

Predicting Information Use from Belief-Bases

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THESIS

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I dedicate this thesis to five amazing individuals: my parents, Carlos and Betty Salas, whose sacrifices and unwavering support motivated me to pursue a higher education; my younger brother and sister, Miguel and Betty Salas, who always inspire me to strive for excellence; and to Maria Jazmin Rios. I could not have accomplished this without her constant encouragement, confidence, and vibrant enthusiasm.

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SUMMARY

Holding particular beliefs can yield various perceived consequences with a strong positive or negative valence. Such valence is presumed to reflect the subjectively experienced affect people have towards those consequences. Thus, perceived consequences of a belief should shape a person's overall affective appraisal of the to-be-believed claim. Therefore, people who defer to affect rather than the relevant evidence as the basis of their belief should also be more likely to incorporate valenced consequences and less likely to incorporate belief-relevant evidence into their reasons for holding that belief. This study examined this possibility by employing a multiple documents paradigm. Participants were allowed to read a set of texts that varied in whether they provided evidence objectively relevant to the theory of evolution versus information about valenced social and emotional consequences of accepting evolution. Participants wrote an essay describing their degree of acceptance of the theory of evolution and their supporting reasons, and were encouraged to include subjectively relevant text information.

Results supported the predicted relationships and the assumption that self-reported belief-bases reflect competing preferences for different types of belief-supporting information. Individuals differed in the relative focus they gave to theory-relevant and consequence-relevant arguments when relating this information to their belief. Such findings argue for the need to incorporate competitive evidence-versus-affect routes and individual differences into models of belief formation and maintenance. This has implications for learning during multiple documents inquiry tasks and the informal information searches people engage in on the internet, where unscientific, emotion-laden arguments on important scientific questions are often more pervasive than valid scientific information.

I. INTRODUCTION

The potential influence of prior beliefs on learning (e.g., Hofer & Pintrich, 2002; Kuhn, 2001), decision making and reasoning (Evans, Handley, & Harper, 2001; Goel & Dolan, 2003; Klaczynski & Lavalley, 2005), and argumentation (Stanovich & West, 1997; West, Stanovich, & Toplak, 2008) has been of great interest to psychologists. Beliefs about scientific controversies have been of particular interest to educators concerned with increasing the public's understanding of science (e.g., Corner & Hahn, 2009; Kolsto, 2001; Zeidler et al., 2002). Given the influence that beliefs have on functioning in an information-driven society, it is important to understand how the distinct belief formation processes that an individual engages in might impact subsequent processing, use, and learning of novel domain-relevant information. Furthermore, gaining a better understanding of individual differences in such belief formation processes can inform models of learning in multiple documents environments and informal information searches.

Belief Formation: Processes and Models

Belief formation in science involves assigning a subjective estimate of the degree to which a science claim is true (Corner & Hahn, 2009). From a normative perspective, a rational belief formation process involves comprehending a scientific claim, evaluating the relevant scientific evidence, forming a personal belief about the truth of the scientific claim, and then updating the belief as new theory-relevant evidence becomes available. This normative process is akin to the coherence evaluation process that characterizes typical models of conceptual change (Chi, 1992; Thagard, 1992). In contrast, an individual might choose to accept or reject belief in the truth of a scientific claim based on the affect one feels or expects to feel as a result of accepting the claim.

This affect can either be a rather direct reaction to the content of the claim or a reaction to the desirability of the perceived social and psychological consequences of accepting the claim (Baron, 1992; Griffin, 2008). For example, one might find the element of randomness in the theory of evolution to be anxiety provoking or one may feel the consequence of being rejected by one's family for accepting evolution to be excessively unpleasant. The subjective valence associated with expected consequences of holding a belief is a source of information that could inform the affect a person expects to experience as a result of the belief.

An implication is that valenced consequences of belief can shape the affect that one experiences or expects to experience in relation to accepting a claim. However, valence is not an inherent property of the consequences themselves. Valence arises from the subjective appraisals of a consequence as positive or negative, which stem from whether one personally feels the consequences are affectively unpleasant and undesirable. This assumed tethering of valence and affect is consistent with definitions that construe valence as an appraisal of “the hedonic tone of the subjectively experienced emotions which range from highly negative (i.e., unpleasant) emotions...to extremely positive (i.e., pleasant) ones...” (Colibazzi et al., 2010, p.378). Thus the definition of valence maps directly onto prevailing definitions of affect in psychology as being “the positivity or negativity of the feelings precipitated by the attitude object”, or as “the predisposition to respond in a favorable or unfavorable way toward the object” (The Handbook of Social Psychology, Vol. ii, p. 419). In fact, models of affect have long-held that the positive-negative valence of objects is a defining dimension of a persons' affective response to the object (Barrett, 2006; Russell, 1980).

The link between perceived positively and negatively valenced consequences of belief in the scientific theory of evolution and affective notions of comfort and desirability has been noted by Brem, Ranney, and Schindel (2003). They examined people's perceived consequences of belief in evolution (the

same consequences employed in the texts used in the current study). They suggest that the valence of these consequences reflect people's own "negative spin" or "positive interpretation" which indicate whether "people find evolution utterly comforting or discomfoting" and whether they "viewed the consequences of accepting evolutionary principles in a way that might be considered undesirable." (p. 198-199).

The subjective and affective nature of valence plays a crucial role in the relationship between ideas about the valenced consequences of belief and the belief itself. Consider a case in which belief in a scientific claim (e.g., "X") being true, leads to a specific consequence (e.g., "a decrease in Y"). In such a case, the valence of consequence "Y" is only negative for an individual who subjectively *feels* negatively about experiencing a decrease in "Y". However, it is important to note that the positively or negatively valenced consequences of belief in a scientific claim are not relevant to the objective veracity of the scientific theory or claim, and thus are not evidence relevant to the claim. Despite not providing belief supporting evidence, such consequences could favor or disfavor belief in the claim via fostering a desire to achieve or avoid those consequences, depending upon their perceived valence.

Using a concrete example from Brem et al. (2003), an individual might perceive that acting immorally and "just like an animal" is a consequence of accepting evolution as true, and therefore may reject belief in evolution given the negative valence of this consequence. The negative valence and unpleasantness of people acting like animals is subjective and reflects the person's own affective reaction to the hypothetical consequence. Furthermore, whether or not this actually is a consequence of accepting evolution is a distinct question from whether or not evolution actually occurs. Neither the consequence nor its perceived negativity provides any evidence against the veracity of evolutionary theory. These consequences become a relevant

determinant of belief if one rejects belief in evolution based upon a motivation to avoid the consequences one feels are unpleasant.

Thus, perceived consequences of belief cannot serve as a normatively rational basis to form one's belief. Based upon this assumption that valence-laden consequences of belief are affective in nature and lack evidential relevance to the claim's veracity, beliefs based in such consequences have been referred to as affect-based beliefs (Griffin, 2008). Even if evidence is used to support the presumed valenced consequences of belief, the belief is still affect-based because that evidence only supports the valenced *consequences* of believing and not the believed claim itself. In the current example, using a study to support the idea that belief in evolution causes behaviors that many deem immoral, and then rejecting belief in evolution for that reason, still means that the rejection of evolution is based in affectively-valenced reasons.

Aside from influencing what belief a person develops, affect-based routes to belief could constrain how people process belief-relevant information. People can and sometimes do make use of affective preferences about claims to determine whether to believe or disbelieve, even when such preferences are irrelevant to the claims' accuracy (Griffin, 2003). This varying reliance upon affective versus evidential considerations is referred to as one's *belief-basis*. Additive models of belief formation relegate affective preferences to being a mere supplement to evidence-based reasoning, as exemplified by Thagard's computational model of hot cognition (HOTCO; Thagard, 2006). Such additive models do not allow for individual differences in the relative use of evidential versus affective information, but instead presume that all people engage fully in syncing beliefs with both their available evidence and their affective preferences.

In contrast, a competitive model of belief formation proposes that affective preferences may lead individuals to bypass the normative reasoning processes involved during the evaluation

of evidential and explanatory coherence, especially when those preferences favor a belief that is not easily justified via evidence-based reasoning (Griffin, 2008). Thus, a competitive model predicts that individuals will vary from each other and across contexts and claims in the relative degree to which they engage in evidence-based explanatory coherence evaluations versus reliance upon affective preferences. Although the belief-basis construct has been framed in the context of information processing during initial belief formation, it should also relate to subsequent use of new belief-relevant information as well as prospective reports of intention to use information.

Griffin (2003) developed a simple self-report measure of belief-bases in which individuals rate statements regarding reasons they hold their belief about a specific claim (e.g., the theory of evolution). The statements in the measure refer to the general abstract notions of “evidence I am aware of” and “scientific evidence” versus affective notions of “comfort”, “use my heart and not my head”, and “just have faith”. People who self-report basing their belief on these affective preferences during belief formation not only also self-report less consideration of relevant evidence and scientific information (Griffin, 2008), but have poorer comprehension of evidence-based information that is either supportive or contradictory of their belief (Griffin, 2003). This poorer comprehension holds even after partialling out variance from prior knowledge of text information, general comprehension skill, task engagement, and reading strategies (Griffin & Salas, 2012). This effect of belief-basis on comprehension is consistent with the assumption that affect-based believers had not previously attempted to reason about relevant evidence they were exposed to, resulting in a less internally coherent body of conceptual knowledge that negatively influenced their ability to construct an accurate representation of novel belief-relevant information.

One assumption of this prior work is that self-reported belief-basis reflects one's willingness and preference to evaluate and utilize evidence-based information about a claim rather than rely on affective preferences. Given the relationship between valence and affect, individuals who adopt an affect-based route to belief should be more likely to incorporate valenced consequences when describing the reasons for their belief. From these assumptions, it follows that self-reported belief-basis should predict how readers respond to and incorporate information that varies in whether it relates to direct, claim-relevant evidence versus valenced consequences of belief in that claim.

This context has ecological validity given that valenced consequences of belief are employed in public debates over whether one should hold those particular beliefs. For example, valenced consequences of belief are the common subject in arguments seeking to persuade people that the theory of evolution is false and that students should be taught in science class that the theory is incorrect (Gitt, 1995; Ham, 1998). In the service of trying to convince people that "evolution is false" and a "misrepresentation of reality", authors will argue that the consequences of belief in the scientific theory of evolution "undermines the foundation of our salvation" and "the very thought of purposefulness" (Gitt, 1995). This rhetorical tactic takes advantage of the long established finding in social psychology that people can be persuaded to accept objectively wrong conclusions about factual issues (Latané, 1981), even when the conclusion is contradicted by directly observed evidence (Asch, 1955), if the believer feels the negative consequences of social rejection are stronger than the consequences of being incorrect (Baron, 1996).

Therefore, the main goal of the present project is to test whether self-reported, retrospective use of evidence and affect during belief formation predicts how people incorporate new specific information about a theory or its consequences when it is made readily available to

them. Belief-bases in evidence versus affect have not been previously studied in relation to how people process, evaluate, and utilize various types of information and arguments. However, an individual difference construct - thinking dispositions - that is conceptually and empirically related to belief-bases has been shown to influence aspects of information processing involving argument evaluation and/or use of evidence.

Thinking Dispositions and Argumentation

Stanovich and West (1997) examine *thinking dispositions*, which they define as differences in general epistemic values or goals that can impact the motivation needed to engage in more computationally costly analytic-based rather than heuristic-based processing. They measured this disposition with an *actively open-minded thinking* (AOT) scale that assesses tolerance for new ideas, uncertainty and disagreement, and the willingness to put forth effort to solve problems and revise current beliefs, especially in light of new evidence. Individuals with high AOT scores evaluated objective argument quality more accurately than those with lower AOT scores, and their evaluations were less biased by prior belief consistency, even when controlling for cognitive ability (Stanovich & West, 1997; West et al., 2008). In a separate study, Sá et al. (2005) found that people low in AOT were more likely to generate arguments that simply reiterated their personal theory rather than include supporting evidence.

This research suggests that individual differences in thinking dispositions predict how people evaluate the quality of other people's arguments that are relevant for their own beliefs, and whether they include evidence in their own arguments. A person who is less sensitive to objective argument quality and the importance of claim-relevant evidence may be more likely to find valenced consequences of a belief to be compelling reasons for accepting or rejecting that belief. The AOT measure only contains a few items (out of 42) that measure the importance

placed on attending to evidence and none that assess the importance of affect. However, Griffin and Salas (2012) found that this subset of AOT items does modestly predict people's evidence-affect belief-basis scores for evolution beliefs ($r = .53, p < .05$). Thus, the literature on thinking dispositions provides some empirical basis to predict that individual differences in belief-basis will relate to whether readers incorporate into their own justifications information from various texts that present either theory-relevant or consequence-relevant information.

Current Study

The current study presented students with two types of texts. Theory-relevant texts were those that provided evidence directly relevant to evaluating the veracity of the scientific theory of evolution. Half of these theory-relevant texts provided evidence for the theory of evolution and half provided evidence against the theory of evolution. In contrast, consequence-relevant texts provided information about the valenced consequences of accepting the theory of evolution. Half of these texts discussed consequences with a negative valence that most people would likely find unpleasant (e.g., increased depression and violence), and the other half discussed positively valenced consequences that most people would likely find pleasant (e.g., emotional well-being and reduced environmental threats).

The reviewed findings combined with the theoretical assumptions underlying the competitive model of belief formation and the belief-basis measure lead to two complementary predictions. First, individual differences in whether people formed their prior belief by considering evidence or by relying on affective appeal (i.e., belief-basis scores) should predict relative differences in the types of texts that readers draw information from when describing the reasons why they accept or reject the theory of evolution. A second hypothesis is that belief-

basis scores should predict differences in how participants rate their prospective likelihood of using information from the different text types to maintain or revise their belief.

Theory-relevant and consequence-relevant information that either favored or dis-favored belief in the theory of evolution was made equally available. Care was taken to provide a context in which external academic learning goals or pressures to justify their belief according to academic or scientific standards were minimal. Participants were given the opportunity to examine each text during an initial reading task, and were subsequently allowed to make use of the text information in the context of writing an essay describing their own acceptance of the theory of evolution. Readers who previously reported that their belief about evolution was more evidence-based were expected to include a greater number of text-based idea units from theory-relevant texts relative to consequence-relevant texts when compared to readers who reported affect-based prior beliefs.

In addition to the assumed preferences for different types of belief-supporting information, inclusion of text ideas in the essays could depend on differences in memory for the text content, or differences in whether readers noticed that the information provided by the texts differed in its relation to the veracity of evolutionary theory. These alternative factors were reduced for the second outcome measure of self-reported prospective use ratings. After the essay writing task, participants were given each text and rated each for how much it “provided evidence-based arguments” or “emotion-based arguments” for “whether or not evolution is true”. Although the consequence-relevant texts did not explicitly focus on whether evolution is true, they were modeled after typical emotionally persuasive arguments that use valenced consequences to argue about the truth of evolution (e.g., Baron, 1996; Brem et al. 2003; Gitt, 1995; Ham, 1998; Latané, 1981). Thus, it makes sense that readers would not view these texts as

providing evidence about the truth of evolution but still providing emotion-based arguments about the truth of evolution.

This task served partly served as a manipulation check, but also made these differing features of the texts highly salient to all readers. Then, with the texts still in front of them so that text memory was not required, readers rated their prospective likelihood of using information from each of the texts in order to support or maintain their belief. It was hypothesized that readers with more evidence-based prior beliefs would give greater prospective use ratings to theory-relevant texts than consequence-relevant texts when compared to readers with affect-based prior beliefs. It was also hypothesized that readers with affect-based beliefs would even give higher use ratings to the texts that they themselves explicitly acknowledged were more emotion than evidence-based with regard to arguing about the truth of evolution.

The essay and self-report predictions rest on the assumption that prior belief-bases are at least partly due to competing preferences for evidence-based versus affect-based justifications for one's belief. Alternative possibilities are that self-reported prior belief-bases merely reflect differences in prior exposure to various types of arguments, differences in how the abstract terminology of "evidence" and "faith" used in the belief-basis measure is interpreted, or differences in the motivation to report having been more rational than one actually was in forming their belief. These alternative factors that might underlie self-reported belief-bases do not make clear predictions about how belief-bases would relate to people's inclusion of the concrete, specific, and equally available information in the theory-relevant versus consequence-relevant texts.

II. METHOD

Participants

One hundred and twenty undergraduates from the psychology subject pool at the University of Illinois at Chicago participated in this study. Twenty two participants were dropped from the analysis due to missing data, and three were dropped due to a failure to follow instructions. The resulting sample was 68% female and the average age was 19.18 years ($SD = 1.42$). Self-reported ethnicity was 3% Native American/ Alaskan Native, 2% Middle Eastern, 25% Asian/Pacific Islander, 8% African American, 19% Hispanic, 40% White, and 3% Other.

Materials

Pre-study questionnaire. The pre-study questionnaire contained items designed to assess students' beliefs about evolution, belief-basis for evolution, prior knowledge of evolutionary theory, and general thinking disposition. Each scale is described briefly in the following subsections (see Appendix A for the complete questionnaire including instructions and items).

Beliefs and belief-bases. Participants rated their level of disbelief or belief (1 – 9 scale) in the claim that “All life forms on Earth, including humans, evolved over millions of years from early life forms.” After reporting their belief, participants completed a previously validated belief-basis scale (See Appendix A; Griffin, 2008; Griffin & Ohlsson, 2001) to indicate the basis for holding their belief. The five items consist of two evidence-relevant reasons and three affective reasons. The difference in number of items per type (i.e., two versus three) stems from factor loading cutoffs after testing multiple items and alternative phrasings during validation (see Griffin, 2003).

The two evidence-relevant items assess the degree to which participants considered “evidence [they are] aware of” and “support from science” when forming their belief. The three affective items assess the degree to which they based their belief on affective motivations related to “comfort”, “trusting [their] heart and not their head”, and “faith”. A difference score was computed by subtracting the mean of the affect-based items from the mean of the evidence-relevant items. Thus, higher belief-basis scores reflect a greater use of evidence relative to affect.

General evidence-seeking disposition. Since Griffin and Salas (2012) found that a modified measure of thinking dispositions (AOT) predicted both belief-basis on evolution and single text comprehension, this measure was included for exploratory purposes. Participants indicated their general disposition towards considering evidence when forming their beliefs by rating five statements that were adopted from the Flexible Thinking subscale of the Actively Open-Minded (AOT) thinking dispositions questionnaire (Stanovich & West, 1997).

Conceptually, this subset of AOT items was selected because of their explicit reference to how one should respond to evidence that conflicts with one’s beliefs (see Appendix A). In this study, the AOT measure and belief-basis were correlated ($r = .44, p < .05$) and related to all of the dependent variables in a similar manner so this measure will not be discussed further.

Assessment of prior knowledge. Participants’ prior knowledge about biological evolution was assessed using a five-item, multiple choice test designed to assess understanding of core concepts in the domain of evolution including natural selection, random genetic variation, differential reproduction, and speciation (see Appendix A). The concepts and phrasing of correct and incorrect choice options were taken from the open-ended responses that students gave in interview style prior knowledge assessments by Shtulman (2006). The current measure has been

shown to predict memory and comprehension of expository science texts about evolution (Salas & Griffin, 2010).

Texts. Eight texts were split across a 2 (Text-Position: pro-evolution vs. anti-evolution) x 2 (Text-Type: theory-relevant vs. consequence-relevant) design such that two texts were constructed for each cell. The four pro-evolution texts provided information that favored belief in the theory of evolution, either by presenting theory-supporting evidence or information about positively valenced consequences of belief. The four anti-evolution texts provided information that favored disbelief in the theory of evolution, either by presenting theory-contradicting evidence or information about negatively valenced consequences of belief. The texts discussed belief in evolution in terms of both “a *belief in/against* evolution” and “*accepting/rejecting* evolution as true.” Norming data collected on separate participants’ agreement ratings for both of these types of wordings suggested that they indeed viewed “belief in” and “acceptance of” phrasings as interchangeable ($r = .86, p < .01$). The lack of a perfect correlation is possibly due to expectations based off of Gricean norms, wherein participants assumed that these two opinion questions must be asking something slightly different. Two of the pro and two of the anti-evolution texts presented theory-relevant arguments: likewise, two of the pro and two of the anti-evolution texts presented consequence-relevant arguments. Thus, each text-type was represented equally across position. Texts were on average 312 words long (range: 264-356). Refer to Appendix B for the full texts.

Regardless of text-position, theory-relevant texts were written in an expository format typical of a science text. Theory-relevant texts were modified from Griffin (2003) and presented arguments with evidence directly relevant to whether or not the theory of evolution is true. The consequence-relevant texts were also written in an expository manner with claims and supporting

examples, but presented claims about positively or negatively valenced consequences of believing in evolution. These texts were modeled after typical emotionally persuasive arguments that attempt to motivate readers to accept or reject evolution, without reference to evidence relevant to the theory's veracity (Gitt, 1995; Hamm, 1998). Specifically, the consequence-relevant texts presented claims either for or against believing in evolution that were based on a desire to achieve or avoid the subjectively valenced consequences. Although the texts provided examples or evidence of these claimed consequences, the evidence pertained only to the *consequences* of belief in the theory. The texts did not provide evidence relevant to evaluating the veracity of the theory itself. The consequences were selected from a sample that had been identified in previous studies (see Brem, et al., 2003), and concerned racism, morality, and a sense of purpose, with the addition of a positively valenced consequence of feeling connected to nature and an ethics-based and threat-based environmentalism.

Specific phrasing in the consequence-relevant texts was included to convey the authors' valenced evaluations and subjective appraisals about the desirability of the consequences. Examples for the anti-evolution texts include the consequences of accepting evolution as being "unjust" "unethical", "unfortunate", "shocking", "damaging", "against our "values", "negatively impacting society" and causing "problems" and a view of life that is "emotionally disturbing", "emotionally damaging", "grim", "tarnished" and "depressing". For the pro-evolution texts, consequences of accepting evolution are described as "emotionally satisfying", promoting "ethically required" and "responsible" behaviors and reducing "damage" and "threats" while yielding "positive benefits" of "improved emotional well-being" that helps us "thrive", "progress", and "embrace" what we should.

This appeal to positive or negatively valenced motivations and reasons for accepting or rejecting evolution that are not relevant to the *veracity* of evolutionary theory is what operationally defines a consequence-relevant argument. Consistent with the construal of valence as reflecting positive or negative affective appraisals, consequence-relevant texts therefore contained the following general structure: belief in the theory of evolution has an impact on how the believer feels towards something (other people, nature, their life), and that change in how people feel is something that the believer finds desirable or aversive.

Regardless of text type, each text presented two main arguments to support its position of whether one should or should not accept the theory of biological evolution as true. Main arguments loosely served as thesis statements for each of the two paragraphs and contained two to three additional components such as a general summary statement, more detailed elaborations, and clarifying examples. For instance, one pro-evolution theory-relevant text argued that evolution should be accepted as true by providing the “the presence of useless vestigial features” as a main argument, and then provided several concrete examples of human vestigial features such as “wisdom teeth, tailbone, the appendix, etc.” An anti-evolution consequence-relevant text argued that belief in evolution should be rejected given the main reason that “belief in evolution causes a depressive view”, and then elaborated on this by stating that “evolution is known to decrease one’s sense of meaning and purpose”. Each main argument along with its relevant summary statements and/or clarifying examples jointly served as a target concept that participants could potentially include in their essays. Specific coding criteria will be further described in the essay coding section.

Since participants initially selected documents to read based on their titles, titles for the

texts were designed to make the type of text (theory-relevant vs. consequence-relevant) obvious to readers. Each title conveyed the gist of the main reasons provided by the corresponding text. As previously discussed, even though the consequence-relevant texts did not explicitly state the reader should accept or reject evolution, we anticipated that the text authors' biased efforts to use valenced consequences to persuade belief or disbelief in evolution would likely be obvious. In fact, it seems extremely rare (we could find no examples) that a speaker would emphasize highly valenced consequences of belief in evolution without having an overarching goal of trying to persuade the audience to accept or reject belief in the theory of evolution. Thus, we expected that readers would view the consequence-relevant texts as comprising emotion-based arguments.

Pilot testing of the text titles indicated that participants were able to detect the intended nature of each text. Using a Likert scale where 1 represents *disagree strongly* and 9 represents *agree strongly*, twenty pilot participants rated each text, based only on the title, for whether they thought it presented “evidence-based reasons to support its position” and “emotion-based reasons to support its position.” A difference score was computed by subtracting the “emotion-based” rating from the “evidence-based” rating for each text. Scores above zero indicate that the text’s arguments were viewed as more evidence-based while scores below zero indicated the text’s arguments were viewed as more affect-based.

The theory-relevant texts had positive scores ($M = 3.08, SD = 2.31$), and no participants had a difference score below zero. A t-test indicated that theory-relevant difference scores were significantly greater than zero, $t(19) = 5.95, p < .001$. The consequence-relevant texts had negative scores ($M = -2.52, SD = 2.54$), with only one participant having a slightly positive difference score of 0.5. Difference scores for the consequence-relevant texts were significantly less than zero, $t(19) = -4.55, p < .001$. Thus, the text titles conveyed the text-type as intended.

Pilot participants rated the text-titles again after reading the full texts, and the results were the same.

In the present study, manipulation checks were conducted using the self-report ratings collected for text-position and text-type in order to examine the extent to which the text dimensions were appropriately perceived by participants (see Appendix C for rating items). Participants provided these ratings as part of the post-essay questionnaire, after their essay but immediately prior to their prospective use ratings, so that the nature of the texts was highly salient for these use ratings. For all of these ratings, scores for the two texts of each of the four types were averaged.

Manipulation check of text-position. Ratings of whether “the text argued that the theory of evolution was true” that were higher than five represent a pro-evolution rating, while values lower than five represent an anti-evolution rating. One-sample t-tests were conducted to examine whether the position ratings were significantly different from five. Both the pro-evolution theory-relevant ($M = 7.78, SD = 1.55$) and consequence ($M = 6.24, SD = 2.09$) texts were rated as significantly greater than five, $t(94) = 17.58, p < .001$, and $t(94) = 5.78, p < .001$ respectively. Likewise, both the anti-evolution theory-relevant ($M = 1.98, SD = 1.66$) and consequence ($M = 2.93, SD = 1.95$) texts were rated as significantly lower than five, $t(94) = -17.72, p < .001$, and $t(94) = -10.32, p < .001$ respectively. The texts’ intended positions were appropriately perceived by participants.

This supports the assumption that the readers viewed the consequence-relevant texts as being part of an effort to persuade them about whether evolutionary theory should be accepted as true. By themselves, valenced consequences of belief are neither pro nor anti in relation to the

veracity of the belief. However, they take on a pro or anti stance when viewed as part of an effort to persuade the reader to take a position on the theory of evolution.

Manipulation check of text-type. As with the pilot study, text-type ratings represent difference scores computed by subtracting ratings of whether the text “provided emotion-based reasons” from ratings of whether the text “provided evidence-based reasons.” Positive values indicate a higher perceived evidence basis, while negative values indicate a higher perceived affect basis. A series of one-sample t-tests were conducted in order to examine whether or not the text-type ratings in the present study were significantly different from zero (i.e., significantly more evidence or affect-based). Consistent with the pilot analyses, participants in this study viewed both the pro-evolution ($M = 3.56, SD = 2.54$) and anti-evolution theory-relevant ($M = 2.65, SD = 2.76$), texts as significantly greater than zero, $t(94) = 13.68, p < .001$, and $t(94) = 9.38, p < .001$ respectively. In contrast, both the pro-evolution consequence ($M = -1.82, SD = 2.87$) and anti-evolution consequence ($M = -2.07, SD = 2.49$) texts were rated as significantly lower than zero, $t(94) = -6.19, p < .001$, and, $t(94) = -8.11, p < .001$ respectively. Thus, participants accurately perceived the intended text types for both the pro and anti-evolution texts.

Essay writing prompt. Participants were provided with a word document containing the following instructions:

Please write a 1-2 paragraph description regarding your personal opinion about evolution. Include the ideas and issues that have most concerned you or that you consider to be important in deciding whether to accept or reject belief in evolution. Feel free to include ideas from the essays if they are relevant to your personal views.

Participants were given ample space to type out their essays below this set of instructions. They were not given access to the texts while writing their essays.

Post-essay questionnaire. The post-study questionnaire consisted of the following sections: a text-rating section (Appendix C), a section identical to the pre-study questionnaire (Appendix A), and a demographic survey (Appendix F). The measures not already reported in the pre-study questionnaire section are briefly described below.

Text ratings and self-reported use. Participants were asked to provide a series of ratings concerning their impressions of the texts. Paper copies of all texts were provided along with a separate rating sheet for each text that includes the text title. Participants were instructed to “feel free to refer back to the text content while making the ratings for each text.” Participants rated their perception of the texts as having evidence-based and affect-based arguments (Text-Type) as well as a pro or anti-evolution position (Text-Position).

Participants reported their prospective use by rating the extent to which each text provided information they would “personally use to support [their] belief regarding whether or not evolution is true” (Support), and “personally use to maintain or revise [their] belief regarding whether or not evolution is true” (Maintain). Self-reported use ratings immediately followed text-type ratings for each text, so the evidential and emotional nature of the arguments should have been salient for all readers while reporting their prospective use. Second, any memory effects on the essays resulting from the texts being unavailable are reduced for the use ratings because participants had concurrent access to the texts.

Demographic survey. Various demographic variables were collected from participants including age, sex, and ethnicity.

Procedure

Participants completed the pre-study questionnaire as part of a mass testing requirement conducted at the beginning of the semester. In a subsequent session, consent was obtained and

participants were seated in front of a personal computer and directed to a web page containing instructions and links to the eight evolution argument texts.

The following instructions were presented on the screen and were read aloud by the experimenter:

For any particular topic, there are many different kinds of ideas and information one can find on the internet and from other sources. Our research goal is to find out what kinds of information people are naturally drawn to and interested in. Below are links to eight short texts presenting different ideas and information about the topic of biological evolution.

You will have fifteen minutes to read. We are interested in the kinds of information and ideas about evolution you would be likely to read on your own. Feel free to read the texts in any order and focus on those texts that you would be most likely to read if these texts came up on a Google search at home. These brief texts only reflect summaries and outtakes from larger texts. Afterwards, you will tell us what you thought about the texts you read and whether you would be interested in reading more.

You can select texts to read by clicking on the title links below. When you want to switch to a new text, click on the button at the bottom of each text page to return to this list. You can select the same text more than once. Before you begin, read all eight of the titles below, so you have an idea of what texts are available to choose from.

These instructions framed the task as one of forming opinions about the various texts and conveying an interest in reading more about the various types of ideas. The instructions provided a context in which there was a purpose for them to engage with the texts while not constraining them to adopt a comprehension-test orientation, thus allowing for participants' individual interests, goals, and motives related to their beliefs about evolution to guide the manner in which

they processed the texts and subsequently wrote their essay. The fifteen minutes reading time allowed readers opportunity to expose themselves to all of the texts, and is the median time that pilot participants took to read all eight texts one time from beginning to end. The instruction to read all the titles before beginning the text reading task allowed participants to expose themselves to the information needed to select texts based upon perceived content and was intended to reduce the bias to begin with the upper left link and go in sequential order.

The position of the links to each text on the web-browser was randomized, and participants were allowed to read in whatever order they choose. Timestamps were recorded for each text page, which allowed for the calculation of reading times per text. However, belief-basis effects on reading times were not expected, due to the ample time given to read all 8 texts in their entirety. Once the reading phase was complete, participants were given the essay writing prompt. Participants did not have access to the texts while writing their essays. After completion of the essay, participants were given paper copies of the texts, and responded to the post-essay questionnaire. They were then debriefed and dismissed.

Essay Coding

The essay coding scheme was designed to test the main hypothesis that when readers are asked to discuss what they consider important “in deciding whether to accept or reject belief in evolution” their inclusion of target concepts from theory-relevant texts relative to the consequence-relevant texts should vary as a function of their self-reported belief-bases. Participants’ essays were composed of several kinds of statements including participants’ statement of their belief or disbelief in the theory of evolution (i.e., belief claims), a range of non-text-based idea units, and text-based idea units.

For an illustration of the main types of statements that were coded see Appendix D, which provides six examples of typical essays. Two essays are from participants who included multiple idea units from theory-relevant texts but only 1 from consequence-relevant texts. A third essay depicts the opposite pattern with multiple consequence-relevant ideas and no theory relevant ideas. A fourth essay contains multiple ideas from both text types. The final two examples depict essays that did not include idea units from any of the texts. One of these essays argues against belief in evolution due to religion, while the other argues for accepting evolution by primarily explaining what the theory says.

Belief claims and non-text-based idea units were not included in any of the study's main analyses, but are included as part of a general description of the nature of students' essays. Text-based idea units were the study's outcome variable of focus. Text-based idea units in the essays were coded according to the list of predetermined target concepts included in Appendix E. In order to interpret the text-based idea unit codes, please refer to the reference key of predetermined target concepts. Each target concept represented an argument that participants could include in their essay describing their reasons for the acceptance or rejection of evolutionary theory. Since each text was designed to have two main arguments, these were the target concepts. The texts included multiple components to each argument, such as a general summary statement, more detailed elaborations, and supporting examples. Participants could reference a target concept by referring to any of these aspects of the argument.

Scoring involved coding each target concept by using a decision rule that assigned a score of "1" if one or more of these ways of referencing the concept were present in an essay, regardless of whether these appeared in part of a sentence, across many sentences, or were repeated more than once. A score of "0" was given to any target concepts not included in the

given essay. Appendix E shows the most general wording of each target concept and the alternative wordings that counted as referencing the target concept. During the initial coding, every component (e.g., summary statement, examples) of a target concept was coded for its presence or absence, and then these were collapsed into a single 0-1 score for each target concept using the above rule. These steps helped ensure that a present concept was not overlooked and/or that multiple mentions of the same concept were not counted as mentions of two different but related concepts. Computing a final essay score involved tallying up all target concepts per essay. With two target concepts per text and two texts of each type, this resulted in a maximum score of four text-based concepts per each of the four text types.

In addition to coding their presence/absence in each essay, text-based idea units were also coded for whether participants agreed with or refuted them. Given that participants were instructed to describe their own belief (rather than refute text information), any target concepts present in the essays were assumed to serve a supportive function by default, unless the participant explicitly indicated disagreement with the text idea, in which case it was coded as serving a refute function. This rhetorical function coding was utilized as a within participant factor in the repeated measure ANCOVA analysis, thereby allowing for tests that collapse across rhetorical function and tests of interactions between function and other variables.

Essays were coded by two independent coders. A single reliability estimate was calculated by treating supportive mentions of each text idea and refuting mentions of each text ideas as independent 0-1 codes. In principle, a participant could mention an idea both in a supporting and a refuting function, though this never occurred. In addition, reliability was calculated using the initial 0-1 codes for each component of the target ideas, thus creating a more conservative estimate since it captures disagreements about components, even though these

would not impact the aggregate 0-1 codes for the target concepts. ReCal was used to calculate Krippendorff's alpha (Freelon, 2010), which indicated a high level of interrater reliability, $\alpha = .95, p < .05$.

It is possible that there is some interesting variance in whether participants make a more general or detailed reference to a target concept and how much of a text-based argument they include. However, the predicted results and theoretical basis focus on potential preferences for types of reasons people incorporate into their evolution belief justifications rather than quantity of information or preferences for providing a summary versus details of that information. This is especially the case in the present context of writing a simple descriptive essay rather than being asked to provide a detailed persuasive argument. Counting the various alternate wordings of the target concepts as separate increases the risk of adding noise variance via the effects of third variables that might be related to verbosity, articulative style, etc. In addition, results for the predicted Belief-Basis x Text-Type interaction emerged regardless of whether the described any-or-none coding rule was used or each alternate wording was counted separately and either summed or analyzed using only the most general wording or the more detailed alternate wordings. Finally, there are additional validity problems introduced by making nuanced distinctions between where one component of a target concept ends and another component begins.

III. RESULTS

Descriptive Statistics

Essay outcome variables. Essays contained an average of 1.76 ($SD = 1.27$) unique text-based idea units (range: 0-5). See Figure 1 for mean number of idea units per text type. Values for number of target concepts in the essays were normally distributed, with skewness and kurtosis values both falling within acceptable levels of normality (i.e., $< |1|$).

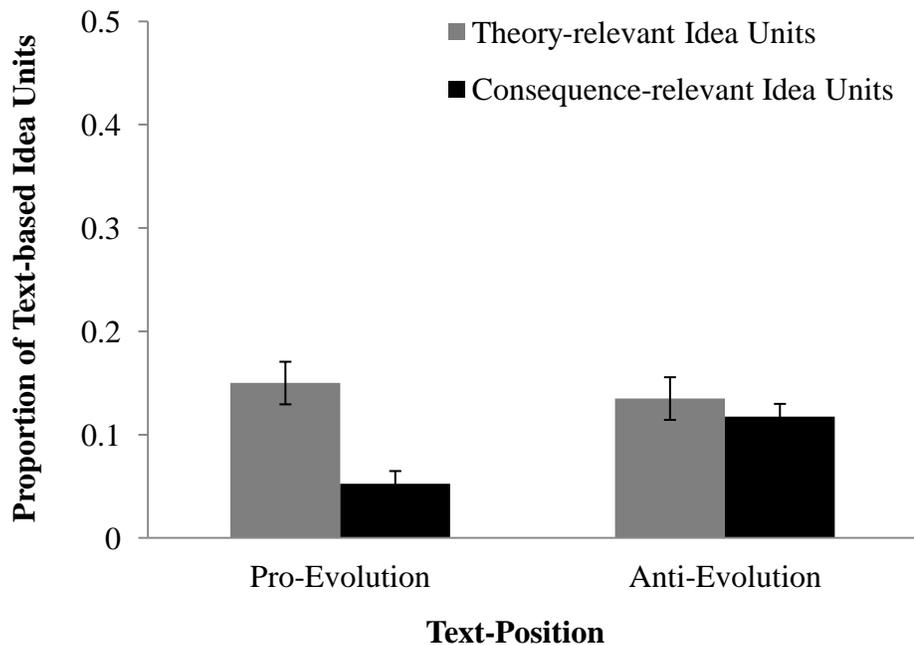


Figure 1. Proportion of Text-based Idea Units for each Text-Type by Text-Position

Although a total of 16 text-based idea units were possible per essay, there were only 4 possible target idea units from each text type. This is relevant because participants might be expected to focus on the ideas in one of the 4 text types. For example, an evidence-based believer in evolution might focus only on the 4 ideas included in pro-evolution theory-relevant texts, especially since they were asked to describe their own reasons for their belief about evolution, and not asked to address all arguments in the texts.

This tendency was supported by a negative correlation ($r = -.21, p < .05$) between inclusion of idea units from theory-relevant and from consequence-relevant texts. The more participants focused on including information from theory-relevant texts the less likely they were to include information from consequence-relevant texts. Of course, the opposite is also true. A similarly negative correlation ($r = -.22, p < .05$) was observed between participant's inclusion of idea units from pro-evolution texts and anti-evolution texts. These negative relationships between using ideas of different text types constrain the total idea units that would likely be observed.

Participant essays contained an average of 9.78 ($SD = 3.63$) sentences and a mean of 196.82 ($SD = 59.72$) words per essay. However, examining a representative sample of essays indicated that text-based idea units comprised an average of 113.56 ($SD = 49.99$) of the total words in each essay. Hence, participants spent the majority of their essays (58%) discussing text-based ideas. The composition of what were coded as text-based idea units was not merely a verbatim description of target concepts. Rather, idea units were paraphrased from the texts and commonly included “filler information” such as rhetorical devices, transitional statements, additional descriptive commentary, statements of agreement or disagreement, etc. For examples of these please refer to the essays in Appendix D.

The portion of the essay that was not comprised of text-based idea units included belief-position claims and information not attributable to any particular text source in the present study. All but two participants explicitly indicated their degree of acceptance of or belief in the theory of evolution one or more times throughout their essay, usually as the first sentence of their essay, with many participants reiterating this position later in the essay. Essays in the Appendix D provide a clear example of this. Participants supported their statement of belief with a

combination of text-based and non-text-based information. The non-text-based information reflected five general categories including prior knowledge of evidence, appeal to scientific authority consensus, religious authority/beliefs, definitional statements, and those classified as other.

Self-report prospective use variables. The self-reported prospective use variables of Maintain and Support were highly correlated ($r = .81, p < .001$) and all results were virtually identical for each variable. These two use ratings were therefore averaged to create a composite used in all subsequent self-report prospective use rating analyses. Participants indicated an average self-report prospective use rating of 4.27 out of 9 ($SD = 1.31$), with values ranging from 1.19 to 7.31. Values for the self-report use ratings were all normally distributed, with skewness and kurtosis values both falling within acceptable levels of normality (i.e., $< | 1 |$).

Correlations among Covariates and Belief-Basis

Several control variables were included in all subsequent analyses, given their theoretical overlap with the predictor and criterion variables of interest. For example, a previous study found that prior evolution knowledge and ACT math scores both correlate with comprehension of expository science texts about evolution, $r(26) = .57, p < .001$, and $r(32) = .30, p < .05$ respectively (Salas & Griffin, 2010). Longer essays are more likely to contain a greater total number of ideas as well, so essay length in number of words was also controlled for.

Pearson correlations among these three control measures (i.e., prior knowledge of evolution, ACT math scores, and essay length), belief-basis, and number of text reasons in the present study are shown in Table 1. There was a significant positive correlation between belief-basis scores and participant's prior knowledge of evolution. In turn, more prior knowledge was marginally related to higher ACT math scores, and higher ACT math scores were significantly

related to longer essays. Longer essays were also significantly related to a greater number of text ideas. These control measures could further relate in complex ways to the *type* of text ideas

Table 1

Pearson Correlations, Means, and Standard Deviations for Belief-Basis, Number of Text Based-Idea Units, Prior Knowledge, ACT Math Scores, and Essay Length

Measure	1	2	3	4	5
1. Belief-Basis	—				
2. Prior Knowledge	.25**	—			
3. ACT Math	.08	.15 [†]	—		
4. Essay Length	-.03	.12	.28**	—	
5. Text-Based Idea Units	.01	-.01	.08	.33**	—
<i>M</i>	3.04	1.28	24.48	196.82	1.76
<i>SD</i>	3.40	1.16	4.06	59.72	1.27

Note. $N = 95$. [†] $p < .10$. * $p < .05$. ** $p < .01$.

readers include in the essays and were therefore included as covariates in the main analyses.

Relationship between Belief-Basis and Outcome Variables

Analysis plan. Gully (1994) presents a method for testing interactive effects among within-subjects categorical variables and a continuous between-subjects variable. In accord with this adaptation of Cohen and Cohen (1983), the within-subjects factors (i.e., text-position and text-type) were entered as usual into a repeated-measures analysis of co-variance (ANCOVA) and the continuous predictor variable (i.e., belief-basis) was entered as a covariate. In contrast to typical situations where the covariate is viewed as a mere control variable, the covariate by within-subjects factor interaction terms are central to the tests of the hypotheses. The ANCOVAs and all follow-up tests also included the control variables of prior knowledge of evolution, ACT math scores, and essay length in number of words.

The central hypotheses were that individuals who previously self-reported evidence-based beliefs would be more likely than those with affect-based beliefs to (1) selectively include

information from theory-relevant texts compared to consequence-relevant texts in their belief description essays, and (2) rate such text information as something they would use while supporting their belief. These hypotheses would be supported by a Belief-Basis x Text-Type interaction, such that the relative use of theory-relevant information over consequence-relevant information is greater for people who report more evidence-based beliefs.

To aid interpretation of any observed interactions, a regression approach was used to estimate the mean levels of the outcome variables for participants who were either strongly evidence-based or affect-based in their prior beliefs (i.e., ± 1.5 standard deviations above and below the belief-basis mean score, respectively). Estimated means for each outcome measure were computed as follows:

$$\widehat{Y}_{outcome} = \alpha + \{B_{bb} [\mu_{bb} \pm (\sigma_{bb} * 1.5)]\} \quad (1)$$

where α is the y-intercept, B_{bb} is the unstandardized regression coefficient for belief-basis, and μ_{bb} and σ_{bb} are the mean and standard deviation of belief-basis scores, respectively. This is the approach typically used in creating point estimates to interpret continuous moderator effects in multivariate regression (Aiken & West, 1991; Cohen & Cohen, 1983). These estimated means were plotted to illustrate the observed significant interactions revealed by the ANCOVA analyses.

In addition and consistent with Gully (1994), a statistical follow-up to any Belief-Basis x Text-Type interactions was performed by correlating belief-basis scores with the consequence minus theory-relevant difference score for each outcome measure. The difference score is a measure of the text-type effect for each participant and reflects their degree and direction of differential use of theory-relevant versus consequence-relevant information. Thus, a positive correlation between this difference score and belief-basis would support the hypothesis that the

greater relative use of theory-relevant over consequence-relevant information is stronger for readers with more evidence-based prior beliefs (higher belief-basis score).

Effects on inclusion of text-based idea units in essays. A Text-Position x Text-Type x Rhetorical Function repeated-measures ANCOVA with belief-basis as the covariate was conducted to test for potential interactive effects on the number of text-based idea units that readers included in their essays. Prior knowledge scores, ACT math scores, and essay length in words were also entered as controls. There was a significant main effect of text-position, $F(1, 90) = 10.53, p < .01, \eta_p^2 = .11$. More idea units were included from the anti-evolution texts ($M = .96, SD = 1.06$) than from the pro-evolution texts ($M = .80, SD = .96$), as seen in Figure 1. There were no significant main effects of text-type, rhetorical function, or belief-basis, $F_s < 2$. Results indicated a significant Belief-Basis x Text-Type interaction as well as a Belief-Basis x Text-Position x Rhetorical Function x Belief-Basis interaction, $F(1, 90) = 10.37, p < .01, \eta_p^2 = .10$, and $F(1, 90) = 5.42, p < .05, \eta_p^2 = .05$ respectively. No other interactions were significant, $p_s > .10$.

Figure 2 depicts the Belief-Basis x Text-Type interaction by plotting the estimated text-based idea units for readers with more evidence-based beliefs (i.e., + 1SD on belief-basis) and readers with more affect-based beliefs (i.e., - 1SD on belief-basis). Estimated means for each group were computed using prediction equations (see Equation 1). As hypothesized, individuals with more evidence-based beliefs showed greater selective inclusion of information from theory-relevant over consequence-relevant texts, whereas individuals with more affect-based beliefs showed the opposite pattern.

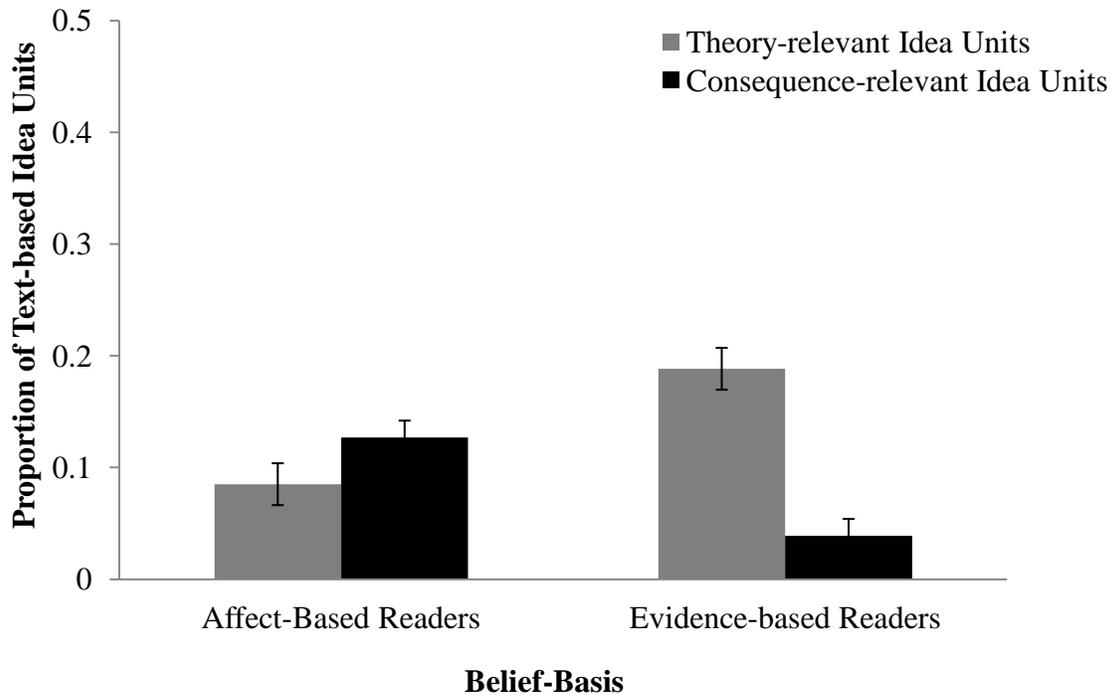


Figure 2. Proportion Text-Based Idea Units by Belief-Basis Collapsing across Rhetorical Function

Note that because these are point estimates they are for interpretive purposes only. The significance test of the differential text-type effect for evidence and affect based believers is reflected by the correlation between each reader’s belief-basis and their theory-relevant idea units minus consequence-relevant idea units difference score. The significant positive correlation ($r = .32, p < .001$) reflects the greater selective inclusion of theory-relevant over consequence-relevant information for readers with more evidence-based prior beliefs. The fact that this interaction was not qualified by any high-order interaction involving both these two variables means that the same pattern held for both pro and anti-evolution texts and regardless of whether the ideas were referred to in a supportive or refutational manner.

The only other significant interaction effect involved the support versus refute function variable but did not involve the central variable of text-type. This was a Rhetorical Function x Text-Position x Belief-Basis interaction. The described regression approach was used to compute estimated mean text-based idea units for readers with more evidence-based beliefs and readers with more affect-based beliefs as a function of text-position and rhetorical function (see Figure 3). The estimated means depict a tendency of evidence-based readers to primarily refer to the text ideas by including the pro-evolution information in a supportive manner while refuting ideas from the anti-evolution texts. In contrast, affect-based readers primarily referred to the anti-evolution texts in a supportive manner while refuting ideas of pro and anti-evolution texts to an equally low degree.

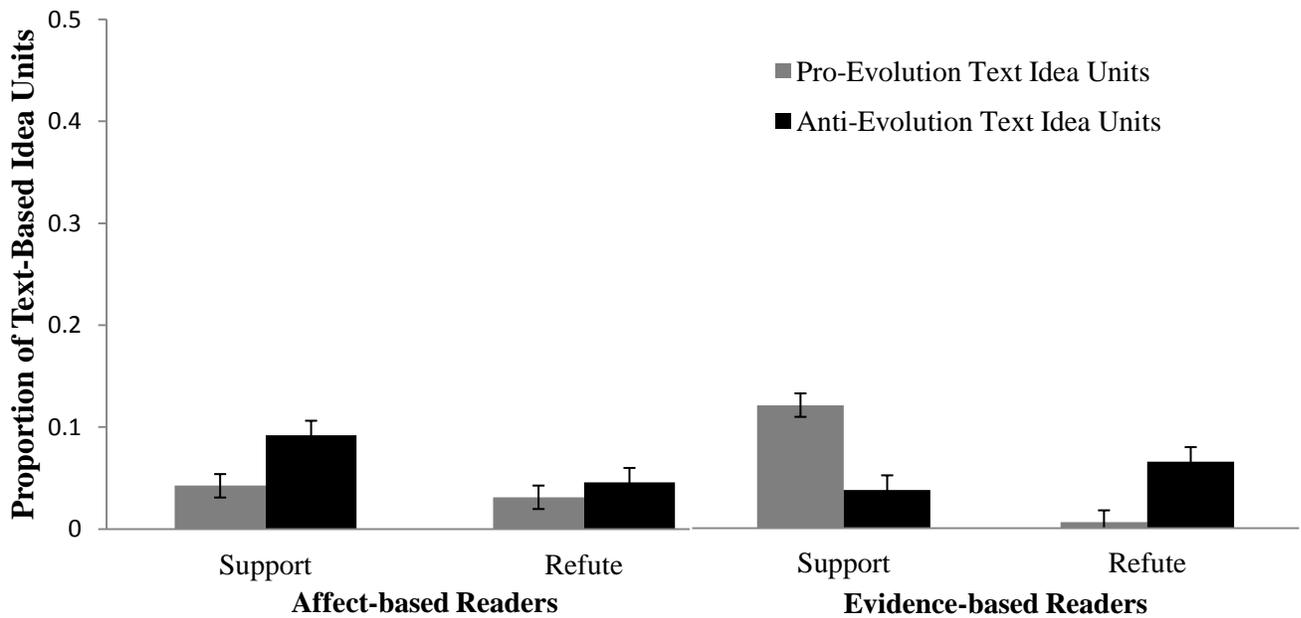


Figure 3. Proportion of Text-Based Idea Units as a Function of Text-Position, Rhetorical Function, and Belief-Basis.

Independent from its relation to the types of texts people referred to, belief-basis also appears to relate to the manner in which participants made use of the pro versus anti-evolution

texts. Though interesting and indicative of strategic position-biased use of the text information, this result is not relevant to the central hypotheses since it does not include or qualify any effects involving the critical variable of text-type. To statistically follow-up this three way-interaction, belief-basis scores were correlated with participants' number of idea units from the pro-evolution minus anti-evolution texts. These correlations were separately computed for the support and refute functions. The resulting coefficients indicate that the more readers' prior beliefs were evidence-based the greater their tendency to support their beliefs using information from pro-evolution more than the anti-evolution texts ($r = .23, p < .05$), and the lesser their tendency to refute more ideas from pro-evolution than the anti-evolution texts ($r = -.15, p = .10$). However, this latter relationship was only marginal, perhaps due to the generally low frequency of refutations.

Effects on self-reported prospective use. The same ANCOVA performed on the essay coding was performed on participants' self-reported prospective use ratings, except that Rhetorical Function was not included as a variable, since it only applies to how readers used text ideas in their essays. The results of the ANCOVA yielded no significant main effects for text-position, $F(1, 90) = .15, ns$, text-type, $F(1, 90) = .38, ns$, or belief-basis, $F(1, 90) = 2.51, ns$. Both the Belief-Basis x Text-Position and the Belief-Basis x Text-Type interactions were significant, $F(1, 90) = 11.13, p < .001, \eta_p^2 = .11$, and $F(1, 90) = 6.71, p < .01, \eta_p^2 = .07$, respectively. However, these two-way interactions were qualified by a Text-Position x Text-Type x Belief-Basis interaction, $F(1, 90) = 5.59, p < .05, \eta_p^2 = .06$. Figure 4 displays the estimated mean self-reported use of each text-type for evidence-based and affect-based readers.

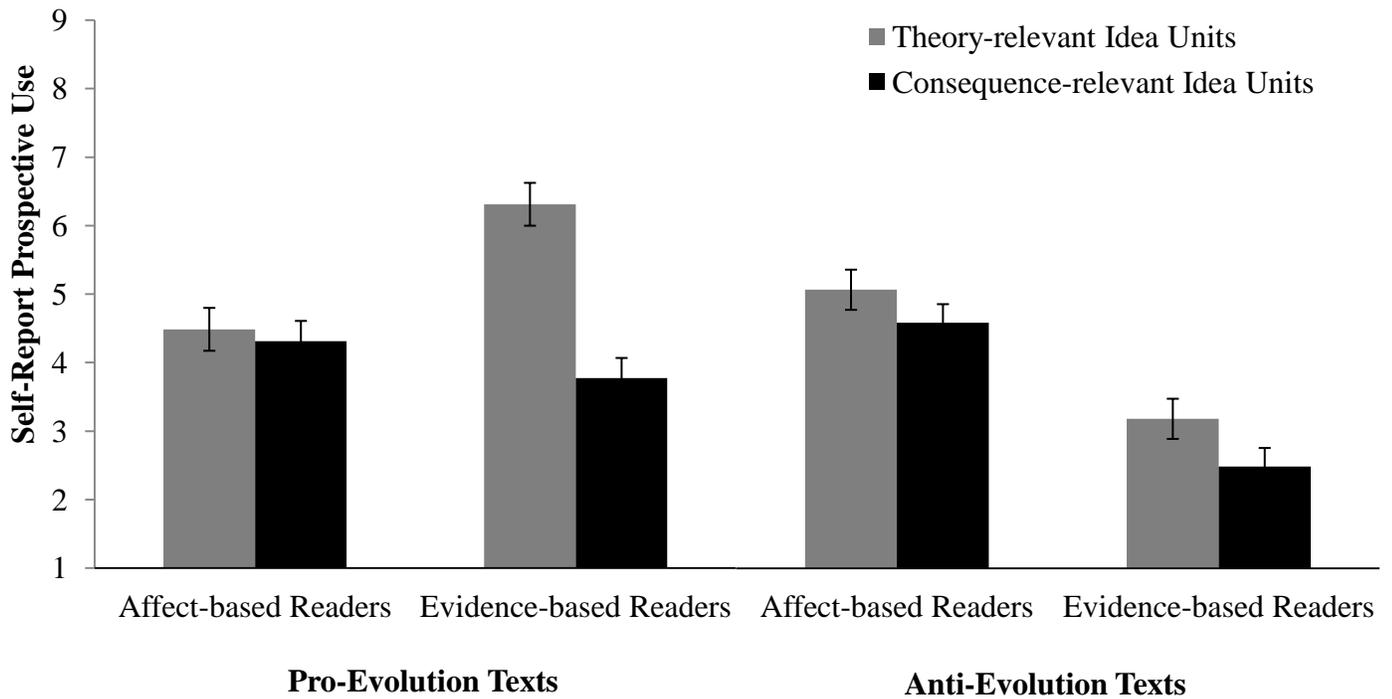


Figure 4. Self-Report Ratings as a Function of Text-Position, Text-Type, and Belief-Basis.

The estimated means show that the Belief-Basis x Text-type interaction existed only for the pro-evolution texts. Consistent with the essay coding results, evidence-based readers reported that they would use the pro-evolution theory-relevant texts more than the pro-evolution consequence-relevant texts to support/maintain their belief. In contrast, affect-based readers gave intended use ratings near the mid-point of the scale, regardless of text-type or text-position. Evidence-based readers gave similarly low use ratings (≤ 3.0 on a 1 to 9 scale) to both types of anti-evolution texts. The strong discrimination in reported use that evidence-based readers showed between the pro-evolution and anti-evolution theory-relevant texts is consistent with the fact that they supported the pro-evolution theory-relevant ideas in their essays but refuted the anti-evolution theory-relevant ideas. It makes sense that they would not intend to use ideas that they thought invalid enough to explicitly refute them in their essays.

To follow up the three-way interaction, belief-basis scores were correlated with participants' theory-relevant minus consequence scores for the reported prospective use measure

but this was done separately for the pro and the anti-evolution texts. For the pro-evolution texts, there was a positive correlation ($r = .34, p < .001$) indicating that the inclination to report greater prospective use of theory-relevant texts relative to consequence-relevant texts was stronger for readers whose prior beliefs were more evidence-based. There was no such relationship for the anti-evolution texts ($r = .03, ns$).

Belief-basis and reading times. Another possible explanation for the essay coding and self-reported use results described above is that they resulted from *initial exposure* differences during reading that would impact later retrieval and availability to be included in the essays. The fact that readers were given enough time to read all 8 texts makes this less likely. However, this explanation can be empirically tested by examining the reading times for each text-type. If initial exposure to the texts was critical to the observed essay results, then the same pattern should be seen in the reading time data that was seen in the essay and reported use data, namely an interaction involving both belief-basis and text-type. An ANCOVA was conducted with reading times as the dependent variable. Six participants were missing reading time data and were therefore excluded for this analysis.

Results of the ANCOVA yielded only a significant main effect for text-position, $F(1, 83) = 5.42, p < .05, \eta_p^2 = .06$. Overall, participants spent slightly more time reading (in seconds) the anti-evolution texts ($M = 381.48, SD = 98.24$) than the pro-evolution texts ($M = 366.16, SD = 90.92$). However, there were no other effects on reading time, $F_s < 1.66$. The lack of any effects involving either text-type or belief-basis means that initial exposure as indicated by reading times cannot account for any of the key findings on essay or the reported use measures.

IV. DISCUSSION

The results supported the hypothesis that self-reported, retrospective use of evidence and affect during belief formation would predict the type of new information that people incorporate into their description of their beliefs. Specifically, a belief-basis by argument-type interaction revealed that individuals who self-reported more evidence-based beliefs incorporated more of the information from the theory-relevant texts into their belief description but included very little information from the consequence-relevant texts. Individuals with more affect-based beliefs showed the opposite pattern by including more consequence-relevant information than theory-relevant information. Furthermore, this particular interaction was not qualified by a higher-order interaction involving text-position or rhetorical function (i.e., support versus refute) variables. Thus, independent of text-position or whether readers agreed with or refuted the text ideas, having a more evidence-based prior belief about evolution predicted greater reference to the ideas in theory-relevant rather than the consequence-relevant texts. However, an additional 3-way interaction revealed that when evidence-based readers referred to the theory-relevant texts they did so in qualitatively different ways depending on the pro or anti-evolution position of the text. Specifically, they referred to the pro evolution theory-relevant texts in a supporting manner, but tended to refute the information in the anti-evolution theory-relevant texts.

The results for the secondary outcome measure of prospective use ratings were consistent with the essay results. Readers with more evidence-based beliefs reported greater intent to use information from the pro theory-relevant texts than the pro consequence-relevant texts, but this was not the case for the anti-evolution texts. They reported little intention to use the anti-evolution theory-relevant texts, which makes sense given that these were the texts that the evidence-based readers refuted in their essays.

The data support predictions that were derived from existing notions about the relationships between valence, affect, and the perceived consequences of belief in evolution. A central assumption is that valence reflects the subjective feelings of pleasantness and desirability that is widely thought to be a defining dimension of affect (Barrett, 2006; Colibazzi, 2010; Russell, 1980). Thus, valence is proposed to arise from an individual's subjective appraisals of a consequence as positive or negative. Prior research on the perceived positively and negatively valenced consequences of belief in evolution has shared the interpretation that such consequences reflect affective appraisals (Brem et al., 2003).

Despite being of no evidential relevance to the veracity of evolutionary theory, non-scientific arguments about whether the theory of evolution should be believed often use these valenced consequences to persuade their audiences (e.g., Gitt, 1995; Ham, 1998), and even in Darwin's era such arguments were employed, "transform[ing] what otherwise would have been a quiet scholarly meeting into a social scandal" where "tempers flared" (Farber, 1994, p. 22). These lines of reasoning imply that ideas about the valenced consequences of belief reflect and can shape the affect one experiences or expects to experience in relation to accepting a claim. Thus, differential reliance upon affective preferences to determine belief in evolution were expected to manifest as differences in use of information related to valenced consequences of belief in evolution.

The supported predictions were also derived from the assumptions of the competitive model of belief formation (Griffin, 2008). This model posits that people vary in their preferences for evidence over affective information when forming a particular belief. Accordingly, one's self-reported preference or belief-basis should predict how readers respond to and incorporate information that varies in whether it provides evidence directly relevant to the theory in question

versus information that is only relevant to the theory in that it relates to the *valenced consequences* of belief in that theory, and by implication to affective biases. If affect and evidence compete for influence on beliefs, then information related to valenced consequences of belief should compete with information about theory-relevant evidence. This competition is revealed by the generally negative relationship between people incorporating theory-relevant and consequence-relevant information into their belief description essays. Readers who referred to one type of information were less likely to refer to the other type of information. The additional assumption that individual differences in which route to belief people take reflect somewhat stable preferences was supported by the fact that previously reported retrospective belief-bases predicted what type of new information they most referenced and rated as more likely to use in the future to revise or support their belief.

These predictions of a competitive model stand contrast with those from additive models of belief formation (e.g., Thagard, 2006), which presume that people engage fully in cohering beliefs with both types of information available to them. If this were the case, then there should not be a generally negative relationship between the use the theory-relevant versus consequence-relevant information, and there should not be predictable individual differences in the relative use of these different types of information across retrospective, current, and prospective measures of information use.

The current data suggest that the epistemic basis of a learner's prior belief has implications for what they do in a multiple-text paradigm where readers are given the opportunity to expose themselves to different types of belief-relevant arguments on a scientific topic and use such information to support or update their beliefs. The data provide evidence that readers are sensitive to whether arguments for a position on a scientific topic follow a

prescriptively normative structure containing theory-relevant evidence or instead employ positively or negatively valenced information as a form of affective persuasion to reject or accept the theory.

The consequence-relevant texts did not explicitly focus on whether evolution is true, but these texts were modeled after typical arguments that use valenced consequences of belief to attempt to persuade readers about the truth of evolution. Specific examples of valenced consequences were taken from a study by Brem et al. (2003), who culled their consequences from various articles and books designed to persuade the public to accept or reject of belief in the scientific theory of evolution. As such, even though readers may not have viewed these texts as providing evidence about the truth of evolution, we expected readers to still view the texts as employing emotional persuasion to support or oppose belief in evolution. The pilot and the manipulation check data support this, as readers did indeed perceive the intended position of these texts regarding “whether or not evolution is true”, and viewed the consequence-relevant texts as relying more on “emotion” than “evidence” to support that position. The valence of the consequences would seem to be the only plausible information that the readers could have used to infer the pro or anti-evolution position of these texts. The fact that readers did perceive these texts as arguing for or against accepting evolution explains why some readers chose to refer to these texts in their essays about why they personally accept or reject evolution.

The current study provided evidence that readers vary in how they respond to this perceived difference in text-type. Objectively, the consequence-relevant texts provide evidence only related to consequences of belief and not for or against the theory of evolution itself. Thus, a normatively rational approach would be to ignore these texts when writing about one’s acceptance or rejection of the theory of evolution. This tendency was only observed for people

who self-reported having more evidence-based prior beliefs, suggesting that these individuals possessed the kind of sensitivity to the evidence-based merits of various arguments that would be expected by a normative model of rational belief formation and updating. In contrast, people with more affect-based prior beliefs included little of the presented theory-relevant evidence in their essays, even though half of it supported their belief, it was readily available, and they were equally exposed to it (as evidenced by the lack of reading time effects). Rather than addressing the merits of the theory-relevant evidence, they focused their efforts on incorporating more of the valenced consequence-relevant information into their belief description, despite the fact that these arguments did not provide any information with objective implications for the veracity of the belief they were describing.

This study's results also support the hypotheses derived from a competitive routes model of belief formation by providing evidence that affective motives compete with rather than merely supplement processing and use of evidence-based information. Individuals were aware of which texts contained more theory-relevant evidence and which texts presented valenced information. Yet some readers did not defer to the evidence they had just read about, and these readers tended to be the ones who made the most reference to and/or reported the intent to make use of the valenced information. Incorporating affective information during belief formation and maintenance appears to be something other than the kind of mere supplementary add-on role that normative models allow for. The results suggest that affect related information can be the primary type of information that determines a belief, and affect appears to substitute rather than supplement available theory-relevant, evidence-based information. Thus, there do appear to be competitive routes to belief that impact the type of information people consider, which could

strongly impact the beliefs they hold and conclusions they reach about scientific topics in which the evidence favors unpleasant conclusions.

The present results are consistent with the assumption that there are somewhat stable preferences for evidence versus affective information as a basis for holding beliefs. Prior evidence for this assumption has been limited to the fact that belief-bases correlate across many varied topics and are predicted by a domain-general measure that assesses the value and importance a person places on using evidence to inform one's beliefs (Griffin, 2003; Griffin & Salas, 2012). However, this prior evidence does not rule out the alternatives that reported belief-bases are merely reflections of differences in what types of information people have available, in how people interpret abstract notions of "evidence", or in motivation to honestly report the type of information that was considered. None of these alternatives account for the present findings because they do not predict that belief-basis should relate to the actual use of specific, concrete theory-relevant evidence and arguments that are all made equally available. The assumption of differing preferences for theory-relevant versus consequence-relevant information was particularly supported by the fact that belief-bases scores predicted the self-reported prospective use ratings, even when readers were made to explicitly evaluate the texts in terms of evidence and affect, and while the texts were right in front of them, so they did not need to rely upon memory.

Limitations

While the essay results are presumed to partially represent what type of information participants preferred to incorporate into their belief justification, memory effects could also have played a role. Essay content would be affected by what information participants can recall from the texts. However, there was no main effect of belief-basis on the number of target text

ideas referenced, and a memory account of the key findings would require that people of different belief-bases had different types of selective memory for the varying types of information. The ample time to read all texts and lack of notable reading time effects make it less likely that exposure could have produced memory effects capable of explaining the key results. Also, preferences for types of information could impact processing in a way that impacts memory, so memory effects are not entirely an alternative account to preferences. Memory differences might be most expected in terms of how much of the specific details related to each target idea people could recall, but the current coding scheme was specifically designed to reduce such sources of variance by only requiring that readers make any general reference to the target idea to get full credit for referencing it. However, there could still be potential selective memory differences for the target ideas due to factors related to belief-basis but not due to reading times or preference-driven processing, and were not captured by the control measures of prior knowledge, ACT scores, and essay length. Follow-up studies may want to test directly for recall.

The fact that participants had hard copies of the texts in front of them while providing their use ratings make these ratings less dependent on memory. Rating each text as a whole also eliminates readers' need to recall any specific details. Other alternative explanations for the essay data are related to cognitive demands of the task, or lack of awareness that the texts varied in the nature of their information. The cognitive demands of the essay writing could have made some participants less able to apply the kind of reasoning that a normative model of information use might require. The self-report use ratings are less cognitively demanding than writing an essay, thus reducing variance in relative information use due to cognitive demands and required effort.

Also, participants provided the use ratings immediately after rating the texts in terms of evidence and affect, making this varying feature of the information types highly salient. Thus, despite having the limitations that come with such self-reports, the results from the self-report prospective use ratings seem especially reflective of participant's subjective intentions, preferences, and goals related to using information that has evidential or affective relevance to the veracity of a claim to form, maintain, or justify their belief about the claim. Furthermore, the coherence between the self-report prospective use ratings and the essay coding results lends support to the assumption that the differential inclusion of various text ideas in the essays was partially determined by the subjective preferences that the belief-basis measure is thought to reflect.

If one integrates the finding of use by text type with the fact that evidence-based readers tended to refute the anti-evolution theory-relevant texts, then the complex 3-way interaction for the self-reported use data is just what one would expect if the essay data reflects preferential concern about different types of belief relevant information. It is possible that this described consistency between the outcome measures merely represents participants reflecting on what kind of information they just wrote about in their essays, and then providing ratings accordingly. However, the results from pilot studies show that the same relationship between self-report use ratings and belief-basis observed in the present study emerges even when participants are instructed to read the texts and then provide prospective use ratings of prospective use *without* an intervening essay writing task. Taken together, the results of the essays and the use ratings demonstrate that there are significant differences in the kind of belief-relevant information one prefers to focus on for a particular topic and that these differences are largely consistent with the information preferences present while initially forming a belief about the topic.

As already mentioned, independent from the hypothesized effects of belief-basis on use of different text-types, there was also a result suggesting a position-bias effect. The results shown in Figure 3 suggested that evidence-based readers tended to support their beliefs using reasons from pro-evolution texts and mostly referred to the anti-evolution texts to refute these texts' claims. Given that evidence-based readers almost exclusively referred to the theory-relevant texts, this means that they were referring to both pro and anti-evolution evidence, but supporting the former while refuting the latter. There are multiple potential ways to interpret this result.

Evidence-based readers tend to believe that evolution is true (Griffin & Ohlsson, 2001). If they are aware that scientists tend to accept evolution, then they would likely be aware that the evidence opposing evolution is viewed by scientists as having less merit. This presumption may prompt them to take a more critical stance towards the anti-evolution evidence and find more flaws with it. Alternatively, once evidence-based readers focus their attention on relevant evidence, their evaluation of that evidence may be based largely upon a self-serving motivation to simply reject all belief-conflicting evidence and accept all supporting evidence without considering scientific merit. Additional studies are needed to explore these possibilities, such as manipulating the objective strength of the evidence and seeing how evidence-based readers respond when the anti-evolution evidence is clearly stronger than the pro-evolution evidence. It is important to note that regardless of the reasons for this position-bias, it does not account for the key finding that evidence-based readers referred more to the evidence in the theory texts overall. The bias concerns how they referred to the information rather than what type of information they most referred to. In sum, while readers with evidence-based beliefs did show a bias towards supportively using pro-evolution information while refuting anti-evolution

information, overall they focused more on the theory-relevant information than the valenced consequence-relevant information regardless of the position of the text.

This study does have several other limitations. Although significant relationships were observed in the predicted direction across all outcome measures, the general size of these relationships was somewhat small. A possible reason for this is floor effects due to the infrequent reference to specific text ideas in the essays. The coding criteria was conservative, given that an idea was only coded if it was stated in clear and specific enough terms that it could be attributed to one specific text. Thus, participants who thought about, were influenced by, and used texts ideas, but who only referred these ideas in very vague terms did not get credit for them. An example would be a person who might have said, “There is a lot of evidence and science supporting evolution” in reference to the various pieces of evidence they read about.

In addition, use of text ideas may have been limited by the essay prompt. Participants were asked to include ideas they “consider to be important in deciding whether to accept or reject belief in evolution”, but they were only told to “feel free to include ideas from the essays” rather than told they should use all relevant essay information. This was done in order to reduce social desirability effects, but the generality of the prompt may have reduced the use of text information to a degree that limited how strongly belief-basis could correlate with its use. Future studies might address this by manipulating the task instructions, perhaps by including explicit instructions to only use the text information provided in their essays combined with changing “describe your belief” to “construct an argument” (e.g., Wiley & Voss, 1999), or “justify your belief”. The instructions at both the time of reading and essay writing can be manipulated. This would likely increase the total use of essay information, and serve as a means of testing whether

the observed relation with belief-basis becomes stronger or perhaps is eliminated when greater emphasis is placed upon justification.

Further, the present study did not code the essays for accuracy or the quality of readers' text representations. Previous studies using the belief-basis measure have found that belief-basis predicts comprehension of new belief-relevant information (Griffin, 2003), independent of control variables and alternative explanations (i.e., prior knowledge, comprehension skills, engagement, and strategy; Salas & Griffin, 2010). These studies used sentence and inference verification tasks to assess comprehension and focused exclusively on evidence-based, expository science texts. It would be informative to investigate whether such findings replicate when using essay data scored for accuracy or whether these comprehension effects extend to the consequence-relevant texts. It would also be informative to see if readers' memory and comprehension of the text information mediates its use.

In sum, the present research found that individuals differ in the relative focus they give to theory-relevant and consequence-relevant arguments when relating this information to their belief. This was observed both in the types of reasons and information included in individuals' essays as well as in their self-report prospective-use ratings. Such findings argue for the need to incorporate competitive evidence-versus-affect routes and individual differences into models of belief formation and maintenance. The assumption that an existing self-report measure of belief-bases reflects preferences between the belief formation routes was supported. The results also suggest the need to consider how evidence and affect-based routes to belief formation can impact the way students seek out and utilize different types of information and arguments. This has implications for learning during multiple documents inquiry tasks and the informal information searches people engage in on the internet where unscientific, emotion-laden arguments on

important scientific questions are often more pervasive than valid scientific information. Both classroom and lifelong learning might benefit from future research to develop training interventions designed to get students to adopt a more evidence-based and less affect based orientation in forming their views on scientific topics.

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Appendix A

AOT Items

INSTRUCTION: Next to each statement, write the number 1 through 6 that reflects your degree of personal agreement.

1	2	3	4	5	6
Disagree Strongly	Disagree Moderately	Disagree Slightly	Agree Slightly	Agree Moderately	Agree Strongly

_____ Certain beliefs are just too important to abandon no matter how good a case can be made against them.

_____ It is objective evidence and not personal emotion that is the best predictor of whether a belief is objectively accurate or true.

_____ One should disregard evidence that conflicts with your established beliefs.

_____ Beliefs should often be revised in response to new information or evidence.

_____ People should always take into consideration evidence that goes against their beliefs.

Belief Items

INSTRUCTION: Indicate your level of disbelief or belief in the following ideas using the 1-9 scale.

1.....	2.....	3.....	4.....	5.....	6.....	7.....	8.....	9
Disbelieve Strongly	Disbelieve Slightly	No Opinion Not Sure			Believe Slightly	Believe Strongly		

_____ I personally believe in the biological theory of Evolution.

_____ All life forms on Earth, including humans, evolved over millions of years from early life forms.

Belief-basis Items

INSTRUCTION: You just reported your opinion about Evolution. We might have different reasons for holding any particular opinion we have. Below are several potential reasons for holding an opinion. Rate each reason to indicate the extent it is a reason *why* you personally hold your opinion about Evolution.

1.....	2.....	3.....	4.....	5.....	6.....	7.....	8.....	9
Not at all My reason				Somewhat My reason				Completely My reason

_____ 1. My opinion about Evolution is based on how good it makes me feel and how comforting it is.

_____ 2. My opinion about Evolution is based on faith.

_____ 3. My opinion about Evolution is based on considering all the evidence I am aware of.

_____ 4. My opinion about Evolution is based on support from science.

_____ 5. My opinion about Evolution is based on trusting my 'heart' and not my head.

Appendix A (continued)
Prior Knowledge Measure

INSTRUCTION: The next 5 questions are designed to test your *knowledge* about the theory of Evolution. DO NOT report your personal beliefs or opinions. Check the answer that you think an Evolutionary Scientist like Charles Darwin would give. Pretend this is an exam in a biology class.

1. Imagine that pollution caused the countryside to become covered in black soot and ash. Years later scientists notice that the local moths are also darker than they used to be. Which of the following would be a good evolutionary explanation for this?

- A. The moths changed to a darker color in order to blend in with their surroundings.
- B. Those moths that just happened to be born darker were more likely to reproduce.
- C. Both above explanations are equally good according to evolution.
- D. Neither of the above, because this scenario could not happen according to evolution.

2. A species of woodpeckers have one-inch long beaks, on average, and their main food source are bugs that live inside trees with bark that is about one and a half inches thick. Compared to its parents, the offspring of any two woodpeckers should develop which of the following features?

- A. A shorter beak, because one generation is not long enough for adaptive variations.
- B. A longer beak, because the offspring will adapt to what is necessary for their survival.
- C. Either a shorter or longer beak is equally likely, because variation from parents is random.
- D. All offspring would have to have the exact same length beak as their parents.

3. A high-school basketball team scores more points per game this season than last season. Which explanation for this change is most analogous to (similar to) how evolution is affected by natural selection pressures?

- A. More students tried out for the same number of spots on the team this year.
- B. The returning players on the team all grew taller over the summer.
- C. The returning athletes were taking more shots on average this year.
- D. On average, each team member practiced harder this season than last.

4. Compared to the number of living bacteria species that exist today, the number of bacteria species that have already become extinct is which of the following:

- A. Fewer, because each extinct species gave rise to many new species.
- B. Greater, because bacteria has existed for billions of years.
- C. Fewer, because the old bacteria species usually adapted.
- D. Either fewer or greater are equally likely.

5. As Chimpanzees continue to evolve in the future, they will become which of the following?

- A. More similar to Humans, because we share a common ancestor.
- B. More similar to Humans, because Human traits are proven to be very adaptive.
- C. Less similar to Humans, because they are evolving towards a different goal.
- D. Less similar to Humans, because they each live in very different environment.

Appendix B

Pro-Evolution Evidence Text #1:

Convergent evidence from multiple fields all point to one conclusion: Life evolved.

Evolutionary theorists propose that all life forms on Earth, including humans, evolved over millions of years from early life forms. Various independent sets of evidence from different scientific fields provide empirical support for this conclusion. Geology, paleontology, astronomy, botany, zoology, herpetology, comparative anatomy, genetics and many other sciences all provide converging evidence that life evolved. The fossil record not only reveals diverse creatures that have become extinct, but also species that have evolved over time, including various transitional species. Specific findings from paleoanthropology and paleontology provide evidence for evolution based on the fossilized remains of these ancient organisms. A consistent finding by many geological sciences is that the fossilized remains of different organisms appear in certain sequences of strata (i.e., parallel layers of rock arranged one on top of the other). These strata reflect different periods of time in earth's history. Not only is the same sequence of strata found throughout the world, but fossils of more recently extinct species never appear in a more ancient layer of rock.

A common objection to evolution is that the earth is simply not old enough to have provided enough time for evolution to occur. However, evidence from some of the fields listed earlier demonstrate that the age of the Earth is much older than the oldest life forms, and the oldest life forms are much older than the oldest fossils of modern creatures. Evidence for this comes from several consistent findings of both cosmological and geological timespans. Specifically, the independent dating of fossils (paleontology; geology), the earth (geology), the moon, sun, solar system, and universe (astronomy) all provide evidence for the timeline of evolution. Data from these fields independently show that the timelines of each converges with that of the others. It is clear that both the quantity and quality of converging evidence from each of these independent fields point to the same conclusion: Life evolved.

Appendix B (continued)

Pro-Evolution Evidence Text 2:

Why we have a tailbone: How evidence of an ancestral past supports the theory of evolution.

Every living creature on this earth is a result of millions of years of evolution. Multiple reasons exist to support the claim that life here on earth evolved. One such reason is that even though there are an enormous variety of organisms existing today, they all share common ancestors. Some opponents of evolution point out that common descent is clearly not the case given the great physical differences we can observe across modern species. However, even though these organisms do indeed differ in numerous important ways, plenty of evidence exists that animals share common basic inherited features. For instance, a well-established finding in various fields of biology is that all vertebrates, from fish to humans, have a common basic body structure characterized by a segmented body and a hollow main nerve cord along the back.

Another reason supporting the conclusion that evolution happened is that modern creatures have body organs and other features that seem useless today but are reminiscent of adaptive features from the past. According to the theory of evolution, natural selection favors characteristics that are adaptive in an organism's environment. The old species from which modern animals descended lived in different environments. So, evolution predicts that modern species will have inherited traits that are not useful to them because they were once useful to the ancient species from whom they descended. There is evidence supporting this prediction that animals today still have these residual features. Examples of these now useless vestigial features in humans include wisdom teeth, a tailbone, an appendix, body hair and goose bumps. Although none of these currently serve a specific function in humans, they were once adaptive features for the primate species of our ancestral past. In sum, the physical features of modern organisms provide multiple types of evidence supporting the evolutionary idea that they are the descendants of common ancient species.

Appendix B (continued)

Anti-Evolution Evidence Text #1:

Evolution is false: evidence from earth's age and an incomplete fossil record.

The theory of biological evolution makes several assertions that are neither logically based nor supported by evidence. Furthermore, certain known facts about the age of the Earth and the wide lack of transitional fossils contradict key arguments made by evolutionary theorists. For example, biological evolution asserts that the complex and diverse forms of life existing today are descended from single-celled organisms in the distant past. The Earth would need to be several billion years old to allow the time for the trillions of adaptive mutations that would result in the complex traits seen in today's organisms. Current knowledge in physics provides evidence that the Earth is simply not old enough to have allowed for natural selection to take place. Measurements of the Earth's magnetic field taken by physicists since the early nineteenth century have revealed that its strength has decreased by five percent every hundred years. Using these figures, scientists have computed that just one hundred thousand years ago, the strength of the field would have torn the Earth apart, making biological existence impossible.

The idea of gradual transformations means that millions of "transitional" or "in-between" creatures would have existed and gone extinct. These creatures would have some traits in common with ancient creatures and some traits in common with modern creatures. However, virtually none of these theoretical creatures exist in the fossil record. Paleontologists have found fossils for eighty percent of currently living species of vertebrate organisms. Despite their thorough searches of the fossil record however, not one of these supposed "transitional" organisms have been identified. The simplest explanation for the lack of transitional fossils is that transitional species never actually existed. A lack of evidence for these fossilized remains clearly supports the conclusion that evolution did not happen. Given the flaws in reasoning and inconsistent evidence present within the theory of evolution, it is not too difficult for one to reject its truth.

Appendix B (continued)

Anti-Evolution Evidence Text #2:

The facts of biological complexity and the limits of genetic transformation provide evidence against evolution.

Evidence suggested by the complexity of biological structures and the limits of genetic transformations contradicts the explanations proposed by the theory of biological evolution. Evolutionary theory states that complex, modern creatures started as simple organisms and slowly acquired complex traits over time, with simpler pieces of these traits being added over many generations. However, there are many complex biological features such as the human eye or even a bird's wing that could not have evolved in this piecemeal manner. These features include many parts that by themselves are useless and only together serve a function, so they must have come into existence suddenly and all at once. Biological features as complex as an eye contain numerous intricate parts that are only useful when they exist together. A variation that produced only a single piece of a complex trait would not be adaptive and would not improve the reproductive success of the creature with this variation. This is similar to an old fashioned mousetrap. By themselves, the piece of wood, the metal bar, and the spring do nothing and only serve a function when they exist together.

Additionally, one species cannot transform into a completely different one. Genes can only mutate and vary in extremely minor ways and cannot produce completely new traits. Specific genetic codes simply do not contain the possible combinations to generate certain features. So, the creation of fundamentally new traits or complex organs would require the addition of new information to the code, which violates basic laws of physics. The genetic code for fish simply does not contain any potential to produce a leg by any combination of its existing genes. For fish to evolve legs requires new added genetic information. However, the 2nd Law of Thermodynamics states that all systems decay, lose information, and become simpler over time, so it is not possible for the genetic code acquire new information and become more complex. These are but a few pieces of evidence that clearly demonstrate the inconsistencies between the assumptions made by evolutionary theory and biological reality. One would be wise to seriously consider these before incorrectly accepting the theory of evolution as true.

Appendix B (continued)

Pro-Evolution Affect Text #1:

Accepting evolution and its positive effects on emotion and social relations.

Among those who accept evolution, it is well known that believing in evolution affords positive emotional and societal benefits. However, some misinformed individuals have advanced arguments against this idea. For instance, the false opinion that natural selection provides support for racist beliefs (e.g., “survival of the fittest”) has led people to incorrectly reject the theory of evolution. Contrary to what they argue, the theory of evolution actually states that we are *all* the same species, and there is no basis to assume large differences. Therefore, accepting the principles of evolution as true actually encourages a more racially tolerant worldview. Research shows that most cultures are more tolerant of racial diversity today than before the theory of evolution was widely accepted. In addition, among modern cultures, those in which the idea of evolution is accepted tend to have higher racial tolerance than those where evolution is not accepted.

In turn, having this more open-minded, diversity embracing outlook often increases individuals’ emotional well-being. As an evolutionarily social species, our emotions benefit from diverse interactions with individuals and from novel experiences. More tolerant views also have positive implications for society at large. Belief in evolution leads to more tolerant views and this increased tolerance has benefits that extend beyond the individual emotional level. This is demonstrated by the fact that businesses, institutions, and communities whose members embrace racial tolerance thrive and experience marked financial, social, and structural progress as they develop more richly diverse social networks. In sum, one must be critical of rejecting evolution based on misinformed ideas, especially given that accepting evolution has been shown to improve emotional wellbeing.

Appendix B (continued)

Pro-Evolution Affect Text #2:

Acceptance of evolution increases one's empathy for other life on earth and promotes environmental consciousness.

Accepting and understanding the theory of evolution provides an ideal platform for developing a positive environmentally conscious view. As products of an evolutionary origin, *Homo sapiens* are intricately connected to the environment. Like all species, we exist only because of a particular delicate balance of environmental conditions to which our particular set of features and traits are adapted. Thus, radical damage and change to those environmental conditions that our actions cause is quite literally damage to ourselves and a threat to our existence. Accepting evolutionary explanations for our origins promotes the realization that we share an intimate connection with the earth and its other life forms. Acceptance of evolution is also predictive of the willingness to accept that we could go extinct if the environment radically changes due to our actions. The majority of research conducted about human impact on climate change and the benefits of certain conservation practices is performed by people who have learned about, accept, and apply the theory of evolution to their work.

It is our evolved intellect that allows humans to both severely impact the global environment, but also to realize that impact and its dangers and do something about it. Accepting our evolutionary past and the rare gift of our intellect makes us more likely to realize that we not only can but are ethically *required* to develop more environmentally responsible behaviors. Research shows that people who accept evolution are more likely to view humans' treatment of non-human animals as an important moral issue. Many individuals who promote the understanding and acceptance of evolution are also the ones on the frontlines of the movement to increase human ethics and environmental responsibility. Public arguments to promote more environmentally responsible practices typically include ideas and claims that are rooted in an evolutionary understanding of ecosystems. Furthermore, acting upon these realizations not only provides a more emotionally satisfying existence and sense of purpose, but it helps maintain the delicate balance of nature.

Appendix B (continued)

Anti-Evolution Affect Text #1:

Evolution and the elimination of moral responsibility: why we should reject evolution.

Advocates of evolutionary theory have proposed that it generates a more intellectually sophisticated ideology that yields many benefits to society. However, a clearer inspection shows that it promotes quite the opposite. A major evolutionary assumption is that humans act violently due to a natural interaction between inherited ruthlessness (e.g., only the fit survive) and negative environmental influences (e.g., societal exposure to immoral beliefs). It is not difficult for one to predict how such ideologies would negatively impact our society. A vivid example of this comes from its indoctrination into our educational system, which has led to the demoralization of our youth. A clear example of evolution's ruthless ideologies is evidenced in school shootings. As belief in evolution has increased in the last few decades, so has the unfortunate rise in school shootings. Many of these have been suicide mass shootings, in which prior to committing suicide, the criminal juvenile cites how the ruthlessness of bullying and the competitive nature in the school's social system has driven him or her to massacre fellow classmates.

Another example of how accepting an evolutionary account of human nature negatively impacts society is that it generates a fatalistic perspective, which destroys the sense of personal responsibility and rids violent criminals of moral culpability for their actions. A particularly vivid example of this is the trial of teenagers Nathan Leopold and Richard Loeb, who were granted a less severe charge for brutally mutilating 14 year old Bobby Franks. Their lawyer Clarence Darrow, using one of the principle tenets proposed by the theory of biological evolution, claimed that his clients were victims whose actions reflect the relentless and brutal evolutionary origins of humankind. Surprisingly, his tactic succeeded. What is the purpose of a justice system if the individuals who violate its moral principles can avoid punishment by claiming it is part of humanity's evolutionary nature? As a society that values justice and fairness, we must be responsible for our own actions, especially if such actions have inflicted harm onto others. It is unwise, unjust, and unethical for society to eliminate personal responsibility, which belief in the theory of evolution clearly promotes.

Appendix B (continued)

Anti-Evolution Affect Text #2:

Accepting evolutionary theory promotes a depressing, fatalistic view of life.

Imagine for a moment, a young individual whose biological makeup consists of genetic material provided by a domestically abusive father and a drug addicted mother. Now imagine, with a heavy heart, having to inform this young person that evolutionary principles predict a grim future, tarnished by his or her strong genetic predisposition towards violence and substance abuse. In this person's shoes, what sense of control over *your* own life would *you* personally develop? Chances are it would be a depressing one at best, and research confirms it. Recent studies have demonstrated that belief in evolution is accompanied by a host of psychological problems ranging from depression and loss of motivation to dissociation from reality and the loss of personal responsibility.

Clearly, accepting evolutionary theory has negative implications. The pessimistic propositions captured in the scenario above are explicitly derived from key principles proposed by the theory of biological evolution which assumes that an individual's behavior is directly driven by their inherited predispositions. Accepting the theory of evolution's premises provides an abundance of emotionally disturbing and philosophically damaging repercussions. Not only does it decrease one's sense of self-determination, but such beliefs make it very difficult to find meaning and purpose in life. Research has shown that even among people who believe evolution, most people view the idea of evolution as being emotionally unpleasant, undermining a sense of purpose and self-determination. In light of the points made above, it is shocking that so many people accept this theory as true. It is my hope that this brief essay invites the reader to seriously consider these negative implications as they construct their belief about evolution.

Appendix C

INSTRUCTION: For the first part of this questionnaire, you will be asked to rate your impression of each of the 8 texts you read earlier. You will be presented with the title of each text, and under each title there will be several statements regarding the text’s content. Please use the scale provided to indicate the extent to which you agree or disagree with what each statement says about that particular text. You will have the 8 texts in front of you, so feel free to refer back to the text content while making the ratings for each text.

1.....	2.....	3.....	4.....	5.....	6.....	7.....	8.....	9.....
Disagree	Disagree		Neither agree		Agree		Agree	
Strongly	Moderately		nor disagree		Moderately		Strongly	

“Essay Title”

Using the scale above, please provide a rating that reflects your degree of personal agreement with each statement.

This essay:

_____ argued that the theory of evolution is true.

_____ provided evidence-based reasons to support its position about whether or not evolution is true.

_____ provided emotion-based arguments to support its position about whether or not evolution is true.

_____ provided information I would personally use to support my belief regarding whether or not evolution is true.

_____ provided information I would personally use to maintain or revise my belief regarding whether or not evolution is true.

Appendix D

Essay examples and coding subscripts

Note: TR = Theory Relevant; CR= Consequence-Relevant; For an illustration of the main types of statements that were coded, each essay features subscript tags surrounding a given statement (e.g., #belief claims#, #non-text-based idea unit#, #text-based idea unit#). The subscript tag labels are provided under each essay. Roman numerals refer to the text, followed by a number indicating the main idea and a letter for supporting ideas. Agree and Refute refers to whether the idea was coded as serving an “agree” function or “refute” function. To interpret the *text-based idea units* please refer to the reference key of target concepts in Appendix E. For example, ideas 4-7 all come from the same anti-evolution Theory relevant text and ideas 4-6 refer to aspects of the same main idea of irreducible complexity, thus they only were counted as a single TR idea unit.

Essay #1(TR units = 3; CR units =1)

¹In my personal opinion, the theory of biological evolution is true. ¹

Although there are varying opinions on the subject, much of the evidence points to and agrees with the concept. For example, in humans especially, ²we have certain traits and physical characteristics that are of no use to us: ³wisdom teeth, an appendix, body hair, and a narrow tail structure at the end of our spinal cord. ³

⁴This evidence suggests human evolution, and more specifically evolution from our ancestors to which these physical elements were important and had a function. ⁴

Some scientists have started denying the theory based on magnetic field calculations, ⁵suggesting that the earth cannot possibly be as old as it is ⁵ ⁶due to lack of fossil evidence ⁶ and ⁷the presence of an extreme magnetic field. ⁷ Of course, this kind of information makes me question my position on biological evolution, but yet, I still think the evidence in favor of it is too strong. ⁸Other scientists suggest that the Earth is as old as we have calculated ⁸ and that ⁹fossil evidence supports this. ⁹

¹⁰One of the articles suggested that a belief in the theory of biological evolution also supported a belief in environmental consciousness. I have strong feelings toward environmental consciousness and therefore, my beliefs in the theory of biological evolution must be sound. ¹⁰

¹¹As a supporter of the theory of biological evolution, I think that many scientists and critics who have disagreed with the scientific evidence are simply too afraid to think otherwise. Of course, religion plays a part in this debate as well. ¹¹ But, to truly decide if the theory of biological evolution is correct, you have to think scientifically.

1. Belief claim

2. II- 2 (Agree)

3. II- 2b (Agree)

4. II- 2a (Agree)

5. III-1 (Refute)

6. III-2b (Refute)

7. III-1b (Refute)

8. I-2 (Agree)

9. I-2a (Agree)

10. VI-1 (Agree)

11. Non-text-based Idea Unit:

Fear/religion as reason for other's beliefs

Appendix D (continued)

Essay #2 (TR units = 3; CR units = 1)

¹Evolution is true because there are massive amounts of evidence supporting it.¹²Almost all of the credible scientists in biology believe in evolution. Furthermore, 94% of the top scientists in the world believe in evolution.²

³Most of the arguments against evolution are based on emotion, made up facts and simple disbelief. One criticism is that evolution will make our societies moral deteriorate. Whether understanding evolution will help or hurt our morals is irrelevant to the fact that it is true.³

⁴Another argument is irreducible complexity. Those who present this argument look at a piece of life and claim it is irreducibly complex. The argument is an argument from ignorance. They can't come up with any way for it to evolve so therefore it is irreducibly complex.⁴

⁵One of their examples is the mouse trap.⁵

⁶You can take away a lot of its parts and it still has some sort of function. Just the piece of wood would be a nice door mat. Screwing in the metal pieces into the floor would only remove its portability.⁶

⁷Another argument is from the 2nd law of thermodynamics. It claims that everything in the universe is becoming simpler so therefore everything on Earth is becoming simpler. This is wrong because the Earth is not a closed system. The Earth is receiving energy from the Sun.⁷

⁸The strongest by far piece of evidence for evolution which the counter arguments can't touch is DNA. With DNA, we can even calculate when the two species split off from each other. We also use genes that stay constant to measure how fast other ones have changed.⁸

⁹Even if we didn't have DNA to study, fossils would also prove evolution sufficiently.⁹

1. Belief claim
2. Non-text-based Idea Unit: Appeal to science authority/consensus
3. III-2 (Refute)
4. IV-1 (Refute)
5. IV-1b (Refute)
6. IV-1a (Refute)
7. IV-2c (Refute)
8. Non-text-based Idea Unit: Prior knowledge of evidence
9. I-1(Agree)

Appendix D (continued)

Essay #3 (TR units = 0; CR units = 3)

¹I personally believe that the theory of biological evolution is true¹. A main reason why I think my beliefs are this way is because ²I grew up learning about evolution throughout my science classes growing up. We learned about the solar system and development of the ape species into human beings.²

¹I believe biological evolution¹, even though there are still some unknowns and questions as depicted in some of the articles against the theory of evolution, have more of a scientific base that can be proved through evidence rather than theories of things just appearing. ³I have noticed that many opponents of the theory of evolution are affiliated with religious groups.³

⁴My belief in evolution is that it is more tangible than any other theories. Even during my lifetime, I can observe the changes in the earth and the impact that we have on it as humans. I agree with the website excerpt that discussed how supporting evolution leads to greater awareness of the impact on our environment.⁴

⁵ Having a greater understanding of evolution makes people more aware of human impact on the earth and how we can change it so the negative impact is not so great.⁵

⁶ I think there are many positive things to get out of the theory of evolution and disagree with the website excerpts that say believing in evolution leads to depression⁶, ⁷fatalistic views, etc. ⁷

1. Belief claim
2. Non-text-based Idea Unit: Prior science/evolution education
3. Non-text-based Idea Unit: Religion as reasons for other's beliefs
4. VI-1 (Agree)
5. VI-1a (Agree)
6. VIII-2b (Refute)
7. VIII-1 (Refute)

Appendix D (continued)

Essay #4 (TR units = 2; CR units = 2)

¹I do believe that biological evolution is true.¹ I was taught about evolution since my freshman year and high school and still to this day I believe it's true. There has to be a scientific answer to why we humans are here, how we got here, and explain our purpose on earth.

²Also many scientists have proven that evolution is how we Homo sapiens have adapted to earth. We are still adapting to this day. We pass down the dominant genes that will help us to survive now and later in the future. Evolution is a theory that is strongly believed in the scientific community and it gives an answer to how we humans have changed on earth.²

³Evolution is also said to be good for racial discrimination because³ ⁴it helps people to realize that we are all the same and came from the same place⁴.

⁵ It has also shown that evolution has be emotionally well for people.⁵ I also feel that religion shouldn't be the only theory to how we humans evolved in life.

⁶The believe in evolution goes back to fossils⁶ and ⁷the study of how old the earth is.⁷ ⁸Evolution is also shown in genetics in which we see that different traits are passed down in genes to offspring's to pass down dominant genes so that we as humans can survive better. ⁸

1. Belief claim
2. Non-text-based Idea Unit: Definitional statements and scientific authority
3. V-1 (Agree)
4. V-1a (Agree)
5. V-2 (Agree)
6. I-1 (Agree)
7. I-2 (Agree)
8. Non-text-based Idea Unit: Prior knowledge of evidence

Appendix D (continued)

Essay #5 (TR units = 0; CR units = 0)

¹I wouldn't say I believe in evolution because it still seems a little open ended.¹ Actually I'm still a little confused on the topic.

²When I think of evolution I think a species evolves and the species it evolves from is extinct. According to scientists humans have evolved from apes, but if humans evolved from apes wouldn't that make the ape species extinct? ²

³Evolution is also a bit harder to believe in because I am religious, and according to my religion God is the creator of everything, and because God created everything evolution can't exist.³

I still wonder what happened to dinosaurs and other extinct species, but so far I have not found an answer that satisfies my question.

⁴I don't think I will ever be fully able to believe in evolution because of the faith I have in my religion.⁴ Anytime evolution is brought up I can't really explain or back it up with anything because I can't believe it. I was brought up to believe in God but for evolution there are too many open ended questions and I need answers. Religion has the bible and although there are many open ended questions

1. Belief claim
2. Non-text-based Idea Unit: Evidence from prior knowledge
3. Non-text-based Idea Unit: Religious Authority/Beliefs
4. Non-text-based Idea Unit: Faith (i.e. "affective considerations")

Appendix D (continued)

Essay #6 (TR units = 0; CR units = 0)

¹I am a strong supporter of the natural theory of biological evolution. ¹

²While many theories exist that try to deconstruct the theory of evolution exist, they fail to provide adequate information to provide an antithetical approach to the rise of species. I believe in evolution because if one can see outside of what society has forced humans to become, then evolution is the only answer. ²

³All species are products of their environment. The earth is primarily water and human beings, the current most complex form of life, are primarily water. Through genetic mutations, certain species were able to develop traits that allowed them to have a more efficient style of living. These organisms became more dominant and reproduced at a higher rate. The species that the dominant organisms arose from became somewhat obsolete and either became extinct or formed another branch of evolutionary species. These adaptations required millions of years, seeing that genetic mutations are very rare in the near perfect mechanism that is DNA reproduction. ³

⁴I do believe that the choices humans are making are causing a reverse evolutionary process. Our reliance on technology and the constant pollution of the environment we are supposed to adapt from has caused us to lose dependence on it; rendering adaptations useless. No longer will physical adaptations occur. The obsession with materials will disrupt the fluidity of nature, and the anxiety and horrible things we consume will cause a stunt in evolution. ⁴

1. Belief claim
2. Non-text-based Idea Unit: Perceived inadequacy of alternate theories
3. Non-text-based Idea Unit: Definitional statement/Prior knowledge
4. Non-text-based Idea Unit: Describes additional beliefs about evolutionary future.

**Appendix E:
List of Target Concepts**

Theory-relevant (TR) Texts

I. Pro Evo TR Text #1:

1. Target concept #1: **There is Fossil evidence**
 - a. Alternate wording#1: Evidence of transitional & extinct species.
 - b. Alternate wording#2: Temporal consistency of fossil order in geological strata.
2. Target concept #2: **Evidence for time required for evolution**
 - a. Alternate wording#1: Dating of fossils and Earth from paleontology and geology
 - b. Alternate wording#2: Dating of moon, Sun, Solar system, Universe from Astronomy.

II. Pro Evo TR Text #2:

1. Target concept #1: **Evidence that Animals share common ancestors**
 - a. Alternate wording#1: Different animals share inherited features.
 - b. Alternate wording#2: Similar basic body structure of vertebrates (segmented body, hollow nerve chord).
2. Target concept #2: **Vestigial/Residual features that seem useless today.**
 - a. Alternate wording#1: Changes in utility due to changes across time in the environment
 - b. Alternate wording#2: Examples of human vestigial features (wisdom teeth, tailbone, appendix, body hair, goose bumps).

III. Anti Evo TR Text #1:

1. Target concept #1: **Age of Earth is too young**
 - a. Alternate wording#1: Earth needs to be old because complex traits take trillions of adaptive mutations.
 - b. Alternate wording#2: Magnetic field would have torn the earth apart 100,000 years ago
2. Target concept #2: **There is a lack of transitional species**
 - a. Alternate wording#1: Thorough search of fossil record (found 80% of current living species)
 - b. Alternate wording#2: No fossils of species.

IV. Anti Evo TR Text #2:

1. Target concept #1: **Complex biological structures like the eye or bird wings could not evolve in gradual/piecemeal manner.**
 - a. Alternate wording#1: Possessing individual parts is not adaptive/useful
 - b. Alternate wording#2: Mousetrap analogy
2. Target concept #2: **Speciation is impossible because mutations are limited to minor transformations**
 - a. Alternate wording#1: Limited genetic combos in any genetic code
 - b. Alternate wording#2: Fish and legs example
 - c. Alternate wording#3: Adding information to genetic code violates the 2nd Law of Thermodynamics

Appendix E (continued)

Consequence-relevant (CR) Texts

V. Pro Evo CR Text #1:

1. Target concept #1: **Evolution acceptance increases racial tolerance**
 - a. Alternate wording#1: Humans are one species, so no basis to assume large differences
 - b. Alternate wording#2: Historical change in tolerance after evolution acceptance
 - c. Alternate wording#3: Current correlation between culture's acceptance of evolution and its racial tolerance
2. Target concept #2: **Being open-minded and tolerant increases emotional well-being & societal benefits.**
 - a. Alternate wording#1: Humans are socially dependent species
 - b. Alternate wording#2: Financial, social, and structural progress from increased social networking

VI. Pro Evo CR Text #2:

1. Target concept #1: **Accepting evolution promotes self-protecting environmentalism**
 - a. Alternate wording#1: Delicate balance of environmental conditions
 - b. Alternate wording#2: Evolutionists accept that environment change can threaten our existence
 - c. Alternate wording#3: Climate and conservation research conducted by evolutionists
2. Target concept #2: **Accepting evolution promotes morality/ethics based environmentalism**
 - a. Alternate wording#1: Increased sense of connection to the environment and other life forms
 - b. Alternate wording#2: Research shows that people who accept evolution are more likely to view animal treatment as a moral issue.

VII. Anti Evo CR Text#1:

1. Target concept #1: **Belief in evolution promotes violence**
 - a. Supporting Idea#1: Evolution says that humans act violently due to inherited ruthlessness (only fit survive) and environmental pressures (immoral beliefs)
 - b. Alternate wording2#: Evolution promotes school shootings
 - c. Alternate wording3#: Shooting on the rise past decades as belief in evolution has increased.
2. Target concept #2: **Evolutionist ideology destroys personal responsibility & moral culpability**
 - a. Alternate wording1#: Lawyer reduced punishment for teenagers who brutally murdered another kid by arguing their actions were part of our brutal human origins.
 - b. Alternate wording2#: Our justice system serves no purpose if immoral acts that harm others are just part of our nature.

Appendix E (continued)

VIII. Anti Evo CR Text #2:

1. Target concept #1: **Belief in evolution promotes a de-motivating lack of personal control/self-determination**
 - a. Supporting Idea#1: Evolution is deterministic since it says we are all genetics.
 - b. Alternate wording#2: If you have bad parents, you will be bad as well (i.e., no self-control)
 - c. Alternate wording#3: Research shows that people who accept evolution find that the idea undermines self-determination.
2. Target concept#2: **Belief in evolution causes a depressive view**
 - a. Alternate wording#1: Decreases sense of meaning/purpose
 - b. Alternate wording#2: Research shows that belief in evolution is accompanied by psychological problems and depression.

Appendix F
Demographic Survey

Age _____

Sex (circle one): M F

ACT or SAT Math Score _____ ACT or SAT Verbal Score _____

What is your current GPA? _____

College Major:

Were you born in the United States? (circle one) YES NO

Is English your native language? (circle one) YES NO

If English is not your first language, AT WHAT AGE did you start speaking English fluently?

Please indicate your ethnicity

___ American Indian or Alaskan Native

___ Middle Eastern

___ Asian or Pacific Islander

___ Black, not of Hispanic origin

___ Hispanic

___ White, not of Hispanic origin

___ Other (specify): _____

Please indicate your religious affiliation

___ Evangelical

___ Baptist

___ Presbyterian

___ Pentecostal

___ Other Christian

___ Islamic

___ Protestant

___ Methodist

___ Catholic

___ Lutheran

___ Hindu

___ Jewish

___ Jewish Orthodox

___ Buddhist

___ Agnostic

___ Atheist

___ None

___ Other

Please specify _____

UNIVERSITY OF ILLINOIS
AT CHICAGO

Office for the Protection of Research Subjects (OPRS)
Office of the Vice Chancellor for Research (M/C 672)
203 Administrative Office Building
1737 West Park Street
Chicago, Illinois 60612-7227

**Approval Notice
Continuing Review**

May 24, 2012

Jennifer Wiley, PhD
Psychology
1054-D B.S.B., M/C 285
Chicago, IL 60612
Phone: (312) 355-2501 / Fax: (312) 413-4122

RE: **Protocol # 2000-0676**
"Understanding in Science: Eyetracking Studies"

Dear Dr. Wiley:

Your Continuing Review application was reviewed and approved by the Expedited review process on May 14, 2012. You may now continue your research.

Please note the following information about your approved research protocol:

Protocol Approval Period: May 23, 2012 - May 22, 2013
Approved Subject Enrollment #: 10,000 (6,517 subjects enrolled)
Additional Determinations for Research Involving Minors: These determinations have not been made for this study since it has not been approved for enrollment of minors.
Performance Sites: UIC
Sponsor: Institute of Educational Sciences, Institute of Education Sciences
PAF#: 2007-02387, 2007-02387
Grant/Contract No: R305H030170, R30B07460
Grant/Contract Title: Improving Monitoring Accuracy From Scientific Text, Improving Metacomprehension and Self-regulated Learning from Scientific Texts

Research Protocol:

- a) Understanding in Science: Eyetracking Studies

Recruitment Material:

- a) UIC Psychology Student Subject Pool recruitment procedures will be followed for this research

Informed Consents:

- a) Agreement to Participate in Research Web Version .5 PEC; Version 9; 05/08/2012
- b) Agreement to Participate in Research Web Version - 1 PEC; Version 9; 05/08/2012
- c) Agreement to Participate in Research Web Version - 1.5 PEC; Version 9; 05/08/2012

Phone: 312-996-1711

<http://www.uic.edu/depts/over/oprs/>

FAX: 312-413-2929

- d) Agreement to Participate in Research Web Version - 2 PEC; Version 9; 05/08/2012
- e) Eyetracking No Bite Bar Version - 1 PEC; Version 2; 05/08/2012
- f) Eyetracking No Bite Bar Version - 1.5 PEC; Version 2; 05/08/2012
- g) Eyetracking No Bite Bar Version - 2 PEC; Version 2; 05/08/2012
- h) Eyetracking - 1 PEC; Version 9; 05/08/2012

Your research continues to meet the criteria for expedited review as defined in 45 CFR 46.110(b)(1) under the following specific categories:

- (4) Collection of data through noninvasive procedures (not involving general anesthesia or sedation) routinely employed in clinical practice, excluding procedures involving X-rays or microwaves. Where medical devices are employed, they must be cleared/approved for marketing. (Studies intended to evaluate the safety and effectiveness of the medical device are not generally eligible for expedited review, including studies of cleared medical devices for new indications.) Examples: (a) physical sensors that are applied either to the surface of the body or at a distance and do not involve input of significant amounts of energy into the subject or an invasion of the subject's privacy; (b) weighing or testing sensory acuity; (c) magnetic resonance imaging; (d) electrocardiography, electroencephalography, thermography, detection of naturally occurring radioactivity, electroretinography, ultrasound, diagnostic infrared imaging, doppler blood flow, and echocardiography; (e) moderate exercise, muscular strength testing, body composition assessment, and flexibility testing where appropriate given the age, weight, and health of the individual.
- (7) Research on individual or group characteristics or behavior (including but not limited to research on perception, cognition, motivation, identity, language, communication, cultural beliefs or practices and social behavior) or research employing survey, interview, oral history, focus group, program evaluation, human factors evaluation, or quality assurance methodologies.

Please note the Review History of this submission:

Receipt Date	Submission Type	Review Process	Review Date	Review Action
05/09/2012	Continuing Review	Expedited	05/14/2012	Approved

Please remember to:

- Use your **research protocol number** (2000-0676) on any documents or correspondence with the IRB concerning your research protocol.
- Review and comply with all requirements on the enclosure, "UIC Investigator Responsibilities, Protection of Human Research Subjects"

Please note that the UIC IRB has the prerogative and authority to ask further questions, seek additional information, require further modifications, or monitor the conduct of your research and the consent process.

Please be aware that if the scope of work in the grant/project changes, the protocol must be amended and approved by the UIC IRB before the initiation of the change.

We wish you the best as you conduct your research. If you have any questions or need further help, please contact OPRS at (312) 996-1711 or me at (312) 996-2014. Please send any correspondence about this protocol to OPRS at 203 AOB, M/C 672.

Sincerely,

Sandra R. Costello

Sandra Costello
Assistant Director, IRB # 2
Office for the Protection of Research Subjects

Enclosures:

1. **UIC Investigator Responsibilities, Protection of Human Research Subjects**
2. **Data Security Enclosure**
3. **Informed Consent Documents:**
 - a) Agreement to Participate in Research Web Version .5 PEC; Version 9; 05/08/2012
 - b) Agreement to Participate in Research Web Version - 1 PEC; Version 9; 05/08/2012
 - c) Agreement to Participate in Research Web Version - 1.5 PEC; Version 9; 05/08/2012
 - d) Agreement to Participate in Research Web Version - 2 PEC; Version 9; 05/08/2012
 - e) Eyetracking No Bite Bar Version - 1 PEC; Version 2; 05/08/2012
 - f) Eyetracking No Bite Bar Version - 1.5 PEC; Version 2; 05/08/2012
 - g) Eyetracking No Bite Bar Version - 2 PEC; Version 2; 05/08/2012
 - h) Eyetracking - 1 PEC; Version 9; 05/08/2012

cc: Jon D. Kassel, Psychology, M/C 285
OVCR Administration, M/C 672

Vita

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Education:

- PhD student, Cognitive Psychology, University of Illinois at Chicago (2009-Present)
- BA, Psychology, California State University Long Beach (2007-2009)
- AA, Psychology & Communication, Cerritos College (2004-2007)

Research Interests:

- Belief formation, belief revision, and explanatory coherence
- Scientific and informal argumentation
- Science learning
- Text comprehension

Fellowships

2009-2012	Abraham Lincoln Pre-Doctoral Fellowship
2008-2009	Sally Casanova Pre-Doctoral Fellowship
2007-2009	The National Institute of Mental Health-Career Opportunities in Research (NIHM-COR) Fellowship

Publications and In Press:

Griffin, T.D., Wiley, J., Britt, M.A., & Salas, C. (2012). The role of CLEAR thinking in learning science from multiple-document inquiry tasks. *International Electronic Journal of Elementary Education*. 5(1), 63-78.

Salas, C.R., Minakata, K. , & Kelemen, W. (2011). Walking before study enhances free recall but not judgment-of-learning magnitude. *Journal of Cognitive Psychology*, DOI: 10.1080/20445911.2011.532207.

Griffin, T. D., Wiley, J., & Salas, C. (in press). Supporting effective self-regulated learning: The critical role of monitoring. To appear in R. Azevedo & V. Aleven (Eds.) *International Handbook of Metacognition and Learning Technologies*. Springer Science.

In preparation and under review:

Griffin, T.D., & Salas, C.R. (in preparation). The Belief-Basis Effect: Differences in Belief Formation Processes Impact Future Learning.

Invited Presentations:

Griffin, T. D., & Salas, C. (2011, October). *Epistemology, thinking dispositions, and learning from multiple documents*. Invited talk at the Workshop for Multiple Documents Learning, Institute for Educational Research, Oslo University, Oslo, Norway.

Conference Presentations:

Salas, C.R., Griffin, T.D., Wiley, J., & Britt, M.A. (2013, July). *Unique Contributors to Understanding of Climate Change in a Multiple-Document Inquiry Task*. Paper to be presented at the Annual Meeting of the Society for Text and Discourse, Valencia, Spain.

Salas, C.R., Griffin, T.D., Wiley, J., & Britt, M.A. (2013, May). *Domain-General Thinking Dispositions Predict Comprehension from Multiple Documents*. Paper presented at the 2013 Midwestern Psychological Association, Chicago, IL.

Salas, C.R., & Griffin, T.D. (2012, July). *Initial Belief Formation Paths Impact Science Argument Selection*. Poster presented at the International Society for the Psychology of Science and Technology 4th Biennial Conference Pittsburgh, PA.

Salas, C.R. & Griffin, T.D. (2012, July). *Use of Emotion-based versus Evidence-based Arguments in a Multiple Documents Environment*. Paper presented at the Annual Meeting of the Society for Text and Discourse, Montreal, Canada.

Salas, C.R. & Griffin, T.D. (2012, May). *Selecting Emotional Versus Evidence-Based Arguments To Support Existing Beliefs*. Poster presented at the Association for Psychological Science Annual Convention, Chicago, IL.

Salas, C.R., & Griffin, T.D. (2012, May). *Belief Formation Differences Predict the Evaluation of Text Based Arguments*. Paper presented at the 2012 Midwestern Psychological Association Meeting, Chicago, IL.

Wiley, J., Britt, A., Griffin, T.D., Steffens, B., Salas, C.R., Kopp, K.J., Dandotkar, S., Higgs, K., & Goldman, S. (2012, April). *Approaching Reading for Understanding From Multiple Sources in History and Science: Initial Studies*. Symposium paper presented at the 2012 AERA Annual Meeting, Vancouver, BC.

Salas, C.R., & Griffin, T.D. (2012, April). *Epistemic Bases of Prior Beliefs Predict Selective Use of Arguments from Evidence Versus Emotion-Based Texts*. Poster presented at the 2012 AERA Meeting, Vancouver, BC.

- Salas, C.R., & Griffin, T.D. (2011, July). *Selective use of more valid evidence-based arguments depends on the underlying basis of prior beliefs*. Poster presented at the 2011 Annual Meeting of the Society for Text and Discourse, Poitiers, France.
- Salas, C.R., & Griffin, T.D. (2011, April). *Belief-bases predict use of arguments varying in evidence and affective content*. Poster presented at the Midwestern Psychological Association Meeting in Chicago, IL.
- Salas, C.R., & Griffin, T.D. (2010, August). *A mediational analysis of the belief basis effect on text Comprehension*. Poster presented at Annual Meeting of the Cognitive Science Society, Portland, OR.
- Salas, C.R., & Griffin, T.D. (2010, August). *Testing alternative explanations for the belief basis effect on text comprehension*. Poster presented at Annual Meeting of the Society for Text and Discourse, Chicago, IL.
- Salas, C.R., Minakata, K., & Kelemen, W. L. (2010, June). *Exercise and Metamemory: Walking Before Study Can Improve Memory and Judgment of Learning Accuracy*. Paper presented at the Annual Meeting of the North American Society for the Psychology of Sport and Physical Activity, Tucson, AZ.
- Salas, C.R., & Griffin, T.D. (2010). *The effect of epistemic dispositions on comprehension of belief-relevant information*. Paper presented at the Midwestern Psychological Association Meeting in Chicago, IL.
- Griffin, T.D., & Salas, C. R. (2009). *Reduced comprehension of explanatory texts due to emotional prior beliefs and their incoherent conceptual frameworks*. Poster presented at the Annual Meeting of the Psychonomic Society, Boston, MA.
- Salas, C.R., & Griffin, T.D. (2009). *Belief-basis effects on text comprehension: superior cognitive framework coherence or increased effortful reading processes?* Poster presented at the CIC- SROP Research Symposium, Ann Arbor, MI.
- Salas, C.R., Minakata, K., & Kelemen, W.L. (2009). *Walking Improves Word Recall but does not influence Metamemory accuracy*. Poster presented at the Association for Psychological Science in San Francisco, CA.
- Salas, C.R., & Griffin, T.D. (2008). *Understanding the theory of evolution: how prior beliefs, belief basis, rationality, and reading behavior affect one's comprehension*. Paper presented at the University of Illinois at Chicago SROP Research Symposium, Chicago, IL.

Salas, C.R. (2008). *The Effects of Personality and Exercise on Metacognitive Accuracy*. Poster presented at the Psych Day Poster Fair at California State University Long Beach, Long Beach, CA.

Fulton, E.K., Salas, C.R., White, K.R., & Kelemen W.L. (2008). *Nicotine Withdrawal Impairs Memory, Confidence, and Metacognitive Accuracy*. Poster presented at the 88th Western Psychological Association Annual Conference in Irvine, CA.

Roberson, R., & Salas, C.R. (2007). *Ethnic Identity and Psychological Distress as Moderated by Ethnic Group Status*. Poster presented at the National COR Colloquium in Albuquerque, NM.

Salas, C.R., Ojeda, D., Luna, A., & Villapudua, A. (2006, March). *Memory, conformity, and gender stereotypes*. Paper presented at the Honors Transfer Council of California Conference hosted at the University of California Irvine, Irvine, CA.

Research Experience:

- Fall 2010-Present **Graduate Student Researcher. Project READi: Reading and Evidence-Based Argumentation in Disciplinary Instruction**
Working on a research program aimed at improving multi-disciplinary discourse comprehension through argumentation. This project is supported by funds awarded to Susan Goldman, Jim Pellegrino, Thomas Griffin and Jennifer Wiley from the Reading for Understanding Network initiative of the Institute of Education Sciences.
- Fall 2009-2010 **Graduate Student Researcher, Griffin & Wiley Eyetracking and Cognition Lab**
Worked on a research program aimed at Improving Metacomprehension and Self-Regulated Learning from Scientific Texts. This project was funded by Grant R305B070460 to Thomas D. Griffin, Keith W. Thiede and Jennifer Wiley from the Cognition and Student Learning Program of the Institute of Education Sciences.
- Summer 2009 **Summer Research Assistant, UIC Transitions Program**
Research Assistant at the University of Illinois at Chicago in collaboration with Dr. Thomas Griffin as part of the UIC-Transitions to the Doctorate Program.
- Spring 2008-2009 **Project Manager, Kelemen Memory and Cognition Lab**
Project manager in Dr. William Kelemen's Memory and Cognition Lab, Cal State University, Long Beach. Responsible for the completion of an independent research study that investigated the potential interactive effects of exercise induced arousal and personality trait differences on cognitive performance and metacognitive accuracy.

- Fall 2008-2009 **Co-Investigator, Kelemen Memory and Cognition Lab**
Co-investigator on a study examining whether the state-dependent memory effects of exercise-induced physiological arousal extend to metamemory.
- Fall 2008-2009 **Research Assistant, Urizar Stress and Health Lab**
Principle role was as an interviewer in a study utilizing the Trier Social Stress Task (TSST, Kirschbaum et al., 1993) to assess whether a mother's prenatal levels of cortisol production predict post-partum depression.
- Summer 2008 **Summer Research Assistant, UIC-SROP**
Conducted a study on the effects of belief bases on comprehension at the University of Illinois at Chicago in collaboration with Dr. Thomas Griffin as part of the UIC-SROP.
- Fall 2007- 2009 **Research Assistant, Kelemen Memory and Cognition Lab**
Involved in a study designed to assess the effects of nicotine gum in conditions of cigarette abstinence as well as non-abstinence on attention, memory, and metacognition.
- Summer 2007 **Research Trainee, NIMH-COR Scholar, CSULB**
I worked with a research team to conduct a secondary data analysis on a subset of a larger survey study that investigated the relationships among cultural values, identity and psychological distress.
- Spring 2006
-Summer 2006 **Research Assistant, Duff Social-Cognition, Cerritos College**
Worked as part of a lab group and assisted in the design of a study investigating the relationship between stereotypes, selective attention, and change blindness.

Teaching Experience:

- Spring 2012 **Teaching Assistant, Multivariate Statistics**
University of Illinois at Chicago, Instructor: Thomas D. Griffin, PhD
Prepared and graded homework assignments and research projects, proctored and graded exams, maintained weekly office hours, and evaluated multivariate analysis plans for a range of psychology and neuroscience study designs.
- Fall 2008 **Teaching Assistant, Behavioral Research Methods**
Cerritos College, Instructor: Dr. Johanna Walthall. Prepared and taught the laboratory section, grading student papers and exams, holding tutorial/office hours, reviewing student experimental proposals, supervising data collection, and assisting with data analysis.

Undergraduate mentoring:

Spring 2011- Fall 2011	Dimitri, Paunov; Alyssa Secreto Project Title: Predicting Information Selection Behaviors from Belief Bases.
Fall 2009-2010	Ilse Salinas Project Title: Pathfinder measures of knowledge coherence and science text comprehension.

Academic Service and Leadership Positions:

Summer 2010	Served as Summer Research Opportunities Mentor, University of Illinois at Chicago.
Fall 2006	Served as Student Representative in the Cerritos College Accreditation Committee for Standard I, WASC.
Fall 2006	Appointed voting student member in Cerritos College Hiring Committee for the Dean of Liberal Arts.
Summer 2006	Appointed voting student member in the Cerritos College Hiring Committee for CalWORKS Coordinator.
Spring 2005-2006	Elected Senator, Cerritos College Student Body Government
Fall 2005	Elected President, Psi Beta Chapter Cerritos College
Spring 2005	Elected Vice President, Psi Beta Chapter Cerritos College

Other Academic Honors and Awards:

2010	National Science Foundation, Graduate Research Fellowship Program, Honorable Mention
2010	Ford Foundation, Predoctoral Fellowship Honorable Mention
2008	Lucia Morales Award for Excellence in Research and Academics
2008-2009	Nominated by CSULB's Psychology Department as an Outstanding Senior in Psychology
2008 -2009	National Hispanic Fund Scholarship (\$2,000)
2008	Summer Research Opportunities Program (SROP) 2008 at the University of Illinois at Chicago (\$3,500)
2008	Erica Wohldmann Poster Presentation Award (\$500)
2008	Western Psychological Association Regional Psi Chi Research Poster Award (\$500)

- 2007-2008 President's List, 3 Consecutive Semesters, California State University Long Beach
- 2007 Inducted into Psi Chi National Honors Society in Psychology
- 2007-2008 National Hispanic Fund Scholarship (\$2,000)
- 2007 Graduated with Honors, Cerritos College
- 2006 Certificate of Academic Achievement in Psychology presented by the Committee of Psychology Teachers at Community Colleges of the American Psychological Association
- 2006 Associated Students of Cerritos College Silver Falcon Award
- 2005 Associated Students of Cerritos College Gold Falcon Award
- 2005 Psi Beta Chapter Fully Funded Travel Award to the American Psychological Association Convention in Washington D.C. (\$1,600)
- 2005 Inducted into Phi Theta Kappa Honors Society, Cerritos College
- 2005 Associated Students of Cerritos College Silver Falcon Award
- 2005 Inducted into Psi-Beta Psychology Honors Society, Cerritos College
- 2005 Dean's List, Spring and Fall semesters, Cerritos College
- 2004-2006 Scholars Honors Program, Cerritos College

Association Memberships:

- APA Student Affiliate (2005-2006)
- APS Student Affiliate (2008-Present)
- Cognitive Science Society, Student Member (2010-Present)
- Midwestern Psychological Association, Student Member (2010-Present)
- Skeptics Society, Student Member (2005-Present)
- Society for Text and Discourse, Student Member (2010-Present)
- Western Psychological Association, Student Member (2005-2009)

Software Skills:

Proficient with Microsoft Excel, Word, PowerPoint, SPSS, R, STATA, and SAS.
 Working knowledge of E-Prime Experiment Software, Python, SQL, and SR/Eyelink Eyetracking software

References:

Available upon request