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Beliefs Versus Knowledge: A Necessary Distinction for Explaining, Predicting, and Assessing Conceptual Change

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Abstract

Empirical research and theoretical treatments of conceptual change have paid little attention to the distinction between knowledge and belief. The distinction implies that conceptual change involves both knowledge acquisition and belief revision, and highlights the need to consider the reasons that beliefs are held. We argue that the effects of prior beliefs on conceptual learning depends upon whether a given belief is held for its coherence with a network of supporting knowledge, or held for the affective goals that it serves. We also contend that the nature of prior beliefs will determine the relationship between the knowledge acquisition and the belief revision stages of the conceptual change process. Preliminary data suggests that prior beliefs vary in whether they are held for knowledge or affect-based reasons, and that this variability may predict whether a change in knowledge will result in belief revision.

Introduction

Theorists and researchers tend to agree that prior concepts often impede people's ability to learn conflicting information (e.g., Chi, 1992; Dole & Sinatra, 1998; Thagard, 1992). The paradox of knowledge acquisition is that new information can only be understood in terms of existing ideas, yet existing ideas act as a filter, often distorting new information to make it more consistent with prior concepts. This raises the question of how we ever learn anything fundamentally new.

At least two widely cited models agree about crucial steps in the conceptual change process (Chi, 1992; Thagard, 1992): (1) recognizing that the new information conflicts with (or is fundamentally different from) existing concepts; (2) constructing a new knowledge structure to support the new information; (3) replacing the old concepts with the new, more coherent concepts. In short, conceptual change involves learning new concepts and then substituting them for the old. Though these models (i.e., Chi, 1992; Thagard, 1992) diverge in some of the details about the process, they seem to agree that conceptual coherence largely determines conceptual replacement.

In addition, Ohlsson and Lehtinen (1997) have suggested that the use of abstract schemas may be needed to explain how new knowledge representations can be created that will not be distorted by the conflicting prior concepts. They suggest that activation of conflicting prior concepts activates related abstract concepts that are not in direct conflict with the new information, and that can be utilized in constructing an accurate representation of the new information. These aspects of the conceptual change process become more important when we consider how beliefs differ from knowledge.

Belief Versus Knowledge

The present paper defines knowledge as the comprehension or awareness of an idea or proposition ("I *understand* the claim that humans evolved from early primates"). After a proposition is known, one can accept it as true ("I *believe* the claim that..."), reject it as false ("I *disbelieve* the claim that..."), or withhold judgment about its truth-value ("I have *no opinion* about the claim that...").

The present knowledge/belief distinction is intended to be psychological. Thus, knowledge and belief refer to qualitatively different aspects of the mental representation: knowledge refers to the representation of a proposition, and belief refers to the representation of a truth-value associated with a proposition. These definitions are consistent with Quine, and Ullian's (1970) argument that people can have knowledge of an idea or proposition, but either not believe it to be true, or hold a belief that the concept is false.

A proper distinction between comprehension versus acceptance or rejection of an idea allows us to consider the multiple influences on belief formation, and to speak more clearly (and realistically) about the relationship between knowledge and belief change.

A Change in Knowledge, Beliefs, or Both?

It is striking that discussions of conceptual change use the terms 'knowledge', 'beliefs', and 'prior conceptions' interchangeably. Recently, diSessa (2000) highlighted the unexamined lack of agreement among conceptual change researchers regarding basic issues such as whether the conceptual change refers to a change in concepts, beliefs, nodes, or links.

In the models previously mentioned (Chi, 1992; Thagard, 1992) conceptual change involves both the creation of new knowledge (step 2), and a process of abandoning the old ideas in favor of the new ones (step 3). Step 2 amounts to acquiring new knowledge or conceptual understanding, while step 3 amounts to belief revision. Thus, belief revision is characterized as rationally disavowing a prior belief whenever the computed conceptual coherence of a new knowledge structure is higher. This account presupposes that knowledge is the only foundation for belief.

The present argument favors a distinction between knowledge and belief, but acknowledges that knowledge of a concept must precede any judgment of its truth or falsehood. The issue being raised here is that acceptance or rejection of a concept may not be solely contingent upon the coherence of its relations to supporting knowledge in the form of evidence, argument, and logical implications. Belief in a concept may serve affective and social functions. Thus, people might accept a certain idea independent of its coherence with relevant knowledge, and perhaps change a belief even though it will reduce conceptual coherence. Beliefs may vary qualitatively in the degree to which they are part of a specified and coherent network of relevant knowledge.

This claim about the varying bases of belief is similar to one made regarding the affective versus cognitive bases of attitudes (e.g., Eagly & Chaiken, 1993). However, while attitudes refer to subjective evaluations of objects as 'positive' or 'negative', beliefs refer to the acceptance or rejection of propositions. Knowing that a person believes in a proposition, such as "humans evolved form primates", tells us nothing about whether that person feels positively or negatively about this state of affairs. Furthermore, attitude-change theories predict greater change in attitudes that are grounded more in affect than cognitions: precisely the opposite prediction being made here for affect-based beliefs.

A number of implications arise when considering the variability in the bases of beliefs. This variability could influence how belief-conflicting information is processed and understood. Even if a new conceptual scheme is understood, the role of affective motivations in belief acceptance calls into question the notion that belief revision results every time a new conceptual scheme increases coherence.

Belief Bases and Conceptual Learning

Part of the importance in making a knowledge/belief distinction lies in the potential influence that a belief's underlying knowledge structure (or lack thereof) might have on the comprehension of belief-conflicting information. The greater conceptual coherence of knowledge-based beliefs should aid in conceptual learning by making conflict recognition more likely and providing a context that facilitates the construction of a new conceptual representation.

Knowledge-based beliefs are defined by greater coherence with related conceptual networks than beliefs held for affective goals. Therefore, a person should more easily recognize when the evidence, argument, or logical implications of a new conceptual scheme are in conflict with a knowledge-based belief than with an affect-based belief. As already stated, conflict recognition is the first step in the conceptual change process and a necessary step in avoiding distortion via assimilation (Chi, 1992; Thagard, 1992). Thus, when people encounter information that conflicts with knowledge-based versus affect-based beliefs, they should be less likely to assimilate and distort and more likely to begin the process of constructing an accurate representation of the information.

Following conflict recognition, the richer and more detailed conceptual context of knowledge-based beliefs should help compare and contrast the belief with the new information, thus facilitating the process of constructing a representation of the new information. By definition, a prior belief that conflicts with new information is relevant to that new information. The concepts of 'black' and 'white' contain components that oppose one another, yet our understanding of 'black' seems to rely heavily on its contrast with the concept of 'white'. Conceptual contrast could help highlight the boundaries that separate and therefore define the concepts.

In addition, contrasting old and new concepts might lead to the generation of useful abstractions that capture the principles underlying the contrast. In fact, the conceptual network underlying knowledge-based beliefs may provide direct links to abstract concepts that already exist. Given the theorized role of abstract concepts in constructing new representations (i.e., Ohlsson & Lehtinen, 1997), the conceptual framework provided by knowledge-based beliefs could prove quite beneficial in the comprehension of conflicting concepts.

The hypothesis that conflicting beliefs can assist learning via conceptual contrast has received indirect support from classroom studies of pedagogical techniques (for a review, see Guzzetti, Snyder, Glass, Gamas, 1993). A meta-analysis of 70 reading and science education studies revealed that techniques that contrasted new concepts with common misconceptions resulted in better comprehension of the new concepts compared to a number of alternative techniques. The problematic conclusion drawn from was that prior concepts impede learning, so they must be refuted. However, refutational techniques did not directly refute the students' *own* prior concepts, but rather informed students of *common* misconceptions, then presented new concepts as a contrast to these misconceptions.

It is possible that merely highlighting contrasting concepts facilitated comprehension. This interpretation is consistent with the fact that students who did not already possess the prior concepts appeared to benefited equally from refutation compared to students who did have the misconceptions. Contrary to a common assumption, these results could be evidence that conflicting prior beliefs can aid in conceptual learning, so long as the prior concepts are made salient and explicitly contrasted with the new information.

In sum, there are sound theoretical reasons to expect that knowledge-based beliefs should lead to greater conceptual understanding of conflicting information than affect-based beliefs. In fact, if the initial problem of recognizing conceptual conflict is overcome, then the conceptual framework of knowledge-based beliefs may result in greater comprehension than when there are no prior beliefs at all. However, the final stage of conceptual change (i.e., belief revision) remains.

Belief Bases and Belief Revision

There are some obvious reasons to expect that the third and final stage of conceptual change will also be influenced by the underlying source of prior beliefs.

Updating beliefs with new knowledge should be heavily influenced by motivation and epistemological values. Those who are affectively motivated to form beliefs independent of conceptual coherence will have little motivation to revise those beliefs in light of new ideas that could increase coherence. These people may be specifically motivated to 'isolate' new information and actively avoid evaluative comparisons of conceptual coherence. Recent work has shown that different kinds of beliefs are associated with different epistemological values, and these values predict how different beliefs are affected by anomalous information (Chinn & Brewer, 2000). Conceptual replacement or belief revision may follow the competitive rules of conceptual coherence, but only when the initial belief is based upon its coherence with other knowledge.

Beyond motivational influences on belief revision, the conceptual structure of prior beliefs is likely to have direct cognitive effects on coherence comparisons. Making meaningful comparisons between affect-based beliefs and new conceptual knowledge will prove difficult given the different levels of conceptual specification. Also, if coherence comparisons are made, the lack of conceptual specificity inherent in affect-based beliefs will make any revision short of complete abandonment cognitively difficult. Thus, affective beliefs seem to face an 'all or nothing' dilemma, where the most probable outcome is a lack of belief revision. Issues of motivation and conceptual structure make it unlikely that affect-based beliefs will be revised following the comprehension of a coherent conceptual framework.

In short, the present paper advances the following arguments: (1) beliefs differ from knowledge; (2) beliefs vary in whether they are held for coherence with supporting knowledge versus affective motives; (3) conceptual change involves both knowledge acquisition and belief revision; (4) the variability in prior belief bases may influence both of these components of the conceptual change process. The first step in the empirical validation of these claims is to demonstrate that people believe in different concepts for affective as well as knowledge-based reasons and that this difference is related to their willingness to change those beliefs.

Method

The following study was a preliminary investigation of the variability in the underlying bases for beliefs. Any attempt to assess whether beliefs are the result of knowledge coherence or affective goals will have weaknesses that can only be overcome with the use of multiple converging methodologies. Our modest goal in this study was to examine whether people would self-report that their beliefs were held for largely affective reasons and not due to support from relevant knowledge. We hoped to demonstrate variability across beliefs regarding their bases in knowledge versus affect. We also expected that people's underlying reasons for holding their beliefs would be related to their self-reported willingness to revise those beliefs in the face of strong conflicting evidence.

Participants

Participants were 120 undergraduates at the University of Illinois at Chicago.

Belief Assessment Materials and Procedures

Participants reported their prior beliefs on five different topics: creationism, evolution, extra sensory perception, the 'opposites attract' theory of romantic attraction, and the existence of an afterlife. The topics were chosen for their potential relationships to relevant knowledge and affect. For each topic participants were told "for the purpose of this study [topic] is defined as...", followed by a one sentence description of the topic. The descriptions were worded as simply as possible and participants were told to ask for clarification if needed.[1]

Following each description was the question "To what extent do you believe in [topic]?" Participants indicated their level of belief on a scale ranging from 1 (completely disbelieve) to 9 (completely believe).

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[1] No participants asked for clarification. Also, failures in definition comprehension would be consistent with the present theory, and would not alter the interpretation of the present results.

Participants were then asked to list their top 3 reasons for their belief on the topic. This self-generation task was designed to examine participants' most accessible reasons that they had previously associated with their belief on the topic.

After participants reported their degree of belief and listed their reasons for all five topics, they were presented with a list of potential reasons why a person might hold any given belief. They were told "for each potential reason below indicate whether that reason is why you personally, hold your belief about the idea." Participants responded on a likert-scale ranging from 1(not at all my reason) to 9(completely my reason). Five reasons were presented, two knowledge based reasons and three affective reasons (see Table 1).

Table 1. Knowledge and Affective Reasons for Belief.
_____

Affective Reasons*:
My belief about [topic] makes me feel good or is comforting.
When it comes to issues like [topic], I trust my 'heart', not my 'head' to tell me the truth.
I don't need proof, I have faith that my belief about [topic] is correct.

Knowledge Reasons*:
My belief about [topic] is a result of examining all of the evidence I'm aware of and choosing the most convincing explanation.
My belief about [topic] is supported by current scientific knowledge.
_____

*Reasons were not labeled 'affective' or 'knowledge'.

After rating their reasons for each belief, participants were asked: "Imagine that you were presented with strong evidence that contradicted your belief. How likely would you be to change your belief?" Participants indicated their willingness to change each belief on a scale from 1(not at all) to 9(completely).

Results

For each of the five topics, participants were classified into one of three groups: 1 to 3 rating = 'disbeliever'; 4 to 6 rating = 'no opinion'; 7 to 9 rating = 'believer'. Believers on one topic could be believers, disbelievers, or have no opinion on the other topics. The results that follow compare the knowledge versus affective reasons given by believers and disbelievers across the five topics. Those with no opinion are not included here.

Self-Generated Reasons
A qualitative examination of participants' self-generated reasons for belief revealed that participants gave both affective and knowledge-based reasons for their beliefs. The types of reasons varied systematically across topics and between believers and non-believers (see Table 2, for prototypical reasons given by 'believers'). The reasons given for belief in creationism, an afterlife, and disbelief in evolution were rarely knowledge-based and often referred to affect. Some participants simply mentioned that the belief was part of their religion or just how they were brought up. In contrast, belief in evolution, and disbelief in creationism and an afterlife were never supported with affective reasons and participants often referred to evidence. Belief and disbelief in ESP and opposites attract was most often supported by personal experience or reference to media portrayals, but affective reasons were also provided.

Table 2. Prototypical reasons for belief*.
_____

Creationism
"I rely on faith"; "the bible says so"; "I couldn't live if I didn't think there was a God"
Afterlife
"I hope there is one"; "It relieves my fear"; "life would be meaningless otherwise"
Evolution
"biological evidence"; "You can observe similarities between species"
ESP
"I have this ability"; "t.v. documentaries"; "It sounds cool"
Opposites attract
"personal experience"; "media"; "I have seen it"
_____

*Reasons for disbelief are not included in this table

Ratings of Knowledge Versus Affective Reasons
The mean scores were calculated for the three affect reasons and the two knowledge reasons. Figures 1 and 2 report the mean levels of knowledge and affect scores, and self-reported willingness to change a belief or disbelief in the face of conflicting evidence. As mentioned previously, each participants belief or disbelief varied as a function of topic. This presents a problem for any straightforward statistical test of the Belief X Topic interaction. Thus, a qualitative comparison of the means was followed-up by a formal test using correlational methods.

As expected, both the mean levels of affect and knowledge associated with a belief varied across the different topics (see Figure 1). Belief in evolution was associated with higher knowledge than affect scores, and with lower affect scores than belief in the other four topics. In contrast, belief in creationism and an afterlife were associated with higher affect than knowledge scores, and with higher affect than belief in the other three topics.
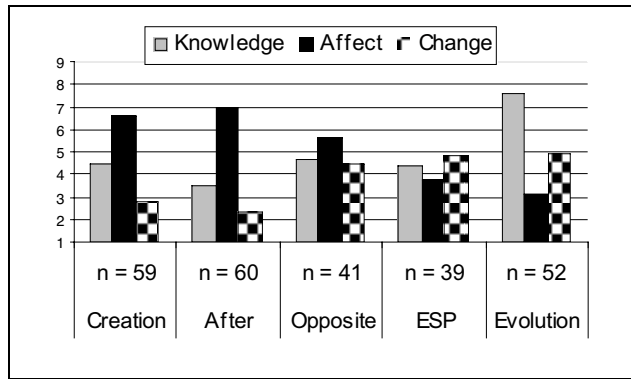
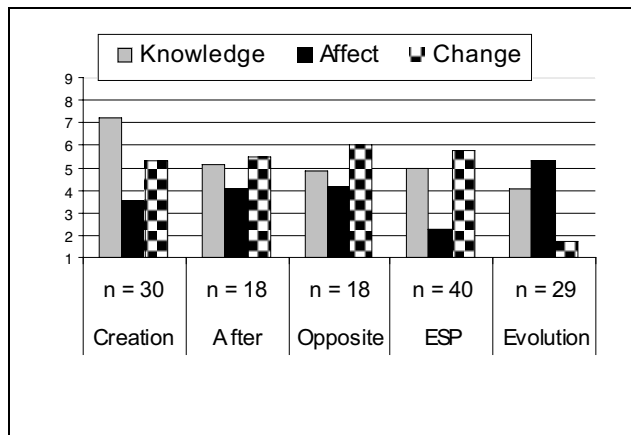Figure 1: Reasons and Will to Change for Believers.

Figure 2: Reasons and Will to Change for Disbelievers.

The opposite pattern of results was found for disbelief across topics (see Figure 2). Specifically, disbelief in creationism was associated with higher knowledge than affect scores, and higher knowledge scores than disbelief in the other four topics. In contrast, disbelief in evolution was associated with higher affect than knowledge scores, and higher affect than the other topics. Overall, the differences in knowledge and affective scores for belief and disbelief across the five topics were consistent with the kinds of reasons participants provided in the self-generation task.

To get around the problem of the membership overlap between believers and disbelievers across topics, belief was treated as a continuous variable. Also, a single score of endorsed reasons was calculated for participants on each topic, by subtracting their affect score from their knowledge score on each topic. Each of the five difference scores was correlated with the continuous measure of belief for the corresponding topic. The results are the five coefficients in Table 3.

For all topics, the knowledge-affect difference score was significantly correlated with the tendency to believe or disbelieve. Negative correlations suggest that

as belief in the issue was greater, knowledge reasons decreased compared to affect reasons. This was the case for belief on all issues except for evolution. As belief in evolution increased the endorsement of knowledge reasons increased greatly compared to affect reasons. These findings are consistent with the descriptive examination of the mean scores for believers and disbelievers.

Reasons for belief were also related to self-reported willingness to change. As seen in Figures 1 and 2, mean change scores were lowest when beliefs were associated with higher affect than knowledge scores, as was the case for belief in creationism, an afterlife, and a disbelief in evolution. This relationship was tested by correlating participants' knowledge-affect difference scores with their willingness to change their beliefs on the five topics. All five bi-variate correlations were significant at $p < .05$, and the coefficients ranged between .30 and .40. Thus, the more a participant's belief was based in knowledge relative to affect, the more willing they were to change that belief in the face of conflicting evidence.

In sum, many participants reported that their beliefs were based more on affect than on any relation to existing knowledge. Also, there was significant variation among beliefs in terms of their knowledge versus affective bases. Lastly, participants claimed they would be less willing to change affect-based beliefs than knowledge-based beliefs if presented with sound belief conflicting evidence.

Table 3. Correlations between knowledge-affect difference scores and belief, on all five topics.

Creationism	Afterlife	ESP	Opposites	Evolution
-.68*	-.38*	-.42*	-.35*	.73*

*$p < .05$.

Discussion

These preliminary results support our hypothesis that beliefs and knowledge are related but distinct constructs. People will not only report that some of their beliefs are held on affective grounds, they will even specifically reject knowledge based reasons as the bases for some of their beliefs. In addition, these self-reported reasons for belief predicted participants willingness to change those beliefs.

These data are only a first attempt to examine this issue. It is a difficult task to assess the true bases for individual beliefs. If belief formation and maintenance are relatively deliberate mental enterprises then it is reasonable to assume that people would be able to accurately report the relationships between their beliefs and relevant knowledge and affective goals. The validity of these self-reports is aided by the fact that

participants' self-generated reasons matched their endorsement of the knowledge and affective reasons that we provided.

It should be noted that self-reported willingness to change a belief was not intended to be an actual measure of belief revision. This point is made obvious by the fact that no belief conflicting information was ever provided to participants. However, we argue that belief revision is highly subject to motivational influence and that epistemological values are integral to people's motivation to update beliefs with any newly acquired knowledge. Self-reported willingness to change a belief reflects belief-specific epistemological values that should affect the motivations relevant to belief revision. Thus, it is noteworthy that participants reported being rather unwilling to change their affect-based beliefs, even if presented with sound conflicting evidence, but relatively willing to change knowledge-based beliefs.

Implications and Future Research

The obvious next step is to see whether these reported differences in belief bases predict how well people comprehend new information in conflict with their beliefs. The distinction between knowledge and beliefs requires that outcome measures be tailored to assess change in one or the other. If conceptual understanding (knowledge change) is being assessed, then participants must be clear that their task is to demonstrate their understanding of the new concepts, and not to report their current point of view.

A similar concern arises when the outcome of interest is belief revision or conceptual replacement. Dependent measures must show that people are spontaneously employing new concepts in their thinking, not merely adapting their thinking to the expectations of experimental or educational settings. Being explicit in our discussions and methodologies about beliefs versus knowledge may reveal where the real disagreements are in the area of conceptual change and perhaps reveal that there is less disagreement than it seems.

Previous accounts of conceptual change have assumed a uniformly negative influence of prior beliefs on conceptual change. We argue that the knowledge versus affective basis of prior beliefs may be an important determinant of whether conflicting concepts are accurately understood. We also contend that the coherence competition accounts of belief revision are too simplistic, given the existence of affect-based beliefs. A conceptual-coherence theory of belief revision only makes sense for the sub-set of beliefs that are initially based on their coherence with current knowledge.

Previous theories claim that conceptual change is in the direction of greater coherence. Thus, incoherent prior beliefs should be more likely to change than coherent beliefs. The present theory suggests several reasons to expect just the opposite in some circumstances. Affect-based beliefs by virtue of their lack of coherence with the conceptual framework might be immune to threats posed by conflicting information. Any new information is likely to be distorted, and if it is accurately comprehended, it will have little influence on an affect-based belief.

The present theory predicts that emotional beliefs not derived from relevant knowledge are the least likely to change in the face of conflicting information. This prediction should make intuitive sense to anyone who has ever had a dinner-time discussion about politics or religion. Scientific ideas may change slowly, but the informal observation that they seem to change quicker than non-scientific ideas may be an indication that the scientific enterprise generally does adhere to the principles of forming ideas based on knowledge and coherent argument.

References

Chi, M. T. H. (1992). Conceptual change within and across ontological categories: Examples from learning and discovery in science. In R. N. Giere (Ed.), Minnesota studies in the philosophy of science: Vol. XV, Cognitive models of science (pp. 129-186). Minneapolis: University of Minnesota Press.

Chinn, C. A., & Brewer, W. F. (2000). Knowledge change in response to data in science, religion, and magic. In K. S. Rosengren, C, N. Johnson, and P. L. Harris (Eds.), Imagining the impossible: Magical, scientific, and religious thinking in children (pp. 334-371). Cambridge, U. K.: Cambridge University Press.

diSessa, A. A. (2000). A complex adaptive systems view of conceptual change. In L. R. Gleitman and A. K. Joshi (Eds.), Proceedings of the Twenty-Second Annual Conference of the Cognitive Science Society (pp. 8-9). Mahwah, NJ: Lawrence Erlbaum Associates Publishers.

Dole, J. A., & Sinatra, G. M. (1998). Reconceptualizing change in the cognitive construction of knowledge. Educational Psychologist, 33, 109-128.

Eagly, A. H., & Chaiken, S. (1993). The psychology of attitudes. London: Harcourt Brace Publishers.

Guzzetti, B. J., Snyder, T. E., Glass, G. V., & Gamas, W. S. (1993). Promoting conceptual change in science: A comparative meta-analysis of instructional interventions from reading education and science education. Reading Research Quarterly, 28, 117-159.

Ohlsson, S., & Lehtinen, E. (1997). Abstraction and the acquisition of complex ideas. International Journal of Educational Research, 27, 37-48.

Quine, W. V., & Ullian, J. S. (1970). The web of belief. New York: Random House.

Thagard, P. (1992). Conceptual revolutions. Princeton, NJ: Princeton University Press.