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Decision-making and evaluation of science causal claims:
effects of goals on uses of evidence and explanatory mechanism

A dissertation submitted in partial satisfaction of the
requirements for the degree Doctor of Philosophy
in Education

by

Jacqueline Yin Sang Wong

2015

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ABSTRACT OF THE DISSERTATION

Decision-making and evaluation of science causal claims:
effects of goals on uses of evidence and explanatory mechanism

by

Jacqueline Yin Sang Wong

Doctor of Philosophy in Education

University of California, Los Angeles, 2015

Professor William A. Sandoval, Chair

Evidence and explanatory mechanism are central to scientific practices. Using such information could also inform decisions about issues in which science can play some role, from policy issues like climate change to personal issues like vaccination. While research suggests that people tend to focus on non-science considerations when making science-related decisions, there is also evidence that people can reason very productively with evidence and mechanism. This study examines how the goals participants pursue when reading a science report influences how they attend to information about causal mechanism and evidence.

Two hundred and seventeen high school students were asked either to evaluate the truth of a scientific claim, to make a personal decision based on the claim, or to make a social policy

decision based on the claim using an online task-based survey. All three groups of participants attended to evidence and mechanism, but participants with different goals requested different types of information and were influenced by evidence and mechanism for different reasons. The findings suggest that goals influence how participants use evidence and mechanism.

The dissertation of Jacqueline Yin Sang Wong is approved.

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Chapter 1

Introduction

To understand whether one thing causes another, scientists seek evidence to see what happens, mechanism to explain how it works, and whether available evidence and mechanism support each other. Proponents of science literacy have highlighted the scientific practice of coordinating evidence and mechanism as important for preparing individuals to deal with the science they encounter in everyday situations. A functional perspective on science literacy (Feinstein, 2011; Ryder, 2001), however, challenges the assumption that scientific knowledge and practices are automatically useful across everyday situations. As researchers and educators, we must reflect on how coordinating evidence and mechanism can be useful when people are dealing with everyday situations and understand how individuals think about evidence and mechanism (or not) in the process. Understanding this thinking process will inform how we might teach about the practice of coordinating evidence and mechanism in ways that will help students use such practice toward their own needs outside of school.

Studies on how people reason about science claims in everyday situations found that participants range from not making any reference to science at all to using evidence and mechanism in thoughtful, productive ways. Efforts thus far to account for age, science content knowledge, and content of issues being considered do not explain why individuals use information about evidence and mechanism sometimes but not others. To make sense of the variation in people's use of evidence and mechanism, it is important to account for the context of reasoning. *For this study, I propose to examine whether and how individuals differ in their use*

of evidence and explanatory mechanism when they encounter science causal claims across different situations. To address this question, I adopt the perspective that cognition is situated within activity. In this case, the situations of interest are instances when individuals encounter science claims in the media, such as reading about the safety of common chemicals or deciding whether to take a health supplement as a preventative measure. I propose that it is important to account for three aspects of such situations: affordances in the situation that support reasoning about evidence and mechanism, individuals' ideas about knowledge, and the extent that the task goal involves knowledge.

Chapter 2

Literature Review

SCIENCE LITERACY

A functional perspective on science literacy

A perpetual issue in science education is to prepare students for a society that is increasingly influenced by science and technology (AAAS, 1989; NRC, 1996; OECD, 2009). For many decades and still prevailing today is an idea of science education for all (Hurd, 1998). From this perspective, an outcome of science education is a science literacy that will be useful outside of professional science settings and within the contexts of everyday life. Most definitions and initiatives for science literacy (e.g. AAAS, 1989; NRC, 1996; OECD, 2009) prescribe teaching scientific concepts and practices with the assumption that these will be useful in contemporary life. However, one critique is that we often assume such concepts from and about science are useful without understanding how people actually draw on them in everyday situations (Feinstein, 2011).

For this study, I will adopt a functional perspective (Feinstein, 2011; Ryder, 2001) of science literacy to emphasize this utility aspect. To avoid confusion, it is important to differentiate the use of “functional” here from science literacy scholars such as Bybee (1997) and Shamos (1995) who use “functional” to mean minimal along a functional to optimal hierarchy. Functional science literacy is not about being scientists but about identifying when science is relevant to self and using science to meet personal objectives. This distinction is important

because it shifts how we understand science literacy from the perspective of professional science to the local perspective of individual actors. Severing the equivalence of science literacy with scientific practices does not preclude scientific concepts and practices from being useful in everyday situations. The challenge here is to understand how the concepts and practices frequently listed within curricular standards and policy documents contribute to the ways individuals use science to meet their needs.

Science literacy for dealing with science claims

There are many situations where individuals might leverage scientific concepts and practices to help them meet their own objectives. One common type of situation is when individuals encounter science claims in the media. Claims about discovery of scientific phenomena or potential benefits and dangers of causal agents such as particular foods, chemicals, or environmental changes are common in the media. People can potentially use these claims to inform their personal decisions, enrich their understanding of their surrounding, or fulfill their curiosity.

Producing causal claims and judging claims produced by others are central to the work of science communities. In scientific practices, a causal relationship is considered more likely if there is empirical data to show that the causal agent and an effect covary. However, covariation alone does not guarantee that a causal relationship exists. Covariation can be coincidental. To make causal judgments, scientists weigh the strength of covariation data with information about the quality of the data (e.g. sample size, methods) and with availability of causal mechanism to explain the covariation (cf. Koslowski, 1996). From an epistemological perspective,

philosophers have long challenged the positivist description of science as direct, theory-independent observations of the world (Kuhn, 1970). In actual scientific practices, scientists depend on their existing knowledge to generate and test hypotheses and to interpret data (Lawson, 2009).

Coordinating covariation evidence and explanatory mechanism to justify one's claims and to evaluate others' claims is a central set of practices that scientists use to construct knowledge (cf. Koslowski, 1996; Kuhn, 2010). Taking a functional perspective on science literacy, we cannot assume that the practices of coordinating evidence and mechanism are automatically useful in all situations. Feinstein (2011) defines functionally science literate persons as "competent outsiders". Competent outsiders do not seek to accomplish scientific ends for their own sake (e.g. produce evidence to support a theoretical claim). Instead, they "recognize the moments when science has some bearing on their needs and interests and to interact with sources of scientific expertise in ways that help them achieve their own goals" (Feinstein, 2011, p.13). Science cannot solve every aspect of everyday problems. Achieving goals and fulfilling needs, as emphasized by Feinstein, also means different things across individuals and situations. It is problematic to assess individuals' everyday reasoning and action based solely on whether individuals attend to evidence and mechanism.

Since the practices of coordinating evidence and mechanism are centrally about knowledge and are scientists' ways to evaluate the status of knowledge claims, we can expect these practices to be useful mainly when individuals need knowledge to accomplish what they are trying to do. In these situations, individuals need to grapple with causal claims to come to conclusions about the state of knowledge to accomplish their goal. In such cases, being a

competent outsider is not about making a particular decision or action, but about how one uses and evaluates claims in the process of coming to that endpoint. Functional science literacy in such cases entails attending to and coordinating evidence and explanatory mechanism as part of one's reasoning process.

REASONING ABOUT CLAIMS WITH EVIDENCE AND EXPLANATORY MECHANISM

Developmental research on scientific reasoning

Based on understandings of how knowledge claims are constructed and evaluated in science communities, educational and psychological research defines scientific reasoning about causal claims as coordination of evidence and explanatory mechanism (Koslowski, 1996; D. Kuhn, 2010; Zimmerman, 2007). The focus of much of this work is to determine whether people across age spans can think scientifically about causal claims and how this reasoning develops from childhood to adulthood. Empirical work found that children and adults alike have rich ideas about causal claims (cf. National Research Council, 2007; Zimmerman, 2007). For example, elementary school aged children can differentiate theories and evidence, understand what it means to put ideas to empirical tests, and can distinguish a conclusive test from an inconclusive test (Sodian, Zaitchik, & Carey, 1991). They can form causal hypothesis based on patterns in covariation evidence (Ruffman, Perner, Olson, & Doherty, 1993). They also show preference for empirical evidence and mechanism over authority as justifications for causal claims (Sandoval & Çam, 2011). Studies with adolescents and adults found that people account for the existence of explanatory mechanisms, the plausibility of mechanisms, and the quantity of data in their reasoning about causal claims (Koslowski, Marasia, Chelenza, & Dublin, 2008;

Koslowski, 1996).

While this body of work provides promising evidence that children and adults can coordinate evidence and mechanism to reason about causal claims, the contexts of reasoning in these studies are not typically those where we expect individuals to encounter when reading about science claims in the media. Indications of people's coordination of evidence and mechanism in this body of work were evident from people's choices of experimental tests (e.g. Sodian et al., 1991), the observations they make (e.g. Klahr & Dunbar, 1988; Ruffman et al., 1993), or their preferences amongst provided data and causal mechanism (e.g. Koslowski, 1996; Sandoval & Çam, 2011). In everyday settings, people typically do not engage in such inquiry activities to test claims nor do they have access to data and information in the same way. If people coordinate evidence and mechanism to evaluate science causal claims they encounter in the media, they would likely have access to and use information about evidence and mechanism in very different manners. Coordination of evidence and mechanism seems highly dependent on the complexity of the reasoning context (Grotzer, 2003; NRC, 2007). It is unclear whether the observed patterns of reasoning would be the same in everyday situations (Grotzer, 2009). As a starting point to understand how people use evidence and mechanism in everyday situations, the following section reviews studies that examine how people reason through personal decisions and social issues that involve science claims.

Research on reasoning in everyday scenarios that involve science claims

In recent years, there is a growing body of research to understand and improve students' reasoning about science-related issues. With the exception of a few studies (e.g. Korpan, Bisanz,

Bisanz, & Henderson, 1997; Ratcliffe, 1999; Sadler, Chambers, & Zeidler, 2004; Tytler, 2001), the focus of this body of work is not to directly examine how people use evidence and explanatory mechanism. Instead, the focus is often to characterize people's reasoning more generally, describing the moral, practical, and other non-science considerations involved in people's reasoning processes. However, these studies do capture how people use science in the process of reasoning about science-related issues.

There is indication that both children and adults do attend to evidence and mechanism when they are reasoning about science claims in the context of a personal or social issue. Both child and adult students justify their conclusions regarding science claims they read with either mechanism or evidence (Ratcliffe, 1999). When asked to determine whether claims presented in news briefs are true, almost all university students requested some information about mechanism and evidence (Korpan et al., 1997). High school students also attempt to evaluate knowledge claims and sources of information when asked to state their conclusions about a controversial health issue (Kolstø, 2001). In the context of a written class assignment to evaluate articles concerning science-related social issues, teacher education students with some science background attended to whether claims were consistent with cited evidence, used prior knowledge of relevant scientific concepts, and demanded methodological or explanatory details (Kolstø et al., 2006).

While the studies mentioned so far found that people do attend to empirical evidence and explanatory mechanism, they do so in inconsistent and sometimes superficial ways. Few of the students in Ratcliffe's (1999) study evaluated the evidence or mechanism they cited and fewer yet referenced both mechanism and evidence. In Korpan and colleague's (1997) study, few of the

university students consistently requested information about mechanism and evidence across multiple news briefs. High school students' attempts to evaluate knowledge claims in Kolstø's (2001) study were often superficial and inconsistent. Recent studies by Nielsen (2012a, 2012b) examined the ways high school students use science in deciding whether human gene therapy should be allowed. He found that the students in the study did refer to science as frequently as 23% of the talk turns during their group discussions. However, Nielsen found that students frequently "co-opted" science to support their position on the issue. Their science talk was *not* about understanding or evaluating the science claims based on evidence and mechanism, then taking the outcome of that reasoning to inform what to do about their issue. Instead, students primarily invoked science in a matter-of-fact manner to support their position. This study highlights that even when individuals invoke science claims in their reasoning about a personal or social issue, they might do so without considering the status of the claim.

Other studies found little to no indications that people attend to evidence, mechanism, or any aspects of science at all. When asked to make a decision or to support their positions on science-related issues, people seem to rely heavily on ethical, emotional, practical, or other considerations that do not draw on evidence and theory. Science plays little or no part in their reasoning. This is true not only of students (Fleming, 1986a, 1986b; Zeidler, Walker, Ackett, & Simmons, 2002), but also college students with science background (Halverson, Siegel, & Freyermuth, 2009) and academic professionals with significant knowledge of scientific practices (Bell & Lederman, 2003). Even individuals who express the need for having empirical evidence to take a position on an issue resort to values and existing beliefs when evidence contains uncertainty (Albe, 2008). Individuals also compartmentalize their attention to evidence.

Students included evidence when describing the science relevant to an issue (Halverson et al., 2009) or to judge scientific merit (Sadler et al., 2004). When asked to state their position on the issue, the same students did not justify their position with any evidence.

Accounting for variations in the use of evidence and mechanism

Across the studies that examined people's reasoning about science-related issues, individuals vary from not making any reference to science at all to using evidence and mechanism in thoughtful ways to evaluate the claims. Accounting for this variation is key to understanding how people use evidence and mechanism and how such reasoning can support people in what they do in everyday situations. Past research has demonstrated that individuals' understanding of relevant science concepts influence their abilities to identify and engage with the science present in social issues (e.g. knowledge about genetics for issues concerning gene therapy) (Lewis & Leach, 2006; Sadler & Fowler, 2006; Sadler, 2004; F. Yang, 2004). Ford (2008) also suggests that individuals with experience in the practices of constructing and critiquing claims, such as experiences with professional scientific work or with targeted inquiry activities in the classroom, are more likely to attend to evidence when evaluating claims. In addition, developmental research on people's use of evidence and mechanism indicates some age-related trends due to younger children's limitations on background knowledge and resources for dealing with more complex tasks (Koslowski, 1996; Zimmerman, 2007). However, differences in understanding of science concepts, experience in science, and age do not explain the variations evident across the studies discussed here. Looking across this body of work, two other sets of factors emerge as potential explanations for why individuals seem to use evidence

and mechanism so differently within and across studies: differences in what counts as evidence and mechanism and differences in contexts of reasoning.

Differences in what counts as evidence and explanatory mechanism

The variations in whether or not people use evidence and mechanism to reason about claims across studies is partly due to differences in what the researchers consider as “scientific”. Unlike the developmental studies on scientific reasoning discussed above, the studies that focused on personal and social issues seldom present participants with opportunities to make their own empirical observations or to interpret data. Without engaging participants directly with inquiry activities or data, it is less obvious what researchers define as evidence. Some studies explicitly focused on data, examining participants’ identification or requests for data (e.g. Korpan et al., 1997; Sadler et al., 2004). Others identified participants’ unspecified references, such as “there needs to be evidence” or “research has to be done”, as evidence (e.g. Bell & Lederman, 2003; Yang & Tsai, 2010).

Participants sometimes provide anecdotes and personal experiences to justify their conclusions or decisions, but such examples are usually considered unscientific and not counted as evidence (e.g. Albe, 2008). While the sources and methods that produced such personal observations might be questionable, they can be considered a form of evidence because they are based on observed instances of the cause and effect. Similarly, individuals sometimes referred to intuitive or common knowledge to support their reasoning. The source and detail of such knowledge is often not articulated and sometimes inaccurate. Nevertheless participants were attempting to provide plausible explanations for why something might be true.

Not all studies disregard intuitive or inaccurate attempts at providing evidence and causal

mechanisms. Kolstø (2001) provides examples of students attempting to evaluate a claim by using insufficient or inaccurate evidence and mechanism. Students attempted to evaluate a claim with implicit notions of whether the research or method was “good”. Students also attempted to evaluate a claim by vaguely stating that it was compatible with what they “know” or whether it seemed logical to them. These examples do not represent ideal scientific notions for how people might use evidence and mechanism to evaluate a claim. Even attempts to use evidence and explanations in vague and insufficient ways, however, are indications that people recognize some need to show or observe what is claimed and to have an explanation for the causal relationships.

The ambiguity across studies of what count as evidence and mechanism result in inconsistencies in what is reported in the findings. Being explicit about how evidence and mechanism are defined might explain part of the variation in how people use evidence and mechanism in everyday situations. It is also important to distinguish coordinating evidence and explanation insufficiently versus not at all because they have different implications for educational practice. The first suggests that people already try to coordinate evidence and mechanism, but we need to teach and support them to do it more productively. If people don’t make any attempts to use evidence and mechanism, then it suggests that we need to help people recognize situations where using evidence and mechanism could help them better accomplish a task.

In this study, I define evidence as any covariation data linking a causal agent and an effect. Since people seldom have access to researchers’ data when they encounter science claims in the media, I include second hand reports of such data as evidence. Mechanism is any explanation for how a causal agent produces an effect. While attempts to use evidence and

mechanism, even when insufficient, should be considered as such, I do not consider all references to science as evidence or mechanism in this study. In prior research, scientific evidence sometimes means reasons or arguments that contain science concepts or terminologies, such as “smaller engines will need smaller amount of fuel” (Simon & Amos, 2011, p.180), rather than empirical observations or second hand reports of observations. While the term evidence is sometimes used colloquially and in research to mean any stated reason to support an argument, this study will focus on evidence as based on data.

Differences in the contexts of reasoning

Issue content. One aspect of context that prior research began to examine is the topic area of the claim. Science claims that have bearings on everyday situations range as broadly as the disciplines within science. Within the wide range of possible topics, educational research commonly engaged participants on topics related to health and environment, such as the applications of medical innovations or issues of climate change. Topçu and colleagues (2010) examined whether preservice teachers support their positions on claims differently across topics that are conceptually related (i.e. gene therapy versus cloning) as well as topics that are conceptually distinct (i.e. gene therapy and cloning versus global warming). There was no significant differences in the ways participants support their positions across topics among the whole sample. There was some indication of within subject variation across topics. The within subject variation, however, accounts for differences in whether participants provide counter-positions and rebuttals, not simply whether they used evidence or mechanism.

Bell and Lederman (2003) also examined participants' reasoning in topics spanning multiple content areas. Across scenarios about fetal issue implantation, global warming, diet's

affect on cancer, and cigarette's affect on cancer, university professors and research scientists considered different "factors" in their decision making, such as issues of moral, pragmatism, personal values, and economics. While the types of considerations varied across topics, they consistently used evidence in the same infrequent and superficial manner. Instead of focusing on the conceptual content, Korpan and colleagues (1997) examined other characteristics of the issues being considered: plausibility, typicality, and familiarity. They found university students requested different types of information to help them evaluate claims across news briefs that differed in these characteristics. Participants requested most information about social context, such as credentials, motivations, and funding sources of the researchers and reported organizations, for the claim that was least plausible. Information about mechanism was requested more frequently for topics that were typical to school science (i.e. insecticide, diet) whereas information about research methods, or how evidence was collected, was requested more frequently for topics that were less typical to school science (i.e. crystals that help people dream about future events, effectiveness of a text book). Lastly, information about evidence in the form of data was requested mostly frequently for the topic that was most personally familiar to the participants.

While context in the form of issue content seem to influence what non-science factors individuals consider (Bell & Lederman, 2003) and the extent counter-positions and rebuttals are given (Topcu et al., 2010), use of evidence and mechanism appear to depend more on specific characteristics of the issues rather than their conceptual content (Korpan et al., 1997). While support for this pattern in reasoning is still limited among studies focused on everyday situations, there are other findings that support this interpretation. Existing evidence from developmental

research on scientific reasoning show that plausibility of causal relationships influence how individuals use evidence (Koslowski, 1996). Influences of typicality and personal familiarity echo the findings that background knowledge of the relevant concepts affect how individuals engage with science in everyday situations (Lewis & Leach, 2006; Sadler & Fowler, 2006; Sadler, 2004; F. Yang, 2004). The overall relationship of issue content with use of evidence and mechanism still warrants further investigation, but these findings suggest that the relationship might have less to do with the issue content but more with individuals' perception and familiarity with the issue.

Availability of information about evidence and mechanism. The information resources that participants have access to during their tasks vary across studies. While most studies introduced issues to participants in the form of short readings in print or online, the type and amount of information about evidence and mechanism vary. Ratcliffe (1999) presented participants with science magazine articles that provided background about how the reported research was conducted and some information about the evidence and mechanism to support the reported claim. In contrast, Bell and Lederman (2003) provided participants with scenarios that contained no information about evidence beyond references to “scientists” or “studies” and only vague references to explanatory mechanism. Other studies provide information about mechanism but no evidence, or vice versa (e.g. Korpan et al., 1997; Nielsen, 2012a; Topçu, Yılmaz-Tüzün, & Sadler, 2010; Zeidler et al., 2002).

Task Questions. The tasks used to engage participants to reason about science-related issue also varied across studies. Researchers elicited participants' thinking with very different questions. The questions can largely be divided into two categories, those that ask participants to

evaluate a claim and those that ask participants to make a decision (see Table 1). The former category asks directly about a causal claim (i.e. whether X causes Y). Occasionally, this type of question is framed in a scenario where a fictitious actor has taken a position on the claim and the participants are asked to explain why they agree or disagree. Ultimately, the task at hand is for the participant to evaluate the causal claim. In contrast, many studies ask participants to make a decision related to a causal claim (e.g. Would you use X for Y?), or simply about the causal agent or desired effect (e.g. Would you use X? What would you do about Y?). In these instances, evaluating the causal claim can potentially inform the decision, but participants are not asked explicitly to do so.

Beyond the two broad types of questions, there is another aspect that differentiates decision-making questions. Some tasks ask participants to decide what government agencies or society as a whole should do (e.g. Bell & Lederman, 2003; Topçu, et al., 2010). Others ask participants to make a personal level decision with personal consequences (e.g. Bell & Lederman, 2003; Kortland, 1996).

These questions make different explicit demands of the participants. It is perhaps not surprising that individuals would respond differently when asked these different questions. Research thus far considered these different task questions as generally involving reasoning about science. There is little attention to whether different tasks shape the reasoning contexts in ways that influence how participants use evidence and mechanism.

Table 1. Task questions used in prior research.

Sources	Task Questions
	Examples of claim evaluation questions:
Albe (2008)	"Are mobile phones dangerous for human health? Why?"
Ratcliffe (1999)	"Chris has read this article and says: This proves that plastic teething rings damage babies' livers. Do you agree or disagree with Chris? Explain why you think this."
Yang & Tsai (2010)	"Do you think now that the earthquakes can be predicted? Why?"
	Examples of societal decision-making questions:
Bell & Lederman (2003)	"Would you support increased legislation on foods associated with cancer, including removing high risk foods from the market?"
Topcu, et al. (2010)	"Should doctors and scientists be permitted to explore therapeutic cloning?"
	Examples of personal decision-making questions:
Bell & Lederman (2003)	"Has your awareness of the benefits of physical activity and a diet rich in fruits and vegetables impacted how you conduct your life? If not, why not? If so, in what way(s)?"
Kortland (1996)	"Now you are standing in the supermarket. It appears that you can choose between milk in a carton and milk in a glass bottle. What are you going to take home, and why?"

Yang and Tsai (2010) provide some early indication that people do use evidence and provide justifications differently across different types of tasks. In their study, they contrasted two tasks. One asks students more directly about claims that earthquake can be predicted. Another includes a claim about well-digging as a cause of land subsidence, but the task asks student more directly about the community's dispute with the well-digging company over safety. More students mentioned that scientific evidence is needed to make them believe in the

earthquake prediction claim than for the well digging company to convince the community of their safety claim, although this demand for evidence was low in both conditions. Students also provided different justification for their reasoning. Students believed in an earthquake prediction claim by whether it aligned with what they already believed (e.g. “I know animals are capable of making prediction”) and whether the prediction was correct (e.g. “The fish experiment was a success.”). In contrast, students’ reasons for believing or not believing in the well digging company’s safety claim were more varied. Some stated that the company has justifications for their claim (e.g. “organization has done the testing”), some stated that the company is authoritative (e.g. “company as guaranteed the safety”), while others suspected that the company could lie about their safety claim or stated that it was impossible to promise safety.

The two tasks used in Yang and Tsai’s study (2010) elicited differences in students’ reasoning, some of which involved differences in whether and how students used evidence. However, the authors did not account for the different types and amounts of evidence provided for the different claims, the extent that the causal claims are made clear in the news article, or whether mechanism was provided to explain the causal relationship. In a way, this study reflects both the observed variations in people’s reasoning and the lack of conceptual handle on context evident in the larger body of research on people’s reasoning in science-related everyday situations. The attention taken by the authors to differentiate tasks that asked more or less directly about a science phenomenon is a productive first step. The interesting though tentative difference observed in students’ use of evidence also warrants further investigation. Moving forward, it is necessary to carefully consider why various elements of context could have an effect on how people use evidence and mechanism and to begin to account for context in more

systematic and theoretically driven manners.

Summary of issues

While research suggests that adults and even young children are able to coordinate evidence and mechanism to reason about causal claims, people's tendency to do so is mixed in the everyday situations of interest to functional science literacy. While people's understanding of relevant science concepts, their experience in science, and age account for some of the variations in how people use evidence and mechanism, the variation observed across existing studies remains largely unexplained. I identified two types of differences across studies that can potentially contribute to variation in the use of evidence and mechanism: differences in what researchers count as evidence and mechanism and differences in reasoning contexts. The issue of what counts as using evidence and mechanism can be resolved by specifying and aligning evidence and mechanism with developmental research on scientific reasoning. It is further clarified by differentiating the question of whether or not people make an attempt to use evidence and mechanism from the question of how well people do it in relation to some normative standards. The issue of differences in reasoning context is more complex.

The situations where people encounter science causal claims in the media are quite different from those where researchers engage participants in testing hypothesis, evaluating evidence, or making observations. Everyday situations are also likely to be quite varied. To understand the implications for how we might expect and prepare people to be functionally science literate individuals in everyday situations, it is necessary make sense of how reasoning context might result in variation in people's use of evidence and mechanism. To do so, we need to come to a better grasp conceptually on why context matters. I identified multiple ways in

which reasoning contexts are different across prior studies. These aspects of context are not intended to make an exhaustive list, but as a way to bring the complexity of the context issue into focus. Reasoning contexts are inherently complex and multi-dimensional. It is yet unclear what parts of context matter most for how people use evidence and mechanism when they encounter science claims. Both conceptually and pragmatically, accounting for a long list of context variables without questioning how they might matter is a wrong-headed approach. Different aspects of context might influence how people use evidence and mechanism to different extent and in qualitatively different ways. I propose to take the theoretical framework of cognition as situated in activity to suggest how to productively account for the influences of context.

EXAMINING EVIDENCE AND EXPLANATORY MECHANISM WITHIN SITUATED ACTIVITY

From a situative perspective, cognition is not an isolated internal process but fundamentally mediated by the material and social aspects of the situation, such as tools, cultural norms, expectations for an activity, or other individuals. From the ways people solve math problems (e.g. Carraher, Carraher, & Schliemann, 1987; Lave, 1988) to the ways they approach science knowledge (e.g. Leach, Millar, Ryder, & Sere, 2000; Rosenberg, Hammer, & Phelan, 2006; Sandoval, 2005; Yang & Tsai, 2010), individuals' action and thinking vary depending on what they perceive as appropriate for the specific situation.

Taking situated cognition as a starting point, it is unsurprising that people would attend to and use evidence and mechanism in various ways across situations. Since the coordination of evidence and mechanism concerns knowledge specifically, I will narrow the focus here from

cognition in general to epistemic cognition. Epistemic cognition as a particular form of cognition refers to individual's thinking about the nature of knowledge and how we come to know. Epistemic cognition can be conscious reflection or in the moment thinking that remains tacit. To understand people's reasoning about science claims from a situative perspective, I propose that we have to examine three aspects of interactions that together shape epistemic cognition. First is how the social material context supports or hinders different ways of making sense of knowledge, what I will refer to as *affordances* (Greeno, Moore, & Smith, 1993; Greeno, 1994) for epistemic cognition. Second are the experiences that individuals draw on to reason about knowledge, or *ideas about knowledge* (Hammer & Elby, 2002; Sandoval, 2009). Third is whether individuals perceive the goal in the situation as requiring knowledge and adopt *epistemic aims* (Chinn, Buckland, & Samarapungavan, 2011) to pursue their goals.

Material and social affordances for epistemic cognition

While the situative perspective conceives of cognition as being fundamentally mediated, material and social context isn't taken to be a cumulative list of factors that determines how a person thinks (Lave, 1988). The argument is not to exhaustively account for every possible variable in a context. Individuals, when engaged in a particular task, attend to, consciously and subconsciously, some aspects of the material and social context that are relevant to what they are trying to do but not others (Lave, 1988). To understand this process more concretely, the concept of affordances (Greeno et al., 1993; Greeno, 1994) is helpful for analyzing how particular aspects of a situation come to shape how people reason about knowledge. Affordances are qualities of the material and social context, presenting particular ways of interacting to the individuals

perceiving them. For example, a solid object with a flat surface at knee height affords sitting. Having information available and clearly connected to a task makes it possible for individuals to use them for the task. To understand how individuals reason about science claims, the concept of affordance focuses our attention to what qualities in a situation demand or support particular forms of epistemic cognition, such as using evidence and mechanism to justify a causal claim.

A number of studies illustrated how affordances for reasoning about knowledge influence individuals' epistemic cognition in situations involving science claims, though they do not examine the use of evidence and mechanism. While the authors did not frame their work in the theoretical framework of affordances, they drew attention to differences in the social or material aspects of situations and examined relationships between such differences and epistemic cognition. One example is Rosenberg and colleagues' (2006) observation of a group of middle school students engaged in a science activity to come up with a rock cycle model. They started the activity with a previously completed worksheet. The affordances of a worksheet, with answer blanks filled in and technical vocabulary prominently featured, focused students on identifying, repeating, and ordering written information to create their rock cycle model. Their approach to knowledge changed when the teacher reorganized their interaction, setting aside their worksheets, vocabularies, and oriented the students to talk to each other. The affordances of this new material and social arrangement focused students to construct knowledge through working out and discussing what they made sense to them.

In two studies that focused on reasoning about science claims with personal relevance, Kienhues and colleagues (2008; 2011) examined the effects of different types of information on how college students think about science knowledge. In one study, they presented two versions

of texts about DNA fingerprinting, one *refutational* text written to highlight the uncertain nature of scientific and another *informational* text written to resemble a relatively certain and stable style of a textbook passage. For those who expressed more structured and static descriptions of science knowledge, reading the refutational text shifted them toward more unstructured, variable descriptions of science knowledge. In contrast, those who initially expressed unstructured, uncertain descriptions of science knowledge shifted in the opposite direction after reading the informational text. In another study (Kienhues et al., 2011), students were asked to advise a fictitious friend about taking medication to lower cholesterol. Students who conducted a web search about cholesterol medication, in comparison with a control group who did not, aligned more with descriptions of medical knowledge as complex and variable. The quantity and depth of information available in the 30-minute search task afforded ways of reflecting on the nature of medical knowledge that differed from the control condition of thinking about a medical issue based only on one's own experience.

A number of studies looked specifically at how context afforded different ways of reasoning with evidence and mechanism. These studies do not deal with science causal claims in everyday situations, but they illustrate how different people attend to and use evidence and explanations differently given different affordances in the context. For example, Masnick and Morris (2008) found that presenting data in different formats affect how third and sixth graders perceive data characteristics. The children were more likely to use information such as sample size and reversed trend to justify their conclusions when data was shown incrementally rather than all at once. Chinn and Malhotra (2002) found that elementary school children, when having access to an explanation for what scientists expect to find in an experiment, were better able to

make accurate observations. Brem and Rips (2000) found that college students produced and assessed evidence and explanation differently depending on whether information about a topic was scarce or plentiful. Koslowski and colleagues (2008) found college students were more likely to see information as evidential and relevant when there was explanation provided to connect it to the causal relationship. However, simply making explanations available isn't sufficient to produce the effect. Evidence and explanatory mechanism need to be present at the same time or have their connection made explicitly clear in order for the students to see the information as evidence.

There are potentially many ways for social and material affordances to support the use of evidence and mechanism for evaluating causal claims in everyday situations. Availability, format, and connection of evidence and mechanism exemplify some aspects of material context that can support the use of evidence. This is not an exhaustive list by any means. How other specific material or social aspects of situations can support coordination of evidence and mechanism remains open to investigation. The examples here serve to help us revisit the context differences that I began to document earlier. In particular, they highlight the differences in what information about evidence and mechanism were presented to participants in across studies. Research suggests that people are more likely to consider evidence and mechanism when information is available and clearly connected (Brem & Rips, 2000; Koslowski et al., 2008). For the present purpose of accounting for variation in people's reasoning in everyday situations, a first step is to attend to whether there is *any* information about evidence and mechanism that would afford individuals to consider them when evaluating a claim. This is a modest first step, but it is a step yet to be taken in most studies that examine people's reasoning in everyday

situations.

Individuals' ideas about knowledge

Unlike behavioral models of cognition, presence of affordances that support a particular way of reasoning does not determine that it will occur (Greeno & MSMTAPG, 1998). It simply contributes to the possibility for that particular way of reasoning. How individuals attune to particular affordances in a situation depends partly on their experiences (Greeno et al., 1993). From this perspective, affordances can influence how we engage in a task by supporting some forms of interaction and not others. But the relationship is not one way. Affordances need to be perceived. The experiences that people have, and the ideas about knowledge and knowing that they come to have along the way, influence how they attend to affordances that support the use of evidence and mechanism.

Theories of epistemic cognition all account for individuals' experiences.

However, most theories assume people to draw on their experiences with knowledge in stable, coherent, and consistent ways, an assumption incompatible with a situative view of cognition. Most epistemic cognition theories posit that people develop through their experiences relatively coherent cognitive stages (e.g. King & Kitchener, 1994; Perry, 1998) or beliefs (e.g. Bendixen & Rule, 2004; Schommer, 1990). People are expected to act on their understandings about science knowledge invariantly across situations (e.g. Bell & Lederman, 2003; Songer & Linn, 1991; Zeidler et al., 2002). This expectation is challenged by studies that compared engagement with science knowledge across contexts and found inconsistencies in students' ideas about knowledge (Leach et al., 2000; Louca, Elby, Hammer, & Kagey, 2004; Rosenberg et al., 2006). Perhaps one

of the most compelling evidence for a situative perspective of epistemic cognition is the inability of many research studies to categorize individuals to one or another type of views (cf. Sandoval, 2005). Most studies, including those attempting to categorize individuals into stages, reported inconsistencies within individuals (Schwartz & Lederman, 2008; Smith & Wenk, 2006; Songer & Linn, 1991). To address this lack of consistency in epistemic cognition, some researchers accounted for context in terms of disciplinary differences (Limón, 2006; Muis, Bendixen, & Haerle, 2006). This body of work on *domain-specificity* posits that individuals have separate sets of epistemic beliefs for different academic disciplines, though each is assumed to be internally coherent. However, recent studies demonstrated that even within a discipline, individuals are sensitive to the way knowledge is presented in a particular situation and show variations in their epistemic cognition (Franco et al., 2012; Muis, Franco, & Gierus, 2011; Muis, Kendeou, & Franco, 2011).

To account for the situation dependent nature of epistemic cognition, Hammer and Elby (2002) model epistemic cognition as a collection of independent epistemic resources that are activated in different combinations across different contexts. People might have epistemic resources for understanding what sort of things knowledge can be, how knowledge come about, what sort of things people do with knowledge, et cetera (Hammer & Elby, 2002). People form various epistemic resources based on their experiences over time (Hammer, Elby, Scherr, & Redish, 2005). These resources are neither right nor wrong on their own, but may be considered more or less productive in different contexts (Elby & Hammer, 2001). When epistemological resources are triggered, they may do so in combination and in varying permutations. There can be considerable inconsistency in a person's reasoning about knowledge if different resources are

triggered across different contexts. By the same token, certain regularity from the context, such as the routine structure of filling out worksheets in a particular classroom, might repeatedly trigger a specific set of resources (Rosenberg et al., 2006).

Epistemic resources are useful conceptually to explain how people draw on their experiences differently across some situations but remain consistent across others. But as defined by Hammer and Elby (2002), epistemic resources are tacit and mental entities that are not directly observable or reportable by individuals. I build on Hammer and Elby's (2002) model that people's resources for dealing with knowledge are manifold, tacit, and sensitive to context. Since I am less concerned with people's mental structure, however, I will avoid the terminology of epistemic resources because I do not intend to make claims about people's resources for coordinating evidence and mechanism at the exact grain size as Hammer and Elby (2002). I will refer to people's experiences about knowledge and science claims, to the extent that they are expressed in their action and reflection, simply as *ideas* about knowledge.

While it might be not be feasible to pin point the specific form of epistemic resources as they exist in people's mind, it is still useful to elicit what ideas about knowledge people are drawing upon in a given situation. This is important because it is often ambiguous to an observer why people reason about knowledge in a particular way (Sandoval, 2012). People may use evidence and explanation based on different ideas about knowledge, such as what counts as evidence or how evidence can be used. For example, someone may cite evidence to justify a science claim because they think it is important to test something out to see if it actually happens. They may also cite evidence because they think evidence would sound convincing and would prevent others from questioning their stance or decision. Eliciting people's ideas about

knowledge, particularly those concerning evidence, mechanism, and causal claims, can give researchers a handle on how people use evidence and mechanism differently across situations. It also has important educational implications. Educators cannot assume what is taught about evidence and mechanism to be constantly and consistently applied in everyday situations. By understanding what ideas about knowledge are linked to productive uses of evidence and mechanism, we can work toward giving students learning experiences that will make these ideas available to them, perhaps even help students draw upon these ideas more readily in everyday situations.

Individuals' goals in situations

People do not constantly reflect on what they know or how they know. Even when they do engage in epistemic cognition, it is often in service of something that they're trying to do and not because they are pursuing knowledge as an end. As a form of cognition that is specifically about knowledge and knowing, it is necessary to account for how knowledge is a part of what individuals are trying to do within a situation. The situated cognition literature offers examples of how a specific form of cognition, such as mathematical reasoning, is embedded in situations where the broader goal is not to do math for its own sake. For example, Lave (1988) illustrates how everyday activities, such as grocery shopping or dieting, give structure to arithmetical thinking. Grocery shoppers can be described as doing math when figuring out the best price per unit for a product. But their goal is not to do math. The quantitative relations they reason through are motivated and shaped by their goals to get the best price on their purchases.

In a similar manner, any epistemic cognition individuals engage in when they encounter

science claims is partly shaped by what the individuals are trying to accomplish in a situation. In particular, people adopt different knowledge goals, what Chinn and colleagues (2011) call epistemic aims, in service of their broader goals in the situations. Epistemic aims are “goals related to finding things out, understanding them, and forming beliefs” (Chinn et al, 2011, p. 146). Accounting for goals and epistemic aims is important because people reason about knowledge differently when doing so toward different goals even when given the same material social affordances and the same experiences with knowledge.

While there is no direct evidence for the influence of epistemic aims on people’s use of evidence and mechanism in everyday situations, there is empirical support for the influence of goals more generally on epistemic cognition from related research. For example, Maggioni and colleagues (2011) found differences across students’ ideas about what they would do to find things out for a school task versus for their own personal purposes. In another study, Porsch and Bromme (2011) found that participants would use more sources of knowledge and rated different sources as useful for a “high-involving” personal situation than a “low-involving” school assignment situation. In Stahl and colleagues’ (2006) study, participants differentiate learning tasks of varying complexity and found different types of knowledge sources and learning strategies to be appropriate for the different tasks. In another study, Braten and Stromso (2010) found that college students understood a set of climate change readings to different extent when given task instructions to justify one’s opinion, to summarize, or to understand. These studies indicate that people are sensitive to variations in task goals and engage in epistemic cognition differently as a result.

There is also indication that goals influence how people use evidence and mechanism in

scientific inquiry within classroom or research settings. Dunbar (1993) found the goals that college students set for conducting experiments influenced their ability to attend to and use evidence that is inconsistent with their hypotheses. Schauble and colleagues (1991) found that fifth and sixth grade students experimented more systematically when working toward a science goal for understanding than a engineering goal for optimization. Glassner and colleagues (2005) found that middle school students differentiated the argument goals of proving a claim and explaining, preferring evidence and explanatory mechanism respectively as better support for arguments.

Taken together, the theoretical framework of situated epistemic cognition and existing empirical findings suggest that goals, particularly knowledge goals, will influence whether and how individuals use evidence and mechanism in everyday situations. It is important to understand what individuals are trying to accomplish and whether knowledge plays a part in their effort to achieve that goal. As discussed earlier, studies that examined science-related everyday situations elicited people's reasoning with many different types of questions. While there is room for participants to interpret any question in their own way, the different task questions suggest different goals, goals that emphasize knowledge to different extent. For example, consider a claim evaluation question that directly asks participants whether they think X causes Y. This type of questions is explicitly about a causal claim. To answer this question, participants would need to make some judgment of the knowledge claim, even if only in a superficial way. In contrast, consider a decision making question, such as whether the participants would take fiber supplement to lose weight. This type of questions is not explicitly about knowledge. It is possible to answer the question with or without considering the status of the claim.

Consider the example of a decision making question “would you take zinc supplements to prevent colds?” One can offer logical answers based on practical considerations (e.g. zinc supplements are expensive), personal preferences (e.g. I don’t like the taste of zinc supplements), personal relevance (e.g. I don’t get colds often), or many other considerations that do not involve evaluating whether taking zinc supplement prevents colds. Since science literacy intends coordination of evidence and mechanism to be helpful for constructing or evaluating knowledge claims, we need to account for whether goals require the evaluation of claims and examine goals’ effects on how people use evidence and mechanism.

Summary and application of conceptual framework

Within science education research, there is increasing interest in how people make decisions and evaluate claims when they encounter science claims in everyday situations. Findings from prior studies range from participants making no considerations of science at all to grappling with evidence and explanations in productive ways. The variations in people’s reasoning across studies cannot be explained by accounting for science background or age alone. A close examination reveals that there are important differences in what researchers consider as evidence and explanation and in the contexts of the reasoning tasks. Accounting for context, in particular, is challenging because of the range of material and social factors that constitute context. It is not immediately clear what parts of context matter for understanding how people deal with everyday situations involving science claims.

To take a systematic and conceptually grounded approach to this problem of context, I adopted a situative perspective on epistemic cognition. Context is seen through the lens of goals,

affordances, and ideas about knowledge. Use of evidence and mechanism is situated within the context of what individuals are trying to do when they encounter a science claim. In particular, I suggest that we need to focus our attention on whether knowledge is needed to accomplish the task's goal. Another aspect is whether the situation provides any material or social affordances that support the use of evidence and mechanism. Last are the ideas about knowledge that the individuals are drawing upon in the situation. For example, having a goal of "figuring out whether zinc supplements prevent colds" might lead individuals to tacitly draw on their idea that something needs to be observed or done to show the relationship, which in turn might lead the person to pay attention to information available in a news article on research that has observed and documented relationships between zinc supplements and colds. We have only limited understanding about how each of these aspects play a role and how they might interact. The purpose of this study is to take a first step in applying this framework to understand how people use evidence and mechanism when they encounter science claims.

As a first step, I propose to focus attention on the role of knowledge goals. The choice to first investigate goal is partly motivated by its potential to help understand existing research and partly by its relevance to functional science literacy. Among the many context differences I identified across existing studies, the one aspect that most directly map onto the proposed conceptual framework is that of the different goals suggested by task questions. The questions used by most studies to elicit participants' thinking readily fall into the categories of claim evaluation and decision making, the former explicitly asks about knowledge while the latter does not. Examining the effects of different goals suggested to participants by these task questions is an expedient first step to provide new insight on how to make sense of the different ways people

use evidence and mechanism across studies.

Understanding the role of goal also has the most immediate impact on functional science literacy. The functional perspective on science literacy challenges researchers and educators to understand how scientific practices, such as those of coordinating evidence and mechanism, can be useful to individuals in everyday situations. As knowledge practices, we expect uses of evidence and mechanism to be helpful when individuals need to evaluate knowledge claims to accomplish what they are trying to do. Individuals might potentially raise questions like “Do I think x causes y?” or “Would I use x for y?” when they encounter science claims in the media. While the former is more explicitly about the knowledge claim, knowledge can also inform the latter decision. Functional science literacy doesn’t mean arriving at a particular decision, but it does mean attending to and coordinating evidence and mechanism to inform the decision making process. If the differences in goals do in fact influence how people use evidence and mechanism, understanding this relationship would inform how we approach instruction, perhaps anticipating potential obstacles by preparing students to coordinate evidence and mechanism productively toward different goals.

The potential effects of affordances will not be the focus of investigation in this study. Nevertheless, it is important to ensure there are affordances that support the use of evidence and mechanism. In order to focus attention on goals, I propose to study the use of evidence and mechanism in situations where evidence and mechanism are made available and clearly connected. Prior research suggests that such information affords the use of evidence and mechanism. Ideas about knowledge will be a secondary focus of this study. In particular, I want to examine the ideas about evidence and mechanism that people express in connection to their

use of evidence and mechanism. This can potentially shed light on how they think information about evidence and mechanism can be used and for what purposes.

Chapter 3

Methods

RESEARCH QUESTIONS

This study was the first step in my effort to examine whether and how individuals use information about evidence and explanatory mechanism when they encounter science causal claims across different everyday situations. To do so, I investigated the following questions in this study:

- RQ1. To what extent do participants use evidence and explanatory mechanism across goals of claim evaluation, societal decision making, and personal decision making?
- RQ2. What ideas do participants express in their reasons for whether evidence and mechanism influenced their decisions?

The primary focus of this study is to examine how participants used evidence and mechanism across different goals. In order to do so, I asked participants to come to a decision about their goals of evaluating a claim, making a personal decision, or making a societal decision. To complement the above research questions on how students used evidence and mechanism, I also pursued a secondary question:

- RQ3. Are students' decisions and change in decisions different across the goals of claim evaluation, personal decision, and societal decision?

DESIGN OVERVIEW

This study investigated the influence of goals on the extent individuals use evidence and

mechanism. Goals served as the independent variable with three conditions: claim evaluation, societal decision-making, and personal decision-making. A between-subject design was used to test the effect of the three goal conditions. The outcome variables, use of evidence and use of mechanism, were captured using an online task-based survey with Likert-like and open response items.

A between-subject design was chosen because the items in the survey were increasingly more explicit in their prompting for participants' uses of evidence and mechanism. To avoid potential carry-over effects from one goal condition to another and from participants' repeated exposure to similar items, a between-subject design provided the most straightforward comparison of goals. The survey also asked participants to reflect on their own thinking process. Such survey items could be cognitively demanding. Administering only one goal to each participant with a between-subject design kept the duration of the study short and avoided potential response fatigue.

PARTICIPANTS

Recruitment

High school students were recruited to participate in this study. Participants were recruited using the informational flyer in Appendix A. The flyer was sent to high school teachers and forwarded electronically to students. As an option upon completing participation in this study, students were also asked to share the flyer with other high school students. All interested students were asked to access the online survey at a time and location of their convenience.

Drop out rate

Of the individuals who accessed the survey website, 5.5% exited on the consent page. Another 3.7% of the individuals started the survey but completed only part of the participant background items when they exited. The remaining 90.8% completed the full survey.

Assignment to condition

Participants were randomly assigned to one of the three goal conditions. The online survey was programmed to automatically assign participants. During the pilot phase of data collection (i.e. first 100 participants), random assignment was conducted by gender to ensure male and female participants were equally distributed across the three goal conditions.

Pilot data showed no difference between gender in two dependent variables of interest, importance of mechanism ($H=0.76$, $df=1$, $p=0.38$) and importance of evidence ($H=0.96$, $df=1$, $p=0.33$). Instead, the data suggested importance ratings of mechanism and evidence were related to items that measured science's and survey topic's relevance to participants. I decided to change the automatic random assignment to equally distribute participants across the three goal conditions by their ratings of science relevance and cold prevention relevance (i.e. survey topic) items. The purpose of this assignment was to minimize group differences in the dependent variables due to independent variables other than goals.

Participants rated science relevance and cold prevention relevance with a 5-point unipolar scale. Since relatively few participants rated at the extremes (i.e. 1's or 5's), participants were consolidated into low (1's and 2's), medium (3's), and high (4's and 5's) groups for ease of goal assignment. With these groupings, science relevance was related to evidence importance

($H=16.87$, $df=2$, $p<0.01$) and mechanism importance ($H=8.85$, $df=2$, $p=0.01$). Cold prevention relevance was also related to evidence importance ($H=18.51$, $df=2$, $p<0.01$) and mechanism importance ($H=20.87$, $df=2$, $p=0.01$). For the rest of data collection, participants were assigned into goal conditions to equally represent these groups in each condition. Table 2 shows the final distribution of science and cold prevention relevance across the three goal conditions.

Table 2. Distribution of science and cold prevention relevance across goal conditions.

	Goal Condition								
	Claim Evaluation			Personal Decision			Societal Decision		
	Cold prevention relevance:			Cold prevention relevance:			Cold prevention relevance:		
	Low	Med	High	Low	Med	High	Low	Med	High
Science relevance:									
Low	4	6	4	4	5	4	4	5	3
Medium	5	14	23	5	13	23	5	14	21
High	2	5	10	2	6	11	3	5	11

Payment

Participants received \$3 in the form of an electronic gift certificate for completing the study.

Description of participants

217 high school students completed the online survey for this study. Table 3 shows participants' background across goals. Distribution of participants across goals do not differ by sex ($df = 2$, $\chi^2 = 0.1$, $p = 0.95$), grade ($df = 6$, $\chi^2 = 4.92$, $p = 0.55$), or race/ethnicity ($df = 12$, χ^2

= 11.75, $p = 0.47$).

Table 3. Demographic background of participants across goal conditions.

	Overall		Goal Condition						
			Claim Evaluation		Personal Decision		Societal Decision		
	<i>n</i> = 217		<i>n</i> = 73		<i>n</i> = 73		<i>n</i> = 71		
	<i>n</i>	%	<i>n</i>	%	<i>n</i>	%	<i>n</i>	%	
Sex									
F	119	55%	41	56%	40	55%	38	54%	
M	98	45%	32	44%	33	45%	33	46%	
Grade									
9	28	13%	10	14%	8	11%	10	14%	
10	53	24%	16	22%	24	33%	13	18%	
11	48	22%	15	21%	15	21%	18	25%	
12	88	41%	32	44%	26	36%	30	42%	
Race/ Ethnicity									
African American	13	6%	3	4%	5	7%	5	7%	
Asian or Pacific Islander	80	37%	24	33%	29	40%	27	38%	
Biracial	11	5%	3	4%	2	3%	6	8%	
Hispanic / Latino	32	15%	13	18%	10	14%	9	13%	
Native American	17	8%	9	12%	5	7%	3	4%	
White, non-Hispanic	62	29%	19	26%	22	30%	21	30%	
Other	2	1%	2	3%	0	0%	0	0%	

Table 4. Participants' perceived relevance of science, relevance of cold prevention, and experience with zinc across goal conditions.

	Overall		Goal Condition					
			Claim Evaluation		Personal Decision		Societal Decision	
	<i>n</i> = 217		<i>n</i> = 73		<i>n</i> = 73		<i>n</i> = 71	
	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>
Interest in science news	3.28	0.92	3.23	0.94	3.32	0.86	3.28	0.97
Usefulness of science for decisions	3.44	0.90	3.45	0.90	3.36	0.87	3.52	0.94
Confidence in science community	3.56	0.65	3.58	0.64	3.64	0.63	3.45	0.67
Interest in cold prevention	3.66	0.94	3.63	0.89	3.63	0.91	3.73	1.04
Personal impact of cold prevention	3.66	1.01	3.73	0.98	3.68	1.08	3.56	0.98
			<i>n</i>	%	<i>n</i>	%	<i>n</i>	%
Taken zinc supplement								
Yes	41	19%	20	27%	9	12%	12	17%
No	124	57%	34	47%	47	64%	43	61%
I don't know	52	24%	19	26%	17	23%	16	23%
Heard of claim								
Yes, a lot	17	8%	9	12%	4	5%	4	6%
Yes, a little	77	35%	21	29%	34	47%	22	31%
No	123	57%	43	59%	35	48%	45	63%

Table 4 shows the descriptives of a number of items about the relevance of science and cold prevention (i.e. topic of survey reading) as well as participant's experience with zinc supplement (i.e. causal agent described in survey reading). As described earlier, the first five

items in this table were combined into two sets of low, medium, and high groups, which were then used as proxies to equally distribute perceived relevance of science and cold prevention across goal conditions. Examining these items individually, participants across goals did not differ by their interest in science news ($df=2$, $F=0.15$, $p=0.86$), their perceived usefulness of science for decision making ($df=2$, $F=0.61$, $p=0.55$), their confidence in the science community ($df=2$, $F=1.63$, $p=0.20$), their interest in learning about cold prevention ($df=2$, $F=0.28$, $p=0.76$), or the extent cold prevention would affect them ($df=2$, $F=0.50$, $p=0.61$). In addition, distribution of participants across goals do not differ by their experience of taking zinc supplement ($df = 4$, $\chi^2 = 7.05$, $p = 0.13$) or whether they had heard of the causal claim ($df = 4$, $\chi^2 = 8.31$, $p = 0.08$).

TASK-BASED SURVEY

A task-based survey, as shown in Appendix B, with a different version for each of the three goal conditions was used for this study. The survey centered around the causal claim that zinc prevents the common cold. Each of the three versions of the survey presented a different task goal connected to this causal claim.

Before I proceeded with data collection online, I tested the online survey with 9 high school students (3 per goal condition) from the UCLA Community School. Students were interviewed individually and onsite after school. The purpose of conducting student interviews was to identify potential points of difficulty or confusion in the survey. Another goal was to estimate the duration of the survey in order to report a realistic length of participation in the survey recruitment and consent material. Interviewees were given as much time as they needed to complete the online survey before I asked them questions about any points of confusions or

difficulties in the survey. A few minor changes in the wording of the survey were made based on student input. No issue concerning the content or structure of the survey emerged from this testing.

The overall structure of all three versions of the survey was the same and consisted of 1) items on participants' background and interest, 2) statement of the causal claim that zinc prevents the common cold, 3) an experimental manipulation of goal in the form of a task question, 4) a short reading about the claim, 5) a series of questions to elicit participants' use of evidence and mechanism in the task, and 6) a manipulation check. Unless otherwise noted below, all survey questions were programmed to require a response before participants could continue on to the next section. The survey took approximately 10 minutes to complete. The survey can be found in Appendix B.

Background and interest items

The survey began with items collecting student demographic information, including gender, ethnicity, and grade. There were also items constructed to capture information on participants' familiarities with and attitudes toward cold prevention and science. These items are the same across all three goal conditions.

Among these items, three were about the relevance of science. Two were about the relevance of cold prevention. These five items were rated with a 5-point unipolar scale.

In addition, one item asked about participants' familiarities with the claim that zinc prevents the common cold. One item asked about participants' familiarities with using zinc, the causal agent. If participants had used zinc before, a follow-up question asked about the frequency

of use.

Causal claim topic

The same science causal claim was used across all three task goal conditions for the survey. A causal claim with an effect on personal health was selected because it was a topic area that people could potentially encounter for both personal and societal decisions. Health-related discovery was also the news topic area in which the American public expressed the most interest when compared against other scientific discoveries or news topics such as economic issues or foreign policy (National Science Board, 2012). The particular claim of zinc preventing the common cold was selected because it could be explained by a simple mechanism and contained a relatively common causal agent, both of which could be described concisely within the short text in the survey. It was also a topic that high school students could conceivably be in the position to make decisions for themselves.

Experimental manipulations

The three goal conditions (claim evaluation, societal decision making, and personal decision making) were manipulated by varying a focal question presented to participants. The claim evaluation goal question asked directly about a causal claim (i.e. Do you agree with the claim that X causes Y?). In contrast, decision making goal questions presented a decision with a causal claim embedded (i.e. Would you use X for Y?). For personal decision making, participants were asked to make a decision for themselves. For societal decision making, participants were asked to decide what a government agency (e.g. a school district) should do. Table 5 shows the goal questions for the three conditions.

Table 5. Questions used to manipulate goal conditions.

Goal Conditions	Questions
Claim Evaluation	Do you agree with the claim that zinc prevents the common cold?
Societal Decision Making	Should schools give students zinc to prevent common the common cold?
Personal Decision Making	Would you take zinc to prevent the common cold?

The experimental manipulation consisted of one of the three goal questions. Participants were asked to respond to the goal questions by rating on a seven-point scale from *Definitely No* to *Definitely Yes* both before and after a short reading. An odd-numbered scale was chosen to provide a midpoint of “undecided”. Based on preliminary testing of the goal questions, a seven-point scale was chosen because reviewers preferred having the options to choose between two intermediate points between the midpoint and the extremes of the scale (i.e. “very unlikely” and “unlikely”, “very likely” and “likely”).

The purpose of presenting the goal question before the text was to let participants read with the goal condition in mind. The pre-reading rating served two purposes. First, it was intended to increase the likelihood that participants fully read the goal question before the reading. Preliminary testing of the experimental manipulation found that reviewers did not fully read the goal questions when not asked to make a response. Second, it provided a reference so that the post-reading rating would indicate whether or not participants changed their response to the goal question after reading the text. Whether or not participants changed their decision was examined as a secondary research question.

The goal manipulations were also reinforced throughout the survey. Whenever a survey item referred to the experimental condition, the respective goal wording was inserted. For example, the claim evaluation condition would ask “if you want more information to help you decide whether zinc prevents the common cold, what would it be?” whereas the personal decision-making condition would ask the same question as “if you want more information to help you decide whether you would take zinc to prevent the common cold, what would it be?” The repetition of goal wording was intended to help participants keep the goal in mind when responding to survey questions about their use of evidence and mechanism.

Short reading

The same short text about the claim that zinc prevents the common cold was used across all three goal conditions. The only exception was the title of the text. The title in each version of the survey was worded to reinforce the respective goal condition. The wording and information presented in the body of the text were identical across conditions.

The text was designed to include information about evidence and mechanism that support the claim. It also included information that is relevant to decision making, but not scientifically based. The text was fictitious and constructed specifically for this study based on existing research studies and news articles. Constructing fictitious text was necessary to control for the type and amount of information that was intended to support the use of evidence and mechanism. Providing some basic information about evidence and mechanism eliminated the possibility that participants did not use evidence or mechanism because they were not able to come up with such information on their own.

The full text, as shown in Table 6 and within the survey, was 287 words in length. The text had a Lexile score of 1070. Lexile text measure is based on the difficulty of a text's vocabulary and complexity of sentences. To place this score for the short reading in a broader context, MetaMetrics (2009) reports that the middle fifty percent of ninth graders in their studies had scores from 855 to 1165.

The text consisted of three paragraphs: first with information about explanatory mechanism, second with information about evidence, and third with non-scientific practical information and opinions relevant to the topic. Information about explanatory mechanism was a description of how the causal agent produces the effect in question. Only one mechanism was provided in the text. One sentence provided the explanatory mechanism. Additional two sentences further clarified the mechanism presented and connect the mechanism to the cause and effect.

Evidence was presented in the form of a sentence summarizing the result of a research study. In the same paragraph, there was also methodological information that supports the evidence, including the study's sample size and a summary of how the study was conducted. The information provided about the study was not intended to be comprehensive. It was impossible to fully describe a research study in such a short text and it was also not typical for similar reporting in the media to do so. The purpose was to provide some basic information while leaving room for participants to request more information. Information about sample size and how a confound was accounted for were chosen to be included because prior research found that people were sensitive to such information when evaluating causal claims (Koslowski, 1996).

Table 6. Description of survey reading by information type.

Text content	Text wording
<i>Paragraph 1: Mechanism</i>	
Causal claim	A research study claims that zinc prevents the common cold.
Background about mechanism	People get colds when cold viruses get into the cells inside our bodies. The viruses then make more viruses inside the cells.
Mechanism	Scientists say zinc keeps cold viruses from making more of themselves.
Connection of mechanism to effect	When cold viruses are not able to reproduce, it is easier for our bodies to fight the viruses off.
<i>Paragraph 2: Evidence</i>	
Methods - study sample	To test whether zinc prevents the common cold, scientists did a research study with 200 high school students.
Methods - experimental groups & treatment	100 of the students took a zinc pill each day for 6 months. The other 100 students took a pill with no zinc each day for 6 months.
Methods - control for alternate cause	The scientists checked that both groups of students had about the same number of colds the year before this research study.
Evidence	53 of the 100 students who took zinc pills got colds during the 6 months of the study. 86 of the 100 students who took pills with no zinc got colds during those 6 months.
<i>Paragraph 3: Non-science</i>	
Decision of applying claim to personal use	Many people are wondering if they should use zinc to prevent colds.
Personal decision anecdote - pro	One student said, "I started taking zinc because it was easy. You can get zinc pills from supermarkets and they are cheap."
Personal decision anecdote - con	Another student said, "I tried a zinc pill before and it tasted really bad. I don't want to take them everyday."
Decision of applying claim to societal use	Some people are also wondering if schools should provide zinc to students.
Societal decision anecdote - pro	One student said, "So many people miss school when they have colds. It's good to help students prevent colds so they don't get sick and fall behind."
Societal decision anecdote - con	Another student said, "It is not the school's job to help students prevent colds. Parents should do that."

The last paragraph contained information relevant to the topic but based on science. In

particular, this non-science information is intended to be relevant to those deciding whether they would use zinc personally or whether schools should provide zinc. This information was presented as quotes from high school students to provide relatable and anecdotal examples of decisions for and against using zinc to prevent colds. Anecdotal examples are frequently used by decision makers and influence health decisions (Ubel, et al., 2001; Zillman, 2006). When narrative examples and statistical information are both present, narrative examples have a stronger influence on decision makers (Betsch, et al., 2011).

Measuring use of evidence and mechanism

After the goal manipulation and reading, participants responded to a series of items that elicited their uses of evidence and mechanism. Use of evidence and use of mechanism were operationalized as 1) importance of information about evidence and mechanism, 2) amount of additional information about evidence and mechanism participants requested, and 3) influence of information about evidence and mechanism.

Information's importance

Participants were asked to rate, on a scale of 1 (not at all important) to 7 (most important): *How important was each part of the reading to how you decided whether [zinc prevents the common cold / you would take zinc to prevent the common cold / schools should give students zinc to prevent the common cold]?* Participants were then presented with each part of the reading to rate. As described earlier, each part of the reading was designed to contain specific type of information. The purpose of having participants rate each part of the reading was to elicit what information (e.g. evidence or mechanism) they think was important for their goal.

Information requests

Participants were asked: *If you want more information to help you decide whether [zinc prevents the common cold/ you would take zinc to prevent the common cold / schools should give students zinc to prevent the common cold], what would it be?* Participants were presented with 5 blank text boxes and additional spaces as needed. Unlike other questions, participants could leave this question blank if they did not want any additional information. The purpose of this item was not to assess the quality of the information requests, but to assess whether and how much participants requested information about evidence or mechanism. A second purpose was to examine what types of information participants requested.

This information request question was asked in addition to the information's importance ratings for two reasons. First, some participants might not have rated the information about evidence and mechanism from the reading as important even if they thought evidence and mechanism in general were important. These participant might not have understood the information in the reading or thought they were insufficient. This open response question provided an opportunity for participants to request any form of evidence or explanatory mechanism regardless of how they thought about the information in the reading.

Second, some participants might want a type of information that was not represented in the text. With an open-ended question, the responses would provide data about what information participants find helpful for their goal when they could request any information they wanted. The inclusion of this question was an effort to capture variation in participants' uses of evidence and mechanism that might not have been measured by the importance rating items.

Influence of evidence and mechanism

Participants were asked two open response items. In the first question, participants were shown the reading again, this time with the evidence excerpt “*53 of the 100 students who took zinc pills got colds during the 6 months of the study. 86 of the 100 students who took pills with no zinc got colds during those 6 months.*” highlighted. They were then asked, respective of their goal condition, “*Did the information highlighted above influence your decision of whether [zinc prevents the common cold? / you would take zinc to prevent the common cold? / schools should give students zinc to prevent the common cold?]*” After selecting *yes* or *no*, they were shown the respective writing prompt “*This information [did not] influenced my decision because...*” followed by a text box for their response. Participants were also given a similar question and writing prompt with the mechanism excerpt “*Scientists say zinc keeps cold viruses from making more of themselves*” highlighted.

The aim of these two items was to elicit participants’ reasons for being influenced or not influenced by evidence and mechanism while addressing their goals. The open responses provided a richer source of data, giving some insight into any ideas about evidence, ideas about mechanism, or epistemic aims that participants might have had in mind when using evidence and mechanism (i.e. research question 2).

The evidence and mechanism excerpts were supported by information in their respective paragraphs and expected to be interpreted by participants as cohesive sets of information. For these items, however, I chose to draw participants’ attention to specific excerpts. This choice was made to focus participants on the information most relevant to the research question. In a self-

administered online survey, especially toward the end of a series of questions, participants were unlikely to write long thorough responses that addressed their thoughts on a whole paragraph. The choice of focusing on short excerpts prevented the likelihood that each participant focused on different statements in the paragraphs, making interpretation of the responses more ambiguous. To compensate for focusing on specific excerpts, the whole reading was shown with these items so participants can refer to the excerpts in their original contexts when writing their responses.

Manipulation check

Participants' perceptions of the goal conditions will be checked with one item at the end of survey. Participants were asked: *Which of the following comes closest to describing what you were trying to do when answering questions in this survey? (Pick only one.)* They were then presented with three options: *I was deciding... if zinc prevents the common cold, ...if I would take zinc to prevent the common cold, ...if schools should provide zinc to students to prevent the common cold.* A majority of participants in each goal condition reported that their respective assigned goal came closest to describing what they were trying to do when answering questions in the survey (see Table 7).

Table 7. Participants' perceived goals across goal conditions.

	Overall		Goal Condition						
			Claim Evaluation		Personal Decision		Societal Decision		
	<i>n</i> = 217		<i>n</i> = 73		<i>n</i> = 73		<i>n</i> = 71		
	<i>n</i>	%	<i>n</i>	%	<i>n</i>	%	<i>n</i>	%	
Perceived goal:									
Claim Evaluation	99	46%	55	75%	29	40%	15	21%	
Personal Decision	69	32%	12	16%	42	58%	15	21%	
Societal Decision	49	23%	6	8%	2	3%	41	58%	

PROCEDURES

Institutional Review Board approval

Institutional Review Board approval from UCLA was obtained prior to recruitment and data collection. This included a review of the informed consent procedures, recruitment procedures, and survey protocols.

Data collection

Survey was administered online via the survey service Qualtrics. Participants accessed the survey at a time and place of their choice. Assignment to goal conditions, as described in the participants section, was done automatically within the survey platform.

ANALYSIS

Research question 1: use of evidence and mechanism

The first set of analyses addressed the research question: to what extent do participants use evidence and explanatory mechanism across goals of claim evaluation, societal decision making, and personal decision making? Use of evidence and mechanism were defined in this study as 1) importance of information about evidence and mechanism, 2) amount of additional information about evidence and mechanism participants requested, and 3) influence of information about evidence and mechanism.

Importance ratings

The fourteen importance rating items were first reduced to a more manageable number of dependent variables. As described earlier, these items represented three different types of information (i.e. evidence, mechanism, non-science). I expected participants to rate items with the same type of information similarly. I used factor analysis to examine whether information type or another grouping would best represent the pattern of responses.

Next, I conducted a two-way analysis of variance to test whether participants' importance ratings (dependent variable) differed according to either the type of information (within-subjects independent variable; mechanism, evidence, or non-science) or goal condition (claim evaluation, personal decision, societal decision). I expected to observe an interaction effect. Since the claim evaluation goal most directly involved knowledge and explicitly asked participants to evaluate a causal claim, I expected participants assigned this goal to rate mechanism and evidence higher than participants assigned with the personal or societal decision goals. I also expected

participants assigned the goal of claim evaluation to rate non-science information lower than participants assigned with the personal or societal decision goals.

Information requests

I first examined the number of requests made by participants. I used a one-way analysis of variance (ANOVA) to test whether the number of requests per participant differed by goal condition.

Next, I analyzed this data in terms of the types of information participants requested. Each request was analyzed according to the coding scheme presented in Table 8, which was adapted from similar studies (Korpan, 1994, 1997; Ratcliffe, 1999). A second coder and I independently analyzed 20% of the data to assess inter-rater reliability. The requests were blinded so the coders did not know which goal condition the participants received. Due to the large number of participants who made no requests, blank responses were automatically coded as “none” and omitted from the calculations of inter-rater agreement in order to avoid an over-estimation of reliability. The two coders agreed on 81% of the requests, with a Cohen’s kappa of 0.78, indicating substantial agreement (Landis & Koch, 1977). Following a discussion of disagreements with the second coder to clarify code definitions, I proceeded to code the remaining requests.

Table 8. Coding scheme for information requests.

Type of request	Definitions: Request for information on...	Examples
Mechanism	... the mechanism or causal agent of the claim.	<i>How does zinc work?</i> <i>What chemicals does zinc contain to prevent a common cold?</i>
Methods	... how the research reported in the article was conducted (e.g. study design, subjects)	<i>How much zinc did they give the students?</i> <i>How did they figure out who got sick?</i>
Data	... the data from the research reported in the article or its statistical analysis.	<i>What's the data?</i> <i>the statistics</i>
Related Research	... other scientific studies or relations between the reported findings and other studies.	<i>experiments from other scientists</i> <i>a study with more people</i>
Social context	... social factors that could influence judgment about the quality of the research reported (e.g. credentials, motivations, etc.)	<i>Who are the scientists that did this study?</i> <i>Are the scientists trying to sell zinc?</i>
Consequences	... potential risks or benefits from using the causal agent (i.e. zinc).	<i>Are there side effects?</i> <i>Is zinc good for you other than preventing colds?</i>
Practicalities	... the application of the causal agent (i.e. zinc), such as cost, or ease of use.	<i>Where can I get zinc?</i> <i>Does zinc only come in pills?</i>
Relevance	... the importance of the issue or applicability.	<i>Does it also work for adults?</i> <i>Do lots of students miss school because of colds?</i>
Ambiguous	Requests that are ambiguous and can be interpreted to fit under multiple categories.	<i>The process</i> <i>zinc</i> <i>more science behind it</i>
Off task	Responses that are not requests for information.	<i>stay away from cold infectants</i> <i>I think zinc should be provided by the schools and optional for the students to take it.</i>

Next, I used a χ^2 test to examine whether the type of information requested depended on goal condition. I expected participants assigned the goal of claim evaluation to make more requests for mechanism and evidence related information (i.e. data, methods, related research). I expected participants assigned decision making goals to make more requests for information about consequences, practicalities, and relevance.

Influence of evidence and mechanism

Participants gave dichotomous *yes/no* responses to whether they were influenced by evidence or mechanism. χ^2 tests were used to examine whether the proportions of participants influenced by evidence or mechanism depended on goals. I expected participants assigned the goal of claim evaluation to more likely be influenced by evidence and mechanism.

Research question 2: ideas about influence of evidence and mechanism

The next analysis addresses the research question: what reasons do participants give for whether evidence and mechanism influenced their decisions? The aim of this analysis is to examine more closely why participants do or do not use information about evidence and mechanism when making their decisions. The data used in this analysis came from the open responses following the writing prompts “This information [did not] influenced my decision because...”.

I followed the same procedure to analyze the open-ended responses for both mechanism and evidence, although these responses were analyzed separately. First, I looked at a random 20% of each type of responses to inductively develop initial codes for each question. I then applied these codes to an additional, randomly selected 20% of the data and refined each coding

scheme. Next, a second coder and I coded a randomly selected 20% of each of the evidence and mechanism responses, using their respective coding schemes. For the evidence responses, we agreed on 86% of the responses, with a Cohen's kappa of 0.82, indicating substantial agreement (Landis & Koch, 1977). For the mechanism responses, we agreed on 84% of the responses, with a Cohen's kappa of 0.80, indicating substantial agreement (Landis & Koch, 1977).

Disagreements were resolved through discussion and I then coded all remaining responses myself. The final codes used for evidence responses are described in Table 9, and the final codes for mechanism responses are described in Table 10. I used χ^2 tests to examine whether the type of reasons given depended on goal condition.

Research question 3: decisions and change in decisions

The primary focus of this study is to examine how participants used evidence and mechanism across different goals. The analyses described so far looked at multiple ways that participants could have used evidence and mechanism when coming to a decision for their respective goals. While the specific decisions that they made were not the focus of investigation, it is still of interest to examine whether participants changed their decisions as a result of reading an article designed to contain relevant scientific information. To complement the above analyses, this section addresses a secondary question: are participants' decisions and change in decisions different across the goals of claim evaluation, personal decision, and societal decision?

Table 9. Coding scheme for reasons of whether evidence influenced decisions.

Code	Definition	Examples
There is evidence	Having evidence is the reason. Students said nothing on what about the evidence influenced them.	<i>It was factual data.</i> <i>It proves that zinc can help prevent the common cold.</i>
Evidence is sufficient	Students included some assessment of why the evidence is sufficient.	<i>The statistics show that there are around 30% less students catching a cold with zinc pills than students without zinc. It shows that zinc works to some potential.</i> <i>The students who took zinc got less sick during those 6 months than those who did not.</i> <i>There was a big difference to the amount of students that got sick.</i>
Evidence is insufficient	Students provided some assessment of why the evidence is insufficient or that the effect is not strong enough (e.g. "Students who took zinc still got sick").	<i>Only seemed like zinc is only 50% effective.</i> <i>More than half the students still got colds even while taking zinc.</i> <i>It's only 100 people and the ratio of colds to no colds is very close so you cannot base a good conclusion about zinc curing a common cold after this</i>
Relevance	Students focus on the relevance of using zinc, such as its potential risk/benefit or generalizability. No assessment of evidence included.	<i>Maybe I should consider taking zinc pills to help prevent getting sick so often.</i> <i>good to our body</i>
Irrelevance	Students explicitly state that the information is irrelevant or implicitly by providing an alternate influence. No assessment of evidence included.	<i>I still think that it is the parent's job to give zinc to their children.</i> <i>It is not relevant</i>
Informed understanding	Students states that they are better informed in general. No assessment of evidence included.	<i>I now feel better informed about the issue.</i> <i>It was a good additive to the paragraph that enhanced my understanding.</i> <i>It help me gain a better understanding about the subject.</i>
Prior knowledge	Students refer to prior knowledge or experience that confirms or contradicts the excerpt.	<i>not directly as I was already aware that zinc helped prevent common colds so this wasn't new to me.</i> <i>i've tried it before</i>
Copied excerpt	Students copied an excerpt from the article as their response without adding or subtracting to it.	<i>The other 100 students took a pill with no zinc each day for 6 months.</i>
Ambiguous	Response is ambiguous and does not fit clearly into one of the above categories.	<i>very believable information</i> <i>I like its</i>
Blank	Response contains only filler text or is obviously off task (e.g. Just because).	<i>n</i>

Table 10. Coding scheme for reasons of whether mechanism influenced decisions.

Code	Definition	Examples
Mechanism explained	Students focused on the explanatory nature of the excerpt, either by stating it explicitly or by paraphrasing the mechanism.	<i>the less of the virus there is, the easier the fight for our bodies.</i> <i>It explains exactly how the zinc would help in preventing the cold.</i>
Explanation insufficient	Students stated that the excerpt is unclear or insufficient.	<i>I don't really understand the science behind it.</i> <i>Explain how</i> <i>I need to know how zinc does this.</i>
Excerpt relevant	Students focus on the relevance of the effect, such as its potential risk/benefit or generalizability.	<i>I get colds often</i> <i>If it works I would take it.</i> <i>good to our body</i>
Excerpt Irrelevant	Students explicitly stated that the information is irrelevant or implicitly by providing an alternate influence.	<i>it's the parents job to take care of the heath of the children</i> <i>I don't care what it does as long as it works</i>
Evidence necessary	Students stated that evidence, data, or proof is necessary or preferred.	<i>There's no data</i> <i>Proof would be better than just saying that scientist say</i>
Scientist, no elaboration	Students referred to the scientists as their reason. Just the fact that scientists provided this explanation is enough. There is no attempt to assess whether these scientists are knowledgeable or trustworthy.	<i>scientist say that it prevents a cold.</i> <i>It's advice from experts on the subject.</i> <i>I trust scientists</i>
Scientist, with elaboration	Students referred to the scientists who provided the information, but provided a reason why the scientist is a reliable source (e.g. did research), or pointed out the need to know who the scientists were.	<i>Who are the scientists? They could be geologists.</i> <i>Scientist are smart and know what they are talking about because they have done studies.</i>
Copied excerpt	Students copied an excerpt from the article as their response without adding or subtracting to it.	<i>When cold viruses are not able to reproduce, it is easier for our bodies to fight the viruses off.</i>
Ambiguous	Response is ambiguous and does not fit clearly into one of the above categories.	<i>it seems pretty credible to me</i> <i>it is good</i>
Blank	Response contains only filler text	<i>n/a</i> <i>because</i>

For this analysis the decisions were dummy coded 1 to 7, with 1 being the most negative (e.g. strongly disagreeing that zinc prevents cold) and 7 being the most positive (e.g. strongly agreeing that schools should provide zinc). I conducted a two-way analysis of variance, using decisions as the dependent variable, goal condition as the between subject independent variable, and time of decisions (i.e. before or after reading article) as within subject independent variable. I also examined the patterns of decision changes across goals by grouping participants into those who changed decisions and those who did not.

Chapter 4

Results

RESEARCH QUESTION 1: USE OF EVIDENCE AND MECHANISM

The first set of analyses address the research question: to what extent do participants use evidence and explanatory mechanism across goals of claim evaluation, societal decision making, and personal decision making? To do so, I focused on three sets of data: 1) participants' importance ratings of information from the reading, 2) participants' requests for information, and 3) participants' self-report of whether evidence and mechanism from the article influenced their decision.

Importance ratings

The fourteen statements that participants rated in terms of importance came directly from the article they read. Since the article was designed specifically to include three different types of information, each in a separate paragraph, the fourteen statements can be divided into three groups: information about mechanism, information about evidence, and non-science information. I expected statements with the same type of information to be rated more similarly than statements with different types of information. Before assuming information type as the grouping to reduce the fourteen statements into a more manageable set of dependent variables, I used exploratory factor analysis to examine the response pattern of participants' importance ratings. If the resulting factor solution matched the expected grouping, information type would be used to reduce this data. If factor analysis revealed a different underlying structure in the data, the factor

solution would be interpreted and considered for use in subsequent analysis instead.

The sample size, with a ratio of 15.5 observations per variable, was sufficient for factor analysis (DeVellis, 2012). There was also sufficient intercorrelation among the fourteen statements to warrant factor analysis (Kaiser-Meyer-Olkin measure of sampling adequacy: overall MSA = 0.88, all MSA > 0.5; Bartlett's test of sphericity: $\chi^2=2107.82$, $df=91$, $p < 0.01$; Pearson's r : 0.00 to 0.84) (Hair, et al., 2009; Tabachnick & Fidell, 2007). Scree test suggested a three factor solution. An orthogonal varimax rotation was applied to the solution to make the factors interpretable. Only factor loadings over 0.40 were considered significant for the current sample size (Hair, et al., 2009). When keeping only significant loadings, the three factors corresponded to grouping the statements by mechanism, evidence, and non-science (Table 11). Statement 4 from the mechanism paragraph loaded onto two factors. Although both loadings were significant, it loaded more highly onto the expected mechanism factor (0.70) than the evidence factor (0.40). In summary, the first factor solution revealed a pattern in the data that matched the expected grouping by the three information types.

Since factor analysis yields multiple possible solutions, I examined alternate solutions for the best fit to the data. An alternate two-factor solution selected based on an eigenvalue criterion rather than scree test was considered. In this case, all the science-related statements (i.e. mechanism and evidence) had significant loadings on one factor, all non-science statements had significant loadings on a second factor, with one cross-loading statement (statement 2). This cross-loading was more difficult to interpret and had less difference between the two loadings (0.59 and 0.44). Even though this alternate solution suggested that the statements could be grouped as science versus non-science, the three-factor solution was more interpretable and

Table 11. Importance ratings by statement and results of 3-factor solution.

Statement ID	Overall	Goal Condition			Factor loadings		
		Claim Evaluation	Personal Decision	Societal Decision	Factor 1	Factor 2	Factor 3
		<i>n</i> = 73 <i>M</i> <i>SD</i>	<i>n</i> = 73 <i>M</i> <i>SD</i>	<i>n</i> = 71 <i>M</i> <i>SD</i>			
Paragraph 1: Mechanism							
1	A research study claims that zinc prevents the common cold.	4.87 1.75	4.68 1.79	4.89 1.74	5.03 1.72		0.60
2	People get colds when cold viruses get into the cells inside our bodies. The viruses then make more viruses inside the cells.	4.70 1.63	4.79 1.40	4.55 1.73	4.75 1.75		0.60
3	Scientists say zinc keeps cold viruses from making more of themselves.	5.05 1.53	4.97 1.55	5.10 1.42	5.08 1.64		0.74
4	When cold viruses are not able to reproduce, it is easier for our bodies to fight the viruses off.	5.24 1.52	5.23 1.45	5.12 1.55	5.38 1.59		0.70
Paragraph 2: Evidence							
5	To test whether zinc prevents the common cold, scientists did a research study with 200 high school students.	5.08 1.59	5.30 1.44	4.85 1.71	5.08 1.59		0.83
6	100 of the students took a zinc pill each day for 6 months. The other 100 students took a pill with no zinc each day for 6 months.	5.17 1.50	5.33 1.31	4.90 1.61	5.27 1.55		0.84
7	The scientists checked that both groups of students had about the same number of colds the year before this research study.	5.14 1.53	5.41 1.18	4.85 1.63	5.15 1.71		0.77
8	53 of the 100 students who took zinc pills got colds during the 6 months of the study. 86 of the 100 students who took pills with no zinc got colds during those 6 months.	5.59 1.53	5.78 1.30	5.38 1.52	5.59 1.74		0.69
Paragraph 3: Non-science							
9	Many people are wondering if they should use zinc to prevent colds.	3.82 1.90	3.68 1.81	3.89 1.97	3.90 1.95		0.77
10	One student said, "I started taking zinc because it was easy. You can get zinc pills from supermarkets and they are cheap."	4.14 1.87	3.77 1.87	4.37 1.82	4.30 1.89		0.80
11	Another student said, "I tried a zinc pill before and it tasted really bad. I don't want to take them everyday."	3.71 2.00	3.36 1.96	3.95 1.96	3.82 2.07		0.74
12	Some people are also wondering if schools should provide zinc to students.	4.16 1.85	3.95 1.91	4.12 1.78	4.42 1.84		0.78
13	One student said, "So many people miss school when they have colds. It's good to help students prevent colds so they don't get sick and fall behind."	4.51 1.93	3.93 1.94	4.51 1.87	5.10 1.83		0.76
14	Another student said, "It is not the school's job to help students prevent colds. Parents should do that."	4.47 1.89	4.12 1.89	4.11 1.87	5.18 1.70		0.65

accounted for more variance in the data. Keeping the mechanism and evidence statements separate would also be more theoretically interesting.

Since the response pattern from the data conformed to the expected grouping by information type, I calculated mean importance ratings for each statement type (mechanism, evidence, non-science), for each participant (see Table 12). These mean importance ratings by statement type are used as dependent variables in subsequent analyses.

Table 12. Importance ratings by information type.

	Overall		Goal Condition					
			Claim Evaluation		Personal Decision		Societal Decision	
	<i>n</i> = 217		<i>n</i> = 73		<i>n</i> = 73		<i>n</i> = 71	
	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>
Mechanism	4.96	1.36	4.92	1.28	4.91	1.35	5.06	1.47
Evidence	5.24	1.35	5.46	1.14	5.00	1.44	5.27	1.42
Non-science	4.13	1.56	3.80	1.63	4.16	1.57	4.45	1.43

I conducted a two-way ANOVA to examine whether participants' importance ratings (dependent variable) differed according to either the type of information (within-subjects independent variable; mechanism, evidence, or non-science) or goal condition (between-subject independent variable: claim evaluation, personal decision, societal decision). I expected to observe an interaction effect. In particular, I expected participants assigned the goal of claim evaluation to rate mechanism and evidence higher than participants assigned with the personal or societal decision goals. I also expected participants assigned the goal of claim evaluation to rate

non-science information lower than participants assigned with the personal or societal decision goals.

There was no significant main effect for goal condition, $F(2,214) = 0.89, p = 0.41$, a significant main effect of information type, $F(2,428) = 70.35, p < 0.01$, and a significant interaction of goal condition by information type, $F(4,428) = 4.15, p < 0.01$. To examine this interaction effect, I conducted post-hoc analyses using Tukey's HSD test with $p = 0.05$. For all three goal conditions, non-science information was rated as significantly less important than both mechanism and evidence information, as shown in Table 12. The effect sizes for these differences, estimated using Cohen's d , are considered medium (Cohen, 1988) for the differences between mechanism and non-science information (Claim Evaluation: $d = 0.67$; Personal Decision: $d = 0.68$; Societal Decision: $d = 0.42$) and range from medium to large for differences between evidence and non-science information (Claim Evaluation: $d = 0.86$; Personal Decision: $d = 0.58$; Societal Decision: $d = 0.58$). Students in the claim evaluation condition rated evidence as more important than mechanism ($d = 0.49$), a pattern not seen in the other two conditions. Another pattern is that participants with the societal decision goal rated non-science information more importantly than participants with either the claim evaluation goal ($d = 0.42$) or the personal decision goal ($d = 0.19$).

Information requests

A second measure of the extent to which participants used different types of information based on their goals was the information they requested. Participants were asked what additional information they would want to help them with their respective goal. Table 13 shows the mean

number of requests made by participants in each condition. Thirty-three percent of participants made no request, 31% made only one request, while the remaining participants made 2 to 7 requests. The number of requests for additional information was not significantly different between goal conditions, $F(2, 214) = 0.77, p = 0.47$.

Table 13. Number of information request per participant.

	Overall		Goal Condition					
			Claim Evaluation		Personal Decision		Societal Decision	
	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>
# of requests per participant	1.32	1.33	1.19	1.38	1.30	1.25	1.46	1.35

Among the sample of 217 participants, there were 286 requests. The most frequent category of request across the whole sample was *related research* (27%), which were requests for additional evidence or scientific studies beyond that presented in the reading. The next most frequent categories were requests for *practical* information about how to use zinc (18%) and requests for information about other beneficial or negative *consequences* of using zinc (16%). The two categories related to the evidence presented in the reading, methods (4%) and data (2%), along with requests for information about the mechanism (7%) are among the least frequent. Table 14 shows the frequencies of these types of requests across goal conditions.

Table 14. Frequencies of information requests across goal conditions.

Type of information requested	Overall		Goal Condition					
			Claim Evaluation		Personal Decision		Societal Decision	
	<i>n</i> = 286		<i>n</i> = 87		<i>n</i> = 95		<i>n</i> = 104	
	<i>n</i>	%	<i>n</i>	%	<i>n</i>	%	<i>n</i>	%
Related research	77	27%	32	37%*	20	21%	25	24%
Practicalities	52	18%	5	6%**	23	24%	24	23%
Consequences	47	16%	10	11%	21	22%	16	15%
Ambiguous	29	10%	10	11%	6	6%	13	13%
Mechanism	20	7%	13	15%**	4	4%	3	3%*
Evidence related	18	6%	7	8%	3	3%	8	8%
Methods	(11)		(4)		(1)		(6)	
Data	(7)		(3)		(2)		(2)	
Off task	18	6%	4	5%	8	8%	6	6%
Social context	14	5%	3	3%	8	8%	3	3%
Relevance	11	4%	3	3%	2	2%	6	6%

*Cells with significant standardized residuals, $p < 0.05$

**Cells with significant standardized residuals, $p < 0.01$

I conducted a χ^2 test to examine whether the type of information requested depended on goal condition. It was necessary to either omit or combine some of the infrequent categories to satisfy the χ^2 requirement of having less than 20% of cells with expected frequencies less than 5 (Cochran, 1954). I chose to combine the categories *methods* and *data*. These two categories are both requests for information about the evidence presented in the reading. This produced an

easily interpretable new category called *evidence related*.

Analyzing the combined *evidence related* category with the other eight categories, request type significantly depended on goal ($df = 16, \chi^2 = 40.88, p = 0.001$). I examined the standardized residuals for each cell to understand the source of this dependence. A large positive standardized residual ($z > 1.96, p = 0.05, z > 2.58, p = 0.01$) indicates that a cell has a significantly higher frequency than expected if the response type was independent of goals (Agresti, 2002). Similarly, a large negative standardized residual ($z < -1.96, p = 0.05, z < -2.58, p = 0.01$) indicates that a cell has a significantly lower frequency than expected if the response type was independent of goals.

Examination of standardized residuals for each cell indicated that the differences between goals mainly resulted from the categories *mechanism*, *related research*, and *practicalities*. Participants assigned the goal of claim evaluation were significantly more likely to request information about *mechanism* ($z = 3.49$) and *related research* ($z = 2.49$) than participants in the other two groups, and were less likely to request information about *practicalities* ($z = -3.61$). In contrast, participants given the societal decision goal were less likely to request information about *mechanism* ($z = -2.06$) than participants in the other two groups.

Influence of evidence and mechanism

The last measure of how participants used evidence and mechanism was defined in terms of whether such information influenced one's decisions. Participants were asked whether the evidence and mechanism statements, shown highlighted from the article, influenced the decisions for their respective goals. As shown in Table 15, the majority of participants in each

task condition reported being influenced by the evidence excerpt and by the mechanism excerpt. Just over half of all participants (54%) responded that their decisions were influenced by both evidence and mechanism.

Table 15. Proportions of participants influenced by evidence and mechanism.

	Overall		Goal Condition						
			Claim Evaluation		Personal Decision		Societal Decision		
	<i>n</i>	%	<i>n</i> = 73		<i>n</i> = 73		<i>n</i> = 71		
	<i>n</i>	%	<i>n</i>	%	<i>n</i>	%	<i>n</i>	%	
Influenced by evidence									
Yes	161	74%	61	84%	55	75%	45	63%	
No	56	26%	12	16%	18	25%	26	37%	
Influenced by mechanism									
Yes	145	67%	53	73%	48	66%	44	62%	
No	72	33%	20	27%	25	34%	27	38%	

I conducted χ^2 tests to examine whether the proportions of participants influenced by evidence or mechanism depended on goals. There was no significant difference in the proportions of participants who were influenced by mechanism across goals ($df = 2, \chi^2 = 1.89, p = 0.39$), but a significant difference in the proportions of participants who were influenced by evidence across goals ($df = 2, \chi^2 = 7.73, p = 0.02$). Examination of standardized residuals for each cell indicated that the differences between goals mainly resulted from those assigned with claim evaluation and societal decision goals. Those with the claim evaluation goal were more likely than the expected frequency to be influenced by evidence ($z = 2.25$). Those with the societal decision goal were less likely than the expected frequency to be influenced by evidence

($z = -2.54$).

Summary of findings regarding use of evidence and mechanism

For the first research question, I wanted to find out whether shifting the goals participants had for reading a science text would affect how they used evidence and mechanism. Contrary to my expectation, participants assigned the goal of claim evaluation did not rate evidence and mechanism higher in importance than participants assigned the decision-making goals. Nevertheless, there were some differences across goals. Participants with the claim evaluation goal rated evidence higher than mechanism, a pattern not seen in the other two groups. In addition, participants with a societal decision goal rated non-science information higher than participants with claim evaluation or personal decision goals.

Next I examined the number and types of information requested by participants to help them come to a decision with their assigned goal. There was no difference in the average number of requests per participant across goal, but there was a difference in the proportions of types of information requested. Participants assigned with evaluation goal were more likely to request for information about mechanism and for additional evidence from related research.

Last, I examined whether participants' decisions were influenced by evidence and mechanism. Overall, a majority of participants reported that they were influenced by evidence or mechanism. There was no difference in the proportion of participants who were influenced by mechanism across the three goals. Participants assigned the goal of claim evaluation were more likely to be influenced by evidence.

RESEARCH QUESTION 2: IDEAS ABOUT INFLUENCE OF EVIDENCE AND MECHANISM

The next analysis addresses the research question: what reasons do participants give for whether evidence and mechanism influenced their decisions? The aim of this analysis is to examine more closely why participants do or do not use information about evidence and mechanism when making their decision. The data used in this analysis came from two open response questions. In this analysis, I examined the themes that emerged from participants' open responses and compared the relative frequencies of these themes across goal conditions.

Ideas about evidence

Responses to the evidence statement were coded with the coding scheme described in the methods chapter, and shown in Table 9 from the Methods chapter. The frequency of reason categories and their distribution among goal conditions is shown in Table 16. The table shows the three most frequent categories all concerned characteristics of the evidence. The two most common reasons given across the entire sample were simply that the excerpt *was evidence*, or that some aspect of the evidence, such as sample size or treatment effect, was *sufficient*. Participants also expressed that the evidence was *insufficient*. For example, they might indicate that the sample size was too small or that the effect of zinc seemed inconclusive. Table 17 shows examples of responses for these frequent categories.

Table 16. Frequencies of reasons for being influenced or not influenced by evidence.

Code	Overall		Goal Condition					
			Claim Evaluation		Personal Decision		Societal Decision	
	<i>n</i>	%	<i>n</i>	%	<i>n</i>	%	<i>n</i>	%
There is evidence	51	24%	24	33%*	13	18%	14	20%
Evidence is sufficient	52	24%	17	23%	18	25%	17	24%
Evidence is insufficient	41	19%	13	18%	12	16%	16	23%
Other	25	12%	8	11%	11	15%	6	8%
Informed understanding	(4)		(2)		(0)		(2)	
Prior knowledge	(4)		(1)		(1)		(2)	
Copied excerpt	(9)		(3)		(6)		(0)	
Ambiguous	(8)		(2)		(4)		(2)	
Irrelevance	23	11%	2	3%*	7	10%	14	20%*
Relevance	15	7%	4	5%	8	11%	3	4%
Blank	10	5%	5	7%	4	5%	1	1%

I conducted a χ^2 test to examine the differences in proportions of the codes across goal conditions. To satisfy the χ^2 requirement to have less than 20% of cells with expected frequencies less than 5, I combined some low frequency categories. I combined the categories *more informed*, *prior knowledge*, *copied excerpt*, and *ambiguous* into one *other* category. The *blank* category was also infrequent but was kept as a separate category because it was qualitatively different. Unlike the blank responses, participants made an attempt to provide a reason in the other four infrequent categories.

Table 17. Examples of responses for frequent categories of reasons for evidence’s influence.

Reason type	Examples
There is evidence	<p><i>When supported with evidence, I'm more likely to believe it</i> — Participant 15, Claim Evaluation</p> <p><i>There was concrete statistics</i> — Participant 95, Personal Decision</p> <p><i>It supported its statement with data</i> — Participant 13, Societal Decision</p>
Evidence is sufficient	<p><i>It seemed fair that people with the Same amount of colds had a significantly lower amount of colds rather than the people who didn't take the zinc</i> — Participant 66, Claim Evaluation</p> <p><i>The study does show that the group who took the zinc pills got less colds than the other group.</i> — Participant 96, Personal Decision</p> <p><i>There's a big difference between those who took the zinc pill and those who didn't.</i> — Participant 65, Societal Decision</p>
Evidence is insufficient	<p><i>It's only 100 people and the ratio of colds to no colds is very close so you cannot base a good conclusion about zinc curing a common cold after this</i> — Participant 158, Claim Evaluation</p> <p><i>More than half the students received the cold virus anyways.</i> — Participant 56, Personal Decision</p> <p><i>I honestly thought the number gap would be more astonishing than just 33.</i> — Participant 3, Societal Decision</p>
Irrelevance	<p><i>While the statistic shows a decrease in patients who got the cold while using zinc, it doesn't change the fact that I don't get colds often and I do not want to be paying for something that only works half the time that I don't really need.</i> — Participant 93, Personal Decision</p> <p><i>I think maybe zinc can just effect people differently.</i> — Participant 35, Societal Decision</p> <p><i>i feel that any sort of medicine should be given at home not school</i> — Participant 210, Societal Decision</p>
Relevance	<p><i>Maybe I should consider taking zinc pills to help prevent getting sick so often.</i> — Participant 49, Claim Evaluation</p> <p><i>Shows I would be less likely to get a cold if I took zinc</i> — Participant 161, Personal Decision</p> <p><i>Colds are so easy to get when there is someone with the cold virus, and having zinc to block what is around you is great.</i> — Participant 200, Societal Decision</p>

For the remaining seven categories, the type of responses given for how evidence did or did not influence participants' decisions was significantly dependent on goal ($df = 12, \chi^2 = 21.45, p = 0.04$). Examination of standardized residuals for each cell indicated that the differences between goals mainly resulted from the categories *there is evidence* and *excerpt irrelevant*. Participants assigned the claim evaluation goal were significantly more likely to express that the excerpt influenced their decision because *there is evidence* ($z = 2.32$). The claim evaluation group was also less likely to express that the *evidence was irrelevant* ($z = -2.68$). Those with the societal decision goal were significantly more likely to express that the evidence excerpt influenced their decision because it was *irrelevant* ($z = 3.04$).

Ideas about mechanism

To analyze participants' responses to why mechanism did or did not influence their decisions, I used the coding scheme (see Table 10) described in the methods chapter. Table 18 shows the distribution of coding categories across goal conditions. The most frequent category, overall, was *mechanism explained*. This is unsurprising since participants were asked about the excerpt that describes a mechanism of how zinc prevents the common cold. The next most frequent category was *explanation insufficient*, with participants stating that they found the mechanism excerpt unclear or insufficient.

While the excerpt was about the mechanism, some participants expressed that they needed or preferred evidence. Similar to the reasons for being influenced by evidence, participants referred to *relevance* or *irrelevance* when responding to the mechanism excerpt. Unique to the set of reasons about mechanism was a focus on the source of the information. In

the article provided to participants, the mechanism was given by unidentified scientists. Some participants stated that they were influenced by the mechanism because scientists provided the information (i.e. *scientist, no elaboration*). Other participants elaborated on the source. For example, they stated why they thought scientists were a reliable source or they indicated they needed to know the background of the scientists. Table 19 shows examples of responses from these categories.

Table 18. Frequencies of reasons for being influenced or not influenced by mechanism.

Code	Overall		Goal Condition					
			Claim Evaluation <i>n</i> = 73		Personal Decision <i>n</i> = 73		Societal Decision <i>n</i> = 71	
	<i>n</i>	%	<i>n</i>	%	<i>n</i>	%	<i>n</i>	%
Mechanism explained	49	23%	20	27%	13	18%	16	23%
Explanation insufficient	28	13%	14	19%*	7	10%	7	10%
Scientists, no elaboration	25	12%	8	11%	9	12%	8	11%
Evidence necessary	23	11%	7	10%	11	15%	5	7%
Excerpt relevant	22	10%	2	3%*	7	10%	13	18%*
Ambiguous	17	8%	6	8%	8	11%	3	4%
Excerpt Irrelevant	16	7%	2	3%	4	5%	10	14%*
Scientists, with elaboration	16	7%	5	7%	4	5%	7	10%
Copied excerpt	12	6%	6	8%	4	5%	2	3%
Blank	9	4%	3	4%	6	8%*	0	0%*

Table 19. Examples of responses for frequent categories of reasons for mechanism's influence.

Reason type	Examples
Mechanism Explained	<p><i>It tells me how zinc affects the cells.</i> — Participant 44, Claim Evaluation</p> <p><i>It gives the reason why zinc is able to prevent us from getting a cold.</i>— Participant 108, Personal Decision</p> <p><i>because it stops the copying of the virus</i> — Participant 23, Societal Decision</p>
Explanation insufficient	<p><i>The scientists did not explain how zinc keeps cold viruses from reproducing.</i> — Participant 9, Claim Evaluation</p> <p><i>It's a very general statement and doesn't' explain why and convince me.</i> — Participant 62, Personal Decision</p> <p><i>Very vague</i> — Participant 29, Societal Decision</p>
Scientists, no elaboration	<p><i>This seems to be based on expert opinion.</i> — Participant 191, Claim Evaluation</p> <p><i>I trust scientists</i> — Participant 21, Personal Decision</p> <p><i>Information was provided by scientists.</i> — Participant 124, Societal Decision</p>
Evidence necessary	<p><i>Give me evidence, not an opinion.</i> — Participant 106, Claim Evaluation</p> <p><i>I was not entirely convinced. I need actual numbers and statistics.</i>— Participant 12, Personal Decision</p> <p><i>There's no data</i> — Participant 33, Societal Decision</p>
Excerpt relevant	<p><i>good to our body</i> — Participant 162, Claim Evaluation</p> <p><i>If zinc can help stop the prevention of cold cells spreading that would be very convenient.</i> — Participant 25, Personal Decision</p> <p><i>It's interesting information, and it could probably help in the future.</i> — Participant 91, Societal Decision</p>
Excerpt irrelevant	<p><i>Still not interested</i> — Participant 202, Personal Decision</p> <p><i>No because I think that some people may just react to zinc differently or it effects people differently.</i> — Participant 35, Societal Decision</p> <p><i>It's still not the school's job to give out medications.</i> — Participant 122, Societal Decision</p>
Scientists, with elaboration	<p><i>Provides facts but does not provide background on scientists.</i> — Participant 209, Claim Evaluation</p> <p><i>Because a scientist says it, it must be true right? But we don't know which scientists or company promotes this, so its iffy.</i> — Participant 52, Personal Decision</p> <p><i>pretty vague statement. How many scientists say this? Do all scientists agree? Who are these "scientists"? Are they qualified?</i> — Participant 163, Societal Decision</p>

The reasons participants gave to explain the influence of the mechanism statement differed significantly by goal condition ($df = 18$, $\chi^2 = 33.51$, $p = 0.01$). Examination of standardized residuals for each cell indicated that the differences between goals mainly resulted from the categories *explanation insufficient*, *excerpt relevant*, *excerpt irrelevant*, and *blank*. Those with the goal of claim evaluation were significantly more likely to express that the mechanism excerpt provided *insufficient explanation* ($z = 2.14$). The claim evaluation group was also less likely to express that the mechanism was *relevant* ($z = -2.57$).

Those with the societal decision goal were significantly more likely to express that the mechanism excerpt was *relevant* ($z = 2.78$). The societal decision group was also more likely to express that the mechanism *excerpt was irrelevant* ($z = -2.64$). In other words, some in this group found the mechanism relevant while other found it irrelevant. But as a group they were more likely to consider relevance as the reason why mechanism did or did not influence their decision.

Lastly, those with the personal decision goal were significantly more likely to have *copied an excerpt* from the articles as their response ($z = 2.14$). No participant with the societal decision goal copied an excerpt from the article ($z = -2.13$). This pattern is difficult to interpret because it was unclear what was meant by the copied excerpts. There was also limited data for this infrequent category, with only 9 participants in total.

Summary of findings about influence reasons

For the second research question, I wanted to find out what reasons participants gave for whether evidence or mechanism influenced their decisions. Participants gave a range of reasons that revealed how they did or did not use the evidence and mechanism information provided. Two

of the most common reasons focused on the characteristics of the information (i.e. *there is evidence, mechanism explained*). Participants pointed out the fact that the information provided empirical support or explanation as the reasons why they were influenced. Some participants went further and assessed the evidence or mechanism provided. They stated the quality of the information as reasons why they were influenced or not (i.e. *evidence is sufficient, evidence is insufficient, explanation insufficient*). Other participants focused on the relevance of the information, indicating that they were influenced or not because they considered the information relevant or irrelevant.

Comparing across goals, participants assigned the goal of evaluation were more likely to give the reason *there is evidence*, more likely to find the *mechanism insufficient*, and less likely to find the evidence *excerpt irrelevant*. Participants assigned the goal of societal decision were more likely to give a relevance-related reason, including *evidence irrelevant, mechanism relevant*, and *mechanism irrelevant*.

RESEARCH QUESTION 3: DECISIONS AND CHANGE IN DECISIONS

The primary focus of this study is to examine how participants used evidence and mechanism across different goals. In order to do so, I asked participants to come to a decision about their goals of evaluating a claim, making a personal decision, or making a societal decision. I did not intend to study the specific decisions of whether participants agreed with the claim about zinc or decided to use zinc personally. It is of interest, however, to examine whether participants changed their decisions as a result of reading an article designed to be relevant to their goals. To complement the above analyses on how participants use evidence and mechanism,

this section addresses the question: are participants' decisions and change in decisions different across the goals of claim evaluation, personal decision, and societal decision?

To review, participants were asked the goal question of their condition both before and after reading the article about zinc and cold prevention. In each instance, they were asked to respond to the question with one of seven choices, from strongly disagree to strongly agree with an undecided middle option. For this analysis the decisions were dummy coded 1 to 7, with 1 being the most negative (e.g. strongly disagreeing that zinc prevents cold) and 7 being the most positive (e.g. strongly agreeing that schools should provide zinc). Figure 1 shows the distribution of decisions before and after reading for each goal. Table 20 shows the means and standard deviations. Overall, participants decided just above the undecided midpoint before they read the article. This is unsurprising because, as noted earlier, only a few of the participants (7.8%) reported having heard a lot about the claim that zinc prevents the common cold prior to this survey. Participants, on the whole, did not change their decisions after reading the article ($t = 1.80, p = 0.07$).

To examine whether decisions before and after reading were different across goals, I conducted a two-way analysis of variance. I used decisions as the dependent variable, goal condition as the between subject independent variable, and time of decisions (i.e. before or after reading article) as within subject independent variable. There was a significant main effect for goal condition, $F(2,214) = 4.57, p = 0.01$, no significant main effect of reading, $F(1,214) = 3.45, p = 0.06$, and significant interaction of goal by reading, $F(2,214) = 4.15, p < 0.01$. This result suggests that goals seemed to have an effect on participants' decision change, although this effect was not uniform before and after the reading.

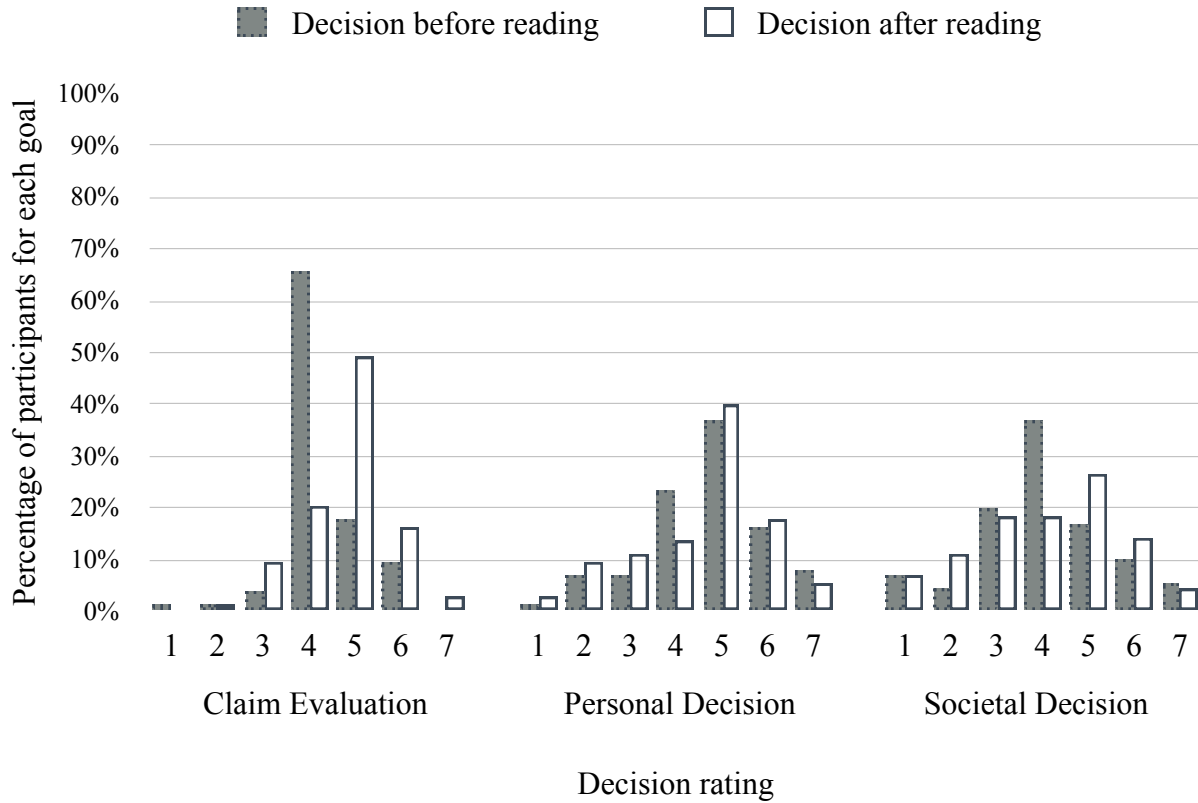


Figure 1. Distributions of decision ratings before and after reading.

Table 20. Means and standard deviations of decisions before and after reading.

Decision	Overall		Goal Condition					
	<i>M</i>	<i>SD</i>	Claim Evaluation		Personal Decision		Societal Decision	
			<i>n</i> = 73	<i>n</i> = 73	<i>n</i> = 71			
	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>
Before	4.34	1.26	4.26	0.85	4.7	1.33	4.04	1.45
After	4.46	1.38	4.78	0.98	4.53	1.44	4.06	1.58

To examine this interaction effect, I conducted post hoc analyses using Tukey HSD test with $p = 0.05$. Before reading the article, participants with the personal decision goal decided significantly more positively than those with claim evaluation goal ($d = 0.40$) or societal decision goal ($d = 0.48$). In other words, participants with the goal of personal decision leaned toward likely to take zinc to prevent colds while others leaned toward undecided. After reading the article, participants with the societal decision goal decided significantly less positively than those with claim evaluation goal ($d = 0.56$) or personal decision goal ($d = 0.31$). For those with the claim evaluation goal, their decisions after the reading were significantly more favorable than before the reading ($d = 0.54$), a pattern not seen in the other two conditions. While these three differences are statistically significant, conceptually these differences are less than one decision rating point and difficult to interpret.

To get a more concrete sense of how participants changed decisions across goals, I looked more closely at the frequencies and patterns of decision changes. Forty eight percent of the total sample of participants did not change their decision after reading the article. Among participants who changed their decisions, a majority of them (88 of 113 participants) changed their decisions by only one step (e.g. from “somewhat agree” to “agree”). Since so few participants changed their decisions by more than one step, I combined participants into three categories: those who changed their decisions in the more favorable direction after the reading, those who changed their decisions in the less favorable direction after the reading, and those who did not change their decisions. Table 21 shows the proportions of these three groups across goal conditions.

Table 21. Proportion of changes in decisions.

	Overall		Goal Condition					
			Claim Evaluation		Personal Decision		Societal Decision	
			<i>n</i> = 73		<i>n</i> = 73		<i>n</i> = 71	
	<i>n</i>	%	<i>n</i>	%	<i>n</i>	%	<i>n</i>	%
Changed decision?								
No	104	48%	22	30%	43	59%	39	55%
Yes, more favorable	73	34%	41	56%	13	18%	19	27%
Yes, less favorable	40	18%	10	14%	17	23%	13	18%

While approximately half of the participants overall did not change their decisions, the pattern was different across goals. Most of those evaluating the claim changed their decision (70%). In contrast, most participants with the personal decision goal and the societal decision goal did not change their decision after reading the article. This change in decision was significantly dependent on goal conditions ($df = 4, \chi^2 = 26.65, p < 0.01$).

In summary, participants with the evaluation goal were on average undecided at the beginning of the survey, but most of them changed their decision after reading the article. Of the claim evaluators who changed their decisions, most of them became more likely to agree with the claim. This pattern is significantly different from those with the personal or the societal decision goals, most of whom did not change their decisions.

Chapter 5

Discussion

In this study, I explored how participants with the goals of claim evaluation, personal decision, and societal decision used evidence and mechanism, the reasons behinds whether evidence and mechanism were influential, and whether participants changed their decision based on the information provided. The findings suggest that participants differed across goals in multiple ways. The findings also showed that all three groups of participants used evidence and mechanism. After discussing the similarities and differences between goal conditions, I examine here some of the patterns specific to participants with the claim evaluation and societal decision goals. I also address the difference between participants' change in decisions and their use of evidence and mechanism. Lastly, I discuss some limitations and implications of the study.

THE INFLUENCE OF MECHANISM AND EVIDENCE ACROSS GOALS

All three groups of participants attended to evidence and mechanism in some ways. A majority in each of the three groups of participants indicated that they were influenced by the evidence and mechanism presented in the reading. In addition, over 40% of participants (41-47% for each goal) gave some assessment of how the evidence was sufficient or insufficient when explaining its influence on their decisions. When asked whether any information might help them with their goal, additional evidence in the form of related research was the most frequent type of requests for those with the claim evaluation and societal decision goals (and a close third most frequent for those with the personal decision goal).

It is possible that all three groups of participants requested and attended to information about evidence and mechanism in this study because such information was made readily available and clearly connected. The intent of including this information in this study was to avoid the potential that participants did not use evidence and mechanism because they lacked experience on the topic to come up with such information or questions on their own. Koslowski and colleagues (1996, 2008) found that people are more likely to recognize and account for evidence when a plausible mechanism is readily available to explain the evidence. Brem and Rips (2000) also found that the availability of evidence increased college students' preference for and ability to generate evidence. In the present study, being provided with one specific set of evidence in the reading might have made it more likely for participants to think of and request additional evidence to help them with their goal.

Such information about evidence and mechanism was not always available in past studies that examined decision-making (e.g. Bell & Lederman, 2003; Fleming, 1986; Sadler & Zeidler, 2005). For example, Sadler and Zeidler (2005) presented a scenario describing gene therapy as a potential treatment for Huntington's disease and asked college students, "*Should gene therapy be used to eliminate HD from sex cells (egg cells or sperm cells) that will be used to create new human offspring?*" The scenario contained background information defining gene therapy and the nature of Huntington's disease, but no empirical evidence or references to existing related research that support gene therapy's potential effectiveness. These studies found that individuals' decision making are often driven or even dominated by emotions, intuitions, and values. These studies contributed to our understanding of decision making by describing the ethics, affects, and personal views that enter into participants' thinking about controversial issues. However, the lack

of available scientific information, especially evidence, might lead us to overlook people's capacity to consider the quality of the science alongside their other concerns.

Research has found that students have the capacity to use explanatory mechanism and evidence to support decisions (Evagorou, et al., 2012; Kolsto, 2006; Ratcliffe, 1997) given targeted curriculum, guidance, and available information within classroom settings. The present study did not attempt to examine whether participants used evidence and mechanism in productive ways. But the findings suggest that, even without the support of a structured classroom setting, participants did attend to evidence and mechanism in their decision making when such information is readily available and clearly connected.

Counter to expectation, participants with the claim evaluation goal did not rate the importance of information about mechanism or evidence in the reading higher than their peers with decision-making goals. Participants in all three groups rated the importance of evidence and mechanism similarly in most respects. In particular, all three groups rated the importance of information about evidence and mechanism more highly than non-science information.

One potential explanation for this unexpected pattern is the design of the reading. The reading was designed to include relevant non-science information in addition to the evidence and mechanism provided. In particular, this information was intentionally presented as quotes from high school students to provide relatable and anecdotal examples of decisions for and against using zinc to prevent colds. Anecdotal examples are frequently used by decision makers and influence health decisions (Ubel, et al., 2001; Zillman, 2006). When narrative examples and statistical information are both present, narrative examples have a stronger influence on decision makers (Betsch, et al., 2011; de Wit, et al., 2008). In the present study, the unexpected lower

importance rating of narrative examples, namely the non-science information, could be due to a number of factors. First, the non-science information was presented as favorable or unfavorable toward the decision, but did not provide personal testimonials of the causal effect typical of narrative examples. For example, Betsch and colleagues (2011) used a narrative that stated, “*Hey all, my little daughter Melanie was vaccinated a half year ago. The PP-vaccination had no adverse effects. All the best, Marie.*” In this example, the effect (i.e. no adverse effects) of the causal agent (i.e. PP-vaccination) was clearly stated. In contrast, one of the excerpts from the reading in the present study stated, “*I started taking zinc because it was easy. You can get zinc pills from supermarkets and they are cheap.*” This quoted individual did not mention the effect of whether zinc prevented colds for him or her. This exclusion was deliberate in the reading’s design, but could have caused the narrative examples to seem less thorough or important to the participants.

The design of the reading also unintentionally placed the sources of the non-science and science information on unequal footings. Participants might perceive different status for the high school students providing the non-science information and the scientists providing the evidence and mechanism information. Research suggests that readers are sensitive to differences in sources, perceiving different trustworthiness, credibility, or usefulness based on source attributes such as affiliation and expertise (Braasch, et al., 2009; Braten, et al., 2009; Kobayashi, 2014; Stromso, et al., 2013). It is possible that the non-science information was rated lower by participants across all three goals due to perceived unequal content and sources.

THE EVIDENTIARY FOCUS OF CLAIM EVALUATION

The findings suggest that participants across goals differed in a few specific ways. The differences were most evident in the open-ended responses from the survey. Those assigned with the claim evaluation goal were more likely to request additional information about evidence in the form of related research. For example, they wanted to know if there were more studies about zinc's effects on the common cold or studies with a larger sample size. They were also more likely to request additional information about the mechanism behind the claim in the reading, such as "*how does zinc work?*". In contrast, participants with the claim evaluation goal were less likely than those with decision-making goals to request information about the practicalities related to using zinc. Practicalities was one of the least frequent type of requests for those with the evaluation goal while it was one of the most frequent type of requests for those with either personal or societal decision goals.

Participants with the claim evaluation goal were also more likely to cite the presence of evidence as their reason for whether the evidence excerpt influenced their decision. Most of these responses can be characterized as identifying the evidential nature of the excerpt highlighted. To appreciate this type of response, it is important to remember that while this question highlighted the evidence excerpt from the reading, the excerpt was not identified to the participants as evidence. Participants providing this type of response were using words such as "*evidence*", "*data*", or "*statistics*" to identify the evidential nature of the information as the reason for its influential. In addition, participants with the claim evaluation goal were more likely to want to know more about the mechanism provided in the reading, citing that the mechanism excerpt provided insufficient explanation. In contrast, participants assigned with the societal

decision goal were more likely than those with the claim evaluation goal to cite relevance or irrelevance as the reasons behind whether evidence or mechanism influenced their decision. For example, participants explained that it wasn't the school's responsibility to provide zinc or that they found it personally relevant to have a way to prevent colds.

In addition to opened-ended responses, participants with the claim evaluation goal were more likely to be influenced by the evidence excerpt. They were also more likely to change their decision (i.e. whether zinc prevents the common cold) after reading the provided information than those who were making personal and societal decisions.

While all three groups of participants rated information about evidence and mechanism as more important than non-science information, participants with the claim evaluation goal were the only group to rate evidence as more important than mechanism. Central to the practice of evaluating claims are judging the plausibility of mechanism and assessing the available evidence. Developmental research found that children prefer explanations over evidence, but this preference diminishes with age and education, shifting to a preference for evidence toward adulthood and among university students (cf. Kuhn, 2001, Sandoval, et al., 2014). This shift to a preference for evidence is important because an explanatory mechanism, even a plausible one, remains unsubstantiated without supporting evidence. In addition to a developmental trend in this preference, contextual factors such as availability (Brem and Rips, 2000) and strength (Kuhn and Felton, 2000) of evidence also influence individuals' preference of evidence versus mechanism. Glassner and colleagues (2005) suggested that this preference might also be sensitive to goals. They found that middle school students preferred evidence over explanation when asked to prove a claim versus to explain a claim. Among participants in the present study,

those with the evaluation goal seem to exhibit a similar preference as those being asked to prove a claim in Glassner and colleagues' study, rating evidence as more important than mechanism.

Another interpretation of this pattern is that participants with the claim evaluation goal were more critical of the information about mechanism than those with decision-making goals. Those with the claim evaluation goal were more likely to request additional information about mechanism and also more likely to cite that the mechanism was insufficient as a reason for whether the mechanism influenced their decision. For example, they expressed that the mechanism provided was lacking details or requested information about how zinc prevented the virus from replicating.

This contrasted with the categories "evidence is sufficient" and "evidence is insufficient", which were similar in frequencies across the three goals. For the responses under the sufficient and insufficient categories, participants gave some assessment of the evidence. While some of these responses concern methodological issues such as sample size or controlling variables, most of them were specifically about the size of the zinc prevention effect. For example, the reduction from 86 to 53 students getting the common cold was insufficient to one societal decision maker. Participants with each of the three goals seem equally attentive to the effect described in the evidence, but those with the claim evaluation goal were more likely to focus on the evidential nature of the information provided.

RELEVANCE OF NON-SCIENCE INFORMATION TO SOCIETAL DECISION GOAL

Those assigned with the societal decision goal were more likely to cite relevance or irrelevance as a reason for whether evidence and mechanism influenced their decision (i.e.

evidence irrelevant: 20%, mechanism relevant: 18%, mechanism irrelevant: 14%). Most of the societal decision-makers who found the evidence or mechanism irrelevant focused on the stance that schools do not have the responsibility or permission to provide zinc to prevent the common colds. The stance that “*it is not the school’s job to help students prevent colds*” was offered in the survey reading as one of the non-science narrative examples. It is unclear why this particular narrative example was resonant with participants while the other narrative examples were not prevalent in the open responses in the same way with any of the three goal conditions. Those with the societal decision goal rated the reading’s non-science information higher than their peers in both the claim evaluation and personal decision goal conditions. In particular, the “*not the school’s job*” excerpt was rated the highest in importance within the non-science paragraph by societal decision makers.

We cannot assume the participants who expressed the “*not the school’s job*” stance had completely ignored evidence and mechanism or that they thought the claim to be false. Instead, a rational person could simultaneously hold such a stance, maintaining that schools should not provide zinc to students, and think the claim is true. Therefore, information about mechanism or evidence were irrelevant and not influential to their decisions. They might choose to use zinc personally, but the societal decision remained a matter of principle and not science. In contrast, Participant 35 from the Societal Decision condition, as shown in the examples given in the results chapter, expressed that neither the evidence nor mechanism influenced her because people could react to zinc differently. She seemed to have discounted the information based on a prior conception that everyone is different biologically, or that substances function differently in each person. This example echoes the selective attention to evidence described in prior research

(Evagorou, et al., 2012; Koslowski, 2012), where individuals attend to evidence that agrees with their existing ideas but ignore evidence that does not fit with what they think. There were only a couple isolated instances of the “*everyone is different*” stance identified in the present data. Its presence does suggest that when people do not use evidence and mechanism, they could be doing so for qualitatively different reasons.

Participants with the personal decision goal also cited reasons of relevance and irrelevance. They were also concerned with the practicalities of using zinc, as evidenced by a relative high frequency of requests for such non-science information. However, their contrast to those with the claim evaluation goal did not seem to be as strong as societal decision-makers. One possible reason is that many personal decision makers were also evaluating the claim. Based on the manipulation check item at the end of the online survey, 40% of those assigned the personal decision goal selected “*I was deciding... if zinc prevents the common cold*” to best describe what they were trying to do during the survey. In comparison, only 21% of those assigned the societal decision goal selected the same response.

CHANGING DECISIONS VERSUS USING EVIDENCE AND MECHANISM

While a majority of participants across all three goals stated that evidence and mechanism influenced their decisions, this pattern was not reflected in a change of their decisions. Recall that the survey asked participants to evaluate or decide (relative to their goal) both before and after the reading containing evidence and mechanism. Seventy percent of those with the claim evaluation goal changed their decision after the reading, but less than half of those with the personal and societal decision goals (41% and 45% respectively) changed their

decisions. In other words, among those with decisions goals, some participants were influenced by the evidence or mechanism presented but did not change their decision.

For participants with the evaluation goal, they were given an unfamiliar claim followed by information about evidence and mechanism that supported this claim. Such information is specifically targeted to support claim evaluation, which can be facilitated by a plausible explanation and empirical data supported with some details about how it was produced (Sandoval, et al., 2014). It makes sense that most participants would change their initial, less informed decision in one direction or another depending on their evaluation of the information provided.

Making a personal or societal decision that involves a science claim are tasks that could be resolved by multiple different determining factors. In addition to evaluating the quality of the claim, participants might base their decision on many reasonable but non-scientific factors. Participants' responses to whether evidence and mechanism influenced their decisions shed some light on the many decision factors at work. As discussed earlier, a participant assigned with the societal decision goal might not think providing health supplements to be part of schools' responsibility. Such a participant might be convinced by the evidence and mechanism provided that zinc prevents the common cold. But such an assessment would not change her view that parents, not schools, should have the responsibility and choice for their children's health. Similarly, a participant assigned with the personal decision goal might not perceive catching colds as a problem for him. He could very well have attended to the evidence, assessed that the claim to be likely true, but still did not change his decision because he saw no personal need for taking zinc as a preventative measure.

The types of information that participants requested in this study reflected the range of factors that could sway decision-making. Two of the most frequent types of requests from participants with decision-making goals concerned the practicalities of how zinc would be consumed (24% of requests for the personal decision goal, 23% of requests for the societal decision goal) and potential risks or consequences of using zinc (22% of requests for the personal decision goal, 15% of requests for the societal decision goal). It is conceivable that even having used the evidence and mechanism provided to conclude that zinc prevents colds, some participants might hesitate to change their decision if they felt they still needed more information to address their practical or safety concerns.

It is also important to consider the perception of probability and risk in decision-making. The evidence provided in the reading showed a decrease in colds amongst research subjects who took zinc. As is typical of medical findings, the prevention effect of zinc in the reading was not 100% successful. Even though the reading indicated that less students got colds when they took zinc, 53 of those 100 students still got sick at some point in a 6-month period. It is well documented that people are risk averse when offered a gain with only moderate probability (Tversky and Kahneman, 1992; cf. Fox and Poldrack, 2009). The common cold is a relatively minor disease that mostly inflicts inconveniences. At the same time, there is a monetary and convenience cost of taking zinc. Some participants, as evident in their information requests, were also concerned about potential risk of side effects. Given potential costs and risks for a moderate probability gain of preventing colds, it is perhaps not surprising that most participants with decision-making goals did not change their decision regardless of whether they considered the evidence presented in the reading.

LIMITATIONS

The generalizability of the findings here might be limited by the choice of causal claim topic. It was not possible to select a topic that is representative of the wide range of science topics that people might encounter in decision-making situations. The claim that zinc prevents the common cold was selected for this study because of its relative simplicity, potential interest, and accessibility to high school students. To minimize effects of uneven prior experiences or opinions among participants, the zinc claim was also selected because it was not widely publicized or controversial. In contrast, topics such as climate change, vaccination, stem cell research, or nuclear energy might elicit emotions or prior beliefs that influence individuals' reasoning about a claim. Research on decision making focusing on such controversial issues found that people's reasoning can be emotional, intuitive, socially oriented, as well as rational (*cf.* Wu & Tsai, 2007). It is unclear how the effects of goals might influence the use of evidence and mechanism when prior beliefs or strong emotions are also present.

The survey questions used in this study, with the exception of information requests, prompted participants to respond to information about evidence and mechanism. These statements were not labeled as evidence and mechanism, but participants were asked specifically to rate their importance and to explain why they did or did not influence their decisions. Without readily available information and specific prompts, individuals might be less likely to consider evidence and mechanism in their decision-making process. The effects of goals in this study, while statistically significant, might have been diminished by the fact that many participants with decision-making goals were prompted to think about evidence and mechanism. Given a more open-ended format, there could be more measurable differences in the extent that participants

used evidence and mechanism across different goals.

Another limitation of this study was the need to assign goals to participants. While the goal manipulations were reinforced throughout the survey, it is possible that participants oriented their goals differently than the ones assigned. The manipulation check item at the end of the survey found that a majority of participants in each condition perceived what they were doing during the survey in a way that matched their assigned goal. However, 21% of those with the societal decision goal and 40% of those with the personal decision goal selected “*I was deciding... if zinc prevents the common cold*” to best describe what they were trying to do during the survey. Another 21% of those with the societal decision goal selected “*I was deciding... if I would take zinc to prevent the common cold*” to best describe what they were trying to do during the survey. It is possible that these participants overlooked their assigned goal. It is also possible that these participants adopted their assigned goal, but they considered the goal of making a decision to involve deciding if zinc prevents the common cold. Limited by a survey format, it remains unclear to what extent participants adopted the goals they were assigned.

The survey format also produced other challenges. The information that participants requested for their goals and the reasons they provided for whether evidence and mechanism were influential provided some insights into how participants used different information across goals. However, these short open responses provided only limited access to participants’ reasoning processes. The coding categories used to analyze this data were defined broadly to avoid inferences beyond what participants wrote. For example, the *evidence insufficient* category might contain both accurate and inaccurate interpretations of the information provided. However, the limited level of details within the written responses did not allow for further classification of

the responses. Using more open-ended methodologies such as think-aloud or interview could potentially reveal additional similarities and differences in how participants use evidence and mechanism for different goals.

IMPLICATIONS

Research in science education is increasingly interested in decision making and the role of science in personal and societal issues. The goal of science education, and science literacy more specifically, emphasizes how the knowledge and practices taught in science classrooms could benefit students in their everyday lives. Being able to understand and use evidence and explanatory mechanism could empower students to make better informed decisions. But the goals in a classroom can be very different from the goals that students pursue when they encounter science outside of school. The findings in this study suggest that goals make a difference in the kinds of information that participants seek and the reasons why evidence and mechanism were influential. If educators want scientific information to be used more broadly outside of schools, we need to better articulate to ourselves and to students how evidence and mechanism can help people pursue different goals.

The findings in this study also suggest we need to be clear both in our instructional practices and in our research that eliciting students' decisions is not the same as finding out about their use of evidence and mechanism. It is possible for people to consider scientific information and still arrive at different decisions. Moving forward, one productive approach is to focus on the decision-making process rather than the decision outcome. For example, it would be informative to understand when and how evidence and mechanism are used in the process of decision-

making.

Qualitative studies that examine decision-making within instructional settings already began to take this approach by closely analyzing students' use of scientific information during classroom discussions. (e.g. Albe, 2008; Evagorou, et al., 2012; Nielsen, 2012). But shifting attention to the decision-making process shouldn't be limited to fine-grained analyses of student talk. Research that seeks to understand the use of mechanism and evidence in everyday situations (e.g. reading science news online, making medical choices) or requires other data collection methods (e.g. interviews, surveys) can also target questions and observations toward what individuals do to make decisions rather than the decisions they make. For example, tracking search terms, time spent, or click histories during a simulated interaction with online science news could shed light on what information participants use and when they choose to use them. Similar to the information request question in this study, questions that elicit specific actions that participants want to take to meet a goal, or tasks that ask participants to help a family member make decision, would encourage participants to explain how they would come to a decision rather than focus on the decision itself.

By adopting such approaches to get a better picture of the decision-making process, future studies could address some of the questions raised by the present study. For example, the findings suggest that those with the personal decision goal appear to be more similar to those with the claim evaluation goal than those with the societal decision goal. Many of those with the personal decision goal also described themselves as evaluating the zinc claim. It would be informative to examine whether people who are making decisions for themselves do in fact evaluate claims more than people who are making societal decisions. I also discussed a few

possible reasons why participants with decision-making goals attended to evidence and mechanism at the group level, but tended not to change their decisions. A more detailed look at the decision-making process could shed light on whether decision change is mainly determined by the non-science considerations discussed above, or whether there is any relationship between decision change to the manner or extent that people attend to evidence and mechanism.

Varying aspects of the decision-making situations in a controlled manner could also shed light on the participants' thinking process and address some questions raised by the present study. For example, the findings suggest that participants with each of the three goals attended to the size of the zinc prevention effect in the evidence (i.e. *evidence sufficient* or *insufficient* reasons). Participants with decision-making goals also raised a number of concerns regarding the risks, benefits, and practicalities of using zinc. It would be interesting to examine whether the characteristics of the evidence (e.g. different effect sizes) or the topic (e.g. desirability of the effect, associated risks, or level of controversy) would influence how participants use evidence for different goals.

Appendix A: IRB documents

Dear teacher,

We are looking for high school students to participate in a UCLA research study. The purpose of the study is to understand how students think about health topics and what kinds of information students find helpful. The results of this study will inform researchers and teachers about ways to prepare students to deal with the science claims they encounter in everyday settings. We ask for your help to share information about this study with students who are 13 years of age or older.

We attached a letter with information for students below. Please share this letter with your students electronically or in hardcopies. We also provided a flyer if there is a convenient location for you to post it.

When participating in this study, students will complete an online survey individually at a time and place of their choice. The survey takes about 10 minutes. It includes a short reading about a health topic and some questions about their thoughts on the topic. Their responses will be anonymous and will only be used for the research study.

As our appreciation for their participation, students will receive a \$3 gift card (Amazon.com).

If you are interested in our research study, we will be happy to share our findings at the conclusion of the study.

Please contact me at jacquelinew@ucla.edu or 310.853.0282 if you have questions about the study.

Sincerely,
Jacqueline Wong
UCLA Department of Education

Dear student,

We are looking for high school students to participate in a UCLA research study. The purpose of the study is to understand how students think about health topics and what kinds of information students find helpful. Here is some information about the study and how to participate:

What will happen if I take part in this research study?

You will complete an online survey. It will take about 10 minutes. All your responses will be anonymous.

What will I get if I participate?

You will receive a \$3 gift card for Amazon.com.

Who can participate?

You must be a high school student who is 13 or older.

To participate or for more information, please go to:

<http://jacquelinew.bol.ucla.edu/survey.htm>

If you have any questions, please contact:

Jacqueline Wong, UCLA Department of Education
310.853.0282
jacquelinew@ucla.edu

Sincerely,
Jacqueline Wong
UCLA Department of Education

Participants Needed for UCLA Research Study

Description of project:

The purpose of the study is to understand how students think about a health topic and what kinds of information students find helpful.

What will happen if I take part in this research study?

You will complete an online survey. It will take about 10 minutes. All your responses will be anonymous.

What will I get if I participate?

You will receive a \$3 gift card for Amazon.com.

Who can participate?

You must be a high school student who is 13 or older.

If you have any questions, please contact:

Jacqueline Wong, UCLA Department of Education
310.853.0282
jacquelinew@ucla.edu

To participate or for more information, please go to:

<http://jacquelinew.bol.ucla.edu/survey.htm>

UCLA Research Study http://jacquelinew.bol.ucla.edu/survey.htm 310.853.0282 jacquelinew@ucla.edu
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UCLA Research Study http://jacquelinew.bol.ucla.edu/survey.htm 310.853.0282 jacquelinew@ucla.edu

UNIVERSITY OF CALIFORNIA, LOS ANGELES
STUDY INFORMATION SHEET

Students' ideas about health topics

You are asked to participate in a research study conducted by Dr. William A. Sandoval and Jacqueline Wong from the Graduate School of Education and Information Studies at the University of California, Los Angeles. You were selected as a possible participant in this study because you are a high school student. Your participation in this research study is voluntary.

Why is this study being done?

This study is being conducted to understand how students think about a health topic and what kinds of information students find helpful.

What will happen if I take part in this research study?

If you volunteer to participate in this study, the researcher will ask you to do the following:

1. Answer a few questions about your interest in reading about health.
2. Read a short text (about 3 paragraphs) about a health topic.
3. Complete an online survey about the text you read.
4. Provide some anonymous background information about yourself (e.g. age, ethnicity).

How long will I be in the research study?

Participation in the study will take about 10 minutes.

Are there any potential risks or discomforts that I can expect from this study?

There are no anticipated risks or discomforts.

Are there any potential benefits if I participate?

You will not directly benefit from your participation in the research.

The results of the research may help researchers understand how students think about current health topics and may help teachers incorporate current health topics in science classes.

Will I receive any payment if I participate in this study?

You will receive a \$3 gift card for Amazon.com.

Will information about me and my participation be kept confidential?

Any information that is obtained in connection with this study and that identify you will remain confidential. It will be disclosed only with your permission or as required by law. Confidentiality will be maintained by not collecting any names in connection with this research. Additionally, data will be stored in password-protected computer and will only be accessible to the researchers.

What are my rights if I take part in this study?

You may withdraw your assent/consent at any time and discontinue participation without penalty or loss of benefits to which you were otherwise entitled.

You can choose whether or not you want to be in this study. If you volunteer to be in this study, you may leave the study at any time without consequences of any kind. You are not waiving any of your legal rights if you choose to be in this research study. You may refuse to answer any questions that you do not want to answer and still remain in the study.

Who can answer questions I might have about this study?

If you have any questions, comments or concerns about the research, you can talk to the one of the researchers. Please contact Jacqueline Wong at 310.853.0282 or jacquelinew@ucla.edu or Dr. William Sandoval at 310.794.5431 or sandoval@gseis.ucla.edu.

If you wish to ask questions about your rights as a research participant or if you wish to voice any problems or concerns you may have about the study to someone other than the researchers, please call the Office of the Human Research Protection Program at (310) 825-7122 or write to Office of the Human Research Protection Program, UCLA, 11000 Kinross Avenue, Suite 102, Box 951694, Los Angeles, CA 90095-1694.

If you wish to keep a copy of this form, you may print or save it for your record.

ONLINE ASSENT/CONSENT OF STUDY PARTICIPANT

I understand the procedures described above. My questions have been answered to my satisfaction, and I agree to participate in this study. I have been given a copy of this form.

By clicking on the "I agree" button, I am agreeing to participate in this study.

I agree. Take me to the survey.

Exit

[Referral information

To appear online after the survey and after information about receiving gift card incentive.]

Your survey is now complete. Thank you!

If you know other high school students who might be interested in participating, please help us share some information about this study. This is optional, but we would really appreciate your help. Your friend(s) will also receive a \$3 gift card to Amazon.com if they decide to complete the survey

Options for sharing:

- Automatically email them with information
- Email them myself
- Share on Facebook

[[if one of the options is selected, the respective information will be displayed below.]

[Automatic email option]

Please enter email addresses of high school students who might be interested in completing this survey. Their email addresses will only be used to send the message below.

Email address(es):

Study information:

High School Students Needed for UCLA Research Study

Description of project:

The purpose of the study is to understand how students think about a health topic and what kinds of information students find helpful.

What will happen if I take part in this research study?

You will complete an online survey. It will take about 10 minutes. All your responses will be anonymous.

Who can participate?

You must be a high school student who is 13 years of age or older.

What will I get if I participate?

You will receive a \$3 gift card for Amazon.com.

To participate or for more information, please go to:

<http://jacquelinew.bol.ucla.edu/survey.htm>

If you have any questions, please contact:

Jacqueline Wong, UCLA Department of Education
310.853.0282
jacquelinew@ucla.edu

You may add a personal message if you would like:

[Email on their own option]

Thank you for telling other students about this study. Please include this link in your email:
<http://jacquelinew.bol.ucla.edu/survey.htm>

You may also copy and paste the information below to your email if you would like:

High School Students Needed for UCLA Research Study

Description of project:

The purpose of the study is to understand how students think about a health topic and what kinds of information students find helpful.

What will happen if I take part in this research study?

You will complete an online survey. It will take about 10 minutes. All your responses will be anonymous.

Who can participate?

You must be a high school student who is 13 years of age or older.

What will I get if I participate?

You will receive a \$3 gift card for Amazon.com.

To participate or for more information, please go to:

<http://jacquelinew.bol.ucla.edu/survey.htm>

If you have any questions, please contact:

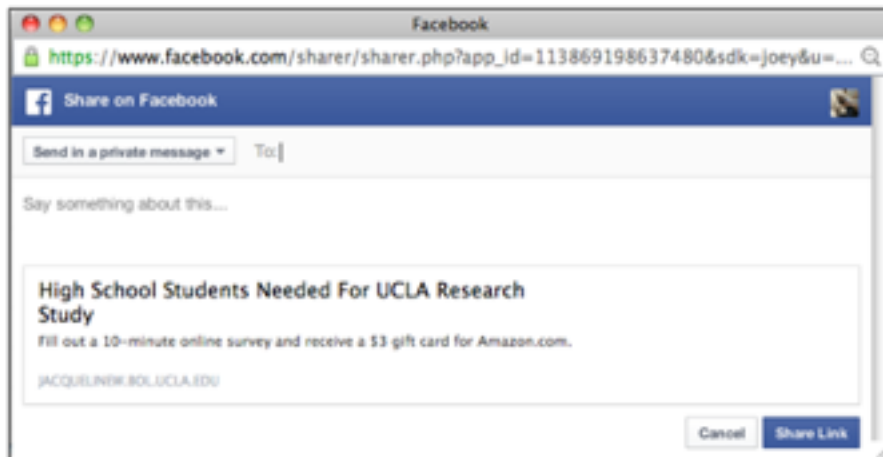
Jacqueline Wong, UCLA Department of Education
310.853.0282
jacquelinew@ucla.edu

[facebook option]

Thank you for sharing information about this study on facebook. Please click on the facebook button.



[After participant click on the facebook "share" button, a window like the one below will pop up. Participant will have the options to share the survey link to their own facebook page, in a message to a friend, to a group they belong to, or to cancel.]



Appendix B: Online Survey

Task-based survey

Each outlined section below represents one page from the online survey. Participants clicked the forward button at the bottom right of each screen to navigate to the next page. The version shown here is the survey for the claim evaluation goal condition. Surveys for the personal and societal decision goals conditions are identical with the exceptions of wording changes as described the experimental manipulation section of the methods chapter.

UNIVERSITY OF CALIFORNIA, LOS ANGELES

STUDY INFORMATION SHEET

Students' ideas about health topics

You are asked to participate in a research study conducted by Dr. William A. Sandoval and Jacqueline Wong from the Graduate School of Education and Information Studies at the University of California, Los Angeles. You were selected as a possible participant in this study because you are a high school student. Your participation in this research study is voluntary.

Why is this study being done?

This study is being conducted to understand how students think about a health topic and what kinds of information students find helpful.

What will happen if I take part in this research study?

If you volunteer to participate in this study, the researcher will ask you to do the following:

ONLINE ASSENT/CONSENT OF STUDY PARTICIPANT

I understand the procedures described above. My questions have been answered to my satisfaction, and I agree to participate in this study.

By clicking on the "I agree" option, I am agreeing to participate in this study.

I agree. Take me to the survey.

Exit

>>

This survey includes:

- *A few questions about yourself.
- *A short article about a health topic.
- *A few questions on your thoughts about the health topic.
- *A few questions on the information you read in the article.

When you click the >> button at the bottom of each page, you will go to the next page of the survey. Once you leave a page you will not be able to go back. Please answer each question as carefully as you can before you go to the next page. You can take as much time as you like.

Remember, there are no right or wrong answers to the questions in this survey. We are interested in finding out what you think about a health topic.



Please tell us a little bit about you:

Grade in school:

Grade 9

Grade 10

Grade 11

Grade 12

Sex:

Female

Male

Ethnicity

African-American

Native American

Asian or Pacific Islander

White, non-Hispanic

Biracial / multi-ethnic

Other

Hispanic / Latino(a)

Zip code of your home.

(If you don't know your zip code, enter your town/city and state.)

I find science reports in the news to be ...

not at all interesting.	slightly interesting.	moderately interesting.	very interesting.	extremely interesting.
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

How useful do you think science knowledge is for helping you make decisions in your life?

Not at all useful	Slightly useful	Moderately useful	Very useful	Extremely useful
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

How much confidence do you have in the science community?

No confidence at all	Hardly any confidence	Some confidence	A lot of confidence	Complete confidence
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

How interested are you in learning about a way to prevent the common cold?

Not at all interested	Slightly interested	Moderately interested	Very interested	Extremely interested
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

How much would it affect you to have a way to prevent the common cold?

Not affect me at all	Affect me slightly	Affect me moderately	Affect me a lot	Affect me completely
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Have you ever taken zinc supplements?

Yes	No	I don't know
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Have you ever heard that zinc might prevent the common cold?

No, I never heard about this.	Yes, I heard a little about this.	Yes, I heard a lot about this.
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

A research study claims that zinc prevents the common cold.

Do you agree with the claim that zinc prevents the common cold?

Strongly Disagree Disagree Somewhat Disagree Undecided Somewhat Agree Agree Strongly Agree



On the next page is a short reading about a research study. The reading has some information about zinc and the common cold. After the reading, you will be asked again whether you agree with the claim that zinc prevents the common cold. You can keep or change your original answer after the reading.



Does zinc prevent the common cold?

A research study claims that zinc prevents the common cold. People get colds when cold viruses get into the cells inside our bodies. The viruses then make more viruses inside the cells. Scientists say zinc keeps cold viruses from making more of themselves. When cold viruses are not able to reproduce, it is easier for our bodies to fight the viruses off.

To test whether zinc prevents the common cold, scientists did a research study with 200 high school students. 100 of the students took a zinc pill each day for 6 months. The other 100 students took a pill with no zinc each day for 6 months. The scientists checked that both groups of students had about the same number of colds the year before this research study. 53 of the 100 students who took zinc pills got colds during the 6 months of the study. 86 of the 100 students who took pills with no zinc got colds during those 6 months.

Many people are wondering if they should use zinc to prevent colds. One student said, "I started taking zinc because it was easy. You can get zinc pills from supermarkets and they are cheap." Another student said, "I tried a zinc pill before and it tasted really bad. I don't want to take them everyday."

Some people are also wondering if schools should provide zinc to students. One student said, "So many people miss school when they have colds. It's good to help students prevent colds so they don't get sick and fall behind." Another student said, "It is not the school's job to help students prevent colds. Parents should do that."

Please take as much time with this reading as you need. We will ask you some questions about this reading and whether you agree with the claim that zinc prevents the common cold on the next pages.

Click the >> button below to go to the questions.



Do you agree with the claim that zinc prevents the common cold?

Your previous answer:

Your answer now:

Strongly Disagree	Disagree	Somewhat Disagree	Undecided	Somewhat Agree	Agree	Strongly Agree
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

>>

How important was each part of the reading to how you decide whether zinc prevents the common cold?

	Not important at all							Extremely important
	0	1	2	3	4	5	6	
A research study claims that zinc prevents the common cold.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
People get colds when cold viruses get into the cells inside our bodies. The viruses then make more viruses inside the cells.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Scientists say zinc keeps cold viruses from making more of themselves.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
When cold viruses are not able to reproduce, it is easier for our bodies to fight the viruses off.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

	Not important at all							Extremely important
	0	1	2	3	4	5	6	
To test whether zinc prevents the common cold, scientists did a research study with 200 high school students.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
100 of the students took a zinc pill each day for 6 months. The other 100 students took a pill with no zinc each day for 6 months.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
The scientists checked that both groups of students had about the same number of colds the year before this research study.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
53 of the 100 students who took zinc pills got colds during the 6 months of the study. 86 of the 100 students who took pills with no zinc got colds during those 6 months.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

	Not important at all						Extremely important
	0	1	2	3	4	5	6
Many people are wondering if they should use zinc to prevent colds.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
One student said, "I started taking zinc because it was easy. You can get zinc pills from supermarkets and they are cheap."	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Another student said, "I tried a zinc pill before and it tasted really bad. I don't want to take them everyday."	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Some people are also wondering if schools should provide zinc to students.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
One student said, "So many people miss school when they have colds. It's good to help students prevent colds so they don't get sick and fall behind."	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Another student said, "It is not the school's job to help students prevent colds. Parents should do that."	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

>>

If you want more information to help you decide whether zinc prevents the common cold, what would it be?

>>

We want to find out what you thought about some parts of the article about zinc and colds.

Here is the article that you read earlier. We want to ask you about the part that is highlighted below.

Does zinc prevent the common cold?

A research study claims that zinc prevents the common cold. People get colds when cold viruses get into the cells inside our bodies. The viruses then make more viruses inside the cells. Scientists say zinc keeps cold viruses from making more of themselves. When cold viruses are not able to reproduce, it is easier for our bodies to fight the viruses off.

To test whether zinc prevents the common cold, scientists did a research study with 200 high school students. 100 of the students took a zinc pill each day for 6 months. The other 100 students took a pill with no zinc each day for 6 months. The scientists checked that both groups of students had about the same number of colds the year before this research study. **53 of the 100 students who took zinc pills got colds during the 6 months of the study. 86 of the 100 students who took pills with no zinc got colds during those 6 months.**

Many people are wondering if they should use zinc to prevent colds. One student said, "I started taking zinc because it was easy. You can get zinc pills from supermarkets and they are cheap." Another student said, "I tried a zinc pill before and it tasted really bad. I don't want to take them everyday."

Some people are also wondering if schools should provide zinc to students. One student said, "So many people miss school when they have colds. It's good to help students prevent colds so they don't get sick and fall behind." Another student said, "It is not the school's job to help students prevent colds. Parents should do that."

Did the information highlighted above influence your decision of whether zinc prevents the common cold?

Yes



No



This information influenced my decision because...

Here we highlighted another part of the article.

Does zinc prevent the common cold?

A research study claims that zinc prevents the common cold. People get colds when cold viruses get into the cells inside our bodies. The viruses then make more viruses inside the cells. **Scientists say zinc keeps cold viruses from making more of themselves.** When cold viruses are not able to reproduce, it is easier for our bodies to fight the viruses off.

To test whether zinc prevents the common cold, scientists did a research study with 200 high school students. 100 of the students took a zinc pill each day for 6 months. The other 100 students took a pill with no zinc each day for 6 months. The scientists checked that both groups of students had about the same number of colds the year before this research study. 53 of the 100 students who took zinc pills got colds during the 6 months of the study. 86 of the 100 students who took pills with no zinc got colds during those 6 months.

Many people are wondering if they should use zinc to prevent colds. One student said, "I started taking zinc because it was easy. You can get zinc pills from supermarkets and they are cheap." Another student said, "I tried a zinc pill before and it tasted really bad. I don't want to take them everyday."

Some people are also wondering if schools should provide zinc to students. One student said, "So many people miss school when they have colds. It's good to help students prevent colds so they don't get sick and fall behind." Another student said, "It is not the school's job to help students prevent colds. Parents should do that."

Did the information highlighted above influence your decision of whether zinc prevents the common cold?

Yes

No

This information did not influence my decision because...



Which of the following comes closest to describing what you were trying to do when answering questions in this survey? (Pick only one.)

I was deciding ...

- ... if zinc prevents the common cold.
- ... if I would take zinc to prevent the common cold.
- ... if schools should provide zinc to students to prevent the common cold.



Thank you for completing the survey. To receive your \$3 gift card for Amazon.com, please enter your email address below. Your email address will not be linked to your survey answers. It will only be used to deliver your gift certificate.

Make sure you click the >> button to send us your email address. We won't have a way to send you your gift certificate if we don't have your email address.



Your gift certificate will be sent to your email address within 24 hours.

If you know other high school students who might be interested in completing this survey, please help us share some information about this study. This is optional, but we would really appreciate your help. Your friend(s) will also receive a \$3 gift card for Amazon.com if they decide to complete the survey.

How would you like to share this survey?

- Share on Facebook
- Automatically email them with information
- Email them myself



Thank you for your help! The survey is now complete.

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