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**THE RELATIONSHIP BETWEEN INTELLECTUAL HUMILITY AND
BELIEF UPDATING ABILITY: A CORRELATIONAL STUDY**

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ABSTRACT

A growing body of research demonstrated the relevance of intellectual humility (a non-threatening recognition of one's intellectual limitations) and belief updating (the ability to revise one's beliefs in light of new information) in behavioral, social, and political domains. Both require the ability to revise one's beliefs and knowledge. This skill is essential as it enables individuals to critically assess their information and refrain from relying on bias and heuristics in their reasoning (Porter et al., 2022). In a sample of 94 individuals, we investigated a possible correlation between intellectual humility and belief updating using the Comprehensive Intellectual Humility Scale (Krumrei-Mancuso & Rouse, 2016) and an adapted version of the belief updating task, respectively. The adapted belief updating task required revising initial estimates about potential real-life events based on feedback about the average occurrence of the same event among the Italian population.

Contrary to our hypothesis, we found no correlation between these two variables. However, we found an interesting relationship between the Lack of Intellectual Overconfidence subscale and Update Bias (the inclination to incorporate primarily new positive information while disregarding negative information). These findings suggest intellectually humble people could have less update bias when integrating further information.

INTRODUCTION

Intellectual humility is defined as a “non-threatening awareness of one’s intellectual fallibility” (Krumrei-Mancuso & Rouse, 2016). Philosophers and psychologist have extensively examined this concept. While there may be varying opinions on its precise meaning, it is evident that intellectual humility has the capacity to yield positive results for both the individual and the society. It provides a clear evaluation of one’s knowledge and consent to make decisions on reliable information. Moreover, intellectually humble people are more inclined to investigate alternative perspectives and have a higher level of regard for other people’s views.

Belief updating represents the cognitive demand of adjourning one’s convictions in the face of new information. Human beings struggle with belief updating because unfavorable information could enhance cognitive dissonance, disrupting their subjective worldview (Festinger, 1962). To shield themselves from this alteration, individuals employ mechanism such as the optimism bias, which predisposes them to embrace a greater quantity of positive news compared to unfavourable news. However, as for intellectual humility, being able to change one’s perspective even with adverse information can provide more adaptability, detect errors and enhance performance. Evidence shows that being able to revise beliefs can even provide better outcomes in healthcare and well-being (Broadbent et al., 2009).

Due to these premises, we sought to investigate a possible relationship between intellectual humility and belief updating in a correlational study. To assess participants’ levels of IH and belief updating we used respectively the Comprehensive Intellectual Humility Scale (Krumrei-Mancuso & Rouse, 2016), and a revised version of the belief updating task originally introduced by Sharot and colleagues in 2011.

CHAPTER 1: INTELLECTUAL HUMILITY

Chapter 1.1: A generic overview of intellectual humility

“I am wiser than this man, for neither of us knows anything fine and good, but this man thinks he knows something when he does not, whereas I, as I do not know anything, do not think I do either. I seem, then, in just this little thing, to be wiser than this man at any rate, as what I do not know, I do not think I know either.” With such words, Socrates explains why the Oracle of Delphi declared him the wisest man on Earth. At first, he was skeptical because he did not presume to possess any additional knowledge compared to others. However, he was forced to change his mind when he concluded that being aware of his ignorance was sufficient to name him the wisest man.

Socrates provides an embryonic example of intellectual humility. Intellectually humble people assess their knowledge more accurately, know their limitations, and tend to be more open toward conflicting information (Du & Cai, 2020). So far, philosophers have conceived intellectual humility as a virtue (Baehr, 2021; Whitcomb et al., 2017). However, with the emergence of positive psychology, it has been redefined in a psychological dimension.

Intuitively, this research field began distinguishing intellectual humility from general humility.

The concept of general humility that includes various subdomains is derived from philosophical investigations (Baehr, 2011; Roberts & Woods, 2007) that primarily examine an individual's disposition toward episteme, which refers to knowledge. General humility involves “an accurate view of one's strengths and weaknesses and [...] an interpersonal stance that is other-oriented rather than self-focused, marked by the ability to restrain egotism” (Davis et al., 2016, p.215). To separate general and intellectual humility and have a deeper insight into this construct, Davis and colleagues (2016) provided a factor analysis and empirical research; the results exhibited that intellectual humility seems to predict general humility, but the contrary does not occur.

From this point on, many definitions of intellectual humility have been provided. Leary and colleagues (2017) refer to intellectual humility as “recognizing that a particular belief may be fallible,

accompanied by an appropriate attentiveness to limitations in the evidentiary basis of that belief and to one's limitations in obtaining and evaluating relevant information.” (Leary et al., 2017, p.793). Other definitions are “a non-threatening awareness of one's intellectual fallibility” (Krumrei-Mancuso & Rouse, 2016, p. 210); “an insight of the limits of one's knowledge” (McElroy et al., 2014, p.20).

All these definitions focus on awareness of one's limits, reflecting intellectual humility as a form of metacognition (Porter et al., 2022). However, it is hard to find consensus on the nature of this construct between philosophers and psychologists. Hazlett (2012) thinks that the core of intellectual humility manifests when suspending a judgment in a disagreement with a peer; Roberts and Wood (2003) define individuals as intellectually humble when they do not place significance on social status. Both authors advance a conceptualization of intellectual humility, which refers primarily to its social nature. Intellectual humility involves better engaging with the social environment; however, psychology provided some insights beyond these definitions.

In Whitcomb's view (2017), intellectual humility comprises four stages that underlie a process: cognitive, behavioral, affective, and motivational responses. These steps contribute to the development of intellectual humility. Firstly, an individual must accept his intellectual limitations (cognitive responses); he must be willing to admit his limitations to other people (behavioral response); subsequently, he should be motivated to assess his strengths and weaknesses (motivational response) while also addressing any emotional response that may arise in the future.

Samuelson et al. (2015) give another perspective on intellectual humility, referring to IH as a construct that includes epistemic and social dimensions. On the one hand, intellectually humble people deeply desire to seek the truth and have a “craving” to learn and inquire; on the other hand, intellectual humility plays a role in the intrapersonal facet (how the individual sees himself) and the interpersonal one, which regulates human interactions. The authors identified three clusters of intellectual humility from this conceptualization: openness to new ideas and knowledge (which

reflects the epistemic side), agreeableness and honesty in disagreement, and modest unpretentiousness and reluctance to brag. These last two indicate the social side of the construct.

Samuelson and Church (2015) give a more cognitive perspective. They compare intellectual humility to Type 1 and Type 2 thinking processes, referring to the dual-process model often examined in psychology and economics. This cognition model involves the Type 1 process (or System 1), which entails “processes that do not make much demand of working memory” (Samuelson & Church, 2015, p. 1099). Intellectual arrogance (the opposite of intellectual humility) relies on Type 1, which implies fast, automatic, and intuitive judgments. Type 1 process is not inherently harmful; it can be detrimental when employed to assess complex circumstances, as it relies solely on preexisting information. On the other hand, intellectual humility can be found in the Type 2 process, which involves analytical, deliberative, and reflective thinking. Samuelson and Church’s perspective is precious for our research as it establishes a connection between intellectual humility and a cognitive process, aligning with the objective of our study.

Having seen some perspectives on intellectual humility, distinguishing it from other behavioral characteristics could be helpful. Intellectual humility is close to openness and attitude correctness, but they differ on many levels. Openness is related to many aspects of life; an individual who owns this trait tends to approach different topics, such as personal matters, politics, art, and attitudes (McCrae & Sutin, 2009). People with high openness scores often exhibit high intellectual humility scores, too. However, the two constructs are separate since intellectual humility primarily signifies a state of self-awareness. Similarly, intellectual humility is not the same as perspective-taking. Like openness, perspective-taking is directed toward the environment, allowing one to embrace different viewpoints; according to psychological scientists, IH concerns the ability to focus on one’s viewpoints and question them.

Another characteristic that could be similar to intellectual humility is attitude correctness. Attitude correctness indicates to what extent people think that “a particular attitude is valid and justified” (Leary et al., 2017, p.794). Intellectual humility differs from this feature because it relates

more to beliefs and viewpoints. Also, intellectual humility is not the same as being uncertain of one's beliefs: being intellectually humble does not imply a lack of self-confidence or a mistrust in one's intellectual capabilities. Individuals possessing elevated intellectual humility acknowledge the possibility of their views being subject to scrutiny, yet they do not approach knowledge with inherent security.

Intellectual humility also presents many counterparts, such as intellectual arrogance, belief superiority, and dogmatism. They all have rigid and closed-minded thinking in common. Dogmatism primarily adheres to specific contexts, such as religion or political affairs, whereas belief superiority extends to a broader range of subjects. Unsurprisingly, individuals with high levels of dogmatism and belief superiority tend to exhibit low levels of intellectual humility since they think their convictions are better than others (Leary et al., 2017). Intellectual arrogance represents the perfect opposite of intellectual humility, which might lead to a lack of objectivity in judgments and, therefore, wrong decisions (Gregg et al., 2017).

After considering all these viewpoints, it can be inferred that intellectual humility will likely have more than a unitary dimension. Several authors approach intellectual humility as a form of metacognition, which helps regulate beliefs and thoughts (Porter et al., 2022). Other scholars (Samuelson et al., 2015; Samuelson & Church, 2015) suggest that intellectual humility encompasses multiple dimensions. They argue that focusing only on metacognition while studying this concept would overlook critical social aspects of intellectual humility. Furthermore, IH has some shared characteristics with factors such as openness and attitude correctness; however, there is the potential for overlap.

Hence, despite a comprehensive analysis of the definitions and characteristics of this subject, delineating its precise boundaries continues to be a challenging endeavor. The upcoming chapter will examine which components impact IH to establish a more coherent framework for understanding this matter.

Chapter 1.2 Intellectual humility and cognitive abilities

As we saw above, intellectual humility shares some attributes with openness and attitude correctness and has many counterparts, such as intellectual arrogance, dogmatism, and beliefs uncertainty (Leary et al., 2017). However, many other factors are related to IH that warrant consideration.

Since intellectual humility is a conscious recognition of one's knowledge, it is unsurprising that the relationship between IH and intelligence has been investigated. In theorizing the cognitive roots of intellectual humility, Samuelson and Church (2015) suggested that humans might not be intellectually humble because they rely on heuristics; they try to find an easier way to understand their surroundings. As mentioned in the first chapter, this conceptualization depends on the dual-system accounts for human cognition. This model involves two ways of thinking: System 1 processes as the most automatic, fast, and non-time-consuming, while System 2 implies slow, analytical, and reflective reasoning. The authors suggested that intellectual humility might rely on System 2 to revise previous beliefs without assuming they are correct. Cognitive ability is also involved in changing beliefs when new information is presented; therefore, it has been recommended that intelligence is likely to impact intellectual humility (De Keersmaecker & Roets, 2017). However, cognitive ability might not be sufficient to enhance intellectual humility via analytical thinking. An individual can stick to his ideas even without relying on System 1; revising one's beliefs requires a certain amount of flexibility. Therefore, Zmygrod and colleagues (2019) proposed that even cognitive flexibility may be involved.

To test these hypotheses, some experimental psychology tasks were used. The assessment of cognitive flexibility involved two tasks: the verbal fluency task, which entails participants generating words related to a specific topic within a time frame of 2 minutes, and the alternate uses task (AUT), in which subjects are required to come up with several application for a given list of items. The Raven's Progressive Matrices were employed to assess cognitive ability. The Comprehensive

Intellectual Humility Scale (Krumrei-Mancuso & Rouse, 2016) was used to determine intellectual humility.

Results showed that intelligence (cognitive ability) and cognitive flexibility positively correlated with intellectual humility. Moreover, cognitive ability and cognitive flexibility have a compensatory effect in predicting intellectual humility. When there is a lack of cognitive ability and a considerable amount of cognitive flexibility, there are benefits to intellectual humility. The same result occurs if there is low cognitive flexibility and high intelligence. Interestingly, this correlation was more robust for epistemic factors of intellectual humility (such as Openness to alternative ideas) rather than for the social ones.

Other findings confirm that an embryonic form of intellectual humility exists even among children and is related to intelligence. Higher intelligence was associated with higher intellectual humility in 6-to 9-year-old children (Danovitch et al., 2017), and a higher skepticism toward information resources was found in children with high levels of intelligence (Lick et al., 2018).

To enhance the connection between these variables, it is worth considering that intellectual humility, intelligence, and cognitive flexibility share attributes and counterparts. Intellectual humility is associated with reduced dogmatism and belief superiority (Leary et al., 2017); conversely, mental rigidity implies a higher tendency to agree with ideologies (Zmigrod et al., 2018). Recent works also suggest that intelligence is likely to predict the ability to revise and reject stereotypes, an underpinning condition in intellectual humility.

Further evidence supports the role of cognitive features in revising beliefs and expanding judgments. A perception of intellectually humble people as smart individuals is sustained by Alfano (2017) and Deffler and colleagues (2016), who reported better general knowledge and memory in individuals with high levels of IH. This supports the notion that individuals high in IH might reassess available information, leading to a more precise understanding of many subjects. Conversely, people who are overconfident about their knowledge of topics tend to be less wise and cultured than others. The phenomenon is referred to as the widely recognized Dunning-Kruger effect (Dunning, 2011),

which has been corroborated by researchers such as Zakay and Glickson (1992). They searched for overconfident behaviors in students, finding that those who exhibited excessive self-assurance throughout an exam had poorer grades than their more modest peers.

This could also be related to the fact that intellectual humility helps improve mastery behaviors when learning; students with greater IH are more ready to seek challenges or persist in the face of obstacles when acquiring new knowledge or skills (Porter, 2020). Other indicators sustain these findings. For example, individuals with high intellectual humility seem to be more sensitive to errors, thanks to a positive correlation with brain potential (Pe), which relates “to the conscious process of error detection” (Bak et al., 2019, p.91). Another explanation for more successful learning could be intellectual humility’s stimulation to pay more attention to new information (Deffler et al., 2016).

Cognitive links to intellectual humility also facilitate social situations. Typically, psychological distance is a valuable tool during arguments since it reduces the affective burden of the conversation. People exhibit high IH while discussing social groups’ contrast (one group vs another) when they could keep an adequate distance from the topic. Moreover, intellectual humility fosters a desire for curiosity (Litman & Spielberger, 2003) and increases one’s ability to tolerate ambiguity, aiding social interactions.

Even if there are undoubtful advantages of intellectual humility in the cognitive domain, the available research is not fully developed. There is some evidence that suggests the opposite of what we explored above. Meagher and colleagues (2016) found that intellectual arrogance predicted higher grades among students. Those who rated themselves as more knowledgeable were indeed right, suggesting that there might be a gap in the literature. Even though the relationship between cognitive abilities, intellectual humility, and academic performance has been investigated successfully in the studies highlighted in this chapter, these new outcomes could provide a new challenge for this field and encourage to engage in further assessments.

1.3 Intellectual humility and personality traits

This section aims to ascertain the personality traits that exhibit a greater affinity toward intellectual humility and those that show a more significant divergence from it.

Researchers argue whether intellectual humility should be seen as a stable trait. The evidence supports this position, even if the effects of intellectual humility differ depending on the personal relevance of the knowledge offered (Leary et al., 2017) and the situation (Grossmann, 2017). Thus, it has been compared with dispositional traits like those presented in the five-factor model of personality (Costa et al., 1991). Initially, a positive correlation was found between intellectual humility and agreeableness, conscientiousness, openness to experience, and emotional stability (Porter & Schumann, 2018), whereas the correlation with extraversion, although small, was observed in a separate study. A negative correlation between IH and neuroticism was highlighted by McElroy and colleagues (2014). Nevertheless, a stronger correlation was established once intellectual humility was assessed using the Krumrei-Mancuso and Rouse scale (2016). With this measure, the only confirmed relationships were between IH, conscientiousness, agreeableness, and neuroticism. These findings enforce the conceptualization of intellectual humility as a willingness to consider and appreciate different viewpoints and a predisposition to experience positive emotions. Individuals with high levels of intellectual humility are not afraid of accepting other's viewpoints and do not hide themselves beyond their convictions. This ability to look beyond one's perspective is reflected in different fields; not surprisingly, intellectually humble individuals have higher religious tolerance (Hook et al., 2015).

Some other features that intellectually humble people own are worth mentioning. Intellectual humility has been associated with several attributes and behaviors that generate favorable outcomes for the individual and the society, named prosocial tendencies. The relationship between general humility and prosocial behaviors has already been proved by previous research (Exline & Hill, 2012). Subsequently, this bond has been extended to intellectual humility, finding that IH is linked to

intergroup tolerance and cooperation with outgroup members (Kross & Grossman, 2012). Intellectually humble people are less inclined to stigmatize individuals who belong to distinct social groups. Additionally, they exhibit superior levels of self-disclosure and demonstrate a propensity to comprehend different perspectives, even when faced with disagreement. This does not mean that people willing to question their beliefs are incapable of prejudice; however, they are more likely to challenge themselves and not judge on the spur of the moment.

Moreover, individuals with high levels of IH tend to be positive and display other-oriented behavior. This occurs probably because they go beyond their self-interest and recognize the reasons and priorities of other people (Exline & Hill, 2012). Acknowledging another person's beliefs increases empathy, the first step to engaging in prosocial behaviors. Also, individuals who do not focus only on themselves and consider other's beliefs develop social curiosity. Thereby, intellectually humble people are more inclined to show prosocial behaviors, such as altruism, benevolence, and gratitude.

When it comes to conflict or disagreement, intellectual humility predicts a higher tendency to forgive and the capability of mastering behaviors during arguments. People aware of their intellectual limits are also more adept at experiencing a feeling of proximity toward their opponent following a disagreement (Peetz & Grossmann, 2021). McElroy and colleagues (2014) demonstrated that perceiving a partner as high in intellectual humility enhances trust in the whole relationship and helps during conflicts. All these characteristics bring more social cohesion and fewer interpersonal conflicts; moreover, they help maintain relationships through adversities (Porter et al., 2022).

Regarding characteristics that diverge from intellectual humility, "The Dark Triad," which comprehends narcissism, Machiavellianism, and psychopathy (Hodson et al., 2018), correlates negatively. Unsurprisingly, humility is quite distant from these features since they are characterized chiefly by selfishness lack of empathy. However, the relationship between intellectual humility and the absence of these characteristics remains uncertain. Given that psychopathology has multiple

causes, it appears unlikely that a lack of humility is the sole source. However, it could be interesting to explore this relationship in further studies.

This concise analysis clearly shows that intellectual humility is associated with certain dispositional features that improve well-being, reduce interpersonal conflict, and facilitate more effective problem-solving during disagreements. More insights on the advantages individuals might derive from intellectual humility will be expounded upon in the subsequent chapter.

Chapter 1.4 The benefits of intellectual humility in everyday life

Intellectual humility is not a natural-developed skill. Intellectual arrogance is prevalent because, in a confidence-demanding world, people are encouraged to defend their beliefs even when this “protection” sounds meaningless (Gregg and Mahadevan, 2014; Gregg et al., 2017). However, intellectual humility provides more psycho-physical well-being and can elicit positive actions for society. This chapter will analyze these advantages, beginning with individual positive outcomes of IH.

Whitcomb and colleagues (2017) sharply identified seventeen reasons intellectual humility is essential in everyday life. Here, we will summarize their deductions. Intellectually humble people are more willing to admit their limitations; they can settle for attainable goals and ask for help when they lack resources. Their capability to focus on achievable goals reduces feelings of anxiety and insecurity. Due to their self-awareness, these individuals can accurately assess results without being influenced by prejudice. For instance, they do not solely credit their triumphs on their abilities and failures to external factors. Moreover, having paid enough attention to revising their beliefs, they can hold them more effectively. Due to this ability, they also respect other people’s opinions and can focus on others rather than themselves.

Some more evidence demonstrated that intellectually humble people report psychological benefits. They are more emotionally stable, confident, and proud of themselves. Moreover, they

achieve greater satisfaction and self-esteem (Bowes and Tasimi, 2023). They even show greater physical health, having lower blood pressure (Van Tongeren et al., 2019). Intellectually humble individuals show more self-confidence and pride (Krumrei-Mancuso & Rouse, 2016). In corroboration with this evidence, intellectual humility influences other behaviors, such as impulsivity and aggression on one side and depressed mood on the other (Krause, 2014).

As the section on cognitive abilities mentions, intellectual humility can affect learning processes and academic performance. It enhances mastery behaviors and predicts good results due to a higher tendency to search for challenges. Dweck and Leggett described these behaviors as “the seeking of challenging tasks and the maintenance of effective striving under failure” (Dweck and Leggett, 1988, page 256). These behaviors are predictors of academic achievement (Burnett et al., 2013; Yeager et al., 2016). The link between mastery behaviors and intellectual humility dwells in the fact that intellectually humble people do a valuable job of this construct and are more driven to pursue knowledge since they do not get for a fact that their knowledge is necessarily accurate (Porter et al., 2020).

In addition to personal advantages, intellectual humility is associated with positive outcomes in socio-political contexts. Multiple studies indicate that being intellectually humble might safeguard against political misinformation, a prevalent issue in contemporary times, mainly when accounting for the impact of social media platforms. Disseminating false information, particularly in the context of political matters, might result in erroneous voting outcomes. To avoid misinformation, efforts have been put in reminding people to check the sources before spreading any news. A helpful approach consists of training people to discern between what is true and what is not, and intellectual humility seems a good predictor of the tendency to investigate issues before talking about them or sharing them on the internet.

Based on this premise, Koetke and colleagues (2022) hypothesized that intellectual humility could serve as a “dispositional factor” for news reliability investigation, as individuals with this trait are more likely to exercise caution and avoid falling into the pitfalls of closed-mindedness and

dogmatism (Haggard et al., 2018). The central hypothesis was confirmed since participants with higher IH could discern between authentic and fake newspaper headlines in Study 1, exhibiting more remarkable investigative behavior. Moreover, subjects who reported high humility expressed a greater interest in the news' truthfulness than participants with lower levels of IH.

Intellectual humility can be used as a prevention measure, too. Research conducted by Huynh and Sergen examined how attitudes toward vaccinations are shaped by intellectual humility. As explained by Katz and Shavitt, "attitudes perform specific functions for the individual [...] related to knowledge and ego-defense" (Huyhn and Senger., 2020, page 1). When people try to protect their peace, sometimes they unconsciously choose a particular attitude (e.g., take an anti-vaccination side). Nevertheless, this mindset could improve rigid behaviors. Thus, researchers tried to identify psychological moderators to shape more flexible reasoning, such as intellectual humility.

As Guess and colleagues say, "Political misinformation entrenches people in their partisan learning." It contributes to creating confusion, promoting radicalization and violence (Culliford, 2021), and significantly impacts citizens' lives. For example, spreading fake news and political confusion about the COVID-19 pandemic led to a much slower process of awareness and vaccination, causing difficulties and deaths. Therefore, the ability to discern between fake and real seems a critical skill to survive everyday life and improve good societal changes instead of hindering them.

Regarding vaccination attitudes, a weak correlation was found in a study conducted by Senger and Huyhn in 2020. In this research, however, intellectual humility was negatively correlated with anti-vaccination attitudes through four dimensions: Mistrust of vaccine benefits, Worries about unforeseen future effects, concerns about commercial profiteering, and overall anti-vaccination attitudes. An interesting finding about this study is that intellectual humility seemed to be a stronger predictor than demographic variables such as age, gender, socio-economic status, and political orientation. Since this research was based mainly on Krumrei-Mancuso and Rouse's conceptualization of intellectual humility, results were compared to each of the four theoretic dimensions of this theory. Intellect and Ego was the main section that drove the outcomes. Therefore,

people with higher intellectual humility probably feel more confident about vaccines when dealing with other viewpoints. They understood that their knowledge regarding the topic may be incomplete and were not afraid to seek further information, and they considered different views.

As Huyhn and Senger stated in their paper, “the predictive relationship between intellectual humility and intentions to vaccinate [...] is noteworthy” (Huyhn and Senger, 2020, page 456). The presence of intentions towards a behavior from which all the population could benefit is strong, and it demonstrates how this construct is a crucial feature in decision-making.

Besides all the advantages already highlighted, it is appropriate to mention that intellectual humility has already been used (implicitly) in clinical interventions. Even though it is not the main therapeutical goal to increase intellectual humility, cognitive-behavioral therapy usually focuses on seeking cognitive bias and shaping flexible thinking.

Therefore, it is evident that intellectual humility impacts how we shape the world and influences our way of thinking. If greater importance were attributed to intellectual humility, there might be practical consequences in everyday life and social and political domains. Moreover, higher intellectual humility could affect clinical practice.

Chapter 1.5: Existing measures of intellectual humility

1.5.1 Questionnaires

Researchers have developed various measures of intellectual humility. These instruments may vary depending on the specific component of IH they aim to measure or their scale structure.

Questionnaires are the most common measure to assess intellectual humility. They can be used to evaluate IH as a trait or state, asking participants how much they think their beliefs might be incorrect or verifying individuals' attitudes toward others during conflicts. Participants can evaluate intellectual humility among themselves (self-report) or close others (informant report). Questionnaires are valid because they can be specific and less time-consuming than interviews or other tasks (Porter et al., 2022). However, they present some flaws related to the social-desirability

bias (the tendency to answer questions in the most socially acceptable way), and participants may provide inaccurate evaluations of their behaviors due to difficulty recalling past experiences.

As far as we know, four scales currently measure intellectual humility.

1. The Intellectual Humility Scale by McElroy et al. (2014)
2. The General Intellectual Humility Scale by Leary et al. (2016).
3. The Comprehensive Intellectual Humility Scale by Krumrei-Mancuso & Rouse (2016) has been used in the current study.
4. Intellectual Humility Scale by Alfano et al. (2017).

Each scale corresponds to a specific framework about intellectual humility and has been designed in a particular format. This section will investigate these measures' characteristics and explain our choice to use the Krumrei-Mancuso & Rouse scale.

The Intellectual Humility Scale, developed early by McElroy et al. (2014), is a bi-factorial informant-report scale. It was built through three studies and refers primarily to intellectual humility related to religious attitudes. McElroy and colleagues conceptualized intellectual humility as a virtue that plays a role “when there is a negotiation of ideas in a relationship or group.” (McElroy et al., 2014, page 20). On this basis, intellectual humility is particularly crucial for gaining trust and endorsement as community leaders and repairing conflicts, whereas being intellectually arrogant is harmful when it comes to teamwork and cooperation.

To structure their scale, McElroy and colleagues selected 60 items based on this conceptualization and tested them on 213 participants. After the analysis, the scale comprehended only 16 items, with two factors consistent with the authors' definition of IH. The first was Intellectual Openness (e.g., “seeks out alternative viewpoints”), and the other was Intellectual Arrogance (e.g., “Has little patience for others' beliefs”). The study was replicated using a different sample, providing additional evidence of internal consistency.

McElroy and colleagues applied their scale to social bonds and religious matters. Since an adequate section of literature on intellectual humility focuses on accepting others' religious

viewpoints, researchers investigated how people would judge a spiritual leader if he committed something profane. In their view, intellectual humility should help repair the relationship with the leader after the betrayal. Results partially confirmed this hypothesis because intellectual humility was related to higher forgiveness. As suggested by Alfano and colleagues (2016), a bi-factorial scale hardly captures the whole construct of intellectual humility, which is more likely a multi-dimensional concept. Moreover, intellectual humility focuses on relational issues and has a crucial role in mediating them, but this is not its only aim.

Unlike McElroy et al., Leary and colleagues aimed to develop a self-report measure of the construct to investigate it better. The General Intellectual Humility Scale is unidimensional and relies on one characteristic of an intellectually humble person: “I accept that my beliefs and attitudes may be wrong.” From this assumption, researchers chose six items that measure the degree to which participants recognize their beliefs may be inaccurate.

After the general scale, the authors aimed to develop a more specific measure to see people’s attitudes toward different topics. Even though a general measure can provide insights into an individual’s overall humility or arrogance, it may not accurately reflect their attitudes in specific areas of interest. A person might be arrogant overall, but he can be willing to change his opinions on some particular issues. The authors agreed on 21 items worded so that a specific topic could be implemented in each of them. Items were tested on political, religious, health, and manners domains. Due to its versatile nature, this scale is particularly fascinating to develop studies on insidious issues, such as vaccinations, abortion, and religious freedom.

The Comprehensive Intellectual Humility Scale by Krumrei-Mancuso and Rouse (2016) was the selected measure for this correlational study. This scale’s strength relies on its multidimensional structure, measuring four aspects of intellectual humility: Independence of intellect and ego, which measure to what extent an individual feels attacked when his beliefs are criticized or threatened; Openness to revising one’s viewpoints, which assesses the willingness of changing ideas in the face of new information; Respect for others’ viewpoints, that reflect the level of respect and tolerance an

individual holds toward other people's opinions; and Lack of intellectual overconfidence, which measures the absence of intellectual arrogance. This scale evaluates both meta-cognitive and interpersonal features of intellectual humility, assessing how people consider their knowledge and to what degree they respect and valorize different views. Therefore, it offers a round perspective of subjective intellectual humility.

Another scale that has been developed is the one by Alfano and colleagues, named the Intellectual Humility and Intellectual Engagement Scale. Based on a four-facet model of intellectual humility, each dimension ranges between a positive and a negative pole (open-mindedness-intellectual arrogance; intellectual modesty-intellectual vanity; engagement-boredom; corrigibility-intellectual fragility). This measure exists both in informant and self-report forms.

Even if they do not assess intellectual humility directly, we deemed it appropriate to mention two additional measures because they focus on attributes related to this construct. First, the Humble Leadership Scale (Owens et al., 2013) assesses three dimensions of intellectual humility, referring directly to group leaders: willingness to see the self accurately, appreciation for others' strengths and contributions, and teachability.

Secondly, we would like to mention the Santa Clara Strengths of Religious Faith Questionnaire (Plante & Boccaccini, 1997), which comprehends items related to IH in the context of religious faith. Given the discovery that intellectual humility is a reliable indicator of religious tolerance (Hook et al., 2017), this scale could prove beneficial in environments where religious conflicts are prevalent. Ultimately, the Lay Epistemic Virtues Scale focuses on intellectual humility and other virtues in everyday life.

1.5.2 Behavioral tasks

Besides questionnaires, behavioral tasks provide another helpful measure of intellectual humility. They can present more advantages compared to questionnaires. As they are not influenced by language, they can be utilized to assess intellectual humility in youngsters. Moreover, they do not reflect a subjective judgment, minimizing biases and inaccuracies. All participants are in the same situations and must face the same challenges.

An example of the behavioral task to assess IH could be measuring the frequency with which a child seeks assistance from a peer with greater knowledge.

However, even if tasks present a valid alternative to questionnaires for all the above reasons, they also offer some limitations. First, it is hard to re-create the same task with the same subjects because they got used to the activity, which can influence the outcomes. Furthermore, behavioral assignments are contingent upon specific circumstances, making it difficult to generalize findings.

For all these reasons, researchers suggest using behavioral tasks and questionnaires to assess intellectual humility. Adopting both measures can result in a more effective assessment and definitive outcomes.

CHAPTER 2: Belief updating

2.1 How beliefs influence everyday life

Beliefs are powerful. First, they allow us to predict the future (Krizan and Windschitl, 2007). Experiencing events consents us to create probability patterns and use them to make our way into the world. Notwithstanding this reality, individuals must be aware of their beliefs' profound influence on their daily existence. Every human possesses core beliefs about himself, others, and the world; these convictions are organized to make assumptions more easily, organize thoughts, and maintain cognitive consistency (Kube & Rozenkrantz, 2020).

Beliefs can be culturally determined (Tweed & Conway, 2006). For example, some cultures (e.g., eastern Asia culture) see each human being as deeply connected and dependent on all the others, whereas Western cultures conceive the person as a distinct and independent subject.

The Self has a massive influence on core beliefs since people think that good things will happen to them and bad things are destined for others. For example, in Lench and colleagues' study (2014), participants were asked to judge if they or other players would receive some cards to win or to lose. Despite equal probabilities, people tended to state that winning cards would occur to themselves. The bias was only related to the Self, meaning no differences were mentioned when judging other players' probabilities.

People's desires and needs can also influence beliefs: desirability bias. This case is very similar to the Self-bias. These two biases are hard to split because people like to assume that good things are related to the Self and desire more of these things than bad ones. According to Krizan and Windschitl's view (2007), we consider desirability bias as a subtype of motivated reasoning. Motivated reasoning occurs when we want to come to a specific conclusion, and we prefer some evidence over others to confirm our hypothesis (Dawson et al., 2002).

One's view of the world can also influence beliefs. People with a proactive view tend to modify their beliefs to a greater extent, and therefore, they tend to reach good outcomes. Given the

potential influence of adopting a proactive perspective on our attitudes, it is understandable that a significant proportion of healthcare research is concentrated on this subject. Broadbent and colleagues (2009) provided some evidence about this matter. They investigated the impact of an intervention on illness perceptions among patients recovering from myocardial infarction and their spouses. In addition to standard care, patients and spouses were given an intervention with a mental health professional to change their views about the illness. Little less attention is given to patients' partners during healthcare practices, but literature shows how increasing spouses' knowledge about rehabilitation can decrease their anxiety and help patients during recovery (Weinman et al., 2000). Before starting, spouses were given the Brief Illness Perception Questionnaire and the causal scale from the Brief Illness Perception Questionnaire-Revised. These measures helped assess the spouses' perceptions and beliefs about their partners' recoveries. Anxiety measures were also taken.

In the experimental group, two sessions were conducted with the patient alone, and the third one was a joint patients-and-spouses session. This joint session aimed to explore the patient's and spouse's beliefs about infarction causes. For example, if a spouse thought about stress as the primary cause of myocardial infarction, they were informed about hereditary and biological risk factors, such as high cholesterol. Considering other causes might improve changes in the patient's lifestyle with help from his partner. Doubts and concerns about other issues about returning home were also explored in this session.

Results proved that modifying beliefs and perceptions about patients' conditions can help reduce anxiety, be more aware of hereditary causes, and increase activities to reduce modifiable risk factors.

Petrie and colleagues provided further evidence on this topic. Patients who believe in the power of rehabilitation are more likely to attend rehabilitation sessions and thus improve their conditions. Conversely, patients with weaker beliefs tend not to search for rehabilitation services even when they are free and available. Discharging dysfunctional beliefs can significantly improve

patients' health conditions. Other characteristics that impact recovery cannot be changed (e.g., genetic factors and demographic variables), making changing beliefs even more crucial.

In this research, patients' beliefs proved relevant for an active recovery. Patients were offered an intervention that consisted of three sessions. Patients' beliefs about the causes of myocardial infarction were investigated in the first session. Patients often had misbeliefs regarding the causes and consequences of the event, so disconfirming their inaccurate perceptions was fundamental. In the second session, patients and psychologists explored several strategies to improve recovery based on the causes assessed in the previous term. At this moment, it was possible to challenge patients' opinions regarding the impossibility of doing physical activity above a certain level, and a personal program of full recovery was implemented instead. The third session focused on reviewing the plan and discussing recovery symptoms. As expected, working on patients' beliefs about their illness and recovery significantly improved their outcomes and personal views. They better understood the illness and were more relaxed when leaving the hospital. They were even more prone to attend rehabilitation. Lifestyle changes were observed, too: most patients began to work earlier.

Probably the most unexpected result was the reduction of angina symptoms. This could be because repeatedly discussing symptoms with an expert led to a more significant normalization. Patients might have decreased levels of worrying about their pain and a greater propensity for normalizing it.

When discussing beliefs' impact on health, mentioning the placebo effect is mandatory. Previous literature found that when people perform a cognitive task and expect a particular substance to enhance their performance, they "set in motion a chain of behaviors to produce that outcome" (Parker et al., 2011, page 607). Nevertheless, they think the placebo is responsible for the outcome (Kirsch, 2004).

There is nothing more representative than this mechanism to show how the strength we apply to ideas can lead to favorable outcomes in healthcare. From Bingel (2011), we know that when positive expectations were elicited in participants under heat pain, an opioid drug (Remifentanyl) had

a doubled effect. When participants were given negative expectations, pain sensitivity increased significantly despite the drug effect.

In their analysis of mechanisms underlying placebo effects, Petrie and Rief (2019) pointed out that expecting a pain reduction probably causes lower neural activity in areas like the upper spinal cord (Eippert et al., 2019). Also, the dopamine-reward system is perhaps involved since believing in receiving an effective treatment can be seen as a reward.

Even open-label placebo has an impact on patients' outcomes. An open-label placebo does not differ from a standard placebo, except that the patient knows the substance's ineffectiveness. One could argue that it should not influence a patient's expectations, but he would be wrong. Open-label placebo proved strong efficacy on irritable bowel syndrome (IBS) patients. In this case, positive expectations are created by telling the patients that they might experience positive outcomes despite the nature of the substance.

Creating beliefs and expectations also interacts with pain treatments. As Schenk and colleagues (2013) suggest, treatment and expectations about treatment interact at a cortical level, resulting in lower pain ratings.

As for healthcare, evidence shows that modifying beliefs leads to achievements in performance, too. Cognitive abilities improved after a fake treatment (Parker et al., 2011). Using a variant of the Balanced Placebo Design, researchers examined the effect of beliefs on a prospective memory task. Prospective memory is a cognitive function that allows us to remember future actions and obligations. Participants were given a mixture of vitamin powder and water in this study. Half were told they were taking an inactive version of a cognitive-enhancing drug called R273, while the other half were told they would take the active principle.

As expected from the hypotheses, subjects who believed that having taken a cognitive-enhancing drug reported better cognitive performance on word-categorization tasks than the other group. Since R273 was unreal, people unconsciously enhanced their cognitive ability and attributed effects to the placebo.

Beyond performance, stress perception has also been shown to be affected by beliefs. People with negative beliefs about stress (perceiving it as detrimental to their health) show an enhanced stress response. Salzman and colleagues (2018) compared the impact of an intervention on expectations and two other interventions (gratitude or distraction) on both psychological and physiological stress responses before acute stress. In the expectations session, participants' beliefs about stress were optimized. Along with the distraction intervention, subjects participating in the expectation session showed lower cortisol levels and a reduced stress response.

Conceiving stress as a negative factor in everyday life proved to have a significant influence on people with high levels of stress. They had a "43% increased risk of premature death" (Kube and Rosenkrantz, 2021, page 248; Keller et al., 2012), but only if they had a negative belief about stress, despite the actual stressors. Also, enhancing a positive belief about stress seems to influence the neurobiological level by producing more adaptive cortisol (Crum et al., 2013). If reasonable expectations about managing stress are generated, cortisol levels seem to decrease.

Optimism and economic choice (Puri & Robinson)

2.2 What is exactly belief updating

Belief updating is "a nascent field of research examining how people adjust their beliefs in light of new evidence" (Kube & Rosenkrantz, 2020). Through beliefs, people shape a subjective reality. Integrating new information implies the challenge of accepting things that might confirm previous beliefs. To avoid losing coherence, people get new information if they are coherent with their previous beliefs and reject it if not. The propensity to accept news that fits prior information is due to the use of heuristics.

In the field of belief updating, the basic design includes a first assessment of the subject's beliefs before new information is provided, followed by a second assessment of beliefs (Kube & Rosenkrantz, 2021). This design consents to examine to what extent beliefs are updated after new information. Using this task, it is possible to relate belief updating to specific psychological processes

or personality traits, and abnormalities in psychological features may lead to impairments in belief updating.

Belief updating is crucial nowadays because it reflects people's craving for cognitive consistency. Changing beliefs is not as easy as it might appear, and individuals must maintain their ideas about the world, others, and themselves as coherently as possible. The risk of updating beliefs is represented by cognitive dissonance. Leon Festinger (1962) exposed the theory regarding cognitive dissonance first. Festinger argued that if a child had to choose between two toys and was told that one toy should return to the store, he would be more driven to pick the one not meant to replace. This would reduce the cognitive dissonance between his desires and a choice that the adult had already made. Cognitive dissonance has much in common with expectations. If a person is standing in the rain, he would expect to be wet soon, and if, for some reason, this does not happen, he will perceive a considerable amount of cognitive dissonance. A gap is generated between what the individual knows for a fact and what happens.

To deal with this mechanism, people have two choices. They can increase the desirability of the alternative they want to fit in, or they can decrease the desirability of the alternative that would make them doubtful about their knowledge. In psychology, this mechanism is known as confirmation bias: to avoid altering reality, people actively search for strategies likely to confirm their previous beliefs and reduce cognitive dissonance.

We want to briefly discuss belief updating's abnormalities in non-clinical populations.

In non-clinical populations, belief updating is characterized by two main biases: optimism bias and self-concept stability. Sharot and colleagues conducted most of the studies regarding optimism bias. People typically select information that matches their optimistic views to favor this bias, while others are left out. When they are presented with some adverse life events, participants tend to update more in front of good news (e.g., if the probability of having an ictus is estimated as 30% and the base rate turns out to be 20%, the second estimate could be around 22%). When they are exposed to bad news, the opposite behavior occurs (for example, if the first estimate for an ictus is

10% and the base rate is 20%, the second estimate could be around 12%). People think good events are more likely to happen to them than tragic ones. This propensity seems to be independent of age, gender, and culture.

Sharot and colleagues investigated the processes that might underlie optimism bias and found exciting findings about the role of dopamine. Since dopamine relates to the reward system in the prefrontal cortex, researchers argued that it might have a role in accepting positive information. Participants were assigned either to the L-DOPA or control condition to assess this hypothesis. Both were asked to perform the belief update task with 80 adverse events. Those in the L-DOPA condition tended to underestimate adverse events if compared to those in the control condition (Sharot et al., 2012). When dopamine levels increase, the capability to accept lousy news is impaired. Thus, the individual tends to underestimate adverse events and overestimate positive ones due to enhanced dopamine levels.

Optimism bias is not always present. It can be reduced under perceived threat: Garrett and colleagues (2018) found a greater tendency to accept lousy news and integrate it in firefighters and participants with induced stress. The authors explained this finding with cognitive flexibility, assuming people can flexibly adjust their beliefs in non-ordinary circumstances.

Even though our argumentations seem to suggest the opposite, optimism bias is not necessarily negative. Optimistic expectations can enhance exploratory behaviors and positively impact motivation (Puri & Robinson, 2007). However, not being aware of this bias can result in dangerous outcomes, such as not adopting preventive measures in the face of disasters (Paton, 2003) or not practicing safe sex (Weinstein & Klein, 1995).

Another bias in belief updating is self-concept stability. In social and personality psychology, it is known that individuals need their self-image to remain stable and coherent over time. To pursue this goal, people tend to select contexts and strategies that allow this image to be untouched. Moreover, they often see themselves in a positive light rather than negative (Leary, 2007). During a study regarding self-perceived assertiveness and emotionality, participants had to interact with other

individuals. Before these interactions, they were given self-report questionnaires regarding their perceived assertiveness and emotionality. Future interaction partners would have examined these questionnaires, and their duty was to evaluate participants through some questions. To discuss together, participants could choose the other partner's answers to the evaluation. The study confirmed that participants tended to select the answers that best fit their self-image about assertiveness and emotionality.

Translating this concept to belief updating, it is reasonable to assume that human beings are more willing to update beliefs that fit with their self-concept. When people receive feedback that does not match their self-concept, they reject it to maintain stability (Swann & Hill, 1982). The actual update occurs when feedback is consistent with their previous idea of themselves. In Korn and colleagues' study, participants had to interact with three other peers in a real-life setting (e.g., Monopoli match) and then receive social feedback. On day 2, they performed a functional magnetic resonance imaging (fMRI) while completing a task on Matlab. They were presented with 1 of 80 trait adjectives and were asked how much they think the adjective fit themselves or another participant. During these trials, they initially gave their estimation, and then they were presented with other participants' mean estimation. For example, in the Self condition, if the adjective was "polite," they were asked, "How do you see yourself?" regarding being polite. They gave their rating, then they saw what they believed was the mean rating three other participants gave the day before. After this feedback, they were allowed to provide a second estimate. If feedback was desirable, they were willing to update their evaluation of themselves on the second estimate. However, if feedback was undesirable, they were unlikely to revise their estimation. This study demonstrates that updating is biased regarding self-identity, but it also shows how optimistic bias and self-concept stability are not mutually exclusive. Kuzmanovic and colleagues (2016) also demonstrated the relationship between these two while investigating the neural mechanisms underlying belief update. According to the definition of optimism bias, "a motivation to adopt the most rewarding (or least aversive) perspective on future outcomes" (Sharot et al., 2011), they hypothesized that the neural circuitry of reward could

play a role in accepting good news more willingly. Functional magnetic resonance imaging was performed while participants completed a belief update task. During the increase of favorable updates (or decrease in unfavorable ones), increased neural activity was highlighted in the subgenual ventromedial prefrontal cortex, which is also responsible for the reward system. When the undesirable update occurred, increasing activity was found in the dorsomedial prefrontal cortex, thalamus, hippocampus, and ventral striatum.

So far, we have investigated belief update biases in healthy populations. In the following section, we will explore anomalies in clinical populations.

In subjects with major depression, there is a complete lack of optimism bias. It is well known that depressed individuals hold a negative view of themselves, others, and the world (Beck, 1964). Therefore, it is unsurprising that they accept undesirable information regarding belief updating. Vice versa, patients suffering from depression struggle to get and integrate positive news, especially if news relates to self-concept. A lack of cognitive flexibility in considering new positive news might be an eligible explanation, but other factors may play a role.

Dopamine levels in significant depression might influence this difficulty. Antidepressant functions confirm this evidence: most of the medications for depression contribute to an increase in dopamine levels, which results in a reduction of pessimistic bias (Sharot et al., 2012; Strunk et al., 2006).

Further evidence has been found in the anxiety spectrum. Recent studies explored to what extent negative beliefs are updated by patients with SAD (social anxiety disorder) when social feedback is provided. Subjects were asked their opinion about themselves and then to perform a fictitious job interview in front of three judges. One was instructed to give positive feedback, the other negative feedback, and the third very neutral feedback. Participants with SAD updated their self-concept in response to negative feedback more often than healthy controls (Koban et al., 2017). Similar results have been found in obsessive-compulsive disorder. OCD patients seem more reluctant to update beliefs than healthy controls, as Moritz and Pohl's research demonstrated. Researchers

asked OCD patients and healthy controls about the probability of being accidentally involved in some events (e.g., burglary). OCD patients were referred to high probabilities even after base-rate evidence.

Shifting from the anxiety spectrum to psychosis, impairments in belief updating have also been found in delusional patients. Since delusional patients are characterized by a damaged reality check, experiments have considered several pictured scenarios instead of classic belief-updating tasks. When psychotic patients face delusional-neutral scenarios, they are asked to guess how plausible each scenario can be. Then, they are provided with previous information about scenarios and asked to give a “second estimate.” Some background information made the scenario initially plausible but then unreal, while others seemed at the end more plausible. Delusional patients struggle with updating their initial interpretation even though it has been proved unplausible.

So far, we have explored what belief updating consists of and which bias characterizes healthy and clinical populations. To summarize, belief updating is a process that occurs when people integrate new information despite prior beliefs. How they relate to this information predicts the quality of belief revising. Eventually, belief updating can be impaired in healthy and clinical populations because of biases and difficulties integrating news into one’s previous belief system.

Given the above, a person could think that belief updating resembles a stable ability. However, it would be a mistake. Belief updating can vary based on various factors, including age, hormones, and neurotransmitters. The bias’s level of belief updating can change during the life span, with adolescents having higher difficulty integrating new adverse information (Moutsiana et al., 2013). We have already examined the role of dopamine in discharging undesirable news because of the reward circuitry system, and oxytocin also guides the reduction of updating of lousy news (Ma et al., 2016). Consequently, we can view belief updating as a dynamic process that can change over time, not a static trait. Moreover, the fact that belief updating has such an emotional nature allows us to be optimistic regarding its improvement during life. In the next chapter, we will explore how beliefs influence everyday life.

CHAPTER 3: THE RESEARCH

3.1 Hypotheses and background

The question of primary interest in our current research is whether intellectual humility can be correlated with belief updating. To our knowledge, there has yet to be a recent study that tried to investigate the relationship between those two variables. Nevertheless, evidence suggests that there might be a connection between intellectual humility and the process of revising one's beliefs. Intellectual humility has been characterized in several manners; however, scholars generally concur with Leary's definition, which asserts that "intellectual humility involves recognizing that one's beliefs and opinions might be incorrect" (Leary, "The psychology of intellectual humility," page 3). Recognizing the potential of errors in thoughts or beliefs is an integral element of updating one's belief since this process entails the capacity to modify initial estimation, regardless of whether the new knowledge is desirable or not. Hence, it is logical to infer that individuals who possess this capability are more inclined to modify their views when there is a possibility of being mistaken, thereby enabling them to update a more significant amount of information in a task involving belief updating. Changing beliefs about social, personal, or political issues is problematic, and intellectual humility is precious when changing ideas is uncomfortable.

Moreover, both belief updating and intellectual humility bond with cognitive flexibility. Correlational studies demonstrated that cognitive flexibility could predict intellectual humility (Zmigrod et al., 2019). This association was especially solid between the *Openness to revising one's viewpoints* and *Respect for others' viewpoints*, respectively Factor 2 and 3 in the Comprehensive Intellectual Humility Scale (Krumrei-Mancuso and Rouse, 2016). Cognitive flexibility is also an impaired crucial feature in several mental illnesses such as depression, anxiety, schizophrenia, and obsessive-compulsive disorder (Maramis et al., 2021; Nassar et al., 2021; Waltz, 2017; Soltani et al., 2013). Patients affected by these illnesses typically show difficulties updating beliefs (Everaert et al., 2018; Moritz & Pohl, 2009) since it entails reconsidering one's assumptions and overcoming rigid

reasoning. The shared association with cognitive flexibility will likely enhance the connection between intellectual humility and belief updating.

On the theoretical and empirical bases discussed, the current study sought to explore the relationship between intellectual humility and belief updating by comparing the results of a belief updating task with the Comprehensive Intellectual Humility Scale's scores. It was hypothesized that higher levels of intellectual humility would be associated with more significant updates toward the base rate during the task. Vice versa, low intellectual humility scores should negatively correlate with less tendency to revise one's beliefs.

3.2 Method

3.2.1 Participants

An Italian sample of 100 adults participated via Gorilla Experiment Builder (Anwyil-Irvine et al., 2020). The sample was 74% female, 19% male, and 6% non-binary, aged 18 to 35 years ($M=24.5$, $SD=2.91$). Regarding the highest level of education completed, nearly half of the participants reported having a bachelor's degree (46%), 27% indicated a master's degree, 23% stated a high-school diploma, and 2% indicated a doctorate/post-graduate title.

The program removed those who still needed to meet the inclusion criteria. Exclusion criteria include people under 18 years old or over 35, participants with cognitive disabilities, participants with diagnosed psychiatric illnesses, participants who failed to complete the seriousness check, and participants who withdrew their data.

Participants provided their informed consent to participate in the study in accordance with the institution's School of Psychology Ethics Committee Approval.

	Frequency	Percent
Female	70	74.468
Male	18	19.149
Non-binary	6	6.383
Master degree	26	27.660
Bachelor degree	44	46.089
High school diploma	22	23.404
Phd	2	2.128

Table 1. Demographic information regarding our sample

3.2.2 Materials

Materials are presented in the same order as they were presented to the participants.

Demographic information

Participants indicated age, gender, handedness, education level, and political orientation.

Emoji Grid

The Emoji Grid was developed by Alexander Toet and Jan van Erp (2020) and was inspired by Russell's Affect Grid (1989). This tool aims to assess subjects' moods intuitively and was initially used to determine people's affective appraisals toward visual, auditory, and olfactory stimuli (Toet & Van Erp, 2020). It is intuitive and language-independent.

It consists of a square grid with many facial icons ranging from liking neutral, and disliking. The dimension pleasant-unpleasant is placed on the horizontal axis, while the arousal increases in intensity through the vertical axis. Participants can report their current mood with a single click on the grid.

In our study, the Emoji Grid was used to assess participants' moods before the beginning of the task.

Belief Update Task

The Belief update task requires participants to estimate how likely a specific event will happen to them. Researchers around the world have used this task to investigate belief formation and optimism (Sharot et al., 2011; Korn et al., 2012; Ma et al., 2016; Kuzmanovic et al., 2016; Kappes and Sharot, 2019; Oganian et al., 2019; Ossola et al., 2020). Different task versions have been used across the studies, depending on the scientists' necessities.

In our task version, we presented 38 adverse life events. Events were selected through statistical websites such as Statista, Eurostat, and Istat. We chose the most recent statistics referring almost only to the Italian population.

We asked the participants to estimate the probability of the event occurring to them (*first estimate*). Then, they were presented with a base rate of the recent events in the Italian population. Having seen the average probability, they should include a second event estimate. They could choose freely to maintain their first estimate or update it. To avoid potential confounds, at the end of the task, participants were called upon to evaluate each event on a Likert scale according to their experience with the event, how arousing they perceived the event, and how negatively or positively they perceived it (these are known as “subjective ratings”).

Regarding the analyses, trials are divided into good news and bad news. In the first case, participants provided a higher first estimate compared with the base rate. Therefore, they learn that the possibility of encountering an adverse event is lower than imagined. On the other hand, they are provided with bad news if their first estimate is lower than the base rate, so the event is more likely to occur than they predicted (see Fig.1a/1b). For each participant, the average update for good and bad news is calculated (Garrett and Sharot, 2022). Besides average updates, update bias is also calculated as a measure of valence. Greater updating in good news trials indicates an optimistic bias, while greater updating in bad news trials indicates a pessimistic one. According to the literature,

optimistic bias is the most frequent among non-clinical populations (Garrett and Sharot, 2014; Korn et al., 2014).

Estimation errors are also calculated. They consist of the difference between the base rate presented and the subject's first estimate on each trial. Not controlling for estimation errors might result in inaccurate findings since participants tend to give too low or too high first estimates. First, too polarized estimates can lead to artificial updates downwards or upwards.

Bad news trial

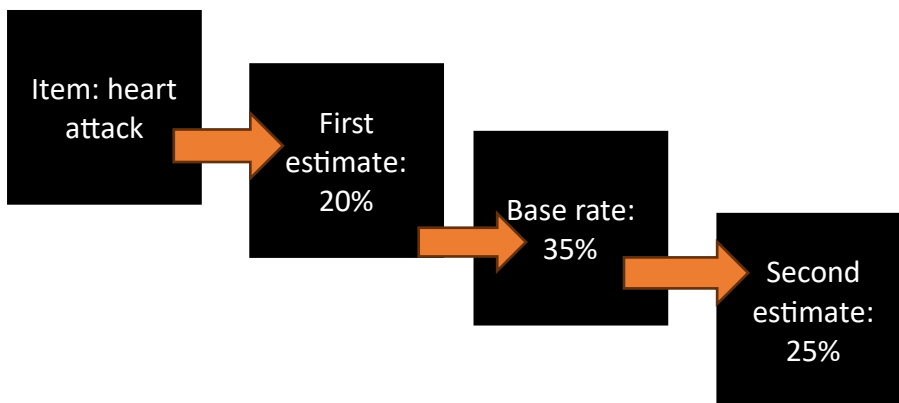


Fig. 1a Example of a “bad news” trial

Good news trial

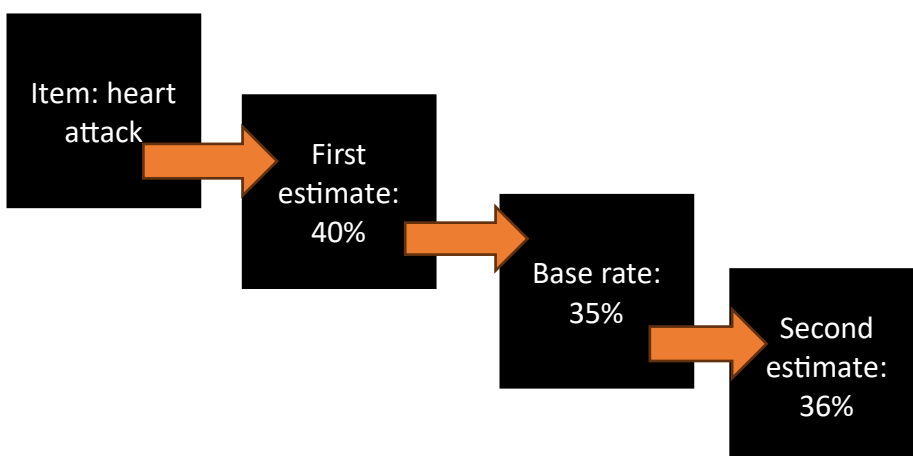


Fig. 1b Example of a “good news” trial

Subjective ratings

Familiarity

Familiarity check has the purpose of measuring how often participants encounter the events. It has five dimensions: *Never, Rarely, Sometimes, Often, always*.

Valence

To see how participants evaluated the events, they were asked to rate each on one of these dimensions: *Very negative, Negative, Quite negative, Neutral, Quite positive, Positive, Very positive*.

Arousal

Participants indicated how arousing they found the events. For each event, they reported if they felt *Very calm, Calm, Quite calm, Neutral, Quite aroused, Aroused, Very aroused*.

Depression, Anxiety, Stress Scale 21 (Bottesi et al., 2015)

The Depression-Anxiety Stress Scale is a self-report questionnaire designed to assess the severity of symptoms related to depression, anxiety, and stress. It was created by Lovibond & Lovibond in 1996. The scale does not represent a diagnostic instrument and is helpful in various research settings (Osman et al., 2012).

Depression subscale refers to a lack of positive affect, such as dysphoria, anhedonia, hopelessness, devaluation of time, and inertia (Asghari et al., 2008). The anxiety subscale is analyzed as an intense fear response and somatic symptoms. The stress subscale measures tension, irritability, and difficulty in relaxing.

The questionnaire consists of 21 items (e.g., “I felt scared without any good reasons,” “I felt that life was meaningless”). Participants are asked to rate the extent to which each item applies to them over the past week on a scale ranging from 0 (“Did not apply to me at all”) to 3 (“Applied to me very much or most of the time”). For each subscale, the scores for identified items must be sum. Since DASS-21 is the short version of the original scale (DASS-42), the final score of each item group needs to be multiplied by 2.

In the current study, we used the Italian version of the scale validated by Bottesi and colleagues (2015), which provided good outcomes defining the distress of clinical and non-clinical subjects.

Concerning the Italian version, results pointed out Cronbach alpha higher than 0.70.

Recommended cut-off scores are specified in Table 2.

	Depression	Anxiety	Stress
Normal	0-9	0-7	0-14
Mild	10-13	8-9	15-18
Moderate	14-20	10-14	19-25
Severe	21-27	15-19	26-33
Extremely severe	28+	20+	34+

Table 2. Indicators of severity in the Depression, Anxiety, Stress Scale

Comprehensive Intellectual Humility Scale (Krumrei-Mancuso & Rouse, 2016)

The Comprehensive Intellectual Humility Scale consists of a 22-item self-report measure of intellectual humility. The scale measures four distinct factors of this construct: Independence of intellect and ego (Cronbach’s alpha=0.914; e.g., “I tend to feel threatened when others disagree with me on topics that are close to my heart”), Openness to revising one’s viewpoint (Cronbach’s alpha=0.872; e.g., “I am willing to change my position on an important issue in the face of good reasons”), Respect for others’ viewpoints (Cronbach’s alpha=0.926; e.g. “I welcome different ways of thinking about important topics”), and Lack of intellectual overconfidence (Cronbach’s alpha=0.822; e.g., “Listening to perspectives of others seldom changes my important opinions”).

Each item is rated on a 5-point Likert Scale, going from 1 (=strongly disagree) to 5 (=strongly agree). Items were summed for each of the subscales (factors). Higher scores indicate higher overall intellectual humility.

The scale has good psychometric properties and good levels of internal consistency, convergent and discriminant validity. Psychometric characteristics are suitable for different ages, genders, and ethnicities.

Seriousness

The seriousness check is a technique aimed at improving online surveys' quality. Inaccurate or careless responses can severely damage survey data, and using a preventive measure to exclude approximate answers might be necessary. The participant is asked if he answered the questions with serious participation (and not randomly).

This measure was used first by Reips (2000). This instrument consists of two main questions. First, participants are asked if they followed the instructions regarding the experimental conditions correctly (e.g., working in a free-distractions area). In the current study, they could answer using a slider ranging from 1(=not at all) to 9(=completely). Subsequently, they are inquired whether they have provided severe responses to the assignments. Participants may indicate that they approached the assignment with seriousness, that they have not, or that they first approached it seriously but then became disinterested. Data were immediately excluded if participants reported not taking the task seriously.

3.2.3 Stimuli

Stimuli in the belief update task consisted of 38 adverse life events (e.g., heart attack, financial fraud). The average probability of that event occurring in the Italian population was found through online resources (such as Healthdesk, Istat, and Statista) for each event. All the online resources are available in the bibliography section.

We tried to choose the most recent percentages to give participants accurate information. Events that could be influenced by gender bias (e.g., breast cancer) were purposely avoided so as not to create potential confounds.

Extremely rare or widespread events were not included. All the probabilities settled between 10% and 70%, even though participants were told they ranged between 3% and 77% to guarantee that the range of potential overestimation was comparable to the range of possible underestimating.

3.2.4 Procedure

The survey was programmed and delivered using Gorilla Experiment Builder, a software developed by Cauldron Science (2016). Participants were recruited through social media such as Instagram, Facebook, and WhatsApp.

As they opened the link, participants were asked to ensure the experimental setting would be quiet and free from distractions. Having set the screen in full mode, they were presented with information about the survey and data treatment. They were assured that data would have been collected anonymously and that they could withdraw from the survey anytime.

The screen displayed inclusion requirements. The poll excluded those under the age of 18 or over the age of 35, as well as those with a confirmed psychiatric disease or cognitive disability. In addition to these criteria, participation in the research was open to everyone. Demographic information was asked regarding gender, age, education level, handedness, and political orientation. All those who met the previous criteria were directed to the belief update task. After three practice trials, participants were presented with 38 adverse life events on a full white background. They were told that none of the events could have a probability higher than 77% or lower than 3%. Each item last on the screen for 2 seconds. For each trial, subjects were asked, “How likely this event could happen to you?”. Considering their life perspective, they could estimate the probability using a slider rated from 3% to 77%. Given the first estimate, the item’s blank last for 500 ms. Subsequently, the base rate of the same event in the Italian population (regardless of age, gender, location, and socio-

economic status) appeared for 2.5 seconds. Afterward, participants were asked to give a second estimate regarding the same event. They were free to keep the previous estimate or to change it if they believed it was necessary.

When the belief update task was completed, subjects should indicate how often they encountered the events(familiarity), how much they found them significant (valence), and how arousing they were (arousal). They could choose their answers within six-block answers per item resembling a Likert scale.

To prevent any depressed symptoms from affecting the process of updating beliefs, we required participants to complete the Depression, Anxiety, Stress Scale (Bottesi et al., 2015). After DASS-21, each participant completed the Comprehensive Intellectual Humility Scale. The items were rated on a scale from 1(=*strongly disagree*) to 5(=*strongly agree*).

To assess if they did the task conscientiously, the last questionnaire participants had to fulfill was the seriousness check. On a scale from 1 (=Not at all) to 9 (=Completely), participants were asked to indicate how consciously they followed the initial instructions regarding completing the task in a quiet environment. Finally, they decided to confirm whether they approached the task seriously or gave random responses.

They were invited to share any comments or suggestions on the final slide of the survey.

3.3 Results

3.3.1 Participants

Data from 100 participants was collected.

Six participants showed an update opposite to the expected one after seeing the base rate, suggesting they might need to understand the task more adequately. Therefore, they were excluded from the sample.

3.3.2 Measures

All analyses were conducted using JASP (Love et al., 2019).

The critical measure was the size of participants' updates after facing the population average for each event. For each subject and trial, we computed the difference between the first and second estimates in each of the 38 trials ("belief update").

Each participant's estimate was classified as positive or negative. If the first estimate were lower than the base rate presented, the information would be categorized as "bad news." If the first estimate were higher than the base rate, it would be classified as "good news" because the lousy events would occur less probably than the participant expected.

The size of the estimation error (the difference between the base rate presented and the participant's first estimation) was also calculated. Trials with an estimation error of zero were excluded before computing the mean estimate.

Along with mean updates and estimation errors, subjective ratings were also calculated. To search for possible confounds, we figured how frequent (*familiarity*), how significant (*valence*), and how arousing (*arousal*) were the events in participants' lives.

All data was tested for normal distribution. Parametric tests were used for normally distributed data, and non-parametric tests were used for non-normally distributed data.

Paired Samples T-Test

Paired sample t-tests (parametric) and Shapiro-Wilkinson tests (non-parametric) were performed to verify whether participants updated their estimates more in response to bad or good news.

We observed an asymmetry in updating, such that participants updated more in response to good news than bad news (*mean good news update*=5.802, *SD*=3.071; *mean bad news update*=4.036, *SD*=3.056). This validates the presence of optimistic bias in the context of belief updating.

The differences in estimation errors between excellent and bad news trials ($t(93) = 1.946$, $p = 0.055$) were calculated along with familiarity, valence, and arousal. There were significant effects on familiarity ($t(93) = 16.863$, $p < .001$) and valence ($Z = 2878$, $p = .0015$), suggesting that the items could have influenced participants' updates. This could have occurred because many events were frequent in everyday life (such as headaches or muscle cramps), and most individuals are likely to experience them.

Correlations

A Pearson correlation (parametric) and a Spearman correlation (non-parametric) were performed to verify the relationship between intellectual humility and belief updating.

Contrary to our hypothesis, no significant correlation was found between the greater tendency to revise one's beliefs and intellectual humility subscales (Independence of intellect, Openness to revising one's viewpoints, Respect for others' viewpoints, and Lack of intellectual overconfidence). Consistently with previous literature (Kube, 2023; Korn et al., 2014), the negative correlation between update bias and depression ($r = -0.26$, $p = .011$) was confirmed. Moreover, we observed a negative correlation between depressive symptoms and the Independence of Intellect and Ego subscale ($r = -0.285$, $p = .005$), which might be explained by sensitivity to criticism (Atlas et al., 1994).

A negative correlation was found between update bias and lack of intellectual overconfidence, suggesting that intellectually humble people tend to have a less optimistic bias, such as individuals with depression ($r = -0.269$, $p = .009$). This agrees with previous literature (Merkle & Weber, 2011; Costello et al., 2023), which states that being overconfident about topics or abilities can lead to psychological bias. This suggests that people who overestimate their knowledge are more optimistic toward new information.

CHAPTER 4: DISCUSSION

Intellectual humility and belief updating have been found to impact daily living significantly. Intellectual humility, defined as a “non-threatening awareness of one’s intellectual fallibility” (Krumrei-Mancuso & Rouse, 2016), consists of a multidimensional nature that allows to make more accurate judgments about one’s knowledge and successfully manage interpersonal relations. Intellectually humble people are more capable of recognizing their limitations and exploring and respecting other viewpoints. Due to this ability, they excel as mediators during disagreements and avoid useless conflicts (Whitcomb et al., 2017).

On the other side, belief updating refers to the cognitive ability to revise one’s estimation about the frequency of life events, given an average estimation. This task reflects the ability to change one’s judgments in the face of new information. Even though the process could seem trivial, data has shown that adjourning beliefs is more challenging than often believed. Human beings seek cognitive consistency; therefore, they are unlikely to update news that does not fit their previous convictions. Embracing unfavorable or unexpected can potentially result in cognitive dissonance, as Festinger (1962) reported. Individuals strive to alleviate this dissonance to uphold a consistent perception of their reality, resulting in biases (such as the optimism bias, which drives people to accept more favorable news than negative ones).

Considering these two variables, it is evident that numerous commonalities exist. Both require assessing one’s knowledge through metacognition and yield comparable results. Engaging in belief revision leads to improved relationship outcomes, heightened self-awareness, and a more profound capacity to navigate fake news and misinformation, ultimately resulting in more informed decision-making.

On this theoretical basis, we explored a possible correlation between intellectual humility and belief-updating task. Given the similarity between those two variables, we hypothesized that people

well-disposed to adjourn their estimations regarding adverse life events would also obtain high scores on the Comprehensive Intellectual Humility Scale (Krumrei-Mancuso & Rouse, 2016).

Contrary to our hypotheses, no correlation was found between those two variables. We can hardly argue whether to attribute this result to an effective lack of relationship between the two constructs or to some limitations in our research. Generally, this sample seems to update their first estimations to a lower extent if compared with other findings (Korn et al., 2012; 2014). To explain this result, we should consider any potential irregularities within the sample. We disposed of 94 participants, mostly university students. The number of participants could have influenced our outcomes, as well as some other reasons. Half of the participants also showed high levels of depressive symptoms on the Depression, anxiety, and Stress Scale (DASS-21); moreover, the female percentage was 74%. Previous findings demonstrate that individuals with depression sometimes exhibit an impaired belief updating, especially when it comes to re-evaluating positive information (Kube, 2023). Also, depression symptoms are higher in women (Albert, 2015; Kuechner, 2017). Another factor worth considering is age. In our sample, the average age was 24 years; it is known from the literature that optimistic bias is higher in the elderly and young adults, while it tends to slow down in midlife (Kube & Rosenkrantz, 2020). A high rate of young adults may have increased the frequency of optimistic bias. Thus, a plausible reason for a diminished adjusted belief or a higher update bias could be the occurrence of a specific sample with peculiar characteristics.

The items may introduce another confounding factor. Certain events, such as backache and train delay, occur frequently, suggesting that many participants likely encountered these experiences. This could have caused participants to stick to their first estimations without updating adequately. Significant effects on subjective ratings (familiarity and valence) might confirm this hypothesis.

Regarding the intellectual humility assessment, the Comprehensive Intellectual Humility Scale was selected due to its alignment with the four dimensions of IH. However, self-report questionnaires possess some well-known limitations. They can enhance social desirability, bringing participants to judge themselves as more intellectually humble than they are. In addition, Porter and

colleagues (2022) have reported some weaknesses in non-specific scales, suggesting that assessments focusing on specific conditions may yield more trustworthy results in evaluating intellectual humility. For example, instead of asking a generic question (e.g., “My ideas are usually better than other people’s ideas”), it could be more advantageous to provide a specific scenario (e.g., “I considered valuable other people’s ideas during a disagreement on a specific topic”).

Although our research has encountered several limits and has not yielded the desired outcomes, it does provide intriguing suggestions for future insights. Firstly, the relationship between the *Independence of intellect* subscale and depression subscale in DASS-21 suggests a new bond to investigate. It would be imprudent to conclude that people with depressive symptoms exhibit a deficiency in intellectual humility. This hypothesis is particularly fragile considering the role of depression in altering the optimism bias in belief updating. Therefore, an explanation could be found in sensitivity to criticism (Atlas, 1994). Evidence supports the mediating role of sensitivity to criticism between trait depression and interpersonal problems (Natoli et al., 2016). The *Independence of intellect* subscale includes items referring to feelings of threat and personal attack (e.g., “I feel small when others disagree with me on topics that are close to my heart”); people with depressive symptoms hold a negative self-perception (Beck, 1964), which may lead them to believe that their thoughts have less significance or correctness compared to those of others. However, exploring this correlation more in future research would be thoughtful.

Another exciting aspect is the negative correlation between update bias and *Lack of intellectual overconfidence* subscale. An inference from this association would indicate that those who exhibit greater intellectual humility and rely not solely on their convictions are less susceptible to optimism bias when adjusting their perspectives. Ballantyne describes one dimension of intellectual humility as “realistic self-assessment,” which would suggest a lack of unrealistic optimism (Worthington & Garrett, 2023). On the other hand, an absence of intellectual overconfidence is associated with “calibrated incorrect-answer confidence” (Costello et al., 2023, p. 14). Calibration was predominantly studied among highly competent individuals, allowing them to

evaluate their capabilities without succumbing to arrogance. This “wise confidence dynamic” (Costello et al., 2023, p. 9) agrees with mechanisms such as cognitive reflection (Krumrei-Mancuso et al., 2020), critical thinking ability (Bowes & Tasimi, 2023), and cognitive ability (Bowes et al., 2022). Intellectual humility might, therefore, correlate with an absence of bias in belief updating, guiding people toward more realistic estimates of life events. If investigated more in future research, this data could influence humans’ abilities to forecast the future and cultivate a greater sense of intellectual humility in guiding preventive behaviors.

Having examined our outcomes and limitations, some suggestions to improve further research imply varying instruments and methods to assess intellectual humility. Since self-report measures have some inherent flaws, to provide better outcomes the use of both questionnaires and behavioral task should be taken into consideration. Furthermore, in order to facilitate the generalization of results, it is important to address potential confounding factors associated with the size and specificity of the sample. This necessitates increasing the number of participants to the greatest extent possible.

In conclusion, improving research in this field could benefit our society. First, as specified above, improving intellectual humility and belief updating could lead to more flexibility and a lack of hasty or inaccurate decisions. It can also play an essential role in shaping new kinds of expectations related to health and well-being (Broadbent et al., 2009; Levy et al., 2009), encouraging patients to work on their beliefs about medical care and illnesses. If there is indeed a negative correlation between intellectual humility and optimism bias, as our results indicate, enhancing this characteristic would be a beneficial outcome to mitigate the adverse consequences of optimism bias. These might be risky behaviors such as not practicing safe sex because people are likely to believe that sexual infections would not occur to them (Weinstein & Klein, 1995) or not taking preventive measures for natural disasters (Paton, 2003). Adjusting beliefs and increasing intellectual humility would also change people’s perspectives on social and political matters. Individuals more susceptible to optimism bias tend to reject adverse information about climate change and do not provide a realistic estimation of climate change affecting them (Beattie et al.,

2017). This results in reduced proactive actions to address climate issues. For these and many other reasons, deepening our knowledge about intellectual humility and belief updating would be helpful, as they serve as tools to transform viewpoints and shape our reality.

References

- Allport, G. W. (1950). The individual and his religion: A psychological interpretation.
- Albert, P. R. (2015). Why is depression more prevalent in women?. *Journal of Psychiatry and Neuroscience*, 40(4), 219-221.
- Ambuehl, S., & Li, S. (2018). Belief updating and the demand for information. *Games and Economic Behavior*, 109, 21-39.
- Anwyl-Irvine, A. L., Massonnié, J., Flitton, A., Kirkham, N., & Evershed, J. K. (2020). Gorilla in our midst: An online behavioral experiment builder. *Behavior research methods*, 52, 388-407.
- Asghari, A., Saed, F., & Dibajnia, P. (2008). Psychometric properties of the Depression Anxiety Stress Scales-21 (DASS-21) in a non-clinical Iranian sample. *Int J Psychol*, 2(2), 82-102.
- Atlas, G. D., Fassett, B., & Peterson, C. (1994). Sensitivity to criticism and depressive symptoms. *Journal of Social Behavior and Personality*, 9(2), 301.
- Aust, F., Diederhofen, B., Ullrich, S., & Musch, J. (2013). Seriousness checks are useful to improve data validity in online research. *Behavior research methods*, 45, 527-535. 10.3758/s13428-012-0265-2
- Bąk, W., Wójtowicz, B., & Kutnik, J. (2022). Intellectual humility: an old problem in a new psychological perspective. *Current Issues in Personality Psychology*, 10(2), 85-97.
- Beattie, G., Marselle, M., McGuire, L., & Litchfield, D. (2017). Staying over-optimistic about the future: Uncovering attentional biases to climate change messages. *Semiotica*, 2017(218), 21-64.

- Beck, A. T. (1964). Thinking and depression: II. Theory and therapy. *Archives of general psychiatry*, 10(6), 561-571.
- Bingel, U., Wanigasekera, V., Wiech, K., Ni Mhuirheartaigh, R., Lee, M. C., Ploner, M., & Tracey, I. (2011). The effect of treatment expectation on drug efficacy: imaging the analgesic benefit of the opioid remifentanil. *Science translational medicine*, 3(70), 70ra14-70ra14.
- Bottesi, G., Ghisi, M., Altoè, G., Conforti, E., Melli, G., & Sica, C. (2015). The Italian version of the Depression Anxiety Stress Scales-21: Factor structure and psychometric properties on community and clinical samples. *Comprehensive Psychiatry*, 60, 170-181.
- Bowes, S. M., Costello, T. H., Lee, C., McElroy-Heltzel, S., Davis, D. E., & Lilienfeld, S. O. (2022). Stepping outside the echo chamber: Is intellectual humility associated with less political myside bias?. *Personality and Social Psychology Bulletin*, 48(1), 150-164.
- Bowes, S. M., & Tasimi, A. (2023). Is intellectual humility ‘good’ for people?. *The Journal of Positive Psychology*, 18(2), 250-253.
- Broadbent, E., Ellis, C. J., Thomas, J., Gamble, G., & Petrie, K. J. (2009). Can an illness perception intervention reduce illness anxiety in spouses of myocardial infarction patients? A randomized controlled trial. *Journal of psychosomatic research*, 67(1), 11-15.
- Broadbent, E., Donkin, L., & Stroh, J. C. (2011). Illness and treatment perceptions are associated with adherence to medications, diet, and exercise in diabetic patients. *Diabetes care*, 34(2), 338-340.

- Burnette, J. L., O'boyle, E. H., VanEpps, E. M., Pollack, J. M., & Finkel, E. J. (2013). Mind-sets matter: a meta-analytic review of implicit theories and self-regulation. *Psychological bulletin*, *139*(3), 655.
- Cartwright-Hatton, S., & Wells, A. (1997). Beliefs about worry and intrusions: The Meta-Cognitions Questionnaire and its correlates. *Journal of anxiety disorders*, *11*(3), 279-296.
- Chiew, K. S., & Braver, T. S. (2014). Dissociable influences of reward motivation and positive emotion on cognitive control. *Cognitive, Affective, & Behavioral Neuroscience*, *14*, 509-529.
- Costa Jr, P. T., McCrae, R. R., & Dye, D. A. (1991). Facet scales for agreeableness and conscientiousness: A revision of the NEO Personality Inventory. *Personality and individual Differences*, *12*(9), 887-898.
- Costello, T. H., Newton, C., Lin, H., & Pennycook, G. (2023). A Metacognitive Blindspot in Intellectual Humility Measures.
- Crawford, J. R., Garthwaite, P. H., Lawrie, C. J., Henry, J. D., MacDonald, M. A., Sutherland, J., & Sinha, P. (2009). A convenient method of obtaining percentile norms and accompanying interval estimates for self-report mood scales (DASS, DASS-21, HADS, PANAS, and sAD). *British Journal of Clinical Psychology*, *48*(2), 163-180.
- Crum, A. J., Salovey, P., & Achor, S. (2013). Rethinking stress: the role of mindsets in determining the stress response. *Journal of personality and social psychology*, *104*(4), 716.

- Davis, D. E., Hook, J. N., Worthington Jr, E. L., Van Tongeren, D. R., Gartner, A. L., & Jennings, D. J. (2010). Relational spirituality and forgiveness: Development of the Spiritual Humility Scale (SHS). *Journal of Psychology and Theology*, 38(2), 91-100.
- Davis, D. E., Hook, J. N., Worthington Jr, E. L., Van Tongeren, D. R., Gartner, A. L., Jennings, D. J., & Emmons, R. A. (2011). Relational humility: Conceptualizing and measuring humility as a personality judgment. *Journal of Personality Assessment*, 93(3), 225-234.
- Davis, D. E., Rice, K., McElroy, S., DeBlaere, C., Choe, E., Van Tongeren, D. R., & Hook, J. N. (2016). Distinguishing intellectual humility and general humility. *The Journal of Positive Psychology*, 11(3), 215-224.
- Dawson, E., Gilovich, T., & Regan, D. T. (2002). Motivated Reasoning and Performance on the was on Selection Task. *Personality and Social Psychology Bulletin*, 28(10), 1379-1387.
- De Keersmaecker, J., Roets, A., Dhont, K., Van Assche, J., Onraet, E., & Van Hiel, A. (2017). Need for closure and perceived threat as bases of right-wing authoritarianism: A longitudinal moderation approach. *Social cognition*, 35(4), 433-449.
- Dennis, J. P., & Vander Wal, J. S. (2010). The cognitive flexibility inventory: Instrument development and estimates of reliability and validity. *Cognitive therapy and research*, 34, 241-253.
- Dweck, C. S., & Leggett, E. L. (1988). A social-cognitive approach to motivation and personality. *Psychological review*, 95(2), 256.

Evans, J. S. B., & Stanovich, K. E. (2013). Dual-process theories of higher cognition: Advancing the debate. *Perspectives on psychological science*, 8(3), 223-241.

Everaert, J., Bronstein, M. V., Cannon, T. D., & Joormann, J. (2018). Looking through tinted glasses: Depression and social anxiety are related to both interpretation biases and inflexible negative interpretations. *Clinical Psychological Science*, 6(4), 517-528.

Exline, J. J., & Hill, P. C. (2012). Humility: A consistent and robust predictor of generosity. *The Journal of Positive Psychology*, 7(3), 208-218.

Festinger, L. (1962). Cognitive dissonance. *Scientific American*, 207(4), 93-106.

Floresco, S. B., Block, A. E., & Maric, T. L. (2008). Inactivation of the medial prefrontal cortex of the rat impairs strategy set-shifting, but not reversal learning, using a novel, automated procedure. *Behavioural brain research*, 190(1), 85-96.

Gregg, A. P., & Mahadevan, N. (2014). Intellectual arrogance and intellectual humility: An evolutionary-epistemological account. *Journal of Psychology and Theology*, 42(1), 7-18.

Gregg, A. P., Mahadevan, N., & Sedikides, C. (2017). Intellectual arrogance and intellectual humility: Correlational evidence for an evolutionary-embodied-epistemological account. *The Journal of Positive Psychology*, 12(1), 59-73.

Grossmann, I. (2017). Wisdom in context. *Perspectives on psychological science*, 12(2), 233-257.

- Heyman, G. D., & Dweck, C. S. (1998). Children's thinking about traits: Implications for judgments of the self and others. *Child development*, 69(2), 391-403.
- Hodson, G., Book, A., Visser, B. A., Volk, A. A., Ashton, M. C., & Lee, K. (2018). Is the dark triad common factor distinct from low honesty-humility? *Journal of Research in Personality*, 73, 123-129.
- Holt, C. A., & Smith, A. M. (2009). An update on Bayesian updating. *Journal of Economic Behavior & Organization*, 69(2), 125-134.
- Hook, J. N., Davis, D. E., Van Tongeren, D. R., Hill, P. C., Worthington Jr, E. L., Farrell, J. E., & Dieke, P. (2015). Intellectual humility and forgiveness of religious leaders. *The Journal of Positive Psychology*, 10(6), 499-506.
- Hopkin, C. R., Hoyle, R. H., & Toner, K. (2014). Intellectual humility and reactions to opinions about religious beliefs. *Journal of Psychology and Theology*, 42(1), 50-61.
- Huynh, H. P., Sramek, K. N., Sifuentes, K. A., Lilley, M. K., & Bautista, E. M. (2022). Keep Calm and Be Humble: Can Intellectual Humility Predict Test Anxiety? *Psychological Reports*,
- Kaneko, D., Toet, A., Ushiyama, S., Brouwer, A. M., Kallen, V., & van Erp, J. B. (2019). EmojiGrid: a 2D pictorial scale for cross-cultural emotion assessment of negatively and positively valenced food. *Food Research International*, 115, 541-551.
- Kappes, A., & Sharot, T. (2019). The automatic nature of motivated belief updating. *Behavioural Public Policy*, 3(1), 87-103.

- Kaptchuk, T. J., Friedlander, E., Kelley, J. M., Sanchez, M. N., Kokkotou, E., Singer, J. P., ... & Lembo, A. J. (2010). Placebos without deception: a randomized controlled trial in irritable bowel syndrome. *PloS one*, *5*(12), e15591.
- Kirsch, I. (2004). Conditioning, expectancy and the placebo effect: A comment on Stewart-Williams and Podd (2004). *Psychological Bulletin*, *130*, 341-343.
- Klauer, K. C., Musch, J., & Naumer, B. (2000). On belief bias in syllogistic reasoning. *Psychological review*, *107*(4), 852.
- Koban, L., Schneider, R., Ashar, Y. K., Andrews-Hanna, J. R., Landy, L., Moscovitch, D. A., ... & Arch, J. J. (2017). Social anxiety is characterized by biased learning about performance and the self. *Emotion*, *17*(8), 1144.
- Koetke, J., Schumann, K., & Porter, T. (2022). Intellectual humility predicts scrutiny of COVID-19 misinformation. *Social Psychological and Personality Science*, *13*(1), 277-284.
- Koetke, J., Schumann, K., Porter, T., & Smilo-Morgan, I. (2023). Fallibility salience increases intellectual humility: Implications for people's willingness to investigate political misinformation. *Personality and Social Psychology Bulletin*, *49*(5), 806-820.
- Korn, C. W., Prehn, K., Park, S. Q., Walter, H., & Heekeren, H. R. (2012). Positively biased processing of self-relevant social feedback. *Journal of Neuroscience*, *32*(47), 16832-16844.

- Korn, C. W., Sharot, T., Walter, H., Heekeren, H. R., & Dolan, R. J. (2014). Depression is related to an absence of optimistically biased belief updating about future life events. *Psychological medicine*, *44*(3), 579-592.
- Krause, N. (2014). Exploring the relationships among humility, negative interaction in the church, and depressed affect. *Aging & mental health*, *18*(8), 970-979.
- Krizan, Z., & Windschitl, P. D. (2007). The influence of outcome desirability on optimism. *Psychological bulletin*, *133*(1), 95.
- Kross, E., & Grossmann, I. (2012). Boosting wisdom: distance from the self-enhances wise reasoning, attitudes, and behavior. *Journal of Experimental Psychology: General*, *141*(1), 43.
- Krumrei-Mancuso, E. J., & Rouse, S. V. (2016). The development and validation of the comprehensive intellectual humility scale. *Journal of Personality Assessment*, *98*(2), 209-221.
- Krumrei-Mancuso, E. J., & Newman, B. (2020). Intellectual humility in the sociopolitical domain. *Self and Identity*, *19*(8), 989-1016.
- Kube, T., Glombiewski, J. A., Gall, J., Touissant, L., Gärtner, T., & Rief, W. (2019). How to modify persisting negative expectations in major depression? An experimental study comparing three strategies to inhibit cognitive immunization against novel positive experiences. *Journal of Affective Disorders*, *250*, 231-240.
- Kube, T., & Rozenkrantz, L. (2021). When beliefs face reality: An integrative review of belief updating in mental health and illness. *Perspectives on Psychological Science*, *16*(2), 247-274.

- Kuehner, C. (2017). Why is depression more common among women than among men?. *The Lancet Psychiatry*, 4(2), 146-158.
- Kuzmanovic, B., Jefferson, A., & Vogeley, K. (2016). The role of the neural reward circuitry in self-referential optimistic belief updates. *NeuroImage*, 133, 151-162.
- Leary, M. R. (2007). Motivational and emotional aspects of the self. *Annu. Rev. Psychol.*, 58, 317-344.
- Leary, M. R., Diebels, K. J., Davisson, E. K., Jongman-Sereno, K. P., Isherwood, J. C., Raimi, K. T., ... & Hoyle, R. H. (2017). Cognitive and interpersonal features of intellectual humility. *Personality and Social Psychology Bulletin*, 43(6), 793-813.
- Leary, M. R. (2018). The psychology of intellectual humility. *John Templeton Foundation*, 3.
- Lench, H. C., Smallman, R., Darbor, K. E., & Bench, S. W. (2014). Motivated perception of probabilistic information. *Cognition*, 133(2), 429-442.
- Lick, D. J., Alter, A. L., & Freeman, J. B. (2018). Superior pattern detectors efficiently learn, activate, apply, and update social stereotypes. *Journal of Experimental Psychology: General*, 147(2), 209.
- Love, J., Selker, R., Marsman, M., Jamil, T., Dropmann, D., Verhagen, J., ... & Wagenmakers, E. J. (2019). JASP: Graphical statistical software for common statistical designs. *Journal of Statistical Software*, 88, 1-17.

- Lovibond, P. F., & Lovibond, S. H. (1996). Depression Anxiety and Stress Scales. *Behaviour Research and Therapy*.
- Ma, Y., Li, S., Wang, C., Liu, Y., Li, W., Yan, X., ... & Han, S. (2016). Distinct oxytocin effects on belief updating in response to desirable and undesirable feedback. *Proceedings of the National Academy of Sciences*, *113*(33), 9256-9261.
- Maramis, M. M., Mahajudin, M. S., & Khotib, J. (2021). Impaired cognitive flexibility and working memory precedes depression: A rat model to study depression. *Neuropsychobiology*, *80*(3), 225-
- Maslow, A. H. (1970). *Motivation and personality*. Harper & Row (Original work published 1954).
- McElroy, S. E., Rice, K. G., Davis, D. E., Hook, J. N., Hill, P. C., Worthington Jr, E. L., & Van Tongeren, D. R. (2014). Intellectual humility: Scale development and theoretical elaborations in the context of religious leadership. *Journal of Psychology and Theology*, *42*(1), 19-30.
- Merkle, C., & Weber, M. (2011). True overconfidence: The inability of rational information processing to account for apparent overconfidence. *Organizational Behavior and Human Decision Processes*, *116*(2), 262-271.
- Moritz, S., & Pohl, R. F. (2009). Biased processing of threat-related information rather than knowledge deficits contributes to the overestimation of threat in obsessive-compulsive disorder. *Behavior modification*, *33*(6), 763-777.

- Moser, J. S., Schroder, H. S., Heeter, C., Moran, T. P., & Lee, Y. H. (2011). Mind your errors: Evidence for a neural mechanism linking growth mind-set to adaptive posterror adjustments. *Psychological science*, 22(12), 1484-1489.
- Moskowitz, S., & Dewaele, J. M. (2020). The role of intellectual humility in foreign language enjoyment and foreign language classroom anxiety. *Eurasian Journal of Applied Linguistics*, 6(3), 521-541.
- Moutsiana, C., Garrett, N., Clarke, R. C., Lotto, R. B., Blakemore, S. J., & Sharot, T. (2013). Human development of the ability to learn from bad news. *Proceedings of the National Academy of Sciences*, 110(41), 16396-16401.
- Nassar, M. R., Wilson, R. C., Heasly, B., & Gold, J. I. (2010). An approximately Bayesian delta-rule model explains the dynamics of belief updating in a changing environment. *Journal of Neuroscience*, 30(37), 12366-12378.
- Oei, T. P., Sawang, S., Goh, Y. W., & Mukhtar, F. (2013). Using the depression anxiety stress scale 21 (DASS-21) across cultures. *International Journal of Psychology*, 48(6), 1018-1029.
- Oganian, Y., Heekeren, H. R., & Korn, C. W. (2019). Low foreign language proficiency reduces optimism about the personal future. *Quarterly Journal of Experimental Psychology*, 72(1), 60-75.
- Osman, A., Wong, J. L., Bagge, C. L., Freedenthal, S., Gutierrez, P. M., & Lozano, G. (2012). The depression anxiety stress Scales—21 (DASS-21): further examination of dimensions, scale reliability, and correlates. *Journal of Clinical Psychology*, 68(12), 1322-1338.

- Ossola, P., Garrett, N., Sharot, T., & Marchesi, C. (2020). Belief updating in bipolar disorder predicts time of recurrence. *Elife*, *9*, e58891.
- Owens, B. P., Johnson, M. D., & Mitchell, T. R. (2013). Expressed humility in organizations: Implications for performance, teams, and leadership. *Organization Science*, *24*(5), 1517-1538.
- Paton, D. (2003). Disaster preparedness: a social-cognitive perspective. *Disaster Prevention and Management: An International Journal*, *12*(3), 210-216.
- Peetz, J., & Grossmann, I. (2021). Wise reasoning about the future is associated with adaptive interpersonal feelings after relational challenges. *Social Psychological and Personality Science*, *12*(5), 629-637.
- Petrie, K. J., Cameron, L. D., Ellis, C. J., Buick, D., & Weinman, J. (2002). Changing illness perceptions after myocardial infarction: an early intervention randomized controlled trial. *Psychosomatic medicine*, *64*(4), 580-586.
- Petrie, K. J., & Rief, W. (2019). Psychobiological mechanisms of placebo and nocebo effects: pathways to improve treatments and reduce side effects. *Annual review of psychology*, *70*, 599-625.
- Plante, T. G., & Boccaccini, M. T. (1997). The Santa Clara strength of religious faith questionnaire. *Pastoral Psychology*, *45*(5), 375-387.

- Plato (2005). *Apology*. In H. N. Fowler (Trans.), *Euthyphro. Apology. Crito. Phaedo. Phaedrus*. Harvard University Press (Original work published ca. 399 B.C.E.).
- Porter, T., & Schumann, K. (2018). Intellectual humility and openness to the opposing view. *Self and Identity, 17*(2), 139-162.
- Porter, T., Schumann, K., Selmeczy, D., & Trzesniewski, K. (2020). Intellectual humility predicts mastery behaviors when learning. *Learning and Individual Differences, 80*, 101888.
- Porter, T., Elnakouri, A., Meyers, E. A., Shibayama, T., Jayawickreme, E., & Grossmann, I. (2022). Predictors and consequences of intellectual humility. *Nature Reviews Psychology, 1*(9), 524-536.
- Puri, M., & Robinson, D. T. (2007). Optimism and economic choice. *Journal of financial economics, 86*(1), 71-99.
- Raylu, N., & Oei, T. P. S. (2004). The Gambling Related Cognitions Scale (GRCS): Development, confirmatory factor validation and psychometric properties. *Addiction, 99*, 757–
- Reips, U. D. (2000). The Web experiment method: Advantages, disadvantages, and solutions. In *Psychological experiments on the Internet* (pp. 89-117). Academic Press.
- Reips, U. D. (2009, February). Internet experiments: Methods, guidelines, metadata. In *Human vision and electronic imaging XIV* (Vol. 7240, pp. 53-61). SPIE.
- Rief, W., & Joormann, J. (2019). Revisiting the cognitive model of depression: The role of expectations. *Clinical Psychology in Europe, 1*(1), 1-19.

- Ronk, F. R., Korman, J. R., Hooke, G. R., & Page, A. C. (2013). Assessing clinical significance of treatment outcomes using the DASS-21. *Psychological assessment, 25*(4), 1103.
- Salzmann, S., Euteneuer, F., Strahler, J., Laferton, J. A., Nater, U. M., & Rief, W. (2018). Optimizing expectations and distraction leads to lower cortisol levels after acute stress. *Psychoneuroendocrinology, 88*, 144-152.
- Samuelson, P. L., & Church, I. M. (2015). When cognition turns vicious: Heuristics and biases in light of virtue epistemology. *Philosophical Psychology, 28*(8), 1095-1113.
- Schenk, L. A., Sprenger, C., Geuter, S., & Büchel, C. (2014). Expectation requires treatment to boost pain relief: an fMRI study. *PAIN®, 155*(1), 150-157.
- Sharot, T., Korn, C. W., & Dolan, R. J. (2011). How unrealistic optimism is maintained in the face of reality. *Nature neuroscience, 14*(11), 1475-1479.
- Simmons, C., Helming, K., Musholt, K., & Sinnott-Armstrong, W. (2023). Where is the golden mean of intellectual humility? Comments on Ballantyne. *The Journal of Positive Psychology, 18*(2), 240-243.
- Soltani, E., Shareh, H., Bahrainian, S. A., & Farmani, A. (2013). The mediating role of cognitive flexibility in correlation of coping styles and resilience with depression. *Pajoohandeh Journal, 18*(2), 88-96.
- Stange, J. P., Connolly, S. L., Burke, T. A., Hamilton, J. L., Hamlat, E. J., Abramson, L. Y., et al. (2016). Inflexible cognition predicts the first onset of major depressive episodes in

adolescence. *Depression and Anxiety*, 33(11), 1005–1012.

Strunk, D. R., Lopez, H., & DeRubeis, R. J. (2006). Depressive symptoms are associated with unrealistic negative predictions of future life events. *Behavior research and therapy*, 44(6), 861-882.

Stuss, D. T., & Alexander, M. P. (2000). Executive functions and the frontal lobes: a conceptual view. *Psychological research*, 63(3-4), 289-298.

Stuss, D. T. (2011). Functions of the frontal lobes: relation to executive functions. *Journal of the International Neuropsychological Society*, 17(5), 759-765.

Sur, S., & Sinha, V. K. (2009). Event-related potential: An overview. *Industrial Psychiatry Journal*, 18(1), 70.

Swann, W. B., & Hill, C. A. (1982). When our identities are mistaken: Reaffirming self-conceptions through social interaction. *Journal of personality and social psychology*, 43(1), 59.

Swann, W. B., & Read, S. J. (1981). Acquiring self-knowledge: The search for feedback that fits. *Journal of Personality and Social Psychology*, 41(6), 1119.

Toet, A., & van Erp, J. B. (2020). The EmojiGrid as a rating tool for the affective appraisal of touch. *Plos one*, 15(9), e0237873.

Truong, L., Kandasamy, K., & Yang, L. (2021). Cognitive Control in Young and Older Adults: Does Mood Matter?. *Brain Sciences*, 12(1), 50.

- Tweed, R. G., & Conway III, L. G. (2006). Coping strategies and culturally influenced beliefs about the world. In *Handbook of multicultural perspectives on stress and coping* (pp. 133-153). Boston, MA: Springer US.
- Van Tongeren, D. R., Davis, D. E., Hook, J. N., & Witvliet, C. V. (2019). Humility. *Current Directions in Psychological Science*, 28(5), 463-468.
- Vaupotič, N., Kienhues, D., & Jucks, R. (2022). Taking a stance on the role of nuclear energy to combat the climate crisis: how communication task and expert's personal stance impact individuals' intellectual humility and strategies for dealing with a complex topic. *Educational and Developmental Psychologist*, 39(1), 70-84.
- Yeager, D. S., Romero, C., Paunesku, D., Hulleman, C. S., Schneider, B., Hinojosa, C., ... & Dweck, C. S. (2016). Using design thinking to improve psychological interventions: The case of the growth mindset during the transition to high school. *Journal of educational psychology*, 108(3), 374.
- Waltz, J. A. (2017). The neural underpinnings of cognitive flexibility and their disruption in psychotic illness. *Neuroscience*, 345, 203-217.
- Weinman J, Petrie K, Sharpe N, Walker S. Causal attributions in patients and spouses following first-time myocardial infarction and subsequent lifestyle changes. *Br J Health Psychol* 2000; 5:263–73

Weinstein, N. D., & Klein, W. M. (1995). Resistance of personal risk perceptions to debiasing interventions. *Health psychology, 14*(2), 132.

Whitcomb, D., Battaly, H., Baehr, J., & Howard-Snyder, D. (2017). Intellectual humility. *Philosophy and Phenomenological Research, 94*(3), 509-539.

Zmigrod, L., Zmigrod, S., Rentfrow, P. J., & Robbins, T. W. (2019). The psychological roots of intellectual humility: The role of intelligence and cognitive flexibility. *Personality and Individual Differences, 141*, 200-208.