'* and AUC (see Figures 2 and 3). These correlations were relatively large by the standards of individual-differences research (Gignac & Szodorai, 2016). Supplementary analyses examining the relationships between intellectual humility and truthfulness judgments separately for true and false headlines showed that, for all measures, intellectual humility was associated with higher truthfulness judgments for true headlines and lower truthfulness judgments for false headlines (see Tables S4-S5 and Figure S1). There were no significant correlations between response bias (*C*) and any of the intellectual-humility measures, with Bayes factors generally providing moderate support for the null, except for AOT-E which only showed anecdotal evidence in favor of the null (see Figure 4). These findings suggest that all the measured dimensions of intellectual humility, and the composite measure, are associated with greater ability to discern true and false news headlines, but intellectual humility is not associated with response bias.

3.2 Metacognitive Discernment

To test our hypothesis that intellectual humility is positively associated with metacognitive discernment, we calculated type-2 SDT measures, with type-2 *d'* as a measure of discernment and type-2 *C* as a measure of response bias. Similar to type-1 SDT, we first binarized responses into hits and false alarms, with responses ≤ 2 coded as withholding a truthfulness judgment, and responses ≥ 3 coded as reporting a truthfulness judgment. Type-2 SDT measures are metacognitive and therefore hits, false alarms, correction rejections, and misses are defined based on the accuracy of participants' initial truthfulness judgments. Trials on which participants either correctly judged a true headline as true (type-1 hit), or a false headline as false (type-1 correction rejection) and then chose to report their response were classified as type-2 hits. Trials on which participants incorrectly judged a true headline as false (type-1 miss) or a false headline as true (type-1 false alarm) and then chose to report their response were classified as type-2 false alarms; for clarity, this coding is also outlined in Table 3. Type-2 hits and false alarms were then used to calculate *d'* and *C*, again using the *dprime* function from the *psycho* package (Makowski, 2018) and the same formulas shown above. We also again measured discernment by using AUC. We first calculated ROC curves by calculating cumulative type-2 hit and

Figure 2

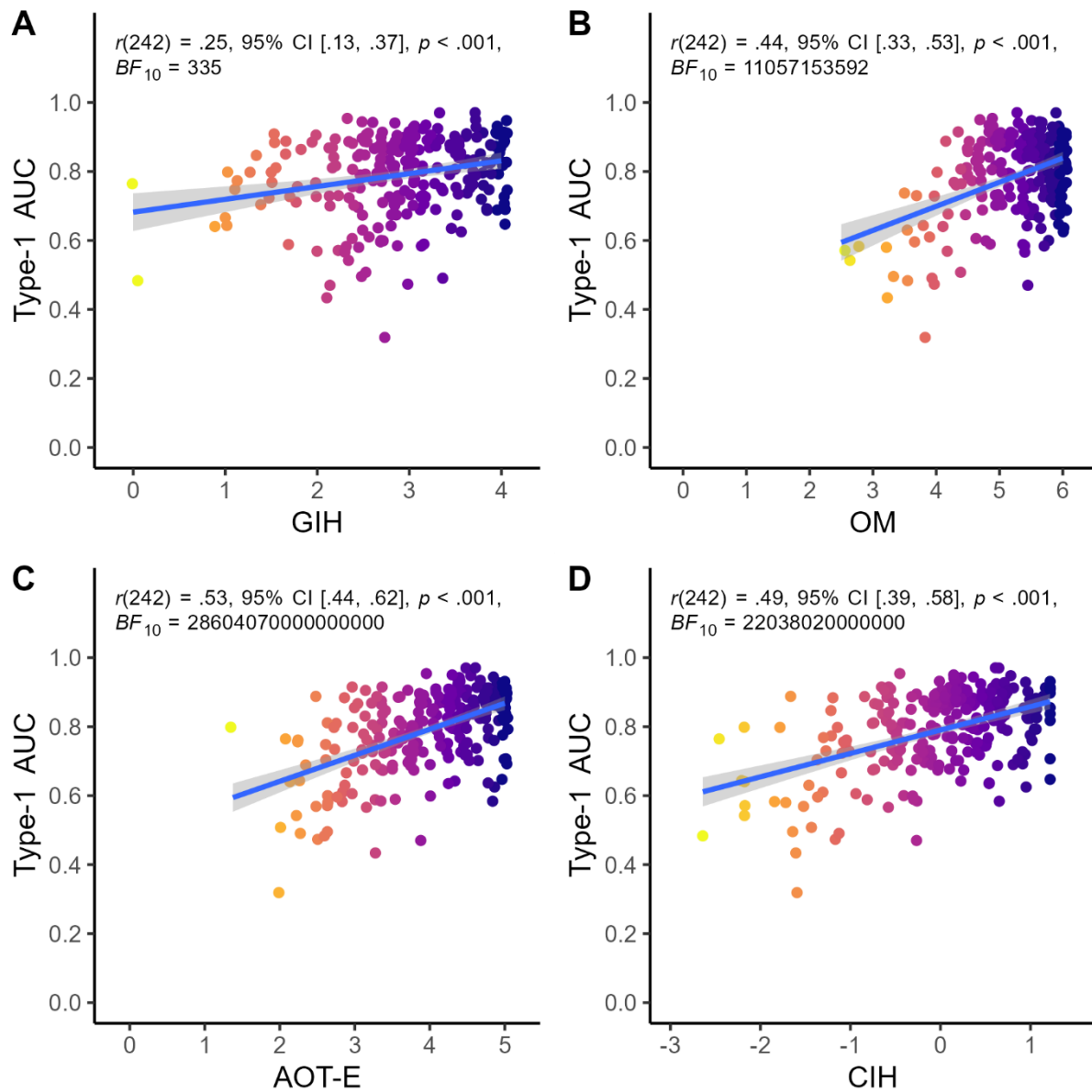
Correlations Between Intellectual Humility and Misinformation Discernment (Type-1 d')



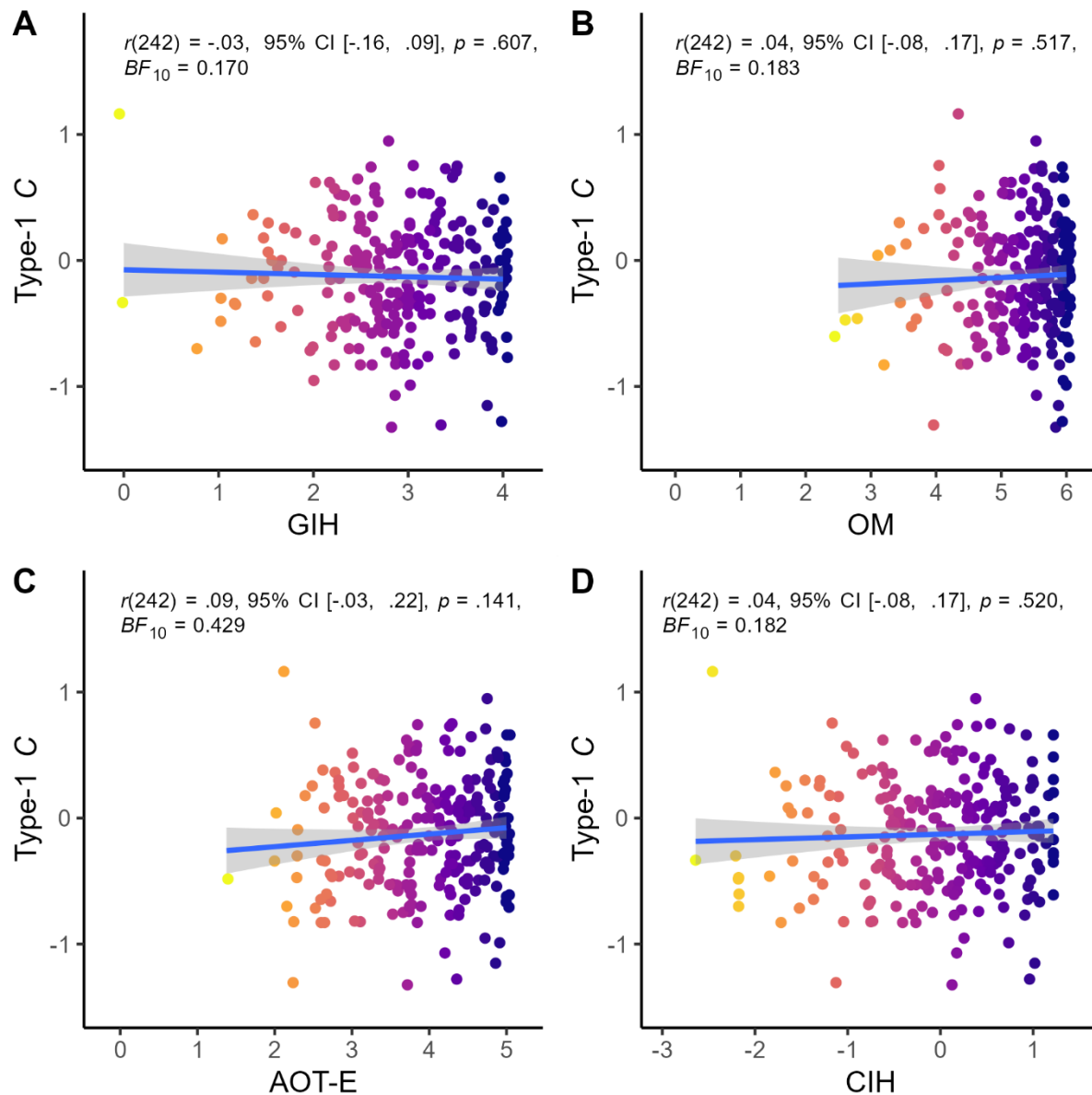
Note. Scatter-plot visualizations of the relationship between intellectual-humility measures and type-1 d' ($N = 244$). GIH, General Intellectual Humility Scale; OM, Open-Mindedness Subscale; AOT-E, Actively Open-Minded Thinking About Evidence Scale; CIH, composite of all three intellectual-humility measures. d' represents ability to discern between true and false headlines; a score of 0 indicates chance performance, scores < 0 indicate discernment worse than chance, scores > 0 indicate discernment better than chance. Fitted lines represent a linear model of the relationship between intellectual humility and type-1 d' ; shaded areas are 95% CIs.

Figure 3

Correlations Between Intellectual Humility and Misinformation Discernment (Type-1 AUC)



Note. Scatter-plot visualizations of the relationship between intellectual-humility measures and type-1 AUC ($N = 244$). GIH, General Intellectual Humility Scale; OM, Open-Mindedness Subscale; AOT-E, Actively Open-Minded Thinking About Evidence Scale; CIH, composite of all three intellectual-humility measures. AUC represents ability to discern between true and false headlines; scores of 0.5 indicate chance performance, scores of 1 indicate perfect discernment. Fitted lines represent a linear model of the relationship between intellectual humility and type-1 AUC; shaded areas are 95% CIs.

Figure 4*Correlations Between Intellectual Humility and Misinformation Response Bias (Type-1**C)*

Note. Scatter-plot visualizations of the relationship between intellectual-humility measures and type-1 C ($N = 244$). GIH, General Intellectual Humility Scale; OM, Open-Mindedness Subscale; AOT-E, Actively Open-Minded Thinking About Evidence Scale; CIH, composite of all three intellectual-humility measures. C represents response bias; a score of 0 indicates no response bias, scores < 0 indicate a liberal bias (more likely to label headline as true), scores > 0 indicate conservative bias (more likely to label headline as false). Fitted lines represent a linear model of the relationship between intellectual humility and type-1 C; shaded areas are 95% CIs.

Table 3*Type-2 Response Coding*

	Type-2 Response	
	Report	Withhold
Type-1 Hit / Correct Rejection	Type-2 Hit	Type-2 Miss
Type-1 False Alarm / Miss	Type-2 False Alarm	Type-2 Correct Rejection

false alarm rates for each participant at each response point and then used the trapezoidal rule to compute AUC as a measure of metacognitive discernment. Descriptives are presented in Table 4.

To examine the relationship between intellectual humility and metacognitive discernment, we correlated all three intellectual-humility measures, plus the composite measure, with type-2 d' , AUC, and C . Consistent with our hypothesis, all intellectual-humility measures were positively correlated with metacognitive discernment, and the strength of these correlations was typical for individual-differences research (Gignac & Szodorai, 2016; see Figures 5 and 6). However, for the correlation between GIH and type-2 AUC, the Bayes factor suggested similar evidence for the null and alternative, and this relationship was no longer

significant after controlling for demographic characteristics (see Tables S8-S13 for analyses controlling for demographic characteristics). There was also a significant negative correlation between GIH scores and metacognitive response bias, indicating participants with higher GIH scores were more likely to report their truthfulness judgments regardless of correctness. None of the other intellectual-humility measures were related to metacognitive response bias, with Bayes factors providing moderate support for the null (see Figure 7). Analyses examining the relationships between intellectual humility and report/withhold judgments separately for correct and incorrect type-1 judgments are reported in the Supplementary Materials (Tables S6-S7 and Figure S2).

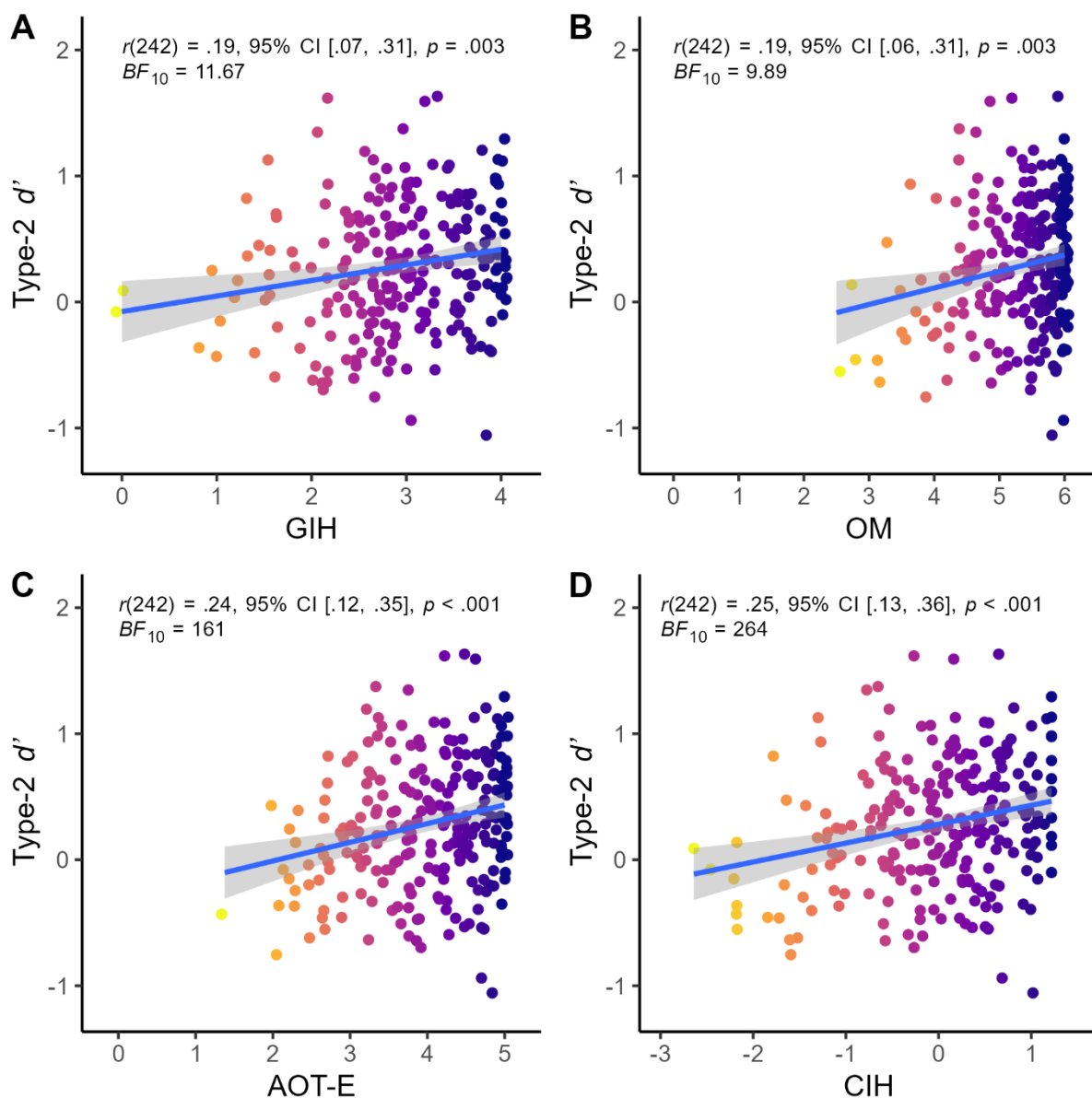
Table 4*Type-2 Signal Detection Theory Descriptive Statistics*

SDT Measure	Mean	SD	Minimum	Maximum
Hits	21.98	13.10	0.00	55.00
False Alarms	6.53	5.93	0.00	27.00
d'	0.28	0.50	-1.06	1.63
AUC	0.56	0.11	0.30	0.86
C	0.17	0.95	-2.13	2.14

Note. Hits, number of correct type-1 judgments that were reported. False Alarms, number of incorrect type-1 judgments that were reported. d' , measure of ability to discern between one's own correct and incorrect responses; positive d' values suggest better discernment, negative values suggest below-chance performance. C , an index of response bias; positive values indicate a bias towards withholding, negative values indicate a bias towards reporting.

Figure 5

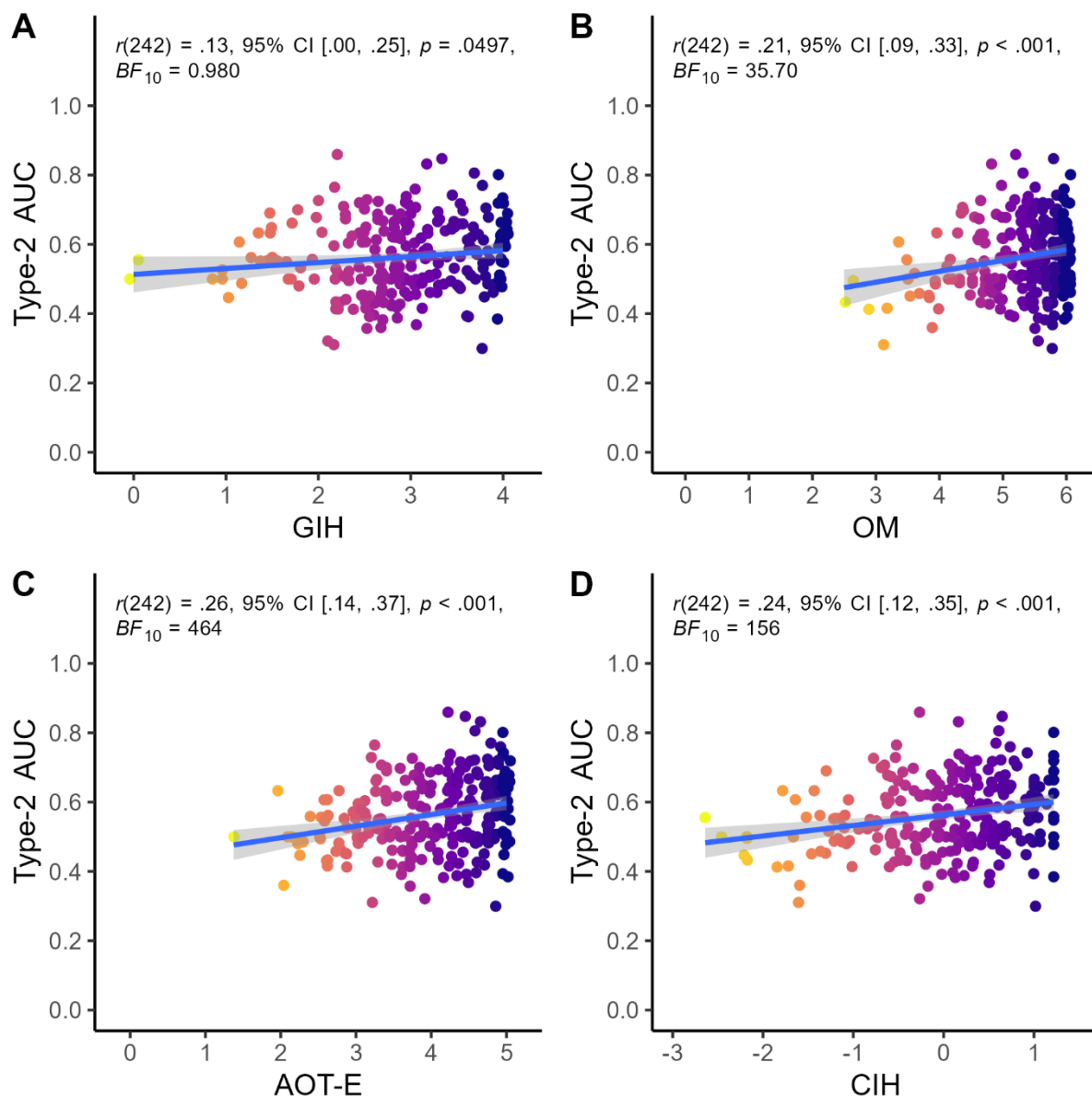
Correlations Between Intellectual Humility and Metacognitive Discernment (Type-2 d')



Note. Scatter-plot visualizations of the relationship between intellectual-humility measures and type-2 d' ($N = 244$). GIH, General Intellectual Humility Scale; OM, Open-Mindedness Subscale; AOT-E, Actively Open-Minded Thinking About Evidence Scale; CIH, composite of all three intellectual-humility measures. d' represents ability to discern between one's own correct and incorrect responses; a score of 0 indicates chance performance, scores < 0 indicate discernment worse than chance, scores > 0 indicate discernment better than chance. Fitted lines represent a linear model of the relationship between intellectual humility and type-2 d' ; shaded areas are 95% CIs.

Figure 6

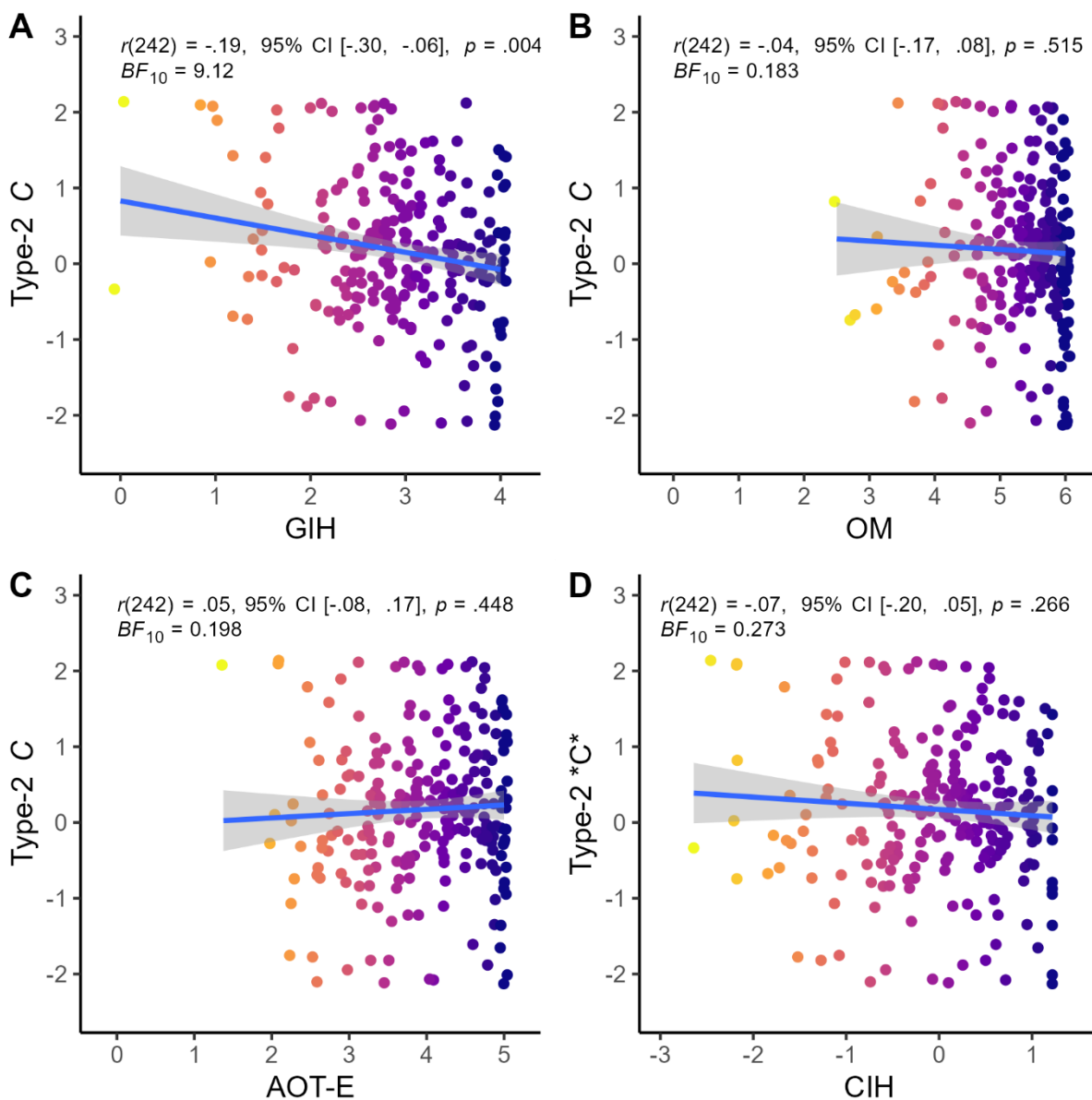
Correlations Between Intellectual Humility and Metacognitive Discernment (Type-2 AUC)



Note. Scatter-plot visualizations of the relationship between intellectual-humility measures and type-1 AUC ($N = 244$). GIH, General Intellectual Humility Scale; OM, Open-Mindedness Subscale; AOT-E, Actively Open-Minded Thinking About Evidence Scale; CIH, composite of all three intellectual-humility measures. AUC represents ability to discern between one's own correct and incorrect response; scores of 0.5 indicate chance performance, scores of 1 indicate perfect discernment. Fitted lines represent a linear model of the relationship between intellectual humility and type-1 AUC; shaded areas are 95% CIs.

Figure 7

Correlations Between Intellectual Humility and Metacognitive Response Bias (Type-2 C)



Note. Scatter-plot visualizations of the relationship between intellectual-humility measures and type-2 C ($N = 244$). GIH, General Intellectual Humility Scale; OM, Open-Mindedness Subscale; AOT-E, Actively Open-Minded Thinking About Evidence Scale; CIH, composite of all three intellectual-humility measures. C represents metacognitive response bias; a score of 0 indicates no response bias, scores < 0 indicate a liberal bias (more likely to report responses), scores > 0 indicate conservative bias (more likely to withhold responses). Fitted lines represent a linear model of the relationship between intellectual humility and type-2 C; shaded areas are 95% CIs.

Table 5*Comparison of Correlation Strength Between Intellectual-Humility and SDT Measures*

Measure	Type-1 d'	Type-1 AUC	Type-1 C	Type-2 d'	Type-2 AUC	Type-2 C
GIH - OM	[-.22, .03]	[-.31, -.06]*	[-.21, .06]	[-.13, .13]	[-.22, .05]	[-.27, -.01]*
GIH - AOT-E	[-.30, -.09]*	[-.39, -.18]*	[-.24, -.01]*	[-.16, .07]	[-.25, -.02]*	[-.35, -.12]*
GIH - CIH	[-.25, -.10]*	[-.32, -.17]*	[-.15, .01]	[-.14, .02]	[-.19, -.03]*	[-.19, -.03]*
OM - AOT-E	[-.20, -.002]*	[-.19, -.004]*	[-.16, .06]	[-.16, .06]	[-.15, .06]	[-.20, .02]
OM - CIH	[-.15, -.01]*	[-.12, .01]	[-.08, .08]	[-.13, .01]	[-.10, .04]	[-.05, .10]
AOT-E - CIH	[-.04, .08]	[-.01, .10]	[-.01, .12]	[-.07, .05]	[-.04, .08]	[.06, .18]*

Note. 95% confidence intervals of the difference in correlations. GIH, General Intellectual Humility Scale; OM, Open-Mindedness Subscale; AOT-E, Actively Open-Minded Thinking About Evidence Scale; CIH, composite of all three intellectual-humility measures. * indicates non-overlapping confidence intervals.

These findings suggest that intellectual humility is generally associated with greater metacognitive discernment. There is also tentative evidence that some aspects of intellectual humility, may be associated with more liberal responding on this specific metacognitive task.

3.3 Differences Between Intellectual-Humility Measures

To test for significant differences in correlation strength between the intellectual-humility measures and the type-1 and type-2 SDT measures, we conducted exploratory analyses using the *cocor* package (Diedenhofen & Musch, 2015). Specifically, we used the Zou (2007) method to generate 95% confidence intervals of the difference in correlations between each intellectual-humility measure and the SDT measures (see Table 5). These analyses revealed that the AOT-E and CIH were significantly more positively correlated with type-1 d' than either the GIH or OM. Additionally, the OM, AOT-E, and CIH were significantly more positively correlated with type-1 AUC than the GIH, and the AOT-E was significantly more positively correlated with type-1 AUC than the OM. The AOT-E and CIH were also significantly more

positively correlated with type-2 AUC than the GIH. The GIH was significantly more negatively correlated with type-2 C than any other measure. There were also significant differences between GIH and AOT-E for type-1 C, and between AOT-E and CIH for type-2 C, although none of these initial correlations were significant.

4. DISCUSSION

Consistent with our first hypothesis, intellectual humility—including all the individual measures and the composite measure—was associated with reduced misinformation susceptibility. Crucially, through the use of SDT, we found that intellectual humility was associated with an improved ability to discern between true and false headlines, and that there was no significant relationship between intellectual humility and response bias. Additionally, all intellectual-humility measures were associated with higher truthfulness judgments for true headlines and lower truthfulness judgments for false headlines. These results suggest that all the measured aspects of intellectual humility—awareness of one's own limitation, openness to diverse and opposing viewpoints, critical evaluation of evidence, and willingness to update beliefs—may help with the detection of

misinformation (Alfano et al., 2017; Deffler et al., 2016; Krumrei-Mancuso et al., 2020; Krumrei-Mancuso & Rouse, 2016; Leary et al., 2017; Porter et al., 2022; Zmigrod et al., 2019). However, we also found that the AOT-E and our composite measure were more positively related to misinformation discernment than the other intellectual-humility measures, suggesting attitudes towards evidence and belief updating may be particularly important for discerning true and false headlines (Pennycook et al., 2020). Further, the finding that intellectual humility was unrelated to response bias, and that it was associated with greater belief in true headlines, should alleviate concerns that intellectual humility is associated with general skepticism or reduced belief in true information.

Consistent with our second hypothesis, intellectual humility was also associated with greater metacognitive discernment for all measures, although for the GIH and AUC this relationship was only marginally significant and not robust to alternative analyses (Bayesian correlation or regression with demographic controls). This indicates that those higher in intellectual humility have greater insight into the accuracy of their truthfulness judgments of news headlines, which may provide additional benefits in reducing misinformation susceptibility. Specifically, if people higher in intellectual humility can more accurately judge when their own truthfulness judgments are likely to be wrong, they would be less likely to endorse false information as true, or to incorrectly discredit true information, even when their initial truthfulness judgments are indeed wrong. This greater metacognitive insight may also encourage people to seek out additional information, particularly when their initial judgments are inaccurate (Koetke et al., 2022, 2023). Given greater awareness of the limits of one's own knowledge is a core component of intellectual humility, finding that all measures were positively correlated with metacognitive discernment (although less robustly for the GIH) also provides convergent validity for these self-

report measures (Porter et al., 2022).

Only one measure of intellectual humility, the GIH, was associated with more liberal metacognitive response bias, and this relationship was significantly more negative (i.e., more liberal) than for all other measures. This result was not predicted and is surprising, particularly given that a key aspect of intellectual humility is awareness of one's own fallibility and limits of knowledge. One potential explanation is that participants with higher levels of intellectual humility, as indexed by the GIH, were more motivated by the study instructions (i.e., being part of a group "dedicated to promoting true news and debunking misinformation") and this led them to more frequently report their truthfulness judgments. An alternative explanation is that participants who reported greater intellectual humility on the GIH believed they were better able to discern between true and false headlines and/or between their own correct and incorrect judgments, and this belief led them to adopt a more liberal criterion and report more of their truthfulness judgments (see also Costello et al., 2023).

The current findings are correlational and therefore should be interpreted cautiously. However, if it can be established that intellectual humility causally contributes to improved misinformation discernment then enhancing intellectual humility may be a very promising intervention to counter misinformation. The relationships between intellectual humility and misinformation discernment were stronger than most individual differences research, with the relationships between misinformation discernment and the AOT-E and the composite measure above the 95th percentile (Gignac & Szodorai, 2016). It is also noteworthy that the relationships between intellectual humility and misinformation discernment were (numerically) stronger than for intellectual humility and metacognitive discernment, particularly given the importance of metacognition within the concept of intellectual humility (Porter et al.,

2022).

4.1 Limitations and Future Directions

As mentioned above, one important limitation is that there may have been additional motivations or factors unrelated to metacognitive discernment or bias that impacted participants' decisions to report or withhold their truthfulness judgments. For example, participants may have differed in the extent to which they were motivated to label information as true or false, their willingness to post their thoughts on social media, or the extent to which they thought it was worthwhile sharing their truthfulness ratings for specific headline, all of which may impact their metacognitive response bias. To minimize the impact of this last point, we intentionally selected headlines that were shareable and current. We believe that framing the task in terms of posting truthfulness judgments as comments or sharing the judgment with others enhanced realism (e.g., encountering a false social-media post and commenting to prevent others being misled). Nonetheless, future research could examine alternative framings or instructions for the metacognitive judgments, such as an incentivized framework where points are awarded (deducted) for reporting correct (incorrect) responses.

Importantly, the use of a cross-sectional correlational design limits our ability to make causal claims about the role of intellectual humility in reducing misinformation susceptibility or improving metacognitive discernment (Rohrer, 2018). Although the reported results were generally robust to the inclusion of political ideology, English proficiency, age, and gender, future research should examine additional potential third variables that may contribute to or explain the relationships between intellectual humility, misinformation discernment, and metacognitive discernment, such as education, intelligence, and/or analytical thinking (Pennycook & Rand, 2020; Porter et al., 2022). Reverse causality is also an important consideration, particularly for the relationship

between intellectual humility and metacognitive discernment. Although intellectual humility may increase one's insight into the correctness of one's judgments, it is also possible that being aware of one's correct, and particularly one's incorrect, judgments increases intellectual humility. Therefore, future work should continue to develop and test approaches to reliably and durably increase intellectual humility (e.g., Koetke et al., 2023; Porter & Schumann, 2018; Porter et al., 2020), thereby enabling causal tests of whether intellectual humility reduces susceptibility to a broad range of misinformation and improves metacognitive performance.

Another important future direction is examination of the mechanisms by which intellectual humility is associated with improved misinformation and metacognitive discernment. Although we found positive relationships for all measures, AOT-E was the strongest predictor of misinformation discernment and a stronger predictor of metacognitive discernment than the GIH (only for the AUC discernment measure). This suggests that attitudes towards evidence and belief updating may play a key role, but it still unclear what specific psychological processes underpin these relationships. For example, it may be that participants with higher intellectual humility are being more deliberative when evaluating the headlines and/or their own responses, engaging in greater cognitive reflection or analytical thinking (Pennycook & Rand, 2020). Intellectual humility may instead (or additionally) be associated with a greater awareness of misleading techniques or other characteristics that help to distinguish true and false information (Cook et al., 2017; Lewandowsky & van der Linden, 2021). In addition to advancing theory, better understanding the mechanisms and/or processing differences that enable intellectual humility to improve misinformation and metacognitive discernment may also enable the development of more targeted and effective interventions.

4.2 Constraints on Generality

This study was conducted in the U.S., and therefore it is not guaranteed that findings would translate to other cultural contexts. While we would expect generalization to other WEIRD populations (Henrich et al., 2010), given potential cross-cultural differences in intellectual humility, the observed relationships may not generalize to non-WEIRD samples (Grossmann et al., 2012; Wei & Wang, 2020). Findings were generally consistent across different intellectual-humility measures, but further work is needed to determine whether specific components of intellectual humility are reliably associated with metacognitive response bias. We also expect the results would generalize to similar misinformation—that is, short-format news headlines or claims—but we note that these represent only a small subset of the broader category of misinformation (Ecker et al., 2024; McCright & Dunlap, 2017; Tay et al., 2024).

5. CONCLUSION

This study helped to clarify the relationship between intellectual humility and misinformation susceptibility by showing that intellectual humility was strongly correlated with participants' ability to discern between true and false headlines but was unrelated to bias to label headlines as true or false. Additionally, intellectual humility was associated with both reduced belief in false headlines and greater belief in true headlines, clearly demonstrating that the relationship between intellectual humility and reduced misinformation susceptibility is not due to general skepticism or bias when making truthfulness judgments. We also found that intellectual humility was generally associated with better metacognitive discernment, although one scale was unexpectedly also associated with increased reporting of truthfulness judgments (possibly due to heightened task motivation). Cumulatively, these findings highlight the potential benefits of intellectual humility for reducing misinformation susceptibility and suggest that

cultivating intellectual humility may be a productive approach to tackling misinformation and improving metacognitive insight.

6. DATA AVAILABILITY STATEMENT

Materials, data, and analysis scripts are available at <https://osf.io/brh83/>

7. CONFLICTS OF INTEREST

The authors declare no competing interests.

8. ACKNOWLEDGEMENTS

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9. AUTHOR CONTRIBUTIONS

T.P. – Conceptualization, Investigation, Methodology, Data Curation, Formal Analysis, Validation, Visualization, Writing (original draft, reviewing and editing); J.H. – Conceptualization, Investigation, Methodology, Data Curation, Formal Analysis, Validation, Writing (original draft); U.K.H.E. – Conceptualization, Methodology, Funding Acquisition, Supervision, Writing (reviewing and editing).

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