Preprint

Relating Information Seeking and Use to Intellectual Humility

Tim Gorichanaz

Department of Information Science

College of Computing & Informatics

Drexel University

Philadelphia, PA, USA

ORCID: 0000-0003-0226-7799

gorichanaz@drexel.edu

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Abstract

Virtue epistemology offers a yet-untapped path for ethical development in information science. This paper presents two empirical studies on intellectual humility (IH), a cornerstone intellectual virtue. Centrally, IH is a matter of being open to the possibility that one may be misinformed or uninformed; it involves accurately valuing one's beliefs according to the evidence. The studies presented in this paper explore the relationship between IH and people's information seeking and use. First, a correlational questionnaire study was conducted with 201 participants considering a recent, real-life task; second, a concurrent thinkaloud study was conducted with 8 participants completing three online search tasks. These studies give further color to prior assertions that people with higher IH engage in more information seeking. The results show, for instance, that those with higher IH may actually favor more easily accessible information sources, and that some dimensions of IH, such as modesty and engagement, may be most important to information seeking. These findings offer a nuanced understanding of the relationship between IH and information behavior and practices. They suggest avenues for further research, and they may be applied in educational contexts and sociotechnical design.

Keywords: intellectual humility, virtue epistemology, information behavior, information practices, information literacy, search engine results pages

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The greatest empiricists among us are only empiricists on reflection: when left to their instincts, they dogmatize like infallible popes.

— William James, "The Will to Believe," 1896

Introduction

Countless exigencies in the world today are calling us to become better thinkers and help others do the same. In post-industrialist societies, we do much of our thinking with information systems, and so those of us in information science have a special opportunity (perhaps an obligation) to make our information systems as conducive to good thinking as possible. One route to realizing this opportunity is with virtue epistemology, an orientation that seeks to define and cultivate methods for wise reasoning. This paper examines the connections between intellectual humility, a crucial epistemic virtue, and information seeking and use, through two empirical studies. The results from this work provide insights for education and design, as well as directions for further research at the intersection of virtue epistemology and information science.

Information and the Virtues

Ethics is the study of right action and living well. The oldest approach to ethics, what we now call virtue ethics, was focused on identifying and cultivating good character traits, and in recent decades this tradition has retaken center stage. In *Technology and the Virtues*, Shannon Vallor (2016) defends virtue ethics as a guiding ethical theory for humanity in today's technological environment. Other ethical theories rely on a stable sociotechnical situation wherein actors can assume the future will be more or less like the present and where the consequences of a given person's actions are more or less predictable. But in the digital age our future is more unknowable than ever before; it is characterized by "acute technosocial opacity," to use Vallor's term (p. 6).

Vallor (2016) traces the evolution of the virtues in three distinct traditions—Aristotelianism, Confucianism and Buddhism—and develops a shared foundation for a global technomoral virtue ethics to serve humanity in the 21st century and beyond. As part of this, she includes a discussion of twelve technomoral virtues: honesty, self-control, humility, justice, courage, empathy, care, civility, flexibility, perspective, magnanimity, and wisdom.

Importantly, these are not traits that one either has or doesn't (like height), but they rather can be practiced and gained. "They are states that the person must cultivate in herself, and that once cultivated, lead to deliberate, effective, and reasoned choices of the good" (Vallor, 2016, p. 18). Synthesizing a large literature, Vallor outlines seven mutually enriching practices of moral self-cultivation, to include recognizing our social roles, emulating exemplary people around us, deciding what kind of person we want to be and moving in that direction, etc. (see Vallor, 2016, Chapters 3–5).

Virtue ethics has inspired virtue-based approaches in other branches of philosophy, such as epistemology, or the study of knowledge. Applying a virtue-based approach to epistemological questions has resulted in the field of virtue epistemology, which does not

aim to produce theories or definitions of knowledge but rather tries to generate guidance for epistemic practice through education. "This kind of epistemology aims to change the (social) world" (Roberts & Wood, 2007, p. 21). While virtue ethics focuses on moral traits, virtue epistemology focuses on intellectual traits, such as love of knowledge, open-mindedness, intellectual courage, intellectual humility and wisdom (Baehr, 2015; Roberts & Wood, 2007; Zagzebski, 1996). At heart, these virtues have to do with a person's engagement with information, both recorded and embodied.

To date there has been almost no engagement with the virtues in information science, with the exception of justice and wisdom. Particularly in the past few years, justice has come to the fore in information science (see, e.g., Cooke et al., 2016), though rarely, if ever, is it framed in terms of virtue. There is also a growing interest in wisdom (see, e.g., Allen et al., 2019; Gorichanaz & Latham, 2019). But as with justice, these discussions have not been connected to the already richly theorized virtue traditions. In both cases, connecting with research in virtue ethics and epistemology would be a path toward deepening and improvement.

Moreover, attentiveness to the virtues also plays an indispensable role in design. Vallor (2016, Part 3) examines a number of emerging technologies and discusses how these could be developed further either virtuously (by attending to the virtues) or viciously (by ignoring them). But beneath the surface, Vallor offers a methodology that can be applied to the design of any information system. If our field is ultimately concerned with the design of better information systems (see Makri, 2020), Vallor's methodology could become a useful part of our toolkit.

Intellectual Humility and Information

Humility

In this paper I focus on the virtue of humility, which can be defined as having an accurate view of one's strengths and weaknesses, as well as being responsive to those of others (Van Tongeren et al., 2019). Humility involves being open to learning from those around us, a lack of concern for self-importance, and recognizing that much in our lives is out of our control—in short, feeling ourselves to be part of something bigger. In common parlance, humility may be erroneously considered a form of self-abasement or lowliness. But Aristotle reminds us in his *Ethics* that a virtue is generally found between vices of deficiency and excess; following this, humility may be better conceptualized as a balance between arrogance on one hand and servility on the other.

Humility is a suitable starting place for research on the virtues in information science because it provides a foundation and gateway for the rest of the virtues. This viewpoint does not originate with me. The *Iliad*, among the oldest extant works of literature, is a cautionary tale of the dangers of hubris—a *via negativa* argument for humility. It was Socrates who, in the fifth century BC, first proposed a vision of wisdom as rooted in humility (Ryan, 2020). Later, Saint Augustine of Hippo wrote in the fifth century AD of humility as the beginning of virtue (*Letters*, 118, 3, 22), and in the thirteenth century Saint Thomas Aquinas offered a systematic discussion of humility in *Summa Theologica* (II-II, q4, a7). Aquinas observed that humility helps us uncover the truth because it removes obstacles such as pride. The only way we can learn anything is by first acknowledging that we don't already know everything.

Outside the West, Vallor (2016) shows that humility has been upheld as a virtue in the Confucian and Buddhist moral traditions as well.

Lately, humility has become a sustained topic of research in philosophy and psychology. *The Routledge Handbook of Philosophy of Humility* (Alfano et al., 2021) presents a recent statement in philosophy, and Wright (2019) offers an overview of how humility has been conceptualized and applied in psychology. Outside academe, humility has long been the subject of religious literature, and it is also appearing in the secular trade literature as well. To cite just two examples, organizational psychologist Adam Grant's (2021) new book *Think Again: The Power of Knowing What You Don't Know* is centered on the role of intellectual humility in business, and executive Dave Balter's (2020) *The Humility Imperative: Effective Leadership in an Era of Arrogance* argues in a similar vein.

Intellectual Humility

Humility is a moral concept in virtue ethics, and its virtue-epistemology analogue is intellectual humility (IH). As the term suggests, IH can be seen as the informational or cognitive component of humility (Bommarito, 2018). Centrally, IH is a matter of being open to the possibility that one may be misinformed or uninformed. To flesh this out in more detail, IH is a disposition to form beliefs accurately in response to the evidence, to recognize the limitations of one's knowledge, to be unconcerned with one's intellectual status and entitlements, and to seek out the broadest range of people and phenomena to learn from (Church & Samuelson, 2017; Snow, 2019). To date there has been scant mention of IH in the information science literature; existing publications (Baer, 2020; Becker, 2016; Cooke & Magee, 2019) merely mention it in relation to the Association of College and Research Libraries (ACRL) Framework for Information Literacy (2016), which specifies that literate information seekers should "demonstrate intellectual humility" (p. 7).

Psychologists and philosophers have been working to devise valid and reliable ways of measuring IH. There are two broad approaches: self-report and informant report. Self-report measures are convenient but may be susceptible to social desirability bias—a person boasting, "I am so humble!" may not in fact be very humble. Informant reports may seem well-disposed to capture the relational aspects, but in practice informants differ wildly in their assessment of a person's IH (McElroy-Heltzel et al., 2019). In light of this, most recent efforts in IH measurement have been on overcoming the limitations of self-report. For instance, researchers have sought to construct items that people can answer with reasonable accuracy and without social desirability bias (Haggard et al., 2018; Krumrei-Mascuso & Rouse, 2016; Porter & Schumann, 2018). Among these efforts, a promising self-report measure was developed by Alfano et al. (2017), which was shown to be valid and reliable, including in comparison with the best informant report instruments available. The Alfano et al. scale consists of a questionnaire with 25 statements with which participants rate their agreement on a 7-point Likert-type scale. The scale measures participants' IH on four dimensions: open-mindedness (vs. arrogance), intellectual modesty (vs. vanity), corrigibility (vs. fragility), and engagement (vs. boredom).

The ability to measure IH has made it possible to explore connections between IH and other behaviors and traits, including those related to knowledge and information. In this connection, three clusters of findings have emerged in the literature: (1) people with higher

IH seek and use new information differently; (2) people with higher IH exhibit more mastery behaviors; and (3) that IH can change and grow.

Regarding information seeking and use, IH has been associated with other personality-related variables, such as curiosity, tolerance of ambiguity, and low dogmatism (Leary et al., 2017). Relatedly, IH has been associated with a greater striving toward gaining new knowledge and more information seeking (Porter & Schumann, 2018). For example, people with higher IH are more open to learning about opposing views during an argument (Porter & Schumann, 2018) and spend more time reading sentences counter to their own beliefs (Deffler et al., 2016). There is also evidence that people high in IH are more attuned to the persuasive strength of arguments (Leary et al., 2017). High IH has even been associated with more general knowledge, as well as qualities such as a propensity for intellectual reflection, intellectual engagement and intrinsic motivation to learn (Krumrei-Mancuso et al., 2020).

Also relevant here are studies relating personality to information seeking and use. Personality is a somewhat stable inclination toward certain behaviors and attitudes that can predict individual differences in a variety of contexts. The currently favored model of personality is the "Big Five" model, which defines personality along five dimensions: neuroticism, extraversion, openness to experience, agreeableness, and conscientiousness (McCrae & Costa, 1991). Correlations between IH and personality traits are debated, but there is some suggestion that people higher in conscientiousness and openness to experience may tend to be higher in IH (Church & Samuelson, 2017). Heinström (2003) demonstrated that personality traits map to patterns of information behavior. To cite two examples relevant to IH, traits extraversion and conscientiousness were negatively correlated with a preference to retrieve information confirming prior knowledge; and both conscientiousness and openness were positively correlated with a willingness to use considerable effort in obtaining information. These findings also appeared in later studies in other countries (Halder et al., 2010; Tidwell & Sias, 2005). In other work, Tidwell and Sias (2005) examined the relationship among personality, perceived social cost, and information seeking regarding performance, tasks and relationships among new employees in business. They found found conscientiousness to be linked to overt information seeking about performance, with neuroticism linked to covert information seeking in this context. In the study, those with higher openness were less likely to seek information about their performance. Later, Schmidt and Wolf (2016) found that people higher in openness spent longer on online search tasks and clicked on results further down the page on search engines. An eye-tracking study of online search and personality showed that people higher in conscientiousness, agreeableness and extraversion perform many information-seeking tasks faster than others (Al-Samarraie et al., 2017). These studies offer some suggestive results, but overall stress the need for further research for a clearer picture, particularly when connecting these findings to IH.

Next, having high IH has been shown to predict "mastery" behaviors, such as seeking out challenges and persisting after intellectual setbacks (Porter et al., 2020). Porter and Schumann (2018) connect IH to a growth mindset, the view that one's abilities are not fixed but rather can be cultivated. According to Porter et al. (2020, p. 1), "those higher in intellectual humility will behave in mastery-oriented ways so that they can become more knowledgeable and accurate." While IH is centered in the intellectual domain, this mastery orientation may tint other aspects of life. For example, one study suggests that higher IH

relates to a greater propensity to adopt new ICTs as a person gets older (Bernabé-Valero et al., 2018). Indeed, IH has been described as a component of wisdom (Grossmann, 2017; Huynh & Grossmann, 2020), and wisdom itself connotes a union between the intellect and other aspects of human being (Vallor, 2016). This also introduces the question of age; research suggests that wise reasoning increases into old age (Grossmann et al., 2010), and we might wonder about the connection between IH and age as well.

Last, there is evidence that IH can change. If IH is indeed a virtue, then this would be expected, as virtues by definition can be cultivated and may manifest differently in different situations (Vallor, 2016). Zachry et al. (2018) showed that, while IH does have some trait-like permanence, it fluctuates from situation to situation. The dynamics of this fluctuation are still being studied; but preliminarily the research shows that a person's IH may be topic-specific, relating to a person's beliefs and attitudes on that topic (Hoyle et al., 2016) and the topic's personal relevance (Leary et al., 2017). A number of pedagogical works suggest that IH can be built and doing so contributes to a person's intellectual performance and fortitude (Baehr, 2015; Huynh & Grossmann, 2020), including effective information seeking (Heersmink, 2018). As mentioned above, the ACRL (2016) has targeted IH in information literacy instruction. In their discussion of the growth mindset, Porter and Schumann (2018) suggest that cultivating a growth mindset in people may be a path to helping them cultivate IH. Also notable is OpenMind (openmindplatform.org), a nonprofit organization that maintains a free online learning platform specifically tuned to increasing participants' IH.

Why Intellectual Humility?

Before going on, it is worth reflecting on why anyone should be intellectually humble, a proposition that is generally taken for granted in research on IH. The question "Why be good?" is a familiar one in ethics (see for instance the parable of Gyges' Ring in Plato's *Republic*), and it is worth posing an analogous question in virtue epistemology: "Why think well?" In this paper, we will consider the more specific formulation: "Why cultivate intellectual humility?"

To this question, one might answer that IH is intrinsically good and contributes to human flourishing. Heidegger (1968), for example, thought that good thinking was the proper response to the gift of being. This is a fine answer, but it is only one way to address the question. "Why" questions look for causes, and Aristotle identified four types of cause (*Metaphysics*, 5). The response that IH contributes to human flourishing identifies the final cause (i.e., end or purpose) in Aristotle's typology. It is worth reflecting also on this question in terms of efficient causes (i.e., impetus or antecedents).

Vallor's (2016, p. 126) answer would be that IH is the necessary response to our situation of acute technosocial opacity. But we can say more. Fortuitously, this is also a place where information science can contribute to virtue epistemology: we may apply our rich conceptualizations of information to reveal a deeper understanding of IH. Given that information can be conceptualized as thing, knowledge or process (Buckland, 1991), we can identify three (efficient) causes for intellectual humility:

1. Considering the "thing" sense of information, *we may not have access to or know about relevant information, or that information may not even exist (yet)*. During a novel pandemic, for instance, we may have questions that demand further research to

answer, and yet the exigency of the situation demands we act sooner rather than later. Sometimes delaying a decision is in effect making that decision.

2. Considering the "knowledge" sense of information, *we may be mistaken about some facts*. In this category sit disproven science, conspiracy theories and everyday misunderstandings. Science teaches us that even those beliefs we hold strongly, we should hold lightly.

3. Considering the "process" sense of information, *we may not know how something works*. This is the issue that bedevils blackbox algorithms, for example, which has given rise to the field of explainable artificial intelligence (XAI).

For these reasons, and likely others, we should cultivate IH and help others do the same. In information science, as educators and designers of sociotechnical systems of various kinds, we perhaps have a special duty to this end.

Opportunities and Research Questions

Of late, information science has been shifting its self-image from the 20th-century notion of being an amoral facilitator of information transfer to being a constructive force for good in the world (Britz, 2008; Tang et al., 2021). Virtue-based approaches are a promising way forward here. Whereas trying to establish consequentialist or rule-based frameworks is problematic, virtue ethics constitutes flexible, productive and responsive action in the world that is both well-tuned to an opaque future and rooted in our human past (Vallor, 2016). Upon this background, the intellectual virtues stand out as a fruitful focus for information science research and development. As there has been scant discussion or theoretical reflection on the virtues in information science to date, there is a vast horizon for research. As discussed above, intellectual humility (IH) stands out in particular.

This paper presents two studies that establish a baseline for research on how IH relates to information needs, seeking and use. Specifically, this responds to the following research questions:

RQ1: What, if any, correlations exist between measures of intellectual humility and information seeking and use?

RQ2: How do intellectually humble people seek and engage with information systems and documents?

These questions were addressed through a mixed methods project, as described below. RQ1 was addressed with an exploratory, correlational questionnaire study, and RQ2 with a thinkaloud study.

Questionnaire Study

To address RQ1, I conducted a large-scale questionnaire study. Preliminary results from this study were presented at iConference 2021 (Gorichanaz, 2021). Based on the literature reviewed above, I established a number of hypotheses to test for correlations. First, recall that IH has been linked to wisdom, and that wisdom has been found to increase with age. There is also the question of education. One would hope that with more education comes more IH—at least in an ideal situation. With this in mind, my first hypothesis is:

H1. IH is correlated with age and education level.

Next, the existing research suggests that IH is correlated with more information seeking, as reviewed above. This could mean many things, such as engaging with more sources or spending more time searching for sources. Because those higher in IH should be engaged with the content, I suspected they would be less likely to favor attractively-presented information. Thus my next four hypotheses:

H2. Those with higher IH will use more information sources for a given task.
H3. Those with higher IH will be less likely to favor easily accessible sources.
H4. Those with higher IH will put less emphasis on the attractiveness of information sources.
H5. Those with higher IH will be more likely to search multiple places for information.

Last, IH theory predicts that for people high in IH, learning new information ignites an interest in learning further information. Also according to theory, people high in IH should have little regard for their social status when it comes to intellectual matters. On these grounds, I hypothesized:

H6. Those with higher IH will have their interest fueled by the discovery of new information.
H7. Those with higher IH will be less likely to have a negative self-image because of the information sources they used.

Methods

I designed and administered a questionnaire to: collect data on participants' information seeking and use in the context of a recent task, measure their IH score using Alfano et al.'s (2017) scale, and collect relevant demographic information. The information seeking and use questionnaire asked participants to choose a recent real-life task that required them to learn something new or practice a skill and then answer a series of questions about the task. I designed the questions with guidance from the literature (e.g., Agarwal et al., 2011); I solicited feedback on the survey from colleagues and tested it in a small pilot study. I hosted the questionnaire on Qualtrics and administered it online through Prolific, a research recruitment service, in October 2020. Through Prolific I hired 201 participants residing in the United States. Each participant was paid $1.50 (USD), on average equating to $12.48 per hour. I analyzed the survey data using IBM SPSS 26 using Spearman's rank-order correlation tests.

Findings

All 201 participants completed the survey, and there were very few missing items. Participants ranged in age from 18–74 and in education from "less than high school" to doctoral degrees. Most participants were age 18–24 (26%) or 25–34 (38%), and the most commonly reported education levels were "some college" (24%) and "4-year degree" (35%).

Regarding the task that the participants chose, 90% selected one that was complete (rather than ongoing). In terms of duration, 41% chose a task whose duration would be measured in "hours," and 21% "minutes." Participants were asked to categorize their task; 29% selected a work-related task, 24% a home-related one, 23% a hobby-related one, and 21% a school-related one. Nearly all participants (98%) conducted a web search as part of their task. The results of the correlation analysis are presented in Table 1.

Table 1. Correlations with Each Participant's Intellectual Humility Score. * indicates $p < 0.05$, ** indicates $p < 0.01$

Item	Corr. Coeff.	Significance	N
Age	0.158*	0.026	200
Education	−0.010	0.891	201
Number of Types of Sources	−0.016	0.817	201
Favor Attractive Information	0.007	0.925	201
Favor Easily Accessible Sources	0.226**	0.001	200
↳ for tasks taking "minutes"	0.436**	0.003	43
Searched Multiple Places	0.172*	0.015	201
↳ for tasks taking "months"	0.817**	0.001	13
↳ for hobby-related tasks	0.377**	0.01	46
Information Fueled Further Interest	0.193*	0.006	201
↳ for hobby-related tasks	0.441**	0.002	46
Contradictory Opinions Fueled Further Interest	0.052	0.463	200
Negative View of Self	−0.464**	0.000	201
Perceived Negative View from Others	−0.466**	0.000	201

H1 was partly supported by the data. There was a weak, positive correlation between IH score and age ($r_s = 0.158$, p = 0.026), but none between IH and education level.

H2 was not supported. Participants were asked to select the different types of information sources they used (person face-to-face, person by phone, website, book, etc.), but no significant relationship was found between the number of information source types selected and IH.

H3 was refuted. There was a weak, positive correlation between participants favoring easily accessible sources and their IH score ($r_s = 0.226$, p = 0.001). For tasks measured in minutes, the correlation was stronger than for tasks of other durations (r_s 0.436, p = 0.003).

H4 was not supported. There was no significant relationship between favoring the attractiveness of information and IH.

H5 was supported by the data. There was a weak, positive correlation between participants' searching multiple places for information and their IH score ($r_s = 0.172$, p = 0.015). The correlation was strong for tasks measured in months ($r_s = 0.817$, p = 0.001), and moderate for those in the hobby category ($r_s = 0.377$, p = 0.01).

H6 was supported. There was a weak, positive correlation between participants agreeing that the more information they found, the more their interest in searching for information grew, and their IH score (r_s = 0.193, p = 0.006). The correlation was stronger for hobby-related tasks (r_s = 0.441, p = 0.002). However, for the question on whether encountering "contradictory opinions" fueled their search, there was no significant correlation between IH and agreement (r_s = 0.052, p = 0.463).

H7 was supported. There was a moderate negative correlation between participants' IH scores and their agreement with statements about being nervous, embarrassed or uncomfortable using information in this task. These questions were grouped into two analytical categories, one for how the participant regarded themselves (r_s = −0.464, p = 0.000) and another for how they thought others would perceive them (r_s = −0.466, p = 0.000).

Discussion

This study considered the relationship between IH and information seeking and use. The results indicate that people with higher IH are less likely to look upon themselves negatively, or think others would, for using a given information source. In addition, the results suggest that people with higher IH are more likely to: be older; favor easily accessible sources; search in multiple places for information; and find that discovering information ignites further interest in their search. This latter set of correlations are generally weak, though they are stronger for some meaningful subgroups of the sample.

Based on prior literature (Grossmann et al., 2010), IH improving with age was expected; but it is striking that IH is not correlated with education. This suggests that, at least in the United States, the higher educational system is not helping students cultivate IH. Further research on a wider sample, ideally including those under age 18 and in other countries, would add color to this finding.

The finding that people with higher IH favor more easily accessible sources is puzzling. Because the correlation is stronger for shorter tasks, it may be an effect of time pressure preventing searchers from referring to difficult-to-access sources. Still, one might suppose *prima facie* that people with higher IH would be more likely to spend time and effort searching for information, which is also asserted in prior literature (e.g., Porter & Schumann, 2018). The finding here should be considered in the context of the other findings, which show that people higher in IH may search in more places for information, particularly for lengthier tasks, and that searching for information is more likely to fuel a search for further information. These observations seem to temper the observation that people with higher IH favor more easily accessible sources. But do the particularities of the task matter? The search context? Other factors? These would be useful questions for further research to take up.

Another interesting observation is that, in general, those with higher IH are more likely to feel their interest sparked as they uncovered more information, as expected. However, it seems that when people uncover contradictory opinions, this does not necessarily fuel further searching. One explanation for this is that discovering contradicting opinions constitutes an endpoint for a search; if Alice aims to discover competing perspectives on a matter, and she does, then she is done searching. But likewise this finding could indicate that searchers become paralyzed by discovering unsavory information, and this would seem to contradict the qualities of IH. Coming to a determination here will require further research.

Thinkaloud Study

The questionnaire study provided an exploratory, quantitative overview of some relationships between IH and information seeking and use, providing an answer to RQ1. To respond to RQ2, which looks for a more fine-grained, in-the-moment and qualitative answer, I conducted a thinkaloud study.

Methods

In a thinkaloud study, participants are asked to perform a prescribed task or set of tasks and verbalize their thoughts as much as possible while doing so. Thinkaloud studies have a long lineage in human–computer interaction as a way to make user interface improvements (Ericsson & Simon, 1993; Nielsen, 2012), and more specifically to the present study they have been used to better understand people's search behavior (Ghenai et al., 2020; Hinostroza et al., 2018). In this thinkaloud study, I asked participants to engage in three online search tasks:

- **Task 1**: Life expectancy has been increasing over the years in many countries. Find the difference in years between the countries with the highest and lowest life expectancy in South America. Identify the main reason for this difference, and explain how it could be improved in the country with the lowest life expectancy.
- **Task 2**: Name the five films which came out in 2015 which had the highest percentage profits.
- **Task 3**: Compare the painting styles of Picasso, Goya, Rembrandt and Salvador Dalí. Look for a painting by each painter which deals with the same subject.

These tasks were drawn verbatim from prior research by Hinostroza et al. (2018) and were selected because they require participants to "scan, evaluate and select webpages and information" (Hinostroza et al., 2018, p. 1935), activities where IH could be supposed to be empirically relevant. After finishing the three tasks, participants were directed to take the IH scale questionnaire. The thinkaloud protocol was implemented on the UserTesting.com platform, which recorded the participant's screen and microphone (but not webcam video). Participants were paid $10 each; the entire session took about 20 minutes on average. Nine participants were recruited and 8 of these led to usable empirical material.

As mentioned, this study was intended to take a qualitative, interpretative eye to the question of IH and information seeking. As an entree into analysis, I first calculated basic metrics for each participant and task: whether each task was complete, whether it was answered correctly, the time spent on each task, the number of web pages visited per task, and the number of queries made (summarized in Table 2). Inspecting these numbers, I looked for any patterns between IH score and task performance. Next, I conducted a qualitative thematic analysis on two subsets of the participants. I considered the three participants with the highest IH scores and the three with the lowest scores as separate groups, and I sought to discern the most distinctive themes for each group. While I expected to uncover certain differences, I was also attentive to avoiding confirmation bias: I made my best effort to identify similarities between these groups and to ensure that the themes uncovered were well-grounded in the participants' words and behavior. To conduct this

analysis, I iteratively and inductively reviewed these six participants' performances, taking notes and recording salient quotations. I watched each recording several times, taking notes on behaviors, quotations and emerging themes, and after several cycles of this a set of themes emerged.

Table 2. Summary of Thinkaloud Participant Metrics

	Participant Totals Across All Three Tasks						Dimensions of IH			
	Tasks Complete	Tasks Correct	Time on Tasks	Pages	Queries	IH Score	Open-Mind	Modst.	Corrgblt.	Engmt.
P1	3	0	10m 24s	5	8	75%	98%	61%	60%	75%
P2	2	1	12m 35s	10	8	78%	100%	58%	93%	58%
P3	2	0	8m 10s	3	5	71%	83%	72%	70%	56%
P4	3	2	14m 38s	7	12	88%	100%	58%	97%	97%
P5	3	3	15m 20s	5	8	81%	95%	69%	77%	78%
P6	3	3	22m 30s	10	8	76%	90%	42%	77%	92%
P7	2	1	10m 19s	10	13	72%	95%	53%	70%	67%
P8	2	0	9m 20s	1	4	82%	100%	69%	80%	75%

Findings

In my inspection of the key metrics for each task and participant (see Table 4), I made a handful of initial observations. To begin, there was no evident pattern between a participant's overall IH score and any of the metrics. But considering only particular dimensions of IH, some patterns did become evident: First, the participants highest in modesty seemed to take less time on tasks, visit fewer pages, and make fewer queries. Second, people highest in engagement seemed to have more complete and correct tasks, spend more time on tasks, visit more pages, and make more queries.

In the thematic analysis, several themes were uncovered that distinctly characterized those higher in IH and those lower in IH. Among the three participants highest in IH, these three themes were most salient:

- *Inspecting the Results in Detail*: Rather than clicking quickly or defaulting to the first search result, this theme indicates a participant combing through the search results and reading the page description snippets. (5 occurrences)
- *"That's Interesting"*: This theme indicates that a participant said aloud that the task or the information they were uncovering was interesting, often as an interjection. For example, after finishing Task 3, P5 stated, "It's interesting to see the comparison, isn't it? Dalí is really out there." (4 occurrences)

- *Revisiting Prompt*: Participants sometimes went back to the task prompt while they were undertaking the task. This seemed to help them remain on-task and redirect their search strategy if necessary. (4 occurrences)

Among the three participants lowest in IH, these three themes stood out the most:

- *Confirming Expectations*: Participants sometimes expressed that the information they found confirmed what they already thought to be the case. For example, on Task 1, P1 found some information on the causes of low life expectancy in Guyana, mentioning healthcare. While reading, P1 said, "Of course I would assume it has to do with healthcare and cleanliness. 'Life expectancy can fall due to war, famine,' of course. […] Already knowing that it's probably related to the kind of healthcare that's provided, I would say this reinforces the thought I already had in my head." (4 occurrences)
- *Verifying Information*: This theme indicates that, after finding some information, a participant looked for another page to verify that information. Sometimes this entailed a new search query, and other times going back to the previous search result page and clicking on a different result. (3 occurrences)
- *Settling*: This theme refers to a participant stopping their search or simply choosing the first result of a search, indicating that they are satisfied with what they found. (2 occurrences)

Last, an interesting theme that was observed in nearly every participant was *Speculating Freely*. This theme refers to a person's reasoning out loud based on intuition rather than external information. To some extent, this behavior is endemic to the thinkaloud method, but I found that those higher in IH used free speculation differently than those lower in IH. For those lower in IH, free speculation was a way to provide an answer to the question given in the task. Without complete information, the person generalized or improvised some reasoning to provide a more complete answer. For example, responding to Task 1, P7 said, "I can't really find any information for why it's so low, the life expectancy. It looks like coronary heart disease is number one […] so it looks like it has something to do with not very good medical […] they don't have a very good medical situation." Those higher in IH, on the other hand, tended to use free speculation as a method for formulating their next search strategy. P4, for instance, working on Task 3, speculated by brainstorming a number of genres and topics common in visual art (e.g., landscape, portrait) and then searched the artists' names along with those genres.

Discussion

The findings from this thinkaloud study suggest that people with higher IH may be more likely to inspect search results in more detail, express interest in the information they are finding, and revisit the prompt as they are continually formulating their search strategy. Those lower in IH, on the other hand, may be more likely to find information that confirms their expectations (or interpret information in that way), seek to verify information they have found, and settle relatively quickly on an answer. The findings also suggest that some dimensions of IH may be especially critical in information seeking and use, namely modesty and engagement, more than IH *tout court.*

I would comment on two potentially puzzling findings in this study. First, *Verifying Information* emerged as a theme among those with low IH, but this seems inconsistent with our expectations. This may serve first as a reminder that the participants in this study did not have *zero* IH, so this kind of behavior may be a baseline one. Further, we might question whether these participants were seeking additional information simply to *verify* the information they previously found, or if they were open to seeing that information *challenged*. The data in this study does not answer that question.

Next, we can observe a possible mismatch between modesty and engagement in information seeking. According to Alfano et al. (2017), both are dimensions of IH. However, in this study, modesty and engagement seem to sit on opposite poles when it comes to time spent on task, the number of pages visited during a task, and the number of queries made during a task. This should be researched more directly and systematically.

Implications for Education and Design

Together, the two studies presented here shed light on the relationship between IH and information seeking and use, giving further color to prior assertions that people with higher IH engage in more information seeking (cf. Porter & Schumann, 2018). We see, for instance, that those with higher IH may favor more easily accessible information sources, counter to our intuitions, and that some dimensions of IH, such as modesty and engagement, may be most important to information seeking—and perhaps in tension. Besides sparking further research, these findings in themselves offer a more nuanced understanding of the relationship between IH and information behavior and practices, and they may be applied in educational contexts and sociotechnical design.

A tenet of virtue ethics is that we become more virtuous in part by emulating moral exemplars (Vallor, 2016). The same could be said of virtue epistemology (Zagzebski, 2017, p. 39). We can surmise, then, that to become more intellectually humble, a person should do what intellectually humble people do. I.e., with reference to the findings in this study: search in multiple places for information, cultivate an interested attitude toward information, take time to formulate a responsive search strategy, etc.

These insights may find immediate use in education. To date, most discussions of IH in education have focused on having conversations (e.g., Baehr, 2015), but these findings direct our attention to the information search process. Educators can devise assignments and checkpoints that habituate students to these practices in classes on any topic, for example. Those offering information literacy instruction can relay these findings and present cases and exemplars to help students view virtuous information seeking as a set of practices that cuts across disciplines.

Next, this work can inform the design of sociotechnical systems. This work has discerned some of the qualities of people with higher IH, and this may bring us to wonder how our information environment could better support and afford these qualities and instill them in a broader population. Search engine results pages (SERPs), for instance, might be modified to better support IH by grouping results in clusters by perspective for some queries rather than list them by popularity or one-dimensional relevance. If searchers seem to be following one path, the search engine could alert them to other possible paths. SERPs may also be able to stimulate searchers' interest through visual design (colors, time-based effects,

etc.). Lastly, SERPs may be able to do a better job of helping searchers interpret the heft of different pieces of information (e.g., help them weigh the evidence provided in a blog post vs. a news article vs. a scholarly book, considering currency and authority, etc.). Similar changes may also be beneficial for social media newsfeeds and other types of sociotechnical infrastructure.

All in all, there are legion opportunities to better support IH in information seekers, students and people of all stripes through thoughtful educational and sociotechnical design applications. Through such efforts, as well as by becoming mindful of other intellectual virtues beyond IH, we may increase people's information capabilities and contribute to a better-informed world.

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