Doubt: Insights from a cross-cultural experiment*

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Abstract

Through a cross-cultural experiment involving participants from Australia, India and the USA, we demonstrate that a decrease in the volume of relevant knowledge can indeed significantly increase the strength of one's opinion (as measured on the Likert scale). Our research shows that people who are less-informed can have stronger opinions than those who are more informed. We finally provide useful insights on why religious opinion is stronger than scientific opinion even on scientific matters (e.g. on the origin of the universe). Our results are robust across different cultures.

Keywords: Asymmetric-information, Belief, Overconfidence

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1. Introduction

In this study of how the strength of opinion depends on the amount of information presented, we experimentally demonstrate that people who are less informed on a matter are more likely to hold stronger opinions on the same. We engage in a thought experiment – if we could take away relevant knowledge on some matter from an agent, would it make his/her opinion on that matter stronger? We implement this thought experiment formally in three different countries and see that people without relevant knowledge on a matter can indeed have stronger opinion on the same. Through this thought experiment we provide useful insights about why religious opinion is often stronger than scientific opinion on matters related to (say) the beginning of the universe, or issues like abortion (among others). This is a first attempt at experimentally understanding the role of (the *relevance* of) information in the determination of the nature and strength of opinion.

Academic research shows that the strength of individual opinion depends on several factors such as *proximity to individuals who hold common or varied ideas* (Visser and Mirabile, 2004); *how often the opinion held is repeated* (Holland et al, 2003); *credibility, confidence, and the attractiveness of the source of information* (Hovland and Weiss, 1951; Moussaïd et al, 2015; Sherif, 1937; Thaler and Sunstein, 2008); and *association with core moral beliefs* (Skitka et al, 2015; Aramovich et al, 2012; Luttrell et al, 2016) among others.[1] While these studies have looked at the forces that shape strong opinion, there are others that have looked into the consequences of strong opinion. For example, it has been shown that strong judgments and attitudes can influence (and therefore predict) individual behavior (Sample and Warland, 1973). Agents proactively look for information to strengthen their own beliefs creating social echo

[1]A basis for what Thaler and Sunstein (2008) call 'collective conservatism' is that "consistent and unwavering people, in the private or public sector, can move groups and practices in their preferred direction."

chambers. To study the availability of information on opinion strength, we adopt a strictly randomized experimental protocol that avoids the problem of self-selection into echo chambers. We finally emphasize that this paper contributes to a line of research that is different from those on the Dunning-Kruger (1999) syndrome, which has more to do with overconfidence in relation to an agent's own-ability, rather than an inflated belief in the truthfulness of the 'knowledge' an agent possesses.

This research question is relevant in the light of the current global outburst of information pollution. Thus, while being important in its own right, this research also immediately connects with other disciplines, such as law, public policy, psychology, cognitive sciences, and media communications (among others). The ability to reserve judgment before a fair trial is critical to effective judicial functioning; a careful display of media content can shape public opinion; strong beliefs have psychological impact on the actions that follow (for example, equating out-groups to less-than-human entities have led to mass genocides Sapolsky, 2017); and public opinion has the capacity to critically shape policy (Gabel et al, 2007).

2. The Experiment

2.1. The idea – 12 Angry Men (1957)

The idea that, a careful evaluation of more information can indeed create *doubt* about one's own prior beliefs, motivates our study. Every new thing learned is a reminder of things that were previously unknown. This reminder could act as an anchor against the formation of very strong beliefs – the openness to the possibility of being less aware creates a constant need to remain

more informed, thereby mitigating any chances of immediately forming strong opinion. Our experimental design is based on the American film '12 Angry Men'.

The film '12 Angry Men' (directed by Sidney Lumet, and adapted from a teleplay by Reginald Rose) is set in a court room where 12 jury members must unanimously decide whether or not to convict an 18-year-old boy on the charge of killing his father. In case of any reasonable doubt about the crime, the jurors are instructed by the court to recommend 'not guilty'. In the beginning, only one jury member is against sending the boy to the gallows. The rest of the film explores how this one individual then persuades the 11 other jurors that there is reasonable doubt about the boy's crime. A careful evaluation (by all the formerly reluctant jurors) of the details of the case leads eventually to the point where everyone unanimously votes 'not guilty'.

2.2. Experiment design

A total of 305 undergraduate and masters' students from the USA, Australia and India participated in this experiment. In each session, students were randomly put into one of three treatment groups. In each treatment, the students were given a printed sheet of paper (shown in the Appendix) with some details from the above murder case. Based on this, they were supposed to answer two questions that followed. The first question captured each participant's belief about the likelihood that the boy had actually committed the murder, and the second question captured how strongly they felt that he should be convicted.[2] The information given on the sheet was the only source of distinction between the three treatments.

[2]The questions were Q1: "How likely according to you is it, that the boy has committed the murder?"; and Q2:"Should the boy be convicted?".

We now come to a discussion of the information we provide from the movie. We first ensure that the witness accounts preserve the element of reasonable doubt. More specifically, the (patchy) *quality* of witness accounts of the said murder is already sufficient for reasonable doubt. For example, it is clear that the location of the second witness and the venue of the murder were separated by a train track between them. The witness claims that she identified the boy through the windows of a train that happened to pass right at the time of the murder. This in turn raises doubts on whether the first witness could hear the boy clearly (as he claims he did – from a distance of several feet), since passing trains are fairly noisy (see appendix).

In addition to the above information on the verbal accounts of the two key witnesses, we also provide information about the eyewitnesses themselves. The information above already makes a case for reasonable doubt, in the presence of which, the strength of opinion must gravitate away from extremes toward neutrality (this reasonable doubt is reflected in the responses to Q2 as discussed later in this subsection). The purpose of giving more information here is to make our candidates feel that still more can be known about the case.[3] Thus, the order in which the information is presented is of critical importance to us.[4] For example, learning that the witness who claimed to run toward the crime venue quickly, is actually in his seventies and has difficulty walking, is an additional source of doubt. We call this the *Default-Information (Default-Info)* treatment.

We then ask if we could 'take away' some information from the above so that our participants are now 'less informed'. We remove the additional information on the witness details in the

[3]More specifically, we want our subjects to ask themselves "Could I be missing something else not given here (clearly, I did not know even this before)?"
[4]This is also true for the order in which the questions are asked.

above treatment and only retain the witness accounts. This treatment is called the *No-Information (No-Info)* treatment (see appendix).

We finally remove the additional information on the witness details in the *Default-Info* treatment and *replace* the same with information that is irrelevant to the case (for example, the color of the walls in the house of one of the witnesses). Thus, this treatment is the same as the above in terms of relevance of information, but not in terms of the volume of content (which is similar to the first treatment). This is the *Irrelevant-Information (Irrelevant-Info)* treatment.[5]

The participants were made to answer the two questions based on the information provided to them (which in turn, depended on the treatment group they were randomly put in). Randomization here avoids the self-selection problem that is observed in the study of echo chambers preventing the understanding of causality – we are interested to know how changes in information, *causes* changes in opinion strength and indeed in our study, any observed differences in opinion between the three treatment groups can only be attributed to differences in knowledge. In addition to the answers to the two questions asked, we also ask our participants to fill up a survey sheet in order to control for other factors that may influence the strength of opinion.[6]

Before we head to the empirical findings, it is important to clarify one point about reasonable doubt. While it is one thing to *hold* a strong opinion, it is quite another to *act* on it. No matter how likely it is according to one's own belief that the murder was indeed committed by the boy (Q1), the existence of reasonable doubt should prevent our participants to take an extreme

[5]The purpose here is to test if *any* (i.e. relevant or irrelevant) additional information has the effect of making the participants feel that still more can be known about the case (before a judgment could be made).
[6]For example, as per the legal practices prescribed by at least one religion, one male witness is worth two female witnesses because females are believed to dramatize and feel strongly about whatever they narrate. So we include gender among other controls.

viewpoint on the matter of *conviction*. We check if the average response to Q2 is statistically different from extreme opinion of conviction in each treatment. The 95% confidence intervals around the mean responses to Q2 in the *Default-Info* (2.5 to 2.8), *No-Info* (3.2 to 3.5), and the *Irrelevant-Info* (3.2 to 3.6) treatments, exclude numbers like 1, 2, 4 and 5, which represent extreme viewpoints on our Likert scale, displaying a tendency for moderation stemming from the reluctance to *convict* someone on the grounds of patchy witness (in other words, the reduction of relevant information did not take away 'reasonable doubt' to shift Q2 related opinion to the extreme).[7] Thus the introduction of our treatments did not lead to extreme opinion in Q2. That the responses to Q2 were more moderate than the responses to Q1 (as we show later) is also an indication of how careful our participants were about answering the questions.

3. Empirical findings

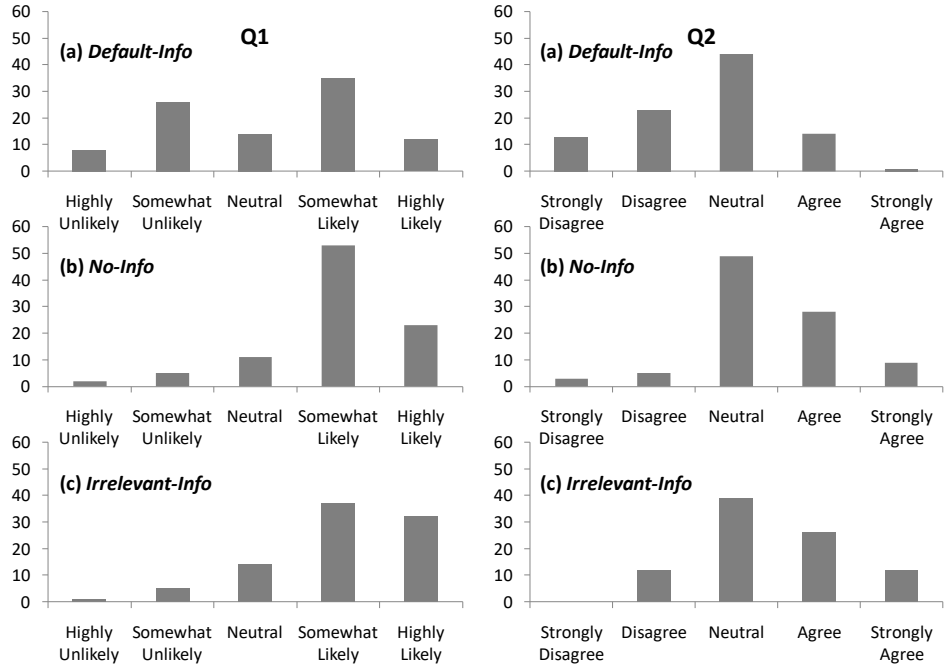
3.1. Descriptive statistics

When each participant came forward to hand over his/her response sheet, s/he was asked if s/he had watched the movie '*12 Angry Men'*. Out of the 305 participants, a total of 27 answered 'yes' to this question, so all our analysis is based on the responses from the remaining 278 participants (95 in *Default-Info,* 94 in *No-Info,* and 89 in the *Irrelevant-Info* treatment). Fig 1 shows the distribution of responses by treatment – the three panels on the left pertain to the first question and the three on the right pertain to the second question.

[7]Indeed, the movie 12 Angry Men "is fiction and doubtless exaggerated" in its display of 11the jury members who initially show blind belief in the testimonies, as Dawkins (2017) notes in the chapter 'Beyond Reasonable Doubt'.

As a first step, we test the null hypothesis that the proportion of people giving *any* particular response (from the five options) is the same across all the treatments, against the alternative that this is not the case. The test statistic for the above hypothesis in relation to the responses to the first question is $\chi^2(df: 6) = 45.76$ (with an associated p-value < 0.0000001), and that in relation to the responses to the second question is $\chi^2(df: 4) = 36.26$ (with an associated p-value < 0.0000003).[8] This hints that the overall response-distributions across the three treatments are individually different for each of the two questions. The chi-square test above only suggests that the *multinomial distributions* across the three treatments are different.

Fig 1. Distribution of responses by treatment



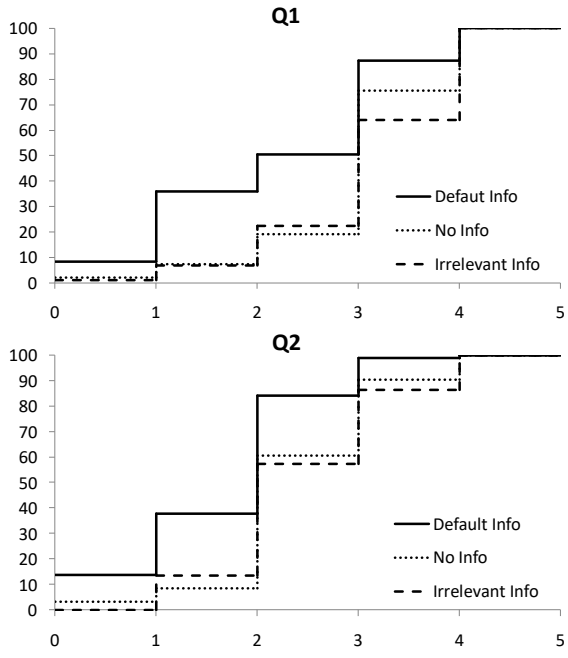
For robustness, we also look at the *direction* of change, without the assumption that the distributions are indeed *multinomial*. We do a crude Kolmogorov-Smirnov test (since our

[8]Note that these tests are equivalent to whether three (in this case) multinomial distributions are identical. This is why we are interested in a chi-square test. Also note that while one would expect (5 - 1) × (4 - 1) = 8 degrees of freedom for either of the tests. Over here, the tests have been done after suitably combining the 'highly unlikely' and 'somewhat unlikely' columns into a common 'unlikely' column for Q1 (on account of a few cells having very low (< 5) frequency), and similarly in relation to Q2, the response columns were called 'unlikely' 'neutral' and 'likely, thereby making a chi-squared test of (3 – 1) × (3 - 1) = 4 degrees of freedom, more relevant.

responses are *ordered* from one extreme to another) by comparing the differences between the cumulative distributions (Fig 2).

In Fig 2, the horizontal axis displays the numbers corresponding to our responses. We immediately see stochastic dominance suggesting the *direction* of change. While the cumulative distributions of the *No-Info* and the *Irrelevant-Info* treatments are intertwined, they both remain jointly to the right of the cumulative distribution of the *Default-Info* treatment (this is true for both the questions). The first inference is that the mean response for the latter is less than those for the other two treatment groups. The Kolmogorov-Smirnov (KS) tests suggest that the responses in the *Default-Info* treatment have a distribution that is statistically distinct from either of the *No-Info* (*p*-value = 0.00018 for Q1, and *p*-value = 0.00057 for Q2) and the *Irrelevant-Info* (*p*-value = 0.00086 for Q1, and *p*-value = 0.00258 for Q2) treatments. The response-distributions in the *No-Info* and the *Irrelevant-Info* treatments are statistically indistinct (*p*-value = 0.5825 for Q1, and *p*-value = 0.9999 for Q2).

Fig 2. Cumulative distribution of responses (%)



Having established (in more than one way) that the response-distributions are different between the treatments across both the questions, we now look into the main findings in relation to the strength of opinion in the following subsection.

3.2. Key results

We begin by analysing if the bulk of responses fall on any of the two (left or right) extremes. The measure of (sample) skewness (γ_1) therefore, intuitively seems the most relevant. However, for our purposes, we compute a modified skewness measure based on the third moment, not about the mean or the origin, but around 3 - our natural point of neutrality (being the midpoint of the values in the Likert scale) in this experimental set-up. We are really interested in seeing on which side of 3 are the bulk of responses observed for each of the treatment groups. We call this measure γ' and defer the standard skewness coefficients (γ_1) to the Appendix.[9] For Q1 in the *Default-Info* treatment, a low skewness value of $\gamma' = 0.2387$, represents moderation in the strength of opinion that empirically cluster around neutrality. The corresponding values for the *No-Info* and the *Irrelevant-Info* groups are $\gamma' = 1.0545$ and 1.1510 respectively, hinting that more observations lie to the right of 3. Clearly, the strength of the generally held opinion in these treatments is stronger in comparison to the *Default-Info* group which observed less extreme (or moderate) responses. Interestingly, it seems that the *Irrelevant-Info* group observes even stronger opinion than the *No-Info* group does. We see that the bootstrapped 95% confidence intervals (with one million replications) for these skewness coefficients for the *Default-Info*, *No-Info* and

[9]Note that since the computed treatment means for Q1 are significantly different from each other (as we will show later), our skewness-measure γ' is a more valid tool for comparison. In exploiting the natural point of neutrality in our experiment we do not lose degrees of freedom (since no parameter values are calculated from the sample). The bootstrapped confidence intervals around the skewness coefficients presented here are robust to the number of replications.

Irrelevant-Info ([0.1958, 0.2800], [1.0308, 1.0754], and *[1.1351, 1.1654]* respectively) do not overlap, suggesting that the *Irrelevant-Info* group observes significantly more extreme opinion than the *No-Info* group. This is an interesting upshot of our paper which we explore in detail in a later section. All this is *despite the fact that Q2 opinions remain moderate* (because convicting the boy for a death sentence is a more difficult task than guessing the likelihood of the crime, as discussed earlier).

The *Default-Info* group observes more moderate opinion compared to the *No-Info* and *Irrelevant-Info* groups. For Q1, the mean of the *No-Info* Group and *Irrelevant-Info* Group are statistically different from 3, which represents neutrality on the Likert Scale (*p*-values < 0.0001 for each), whereas, the mean in the *Default-Info* group is not statistically different from 3 (*p*-value = 0.1533). The mean value of the *No-Info* and the *Irrelevant-Info* groups are not statistically different from 4, which represents an opinion driven towards the likely extreme (*p*-values of 0.6398 and 0.5666 respectively), whereas the mean of the *Default-Info* group is statistically different from 4 (*p*-value < 0.0001). Clearly, the opinion of people who are armed with more relevant information, gravitates towards neutrality in comparison with those who have irrelevant or no information, (and therefore, harbour more extreme opinion).[10] We now look at the determinants of strong opinion (Table 1), using the following regression specification.

$$Response_i = \alpha_0 + \alpha_1 NoInfo_i + \alpha_2 IrrelevantInfo_i + \boldsymbol{X_i\beta} + \varepsilon_i \qquad (1)$$

[10]The pair-wise comparisons of the means for Q1 across different treatments also confirm this. The difference between the average responses in the *Default-Info* and the *No-Info* treatments is statistically significant ($t_{df:\ 187}$ = 5.05, with a *p*-value < 0.0001; correspondingly $t_{df:\ 187}$ = 5.53, with a *p*-value < 0.0001 for Q2), as is that between the *Default-Info* and the *Irrelevant-Info* treatments ($t_{df:\ 182}$ = 5.50, with a *p*-value < 0.0001; correspondingly $t_{df:\ 182}$ = 5.76, with a *p*-value < 0.0001 for Q2). The difference between the means of the *No-Info* and the *Irrelevant-Info* treatments is not significant ($t_{df:\ 181}$ = 0.74, with a *p*-value = 0.4591; correspondingly $t_{df:\ 181}$ = 0.42, with a *p*-value = 0.6725 for Q2). All the means are statistically different from 5 with *p*-values < 0.0001.

where the left-hand-side is the response of the *i*th individual, $NoInfo_i$ and $IrrelevantInfo_i$ on the right-hand-side are the treatment dummies (respectively associated with the coefficients α_1 and α_2). $\boldsymbol{X_i}$ is the vector of observable covariates (gender, age, geography, reading and movie tastes among others), associated with the coefficient vector $\boldsymbol{\beta}$. The constant of regression is α_0, and ε_i is the stochastic error term. That we only have two treatment dummies makes *Default-Info*, the default (treatment) group (i.e. α_1 and α_2, represent deviations from this treatment group).

Table 1: Determinants of opinion strength

	Dependent Variable: Response to Q1	Dependent Variable: Response to Q1	Dependent Variable: Response to Q2	Dependent Variable: Response to Q2	Dependent Variable: A1 = 5 (Logistic)	Dependent Variable: A2 = 5 (Logistic)
	(1)	(2)	(3)	(4)	(5)	(6)
No Info	0.7785***	0.8033***	0.7197***	0.7187***	0.8305**	2.2431**
	(0.1539)	(0.1518)	(0.1300)	(0.1306)	(0.3830)	(1.0751)
Irrelevant Info	0.8772***	0.9036***	0.7743***	0.7804***	1.1391***	2.6331**
	(0.1581)	(0.1544)	(0.1343)	(0.1333)	(0.3705)	(1.0558)
Australia		-0.3567**		-0.1053	-0.4272	0.6641
		(0.1405)		(0.1409)	(0.3716)	(0.5881)
India		-0.3954***		0.1375	-0.3172	0.8087
		(0.1481)		(0.1235)	(0.3296)	(0.5379)
Male		0.0241		-0.0477	0.0864	0.3369
		(0.1213)		(0.1074)	(0.2908)	(0.4622)
Constant	3.1789***	3.3398***	2.6526***	2.6559***	-1.8242***	-5.1227***
	(0.1243)	(0.1396)	(0.0956)	(0.1172)	(0.3888)	(1.1093)
Observations	278	278	278	278	278	278
R-Squared	0.1317	0.1624	0.1375	0.1464	0.0515 (Pseudo)	0.1051 (Pseudo)
P-value for Joint Significance	0.0000	0.0000	0.0000	0.0000	0.0020	0.1223

*, ** and *** represent significance at 10%, 5% and 1% levels respectively. Robust standard errors in parentheses.

In column 1 (Table 1), we look at the determinants of the responses to Q1. We immediately see that the opinions represented in the *No-Info* and the *Irrelevant-Info* treatments are significantly stronger in comparison to those observed in the *Default-Info* treatment group. There is no

statistical difference in the responses to Q1 between the *No-Info* and the *Irrelevant-Info* treatments. These results persist when we introduce additional controls (Column 2) for geography and gender (among still others). We additionally learn that candidates from Australia and India harbour weaker opinion in comparison to those from the USA.

The opinions in the *No-Info* and the *Irrelevant-Info* treatments are significantly stronger than those in the *Default-Info* treatment even for Q2 (columns 3 and 4). The last two columns 5 and 6 (respectively for Q1 and Q2) show the results from logistic regressions where the dependent variable is a dummy representing that the response (A1 and A2, respectively for Q1 and Q2) is '5' (the most extreme relative to the average). These two columns explain the most important results we observe – what drives the significantly higher (aggregate) opinion strength in the *No-Info* and the *Irrelevant-Info* groups relative to the *Default-Info* group is the significantly higher likelihood of an extreme opinion in the former groups. We finally come to a slightly surprising result of this experiment (already hinted in our skewness coefficients).

The opinions are consistently the most extreme (although not significantly so) in the *Irrelevant-Info* treatment. In fact, in column 5, we even see marginally (p-value = 0.089) higher likelihood of extreme opinion in the *Irrelevant-Info* group than in the *No-Info* group (also the reason why the skewness coefficient confidence intervals for *Irrelevant-Info* group is higher than the *No-Info* group). Monotheistic evangelists who are confronted with questions on evolution are sure to bring up *HMS Beagle* (Charles Darwin's ship) in their answers to signal authenticity in their accompanying claims. Note that the name of the ship itself is irrelevant to the discussions in question, but the mention of it has the effect of increased confidence (partly stemming from a detail that is verifiably true, although irrelevant at the same time). Debaters are known to be armed with this technique which we call as the *DAFT* (*Desperate Affirmation from Trivia*) effect.

We feel that individuals with the DAFT effect have an illusion of knowing more than they actually do because of the trove of irrelevant information that they hold onto.

4. A concluding discussion

We first notice that there is a uniformly low proportion (less that 15%) of neutral answers across all treatments. This may partially stem from an inherent desire for certainty. There is an evolutionary advantage in quick decision making which is facilitated by looking at matters in black and white (where gray areas leave agents undecided).[11] For example, for (say) legal purposes, a person is said to reach adulthood on turning 18 (although the journey toward adulthood is in fact, very gradual since any person does not turn into an adult exactly in the instant the eighteenth birthday begins).

On other matters, such as evolution, it is frequently emphasized that there was no last non-human entity that gave birth to the first human entity (each agent belongs to the same specie as its parents and offspring). Similarly, on matters in relation to abortion, there is interest among religious groups on when exactly does a fetus become *human*, contrary to what scientists recognize as a gradual process, as Dawkins (2017) notes in the chapter 'The dead hand of Plato'. Unfortunately, he also notes that "the fury with which untenable beliefs are defended is inversely proportional to their defensibility."

We emphasize that while there are advantages from making proactive decisions, it is important to recognize where one must not escape gray areas. Questions like "why adulthood at 18?" or

[11]On seeing a visibly hungry tiger, the agent who immediately runs for life has a higher survival (and hence evolutionary) advantage in comparison with an agent who only chooses to run after having *completely* analyzed the situation for himself (something on the lines of – "it is big, looks hungry, has canines, can outrun me … and I am on the menu, so *now* I should run!").

"when did the first human arrive?", or "when does a fetus exactly become a human being?", or even "why designate statistical significance at *p*-value < 0.05?" should *not* look blindly for black and white answers, for strong opinion (possibly stemming from the Dunning-Kruger syndrome) could have extremely adverse consequences.[12] The recognition of what we do not know in the gray areas could be a first step at humility – one that stems from exploring more, only to realize how little is known.

This is indeed what relevant information does to us – it makes us conscious of the possibility that that we may not know other things that could be relevant. This in turn, prevents us from making very strong judgments on crucial matters as we have demonstrated in our experiment.[13] The urge to take a side/stance can stem from the need to make a decision, but such an urge often bypasses the need to stop and ask "is there more to be known?" We have shown that opinion can be stronger when people are indeed less informed (and do not think about whether more could be known).[14]

The method of scientific inquiry to understand several realities originated among ancient Ionians and the Greek who recognized knowledge to be a key pillar of wisdom. Christopher Hitchens borrows from this ancient culture to define the educated as one who knows how ignorant and less-informed s/he is (Hitchens, 2011). We have experimentally shown that people who are strongly confident of their opinion are more likely to be the ones who are either genuinely less informed, or harbor a lot of irrelevant information. Clearly, there is a reason why religious

[12]This syndrome is said to exist in people who vehemently hold on to their opinion, believing it to be true (if not the best) and stonewalling any criticism.
[13]The order in which the information was revealed was critical in the *Default-Info* treatment. After reading the testimonies, we wanted our readers to think "now I did not know *that!*" on reading the description of the witnesses.
[14]In addition, the ease of processing information has a direct bearing on the strength of judgment (Reber and Schwarz, 1999).

opinion on (say) matters of evolution, or the origin of the universe, is perpetually stronger than scientific opinion. We sum up our argument with the following quote.

'*True wisdom is less presuming than folly. The wise man doubts often, and changes his mind; the fool is obstinate, and doubts not; he knows all things but his own ignorance.*' – Akhenaton.

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APPENDIX

Default-Info Treatment

Answer the questions at the end that follow the details in relation to a murder trial:

A young boy who is suspected of killing his father is under trial. The coroner fixed the time of (the father's) death to be around midnight. The murder happened next to a train station when a train happened to pass by, creating a noise that lasted about six seconds. There were two key eye witnesses in the case. Their statements are recorded below:

Testimony of the first witness:

"I live downstairs below the room where the killing took place. At exactly ten minutes past midnight, I heard loud noises that sounded like a fight. I clearly heard the boy yell "I am going to kill you", immediately after which I heard the sound of a body hitting the floor."

"On hearing this sound, I was quick to head out of my bedroom (covering a distance of only 12 feet), and rushed towards the front door of my house crossing my living room (another 23 feet), in fifteen seconds, which is why I could catch a glimpse of the boy running away down the stairs."

"I immediately called the police, who found the victim stabbed by a (switchblade) knife on his chest."

Testimony of the second witness:

"On the night of the murder, I was trying to sleep on my bed since 11PM. My bed is by the window, through which I could look directly at the boy's house." Almost after an hour of trying to get sleep, I looked out and saw a noisy train that passed between our (mine and the boy's) homes at that very instant."

"Since the train had no passengers, and the lights were out, it was easy for me to see the boy's house through the windows of the (last two cars of the) moving train. I have known the boy all my life so I could identify him stab his father on the chest."

It all happened at about sixty feet away from my window and I checked the time at that very instant. It was exactly 12:10."

A description of thetwo witnesses above is provided below:

Eyewitnesses\Characteristics	**Age**	**Gender**	**Additional Information**
First Eyewitness	75 years	Male	Visible difficulty in walking due to a painful left leg.
Second Eyewitness	45 years	Female	Well-dressed, visibly dyed hair, marks on the nose from her spectacle that she was not wearing that day.

A. How likely according to you is it, that the boy has committed the murder? (encircle an option)

1. Highly unlikely 2. Somewhat unlikely 3: Neutral 4. Somewhat likely 5. Highly likely

B. Should the boy be convicted? (encircle an option)

1. Strongly disagree 2. Disagree 3. Cannot decide 4. Agree 5. Strongly agree

No -Info Treatment

Answer the questions at the end that follow the details in relation to a murder trial:

A young boy who is suspected of killing his father is under trial. The coroner fixed the time of (the father's) death to be around midnight. The murder happened next to a train station when a train happened to pass by, creating a noise that lasted about six seconds. There were two key eye witnesses in the case. Their statements are recorded below:

Testimony of the first witness:

"I live downstairs below the room where the killing took place. At exactly ten minutes past midnight, I heard loud noises that sounded like a fight. I clearly heard the boy yell "I am going to kill you", immediately after which I heard the sound of a body hitting the floor."

"On hearing this sound, I was quick to head out of my bedroom (covering a distance of only 12 feet), and rushed towards the front door of my house crossing my living room (another 23 feet), in fifteen seconds, which is why I could catch a glimpse of the boy running away down the stairs."

"I immediately called the police, who found the victim stabbed by a (switchblade) knife on his chest."

Testimony of the second witness:

"On the night of the murder, I was trying to sleep on my bed since 11PM. My bed is by the window, through which I could look directly at the boy's house." Almost after an hour of trying to get sleep, I looked out and saw a noisy train that passed between our (mine and the boy's) homes at that very instant."

"Since the train had no passengers, and the lights were out, it was easy for me to see the boy's house through the windows of the (last two cars of the) moving train. I have known the boy all my life so I could identify him stab his father on the chest."

It all happened at about sixty feet away from my window and I checked the time at that very instant. It was exactly 12:10."

A. How likely according to you is it, that the boy has committed the murder? (encircle an option)

1. Highly unlikely 2. Somewhat unlikely 3: Neutral 4. Somewhat likely 5. Highly likely

B. Should the boy be convicted? (encircle an option)

1. Strongly disagree 2. Disagree 3. Cannot decide 4. Agree 5. Strongly agree

Irrelevant-Info Treatment

Answer the questions at the end that follow the details in relation to a murder trial:

A young boy who is suspected of killing his father is under trial. The coroner fixed the time of (the father's) death to be around midnight. The killing happened next to a train station when a train happened to pass by, creating a noise that lasted about six seconds. There were two key eye witnesses in the case. Their statements are recorded below:

Testimony of the first witness:

"I live downstairs below the room where the killing took place. At exactly ten minutes past midnight, I heard loud noises that sounded like a fight. I clearly heard the boy yell "I am going to kill you", immediately after which I heard the sound of a body hitting the floor."

"On hearing this sound, I was quick to head out of my bedroom (covering a distance of only 12 feet), and rushed towards the front door of my house crossing my living room (another 23 feet), in fifteen seconds, which is why I could catch a glimpse of the boy running away down the stairs."

"I immediately called the police, who found the victim stabbed by a (switchblade) knife on his chest."

Testimony of the second witness:

"On the night of the murder, I was trying to sleep on my bed since 11PM. My bed is by the window, through which I could look directly at the boy's house." Almost after an hour of trying to get sleep, I looked out and saw a noisy train that passed between our (mine and the boy's) homes at that very instant."

"Since the train had no passengers, and the lights were out, it was easy for me to see the boy's house through the windows of the (last two cars of the) moving train. I have known the boy all my life so I could identify him stab his father on the chest."

It all happened at about sixty feet away from my window and I checked the time at that very instant. It was exactly 12:10."

A description of the two witnesses above is provided below:

Eyewitnesses\Characteristics	**Age**	**Gender**	**Additional Information**
First Eyewitness	75 years	Male	Loves listening to the radio and loves to read.
Second Eyewitness	45 years	Female	Lives in a small house with a bedroom with light green walls and a white ceiling with a single fan.

A. How likely according to you is it, that the boy has committed the murder? (encircle an option)

1. Highly unlikely 2. Somewhat unlikely 3: Neutral 4. Somewhat likely 5. Highly likely

B. Should the boy be convicted? (encircle an option)

1. Strongly disagree 2. Disagree 3. Cannot decide 4. Agree 5. Strongly agree

Please provide the following details:

Course:_____ Age (in years) as on July 2019:

Gender (encircle one): M / F / Other / Prefer not to disclose

How do you best identify yourself (Please tick one option below)

□ White □ Black □ Asian □ Hispanic □ Caucasian □ Other

Among the following genre (type) of movies, please tick the options that you prefer to watch most

□ Romantic □ Thriller □ Fantasy □ Action □ Horror □ Documentary

□ Comedy □ Tragedy □ Drama □ Super-hero □ Mystery □ Science-fiction

□ Other

Among the following genre (type) of books, please tick the options that you prefer to read most

□ Fiction □ Non-fiction □ Biography/autobiography □ Romantic

□ Religion □ Self-help □ Popular-science □ History □ Play/theatre

□ Geography □ Thriller □ Fantasy □ Action □ Horror □ Documentary

□ Comedy □ Tragedy □ Drama □ Super-hero □ Mystery □ Adventure

Appendix 2

Skewness Coefficients

Q1	*Q2*
No-Info (γ_1) = -1.1536 *Relevant-Info (γ_1) = -0.2011* *Irrelevant-Info (γ_1) = -0.8948*	*No-Info (γ_1) = -0.1682* *Relevant-Info (γ_1) =-0.2113* *Irrelevant-Info (γ_1) = -0.2205*

Appendix 3: Determination of sample-sizes

Let $\bar{X} = \frac{X_1 + \ldots + X_n}{n}$ (where *n* is the number of participants in a given treatment group). $\bar{X}$ represents the average response of the participants in the given treatment group. Suppose that the population mean of this variable is μ. Now, consider the test of the null hypothesis that $\mu = \mu_0$. The question is: what would be the minimum sample that is required for such a test to have reasonable power against an alternative hypothesis that the population mean is $\mu_1 > 0$? We consider the alternative hypothesis to be $\mu_1 = \mu_0 + 1$ (since the minimum possible arithmetic difference between any two responses on the Likert scale is *1*). It is clear that the sample size that has reasonable power for this alternative hypothesis would also have at least that much power for any $\mu_1 > \mu_0 + 1$ (e.g. $\mu_0 + 2$). We do not make any assumption(s) on the distribution of X_i (and therefore $\bar{X}$) under the null or the alternate hypothesis (Banerjee, 2020). Our decision rule, for realizations $\bar{x}$ of the sample mean, and a critical value *c* (> *0*) is

$$d(\overline{x}) = \begin{cases} \mu_0 \; for \; \overline{x} \leq \mu_0 + c \\ \mu_1 \; for \; \overline{x} > \mu_0 + c \end{cases}$$

We work out a general expression for *n* that simultaneously contains both the (Type I and Type II) errors within specified (upper) limits α and β without relying on the CLT (*Lemmas 1* and *2*).

Lemma 1. The probability of a Type I error does not exceed α when we fix α equal to $\sigma_X^2/(nc^2)$.

Proof: We recognize that $\underbrace{\mathrm{P}(\overline{X} \leq \mu_0 + c) \geq \mathrm{P}(\mu_0 - c \leq \overline{X} \leq \mu_0 + c)}_{LHS\ spans\ more\ values} \geq \mathrm{P}\left(\mu_0 - c < \overline{X} < \mu_0 + c\right) = \underbrace{\mathrm{P}\left(\left|\overline{X} - \mu_0\right| < c\right) \geq 1 - \frac{\sigma_X^2}{nc^2}}_{Chebyshev's\ inequality}$. Combining these two inequalities gives us $\mathrm{P}(\overline{X} \leq \mu_0 + c) \geq 1 - \frac{\sigma_X^2}{nc^2}$, subtracting each side of which from *1*, gives us $\mathrm{P}(\overline{X} - \mu_0 > c | \mu = \mu_0) \leq \frac{\sigma_X^2}{nc^2}$. Since, the LHS here is the probability of a Type I error, fixing α equal to $\sigma_X^2/(nc^2)$, completes the proof. ■

Lemma 2. The Type II error does not exceed β when we fix β equal to $\sigma_X^2/n(\mu_1 - \mu_0 - c)^2$.

Proof: The steps involved are exactly the same as those for the proof of *Lemma 1* above. ■

Note that no assumptions on the functional forms of the underlying population distributions were made in proving the above lemmas. Clearly therefore, the errors obtained from *any specified pair of distributions* will necessarily be contained within these bounds. We turn to this now.

Theorem 1. If sample size is determined according to the following rule

$$n = \frac{\sigma_X^2}{\left(\mu_1 - \mu_0\right)^2}\left(\frac{1}{\sqrt{\alpha}} + \frac{1}{\sqrt{\beta}}\right)^2 \qquad (A)$$

then the statements *P(Type I error)* $\leq \alpha$, and *P(Type II error)* $\leq \beta$, are simultaneously true, regardless of the functional forms of the underlying densities (assumed under the hypotheses).

Proof: Solving for *c* in *Lemma 1*, gives us $c = \sigma_X/\sqrt{\alpha n}$. Putting this value of *c* in the expression for β in *Lemma 2*, gives us $\beta = \frac{\sigma_X^2}{n\left(\mu_1 - \mu_0 - \frac{\sigma_X}{\sqrt{\alpha n}}\right)^2}$. Finally, solving for *n* completes the proof. ■

In this expression, we fix the probabilities of Type I error (α) and Type II error (β) to be 0.05 and 0.10 respectively (The target power of our test is 90%). We take $\mu_1 - \mu_0 = 1$. The only limitation is that we do not know the value of σ_X. So we use estimates from pilot studies (1.22, 0.91, and 0.94 respectively for the *Default-Info, No-Info* and the *Irrelevant-Info* treatments), which give us sample sizes of *n = 87, 48,* and *52* respectively for the *Default-Info, No-Info* and the *Irrelevant-Info* treatment groups, which are comfortably exceeded by our actual sample sizes, thereby guaranteeing a minimum statistical power of 90% for our test.