Knowledge Emotions: Feelings that Foster Learning, Exploring, and Reflecting

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When people think of emotions they usually think of the obvious ones, such as happiness, fear, anger, and sadness. This module looks at the knowledge emotions, a family of emotional states that foster learning, exploring, and reflecting. Surprise, interest, confusion, and awe come from events that are unexpected, complicated, and mentally challenging, and they motivate learning in its broadest sense, be it learning over the course of seconds (finding the source of a loud crash, as in surprise) or over a lifetime (engaging with hobbies, pastimes, and intellectual pursuits, as in interest). The module reviews research on each emotion, with an emphasis on causes, consequences, and individual differences. As a group, the knowledge emotions motivate people to engage with new and puzzling things rather than avoid them. Over time, engaging with new things, ideas, and people broadens someone’s experiences and
cultivates expertise. The knowledge emotions thus don’t gear up the body like fear, anger, and happiness do, but they do gear up the mind—a critical task for humans, who must learn essentially everything that they know.

Tags:
Awe, Confusion, Emotion, Interest, Learning, Motivation, Surprise, Wonder

Learning Objectives

• Identify the four knowledge emotions.
• Describe the patterns of appraisals that bring about these emotions.

• Discuss how the knowledge emotions promote learning.

• Apply the knowledge emotions to enhancing learning and education, and to one’s own life.

Introduction
The knowledge emotions—surprise, interest, confusion, and awe—are what help to promote learning. For example, if something unusual happens (surprise), you study it to figure out why it happened. [Image: typexnick, https://goo.gl/WIJrRR, CC BY 2.0, https://goo.gl/BRvSA7]
What comes to mind when you think of emotions? It’s probably the elation of happiness, the despair of sadness, or the freak-out fright of fear. Emotions such as happiness, anger, sadness, and fear are important emotions, but human emotional experience is vast—people are capable of experiencing a wide range of feelings.

This module considers the knowledge emotions, a profoundly important family of emotions associated with learning, exploring, and reflecting. The family of knowledge emotions has four main members: surprise, interest, confusion, and awe. These are considered knowledge emotions for two reasons. First, the events that bring them about involve
knowledge: These emotions happen when something violates what people expected or believed. Second, these emotions are fundamental to learning: Over time, they build useful knowledge about the world.

Some Background About Emotions

Before jumping into the knowledge emotions, we should consider what emotions do and when emotions happen. According to functionalist theories of emotion, emotions help people manage important tasks (Keltner & Gross, 1999; Parrott, 2001). Fear, for example, mobilizes the body to fight or flee; happiness rewards achieving goals and builds attachments to other people. What do knowledge emotions do? As we’ll see in detail later, they motivate learning, viewed in its broadest sense,
during times that the environment is puzzling or erratic. Sometimes the learning is on a short time scale. Surprise, for example, makes people stop what they are doing, pay attention to the surprising thing, and evaluate whether it is dangerous (Simons, 1996). After a couple seconds, people have learned what they needed to know and get back to what they were doing. But sometimes the learning takes place over the lifespan. Interest, for example, motivates people to learn about things over days, weeks, and years. Finding something interesting motivates “for its own sake” learning and is probably the major engine of human competence (Izard, 1977; Silvia, 2006).
What causes emotions to happen in the first place? Although it usually feels like something in the world—a good hug, a snake slithering across the driveway, a hot-air balloon shaped like a question mark—causes an emotion directly, emotion theories contend that emotions come from how we think about what is happening in the world, not what is literally happening. After all, if things in the world directly caused emotions, everyone would always have the same emotion in response to something. **Appraisal theories** (Ellsworth & Scherer, 2003; Lazarus, 1991) propose that each emotion is caused by a group of appraisals, which are evaluations and judgments of what events in the world mean for our goals and well-being: Is this relevant to me? Does it further or hinder my
goals? Can I deal with it or do something about it? Did someone do it on purpose? Different emotions come from different answers to these appraisal questions.

With that as a background, in the following sections we’ll consider the nature, causes, and effects of each knowledge emotion. Afterward, we will consider some of their practical implications.
High Novelty, Complexity, Unfamiliarity

**SURPRISE**

**CONFUSION**

Low Ability to Understand (Coping Potential)

**INTEREST**

High Ability to Understand (Coping Potential)
Figure 1. The appraisal space of surprise, interest, and confusion.

**Surprise**

Nothing gets people’s attention like something startling. **Surprise**, a simple emotion, hijacks a person’s mind and body and focuses them on a source of possible danger (Simons, 1996). When there’s a loud, unexpected crash, people stop, freeze, and orient to the source of the
noise. Their minds are wiped clean—after something startling, people usually can’t remember what they had been talking about—and attention is focused on what just happened. By focusing all the body’s resources on the unexpected event, surprise helps people respond quickly (Simons, 1996).

Surprise has only one appraisal: A single “expectedness check” (Scherer, 2001) seems to be involved. When an event is “high contrast”—it sticks out against the background of what people expected to perceive or experience—people become surprised (Berlyne, 1960; Teigen & Keren, 2003). Figure 1 shows this pattern visually: Surprise is high when unexpectedness is high.
Emotions are momentary states, but people vary in their propensity to experience them. Just as some people experience happiness, anger, and fear more readily, some people are much more easily surprised than others. At one end, some people are hard to surprise; at the other end, people are startled by minor noises, flashes, and changes. Like other individual differences in emotion, extreme levels of surprise propensity can be dysfunctional. When people have extreme surprise responses to mundane things—known as hyperstartling (Simons, 1996) and hyperekplexia (Bakker, van Dijk, van den Maagdenberg, & Tijssen, 2006)—everyday tasks such as driving or swimming become dangerous.

Interest
Curiosity, a most familiar emotion, is the reason humans have developed and thrived as they have today. [Image: CC0 Public Domain, https://goo.gl/m25gce]

People are curious creatures. **Interest**—an emotion that motivates exploration and learning (Silvia, 2012)—is one of the most commonly experienced emotions in everyday life (Izard, 1977). Humans must learn
virtually everything they know, from how to cook pasta to how the brain works, and interest is an engine of this massive undertaking of learning across the lifespan.

The function of interest is to engage people with things that are new, odd, or unfamiliar. Unfamiliar things can be scary or unsettling, which makes people avoid them. But if people always avoided new things they would learn and experience nothing. It’s hard to imagine what life would be like if people weren’t curious to try new things: We would never feel like watching a different movie, trying a different restaurant, or meeting new people. Interest is thus a counterweight to anxiety—by making unfamiliar things appealing, it motivates people to experience and think about new things. As a result, interest is an **intrinsically motivated** form
of learning. When curious, people want to learn something for its own sake, to know it for the simple pleasure of knowing it, not for an external reward, such as learning to get money, impress a peer, or receive the approval of a teacher or parent.

Figure 1 shows the two appraisals that create interest. Like surprise, interest involves appraisals of novelty: Things that are unexpected, unfamiliar, novel, and complex can evoke interest (Berlyne, 1960; Hidi & Renninger, 2006; Silvia, 2008). But unlike surprise, interest involves an additional appraisal of coping potential. In appraisal theories, coping potential refers to people’s evaluations of their ability to manage what is happening (Lazarus, 1991). When coping potential is high, people feel capable of handling the challenge at hand. For interest, this challenge is
mental: Something odd and unexpected happened, and people can either feel able to understand it or not. When people encounter something that they appraise as both novel (high novelty and complexity) and comprehensible (high coping potential), they will find it interesting (Silvia, 2005).

The primary effect of interest is exploration: People will explore and think about the new and intriguing thing, be it an interesting object, person, or idea. By stimulating people to reflect and learn, interest builds knowledge and, in the long run, deep expertise. Consider, for example, the sometimes scary amount of knowledge people have about their
hobbies. People who find cars, video games, high fashion, and soccer intrinsically interesting know an amazing amount about their passions—it would be hard to learn so much so quickly if people found it boring.

A huge amount of research shows that interest promotes learning that is faster, deeper, better, and more enjoyable (Hidi, 2001; Silvia, 2006). When people find material more interesting, they engage with it more deeply and learn it more thoroughly. This is true for simple kinds of learning—sentences and paragraphs are easier to remember when they are interesting (Sadoski, 2001; Schiefele, 1999)—and for broader academic success—people get better grades and feel more intellectually engaged in classes they find interesting (Krapp, 1999, 2002; Schiefele, Krapp, & Winteler, 1992).
Individual differences in interest are captured by **trait curiosity** (Kashdan, 2004; Kashdan et al., 2009). People low in curiosity prefer activities and ideas that are tried and true and familiar; people high in curiosity, in contrast, prefer things that are offbeat and new. Trait curiosity is a facet of **openness to experience**, a broader trait that is one of the five major factors of personality (McCrae, 1996; McCrae & Sutin, 2009). Not surprisingly, being high in openness to experience involves exploring new things and findings quirky things appealing. Research shows that curious, open people ask more questions in class, own and read more books, eat a wider range of food, and—not surprisingly, given their lifetime of engaging with new things—are a bit higher in intelligence (DeYoung, 2011; Kashdan & Silvia, 2009; Peters, 1978; Raine, Reynolds, Venables, & Mednick, 2002).
Confusion

Sometimes the world is weird. Interest is a wonderful resource when people encounter new and unfamiliar things, but those things aren’t always comprehensible. **Confusion** happens when people are learning something that is both unfamiliar and hard to understand. In the appraisal space shown in Figure 1, confusion comes from appraising an event as high in novelty, complexity, and unfamiliarity as well as appraising it as hard to comprehend (Silvia, 2010, 2013).
Has anyone ever told you to “look up that answer for yourself?” The effort of working through your own confusion helps you learn the material better than simply being given the answer. [Image: CollegeDegrees360, https://goo.gl/1Edneb, CC BY-SA 2.0, https://goo.gl/rxiUsF]
Confusion, like interest, promotes thinking and learning. This isn’t an obvious idea—our intuitions would suggest that confusion makes people frustrated and thus more likely to tune out and quit. But as odd as it sounds, making students confused can help them learn better. In an approach to learning known as impasse-driven learning (VanLehn, Siler, Murray, Yamauchi, & Baggett, 2003), making students confused motivates them to think through a problem instead of passively sitting and listening to what a teacher is saying. By actively thinking through the problem, students are learning actively and thus learning the material more deeply. In one experiment, for example, students learned about scientific research methods from two virtual reality tutors (D’Mello, Lehman, Pekrun, & Graesser, in press). The tutors sometimes contradicted each other, however, which made the students confused.
Measures of simple learning (memory for basic concepts) and deep learning (being able to transfer an idea to a new area) showed that students who had to work through confusion learned more deeply—they were better at correctly applying what they learned to new problems.

In a study of facial expressions, Rozin and Cohen (2003) demonstrated what all college teachers know: It’s easy to spot confusion on someone’s face. When people are confused, they usually furrow, scrunch, or lower their eyebrows and purse or bite their lips (Craig, D’Mello, Witherspoon, & Graesser, 2008; Durso, Geldbach, & Corballis, 2012). In a clever application of these findings, researchers have developed artificial intelligence (AI) teaching and tutoring systems that can detect
expressions of confusion (Craig et al., 2008). When the AI system detects confusion, it can ask questions and give hints that help the student work through the problem.

Not much is known about individual differences related to confusion, but differences in how much people know are important. In one research study, people viewed short film clips from movies submitted to a local film festival (Silvia & Berg, 2011). Some of the people were film experts, such as professors and graduate students in media studies and film theory; others were novices, such as the rest of us who simply watch movies for fun. The experts found the clips much more interesting and
much less confusing than the novices did. A similar study discovered that experts in the arts found experimental visual art more interesting and less confusing than novices did (Silvia, 2013).

Awe
Feeling awe often involves a sense of “feeling small,” like when you look up at the night sky or meet someone you really admire and respect. [Image: Kevin Dooley, https://goo.gl/FEC1nE, CC BY 2.0, https://goo.gl/BRvSA7]
Awe—a state of fascination and wonder—is the deepest and probably least common of the knowledge emotions. When people are asked to describe profound experiences, such as the experience of beauty or spiritual transformation, awe is usually mentioned (Cohen, Gruber, & Keltner, 2010). People are likely to report experiencing awe when they are alone, engaged with art and music, or in nature (Shiota, Keltner, & Mossman, 2007).

Awe comes from two appraisals (Keltner & Haidt, 2003). First, people appraise something as vast, as beyond the normal scope of their experience. Thus, like the other knowledge emotions, awe involves appraising an event as inconsistent with one’s existing knowledge, but the degree of inconsistency is huge, usually when people have never
encountered something like the event before (Bonner & Friedman, 2011). Second, people engage in accommodation, which is changing their beliefs—about themselves, other people, or the world in general—to fit in the new experience. When something is massive (in size, scope, sound, creativity, or anything else) and when people change their beliefs to accommodate it, they’ll experience awe.

A mild, everyday form of awe is chills, sometimes known as shivers or thrills. Chills involve getting goosebumps on the skin, especially the scalp, neck, back, and arms, usually as a wave that starts at the head and moves downward. Chills are part of strong awe experiences, but people often experience them in response to everyday events, such as compelling music and movies (Maruskin, Thrash, & Elliot, 2012; Nusbaum
& Silvia, 2011). Music that evokes chills, for example, tends to be loud, have a wide frequency range (such as both low and high frequencies), and major dynamic shifts, such as a shift from quiet to loud or a shift from few to many instruments (Huron & Margulis, 2010).

Like the other knowledge emotions, awe motivates people to engage with something outside the ordinary. Awe is thus a powerful educational tool. In science education, it is common to motivate learning by inspiring wonder. One example comes from a line of research on astronomy education, which seeks to educate the public about astronomy by using awe-inspiring images of deep space (Arcand, Watzke, Smith, & Smith, 2010). When people see beautiful and striking color images of supernovas, black holes, and planetary nebulas, they usually report
feelings of awe and wonder. These feelings then motivate them to learn about what they are seeing and their scientific importance (Smith et al., 2011).

Regarding individual differences, some people experience awe much more often than others. One study that developed a brief scale to measure awe—the items included statements such as “I often feel awe” and “I feel wonder almost every day”—found that people who often experience awe are much higher in openness to experience (a trait associated with openness to new things and a wide emotional range) and in extraversion (a trait associated with positive emotionality) (Shiota, Keltner, & John, 2006). Similar findings appear for when people are asked how often they experience awe in response to the arts (Nusbaum &
Silvia, in press). For example, people who say that they often “feel a sense of awe and wonder” when listening to music are much higher in openness to experience (Silvia & Nusbaum, 2011).

Implications of the Knowledge Emotions
knowledge emotions help us form relationships and solve important problems.


Learning about the knowledge emotions expands our ideas about what emotions are and what they do. Emotions clearly play important roles in everyday challenges such as responding to threats and building
relationships. But emotions also aid in other, more intellectual challenges for humans. Compared with other animals, we are born with little knowledge but have the potential for enormous intelligence. Emotions such as surprise, interest, confusion, and awe first signal that something awry has happened that deserves our attention. They then motivate us to engage with the new things that strain our understanding of the world and how it works. Emotions surely aid fighting and fleeing, but for most of the hours of most of our days, they mostly aid in learning, exploring, and reflecting.

Outside Resources
Video: A talk with Todd Kashdan, a well-known scholar in the field of curiosity and positive psychology, centered on curiosity

Todd Kashdan
Video: More from Todd

Becoming a mad scientist with your life: Todd Kashdan at...
Web: Aesthetics and Astronomy, a project that uses wonder and beauty to foster knowledge about the science of space
http://astroart.cfa.harvard.edu/ (http://astroart.cfa.harvard.edu/)

Web: The Emotion Computing Group, an interdisciplinary team that studies how to measure confusion and harness it for deeper learning, among other intriguing things
Discussion Questions

1. Research shows that people learn more quickly and deeply when they are interested. Can you think of examples from your own life when you learned from interest versus from extrinsic rewards (e.g., good grades, approval from parents and peers)? Was learning more enjoyable or effective in one case?
2. How would you redesign a psychology lecture to harness the power of the knowledge emotions? How could you use interest, confusion, and awe to grab students’ attention and motivate them to reflect and learn?

3. Psychology, like all the sciences, is fueled by wonder. For psychology, the wonder is about human nature and behavior. What, to you, is the most wondrous, amazing, and awe-inspiring idea or finding from the science of psychology? Does reflecting on this amazing fact motivate you to want to know more about it?

4. Many people only want to know something if it is practical—if it helps them get a job, make friends, find a mate, or earn money. But emotions such as interest and awe, by motivating learning for its own
sake, often engage people in things that seem frivolous, silly, or impractical. What does this say about learning? Is some knowledge necessarily more valuable than other kinds?

**Vocabulary**

**Accommodation**
Changing one's beliefs about the world and how it works in light of new experience.

**Appraisal structure**
The set of appraisals that bring about an emotion.
Appraisal theories
Evaluations that relate what is happening in the environment to people’s values, goals, and beliefs. Appraisal theories of emotion contend that emotions are caused by patterns of appraisals, such as whether an event furthers or hinders a goal and whether an event can be coped with.

Awe
An emotion associated with profound, moving experiences. Awe comes about when people encounter an event that is vast (far from normal experience) but that can be accommodated in existing knowledge.

Chills
A feeling of goosebumps, usually on the arms, scalp, and neck, that is often experienced during moments of awe.

Confusion
An emotion associated with conflicting and contrary information, such as when people appraise an event as unfamiliar and as hard to understand. Confusion motivates people to work through the perplexing information and thus fosters deeper learning.

Coping potential
People's beliefs about their ability to handle challenges.

Facial expressions
Part of the expressive component of emotions, facial expressions of emotion communicate inner feelings to others.

**Functionalist theories of emotion**

Theories of emotion that emphasize the adaptive role of an emotion in handling common problems throughout evolutionary history.

**Impasse-driven learning**

An approach to instruction that motivates active learning by having learners work through perplexing barriers.

**Interest**
An emotion associated with curiosity and intrigue, interest motivates engaging with new things and learning more about them. It is one of the earliest emotions to develop and a resource for intrinsically motivated learning across the life span.

Intrinsically motivated learning
Learning that is “for its own sake”—such as learning motivated by curiosity and wonder—instead of learning to gain rewards or social approval.

Knowledge emotions
A family of emotions associated with learning, reflecting, and exploring. These emotions come about when unexpected and unfamiliar events
happen in the environment. Broadly speaking, they motivate people to explore unfamiliar things, which builds knowledge and expertise over the long run.

**Openness to experience**
One of the five major factors of personality, this trait is associated with higher curiosity, creativity, emotional breadth, and open-mindedness. People high in openness to experience are more likely to experience interest and awe.

**Surprise**
An emotion rooted in expectancy violation that orients people toward the unexpected event.
Trait curiosity

Stable individual-differences in how easily and how often people become curious.

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Paul J. Silvia, an Associate Professor of Psychology at the University of North Carolina at Greensboro, has published widely on the topics of interest, curiosity, and knowledge-seeking. He is the author of five
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Abstract

Learning Objectives

Introduction

Some Background About Emotions

Surprise

Interest

Confusion

Awe
Implications of the Knowledge Emotions

Outside Resources

Discussion Questions

Vocabulary

References

Authors

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