Considering the Role of "Need for Cognition" in Students' Acceptance of Climate Change & Evolution

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Abstract

Anthropogenic climate change (ACC) and evolution are examples of issues that are perceived differently by scientists and the general public. Within the scientific community, there are clear consensuses that human activities are increasing global temperatures (ACC) and that evolutionary mechanisms have led to the biodiversity of life on Earth (evolution). However, there is much debate in the public discourse about the scientific evidence supporting these topics. The purpose of our study was to explore the relationship between a student's need for cognition (NFC) – preference to engage in and enjoy thinking – and the student's acceptance of ACC and evolution. The results revealed that students with a higher NFC were more accepting of both ACC and evolution. Future investigations should include evaluating the efficacy of different instructional techniques on NFC and acceptance of polarizing topics such as evolution and ACC.

Key Words: *Need for cognition; critical thinking; evolution; Darwinism; climate change; global warming; science denial; skepticism.*

○ Introduction

From the Scopes Trial in 1925 to the present-day "teach the controversy" and climate-change-denial campaigns, the U.S. educational system has a history of heated debates about the content and presentation of ideas in publicly funded institutions. Recent legislation highlights the importance of these issues to the broader public. For example, a law in Tennessee enacted in 2012 states:

> The teaching of some scientific subjects, [namely]…biological evolution…and…global warming can cause controversy… . The state board of education, public elementary and secondary school governing authorities, directors of schools, school system administrators, and public elementary and secondary school principals…shall endeavor to assist teachers to find effective ways to present the science curriculum as it addresses scientific controversies. Toward this end, teachers shall be permitted to help students understand, analyze, critique, and review in an objective manner the scientific strengths and scientific weaknesses of existing scientific theories covered in the course being taught. Neither the state board of education, nor any public elementary or secondary school governing authority, director of schools, school system administrator, or any public elementary or secondary school principal or administrator shall prohibit any teacher in a public school system of this state from helping students understand, analyze, critique, and review in an objective manner the scientific strengths and scientific weaknesses of existing scientific theories covered in the course being taught. (State of Tennessee, 2012)

A similar law is in effect in Louisiana (State of Louisiana, 2008), and similar pieces of legislation have been proposed in other states (see http://ncse.com/evolution/anti-evolution-anti-climate-science-legislation-scorecard-2013) in which topics as scientifically disparate as evolution and anthropogenic climate change (ACC) are being dealt with legislatively together and teachers are being told they can teach about scientific controversies surrounding these topics, in spite of the fact that the science behind both evolution and ACC is well established and not controversial (Oreskes, 2004; Kitzmiller v. Dover, 2005; IPCC, 2013).

> *Acceptance of ACC is the acceptance that the scientific evidence shows that the Earth's average temperature is increasing.*

Despite the scientific consensus on these topics, public acceptance of evolution and ACC is low (Lorenzoni & Pidgeon, 2006; Miller et al., 2006; Pew Research Center, 2011). College introductory biology courses often teach the science of evolution and ACC, but instructors are often frustrated by some students' lack of acceptance of these topics. Understanding the students who struggle with acceptance of the science behind these topics may be helpful in devising strategies to address them in the classroom.

Students' Acceptance of Evolution

Acceptance of biological evolution can be characterized as acceptance of the idea that populations change over time and that current

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species (including humans) are the result of millions of years of evolutionary processes (Johnson & Peeples, 1987; Rutledge & Sadler, 2007). Fewer than 50% of adults in the United States accept biological evolution (Miller et al., 2006). Among college students, the acceptance of evolution appears to be higher (Moore & Cotner, 2009; Paz-y-Miño & Espinosa, 2009). College students' knowledge about and acceptance of evolution seem to be influenced by their religious and political views and by their exposure to evolution and creationism in secondary school (Moore & Cotner, 2009; Moore et al., 2009). Previous studies have shown that students with nonconservative religious views and liberal political affiliations generally have a better understanding of evolution (Cotner et al., 2010).

Students' Acceptance of ACC

Acceptance of ACC is the acceptance that the scientific evidence shows that the Earth's average temperature is increasing, a phenomenon largely caused by human activity (Dunlap et al., 2000; Zehr, 2000; Pew Research Center, 2011; Hamilton, 2012). While the science of climate change is well established and well accepted within the scientific community, there is little emphasis on climate change education in primary and secondary education (Sharma, 2012). Thus, most students entering college have probably not received formal instruction in the science of climate change. Student opinions are therefore likely to have been derived from various media sources (Krosnick & MacInnis, 2010; Hmielowski et al., 2014), personal experience, and other societal influences (Lorenzoni & Pidgeon, 2006). According to national surveys, the acceptance of climate change in the United States has fluctuated. In a 2011 Pew Research Center survey, 38% of respondents agreed that there is solid evidence the Earth is warming because of human activity (ACC). This number is slightly increased from the values in 2009 and 2010, but still below the 2008 value of 47%. Acceptance of ACC is closely related to political affiliation, with Democrats much more likely to accept ACC (Pew Research Center, 2011). In a sample of college students in the southeastern United States, acceptance of ACC was related to religious affiliation, with non-Christians more likely to accept ACC than those identifying as Christian in this largely Southern Baptist population (Fusco et al., 2012). Likewise, consumers of conservative media sources, such as Fox News and conservative talk radio, were shown to have less confidence in the science of ACC and to rely more heavily on heuristics (i.e., mental shortcuts) to arrive at conclusions on topics such as ACC (Gauchat, 2012; Hmielowski et al., 2014). One of the problems associated with climate change science is the multifaceted nature of the evidence (including the disciplines of physics, atmospheric chemistry, and biogeochemical cycling) and how difficult it is for one individual to be familiar with all of the evidence supporting ACC. Consequently, nonscientists often rely on personal experiences and secondary sources for their understanding of climate change, leading to bias and inaccuracies in their understanding (Weber & Stern, 2011).

Need for Cognition

We set out to investigate acceptance of ACC and evolution by searching for significant underlying factors that could better explain or predict students' acceptance of ACC and evolution. Our readings of Anne Bost's summary and brief history of the need for cognition (NFC; Bost, 2007) piqued our interest in this cognitive trait, and we hypothesized that NFC might be related to acceptance of these topics of public controversy. Need for cognition (NFC) is a measure of individual difference in inclination to consistently engage in and enjoy effortful cognitive activity (Cacioppo & Petty, 1982; Bost, 2007). NFC provides a metric for comparing an individual's propensity to seek out additional information, critically analyze evidence, and engage in abstract thinking (Kardash & Scholes, 1996). Surveys have shown that NFC is positively correlated with verbal reasoning ability (Fleischhauer et al., 2010), academic success (Sadowski & Gulgoz, 1992, 1996; Cacioppo et al., 1996), general cognitive ability and skill acquisition (Day et al., 2007), an individual's rational processing of information (Petty et al., 2009), and life satisfaction among college students (Coutinho & Woolery, 2004).

Furthermore, NFC has been weakly and negatively ($P < 0.05$; $r = -0.27$) correlated with dogmatism – defined as the unwillingness to consider multiple sides of an issue (Cacioppo & Petty, 1982). When considering issues that have religious or political ramifications (viz. ACC and evolution), dogmatism becomes a force of resistance that makes it challenging to partake in productive discussions.

From this reasoning, we decided to investigate the relationship between an individual's NFC and his or her acceptance of ACC and evolution. High-NFC individuals possess the motivation to ruminate and the desire to engage in new experiences that stimulate thinking, whereas low-NFC individuals view thinking more as a chore and tend to accept new information at face value (Cacioppo et al., 1996). High-NFC individuals actively acquire relevant information, base judgments on empirical information from a variety of sources, and scrutinize claims when forming opinions. For example, in a study by Kardash and Scholes (1996), 96 undergraduates were given a questionnaire to assess their level of need for cognition and indicate their degree of belief that HIV causes AIDS. After reading two conflicting views regarding the HIV–AIDS relationship, students wrote a concluding paragraph. High-NFC students were more likely to write reflections that portrayed the inconclusive nature of the mixed evidence they had read. By contrast, the authors concluded that the low-NFC students found the contradictory nature of the information to be cognitively overwhelming, as reflected in the students' writing. Being overwhelmed may have led the students to choose to ignore the information in conflict with their personal beliefs (Kardash & Scholes, 1996).

This research suggests that high-NFC individuals tend to deliberate more thoughtfully and to carefully evaluate the inconclusive nature of mixed evidence (as demonstrated by their written conclusions of mixed evidence). If this is the case, it is reasonable to hypothesize that NFC predispositions may shape an individual's thinking and understanding of similarly controversial subjects, such as ACC and evolution. We hypothesized that students with a higher NFC would have higher acceptance of both ACC and evolution. Furthermore, we hypothesized that there would be a correlation between students' acceptance of ACC and evolution.

Thus, the goals for this investigation were threefold:

(1) to develop and validate a single tool by which educators could evaluate students' NFC, acceptance of ACC, and acceptance of evolution;

(2) to use this tool to better characterize the students who struggle with acceptance of evolution and ACC; and

(3) to suggest strategies to better address the challenge of instructing students who reject the scientific evidence that supports ACC and/or evolution.

Table 1. Factor loadings for latent variable exploratory factor analysis.

Question	Factor 1: Evolution	Factor 2: ACC	Factor 3: NFC
Like complex tasks	0.0	0.0	**0.8**
Thinking more abstractly	0.0	0.0	**0.8**
Dislike substantial intellectual effort (INVERTED)	0.0	0.1	**0.5**
Like learning new ways to think	0.1	0.1	**0.4**
Like tasks that don't think about once learned (INVERTED)	0.0	0.0	**0.5**
Solid evidence average temperature increases	0.0	**0.7**	0.0
Solid evidence humans alter climate	0.0	**0.8**	0.0
Scientists accept humans alter climate	0.0	**0.6**	0.0
Ecological crisis exaggerated (INVERTED)	0.1	**0.5**	0.0
Unclear data about evolution (INVERTED)	**0.6**	0.1	0.0
Earth is at least 1 billion years old	**0.6**	0.0	0.0
Evolution is scientifically valid	**0.8**	0.0	0.0
Scientists accept evolution is scientifically valid	**0.6**	0.1	0.0
Organisms today evolved	**0.9**	0.0	0.0
Age of Earth is <20,000 years (INVERTED)	**0.6**	0.0	0.0
Modern humans evolved	**0.9**	0.0	0.0

○ Methods

Participants

We invited 1463 University of Minnesota–Twin Cities undergraduates enrolled in courses designed for students in nonbiology majors and 298 enrolled in courses designed for biology-related majors to participate in the survey. Students in the biology majors courses were not included in the analysis because of low response rate (these students received multiple surveys at the beginning of the semester, and we think this generated confusion). In all, 804 majors participated, and 628 completed the survey (completion rate = 78.11%). Participation in the survey was voluntary, and students who received extra credit were informed that they could omit any survey items and still get the extra credit. This study was determined to be exempt from review by the University of Minnesota's Institutional Review Board (study 1211E24362).

Survey

The survey administered to the students had multiple goals from various researchers. Our research focus was NFC and its relationship to perceptions of contemporary scientific issues (ACC and evolution), and only the questions pertaining to these topics were included in this analysis.

In an attempt to eliminate social desirability bias (the tendency for respondents to agree with survey questions), we included reverse scoring items (marked with an asterisk). The survey items administered are listed below. In order to analyze the data, "strongly disagree" was assigned a score of 1, "disagree" was assigned a score of 2, "neutral" was assigned a score of 3, "agree" was assigned a score of 4, and "strongly agree" was assigned a score of 5. Reverse-worded questions were scored as an inverse (e.g., "strongly agree" assigned a score of 1).

Survey questions were analyzed using latent variable exploratory factor analysis (using the command "fa" from the package "psych," which is an additional package for the statistical analysis software R; R Development Core Team, 2012; Revelle, 2012). Latent variable exploratory factor analysis uses eigenvalues to group highly correlated questions that are based on the premise that high correlation implies that the questions target different aspects of the same underlying concept. The results for each question are reported as a number between 0 and 1, with a higher number implying that the question better correlates with the underlying factor. Under the latent variable exploratory factor analysis (see Table 1), three underlying concepts emerged: NFC (factor 3), ACC acceptance (factor 2), and evolution acceptance (factor 1). There were three originally included questions that did not correlate highly with any of the latent variables. Once the questions were examined retrospectively, they were eliminated because of their ambiguity. NFC, ACC, and evolution acceptance (Evolution) were then assigned a score based on the average of the survey questions associated with the latent variable.

Survey Items

NFC: This is defined as the measure of the tendency for an individual to engage in and enjoy thinking (Cacioppo & Petty, 1982; Tolentino et al., 1990). Survey items were adapted from Bost (2007) and have previously been shown to be a valid and reliable measure of individuals' NFC (Cacioppo & Petty, 1982; Cacioppo et al., 1984, 1996; Sadowski & Gulgoz, 1992; Sadowski, 1993).

1. I would prefer deliberating hard for long hours on complex tasks that challenge my thinking abilities rather than simple, lower-mental-effort problems.

2. I enjoy thinking harder and more abstractly than I have to, and the idea of relying on this kind of thinking ability to make my way to the top appeals to me.
3. *I dislike having the responsibility of handling an important situation that requires a lot of thinking or undertaking a task that requires substantial intellectual effort.
4. I find it appealing to learn about new ways to think and to contemplate issues even when they do not affect me personally.
5. *I like tasks that require little thought once I've learned them; I don't care how or why something works, as long as it gets the job done.

ACC: This is defined as an individual's acceptance that the Earth's average temperature is increasing and that this phenomenon is largely caused by human activity (Dunlap et al., 2000; Zehr, 2000; Pew Research Center, 2011; Hamilton, 2012).

1. There is solid evidence that the Earth's average temperature has shown recent increases (global warming).
2. There is solid evidence that human activities are altering the Earth's climate.
3. Most scientists accept that human activities are altering the Earth's climate.
4. *The so-called "ecological crisis" facing humankind has been greatly exaggerated [question from Dunlap et al., 2000].

Evolution: This is defined as an individual's acceptance that populations change over time and that current species (including humans) are the result of millions of years of evolutionary processes (Johnson & Peeples, 1987; Rutledge & Sadler, 2007). Questions were adapted from the Measure of Acceptance of the Theory of Evolution (MATE; Rutledge & Sadler, 2007).

1. *The available data are unclear about whether evolution actually occurs.
2. The Earth is at least 1 billion years old.
3. Evolution is a scientifically valid theory.
4. Most scientists accept evolutionary theory to be scientifically valid.
5. Organisms existing today are the result of evolutionary processes that have occurred over millions of years.
6. *The age of the Earth is less than 20,000 years.
7. Modern humans are the product of evolutionary processes that have occurred over millions of years.

Survey Administration

Students were invited to participate in the survey via e-mail before the first day of the fall 2012 semester. The e-mail provided a link to a Survey Monkey (http://www.surveymonkey.com) survey. In some sections of the courses, students were offered 1 extra credit point for participating in the survey. In other sections, students were incentivized to take the survey by being offered entry into a drawing for a gift card.

Data Analysis

Data analysis was performed using the statistical software R (R Development Core Team, 2012). R is a freeware statistical software that is used across many disciplines and is the most commonly used statistical software for statisticians. The latent variable exploratory factor analysis was performed using the fa() command in the additional psych package (Revelle, 2012). Latent variable exploratory factor analysis looks at the answers for each of the survey questions and uses the correlation matrix for these answers to group those questions that are most closely aligned, based on the number of groupings asked for. In other words, a latent variable exploratory factor analysis can see whether the several questions that are written to understand the different aspects of one underlying concept actually do reflect that underlying concept (factor) or whether some of the questions are more directly related to other concepts (factors). In our case, we tested the survey data from the 16 statements listed above. This analysis indeed found that the five NFC questions were one factor, the four ACC questions were another factor, and the seven Evolution questions were a third factor (Table 1).

Average scores were created for each of the three factors: scores from the five questions that loaded onto the third factor, NFC, were averaged to create an NFC score that ranged from 1 to 5. Similar averages were created for the ACC score (an average of the four questions) and the Evolution score (an average of the seven questions).

The coefficient of determination (R^2) was used to understand the relationship between the three factors "need for cognition," "ACC," and "Evolution." R^2 determines how much of the variability between students with respect to one factor can be explained by another factor.

The alpha() command in the additional "pysch" package was used to check the internal consistency, or reliability, of our data. This command finds Cronbach's alpha for each factor. Cronbach's alpha measures how similar the answers are for questions that make up a given factor and, therefore, how reliably the data reflect the students' attitudes toward the underlying concept. Proposed by Lee Cronbach (1951), it is the most commonly used metric for internal reliability of a factor based on multiple variables (Peterson & Kim, 2013).

For analysis, students were grouped into categories of high, medium, and low NFC. Average scores on the NFC items <2.5 (corresponding to an average answer of "strongly disagree" or "disagree") were categorized as low; scores between 2.5 and 3.49 (corresponding to a response of "neutral") were categorized as medium; and average scores 3.5 and higher (corresponding to an average response of "agree" or "strongly agree") were categorized as high. Based on these groupings, analysis of variance was performed to determine whether there was a statistically significant difference between the three levels of NFC, and Tukey's HSD pairwise comparisons were done comparing acceptance of ACC and evolution between the groups. Tukey's HSD creates multiple intervals (for all combinations of two of the three groups) with an overall type I error of 5% and can therefore be used to isolate where the statistically significant difference lies.

○ Results

Cronbach's α values ranged from 0 to 1, with numbers closer to 1 reflecting a higher reliability; a value ≥ 0.7 indicates that the data collected adequately reflect the participant's views on the underlying concept (Kline, 2005). For NFC, $\alpha = 0.72$; for ACC, $\alpha = 0.75$; and for Evolution, $\alpha = 0.89$, indicating that the questions asked for each topic were reliable measures of a single underlying concept.

The score distribution for NFC, ACC, and Evolution scores is presented in Figure 1. Relatively few students fell into the low category for ACC and Evolution: 1.6% and 3.3%, respectively. Although these

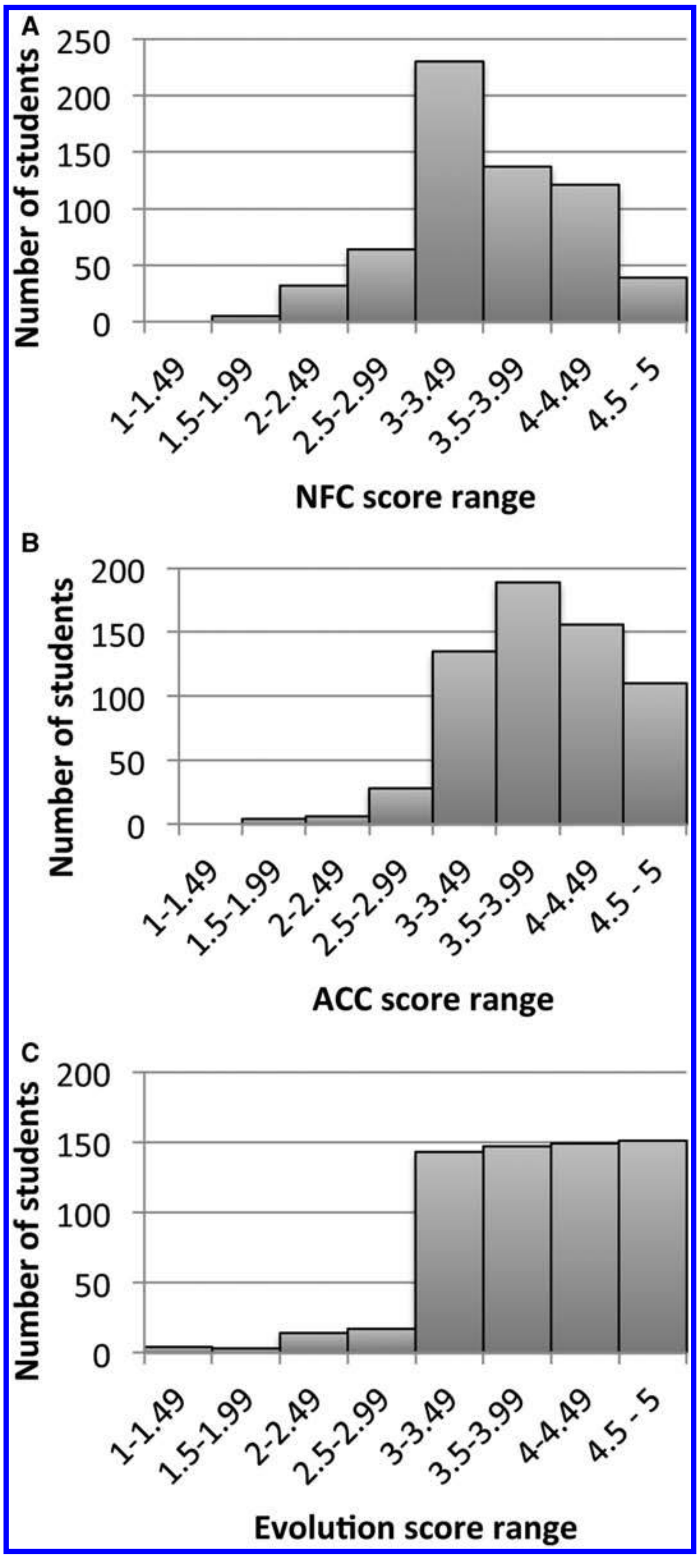

Figure 1. Histograms showing distribution of students according to their measured (A) need for cognition (NFC); (B) acceptance of anthropogenic climate change (ACC); and (C) acceptance of evolution.

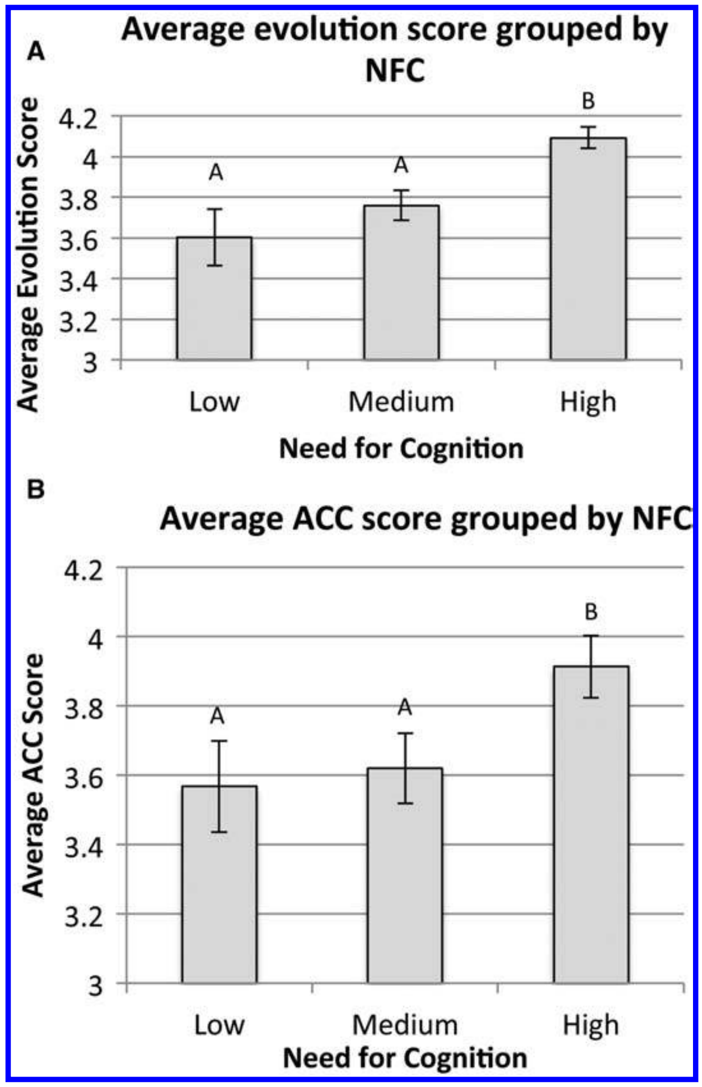

Figure 2. Acceptance of (A) evolution and (B) anthropogenic climate change (ACC) as grouped by high, medium, and low need for cognition (NFC). Bars marked "A" are significantly different from those marked "B" ($P < 0.01$).

percentages are small, 1.6% represents 10 students, a small number but large enough for statistical analysis. The medium category for ACC and Evolution had 26.0% and 25.5% of students, respectively; and 72.5% and 71.2% were in the high category for ACC and Evolution, respectively. Values for ACC and Evolution were significantly higher in students characterized as having high NFC than in those categorized as having medium or low NFC ($P < 0.01$; Figure 2).

With a correlation of $r = 0.29$ ($R^2 = 0.09$), NFC alone helps explain students' acceptance of ACC ($P << 0.0001$). With a correlation of $r = 0.31$ ($R^2 = 0.10$), NFC alone helps explain students' acceptance of evolution ($P << 0.0001$). With a correlation of $r = 0.445$ ($R^2 = 0.20$), students' acceptance of ACC and evolution were significantly related ($p << 0.0001$). These statistics are highly significant but, since R^2 must be near 1 for NFC to be the primary explanation of a student's acceptance of a scientific concept, there must be other influences that can affect students' acceptance of these issues.

○ Discussion

We had three goals for this study: (1) to develop and validate a tool by which educators could evaluate students' NFC, acceptance of

ACC, and acceptance of evolution; (2) to use this survey tool to better characterize the students who struggle with evolution and ACC; and (3) to derive suggestions for strategies to better address the needs of students who do not accept ACC and/or evolution.

1. Can a Simple Survey Instrument Evaluate Student NFC, Acceptance of ACC, and Acceptance of Evolution?

Other studies of NFC have used longer surveys with slightly different statements, but the Cronbach's alpha value of 0.72 indicates that the five NFC survey questions we used do target one underlying factor and are therefore likely to be measuring the psychological personality trait that we set out to measure (NFC). Our Cronbach's alpha scores were somewhat lower than those for NFC tools that contained more items (Cacioppo et al., 1996). However, for large-scale surveys with varying goals, such that survey length for each topic is limited, our results suggest that when survey space is limited, fewer statements can be used to assess NFC. Likewise, our four statements for ACC and seven for Evolution had high enough Cronbach's alpha values to indicate that these questions can be used as reliable indicators of students' acceptance of ACC and evolution.

2. Can this Tool Characterize Students who Struggle with Evolution and Acc?

We have used our survey tool to better characterize undergraduate students who struggle to accept scientifically supported ideas such as ACC and evolution. We found that higher NFC positively correlated with increased acceptance of publicly controversial topics of ACC and evolution. These results support the hypothesis that higher NFC promotes the objective interpretation that is necessary to apply when evaluating scientific data and theories (Kardash & Scholes, 1996). We also found a significant correlation between acceptance of ACC and of evolution.

Surprisingly to us, our survey had a relatively small number of students with low acceptance of ACC and evolution, as well as a relatively small number of students with low NFC (Figure 1). This may be attributable to the college population we surveyed, or it may reflect respondents' desire to appear accepting at the beginning of a biology course. The magnitude of the correlation between NFC and acceptance of ACC and evolution, while highly significant, is small. It would be informative to repeat this study in a population with greater expected proportions of low acceptance of these topics and low NFC in order to see whether the magnitude of the correlation might increase. However, the population of students who we characterized as ambivalent about ACC and evolution represents students who are struggling with these issues (given the nonambivalent nature of the science).

3. What are Some Strategies to Better Address the Needs of the Students who do not Accept ACC and/or Evolution?

The significant relationship between students' acceptance of evolution and ACC may provide some insights into approaches to address both these issues. There is more published guidance for approaching evolution instruction than for ACC, but some of the tips for improving evolution acceptance may apply to ACC instruction as well. For example, Cotner et al. (2010) offered several key trouble spots that predict, and potentially explain, some students' resistance to evolution. Their results suggest that students' lack of acceptance of the age of the Earth – and related lack of understanding of the concept of "deep time" – make acceptance of evolution difficult and make alternative (creationist) explanations seem more reasonable. The creationist teachings about life's origin, by contrast, are relatively easy to learn. Cotner et al. (2010) suggested that instructors need to understand that in teaching about the age of the Earth, they are teaching a conceptual change to their students. There may be similarly troublesome concepts regarding climate change that our students struggle with and that instructors need to address more explicitly.

One example of a college-level course designed to increase acceptance of, interest in, and knowledge about evolution was started in 2002 at Binghamton University and is described by David Sloan Wilson (2005). This course, "Evolution for Everyone," presents the controversial subject as nonthreatening, applicable, and alluring. The course emphasizes the creation of a conceptual framework with which students can approach any scientific topic. This allows students to intuitively perceive evolutionary ideas as tools that can be used to better understand the world and address global problems, even before they are fully exposed to evolutionary principles and data.

College biology students' acceptance of evolution has been shown to be directly related to their understanding of science in general (Johnson & Peeples, 1987). Because of this relationship, it has been suggested that educators prioritize teaching the nature of science (Lombrozo et al., 2008) and its content in more relatable contexts (Sloan Wilson, 2005; Shtulman & Calabi, 2008, 2012) in an effort to improve students' acceptance of evolution. It may be that students who reject both ACC and evolution have similar misunderstandings of the process of science and perhaps have one or two "problem spots" with ACC acceptance that need to be identified and addressed directly.

A growing body of literature suggests strategies to address students' failure to accept evolution, but there is less information available about strategies to address students' failure to accept ACC. One study of middle school students found that those who participated in an activity in which they critically compared two models of climate change (one in which climate change was caused by humans and one in which it was caused by variations of solar output) experienced and maintained greater knowledge and acceptance of ACC (Lombardi et al., 2013).

Need for cognition has been described in the literature as a stable trait but not an invariant one (Cacioppo et al., 1996). In the present study, we found a correlation between NFC and students' acceptance of publicly controversial topics. Whether high NFC causes students to be more likely to accept these controversial topics is not clear. However, a growing understanding of the plasticity of certain cognitive traits such as working memory (e.g., Jaeggi et al., 2008) make it reasonable to hypothesize that educational interventions could dually increase NFC and acceptance of these issues. It is worth investigating whether NFC could be positively changed. Although we are not aware of specific research on postsecondary classroom techniques to increase NFC, we think it is worth exploring if a classroom environment that rewards intellectual risk-taking could positively affect NFC. We hypothesize that if we can increase confidence in scientific abilities, students' enjoyment of effortful cognition might increase. Further, faculty who reward students for taking intellectual risks and create an overall supportive learning environment

(Thompson & Wheeler, 2008) while exploring issues of scientific controversy should see increases in their students' NFC and ability to accept scientifically sound, but controversial, ideas.

Unlike learning about complicated noncontroversial topics, the process of coming to terms with complicated controversial topics necessitates both a fairly sophisticated understanding of the details of the topic and an understanding of common misrepresentations one often encounters in the nonscientific community. Mulling over data by comparing and contrasting scientific claims with those found in less scientific sources are practices that would be performed by high-NFC individuals. Rewarding this type of behavior in the classroom and providing a safe environment to explore these topics might lead to higher NFC and positively affect an individual's acceptance of controversial topics.

○ Future Directions

Further research is needed to understand the efficacy of teaching techniques meant to improve a student's NFC and acceptance of controversial topics. Future studies could evaluate the relationship between NFC and other biological subjects that evoke public controversy, such as the safety of childhood vaccinations or of currently available genetically modified foods. Hypothetically, similar results would be expected: Individuals with higher need for cognition are more apt to critically evaluate information and arrive at data-supported conclusions.

Likewise, it would be interesting to evaluate the relationship between opinions on issues of scientific consensus and public controversy with other relevant psychological traits, such as an individual's "need for cognitive closure" (i.e., preference for order and predictability, decisiveness, discomfort with ambiguity, closed-mindedness) or "feeling of certainty" (i.e., intuitive cognition used when making decisions about theoretical claims). Because the scientific process does not lend itself to cognitive closure (because of the iterative nature of the process) or elicit feelings of certainty, failure to attain either or both could help explain why some students deny scientifically supported ideas (Webster & Kruglanski, 1994; Ha et al., 2012).

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