

[HowStuffWorks](#) / [Science](#) / [Life Science](#) / [Inside the Mind](#) / [Emotions](#)

How Fear Works

By: [Julia Layton](#)



**See more human
senses pictures.**

It's dark out, and you're home alone. The house is quiet other than the sound of the show you're watching on TV. You see it and hear it at the same time: The front door is suddenly thrown against the door frame.

Your breathing speeds up. Your heart races. Your muscles tighten.

A split second later, you know it's the wind. No one is trying to get into your home.

For a split second, you were so afraid that you reacted as if your life were in danger, your body initiating the fight-or-flight response that is critical to any animal's survival. But really, there was no danger at all. What happened to cause such an intense reaction? What exactly is fear? In this article, we'll examine the psychological and physical properties of fear, find out what causes a fear response and look at some ways you can defeat it.

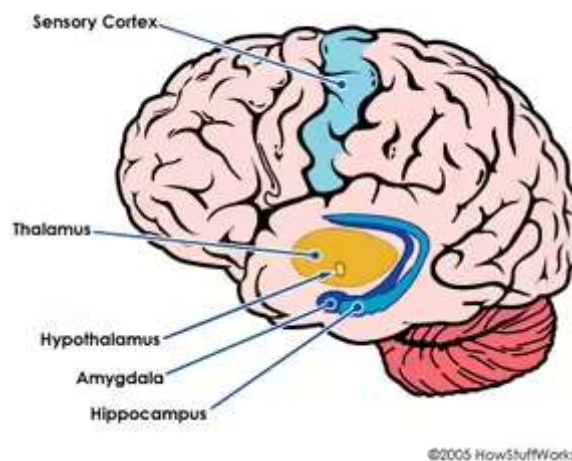
What is Fear?

Fear is a chain reaction in the **brain** that starts with a stressful stimulus and ends with the release of chemicals that cause a racing **heart**, fast breathing and energized **muscles**, among other things, also known as the fight-or-flight response. The stimulus could be a **spider**, a knife at your throat, an auditorium full of people waiting for you to speak or the sudden thud of your front door against the door frame.

The brain is a profoundly complex organ. More than 100 billion nerve **cells** comprise an intricate network of communications that is the starting point of everything we sense, think and do. Some of these communications lead to conscious thought and action, while others produce **autonomic responses**. The fear response is almost entirely autonomic: We don't consciously trigger it or even know what's going on until it has run its course.

Because cells in the brain are constantly transferring information and triggering responses, there are dozens of areas of the brain at least peripherally involved in fear. But research has discovered that certain parts of the brain play central roles in the process:

Parts of the Brain Involved in Fear Response

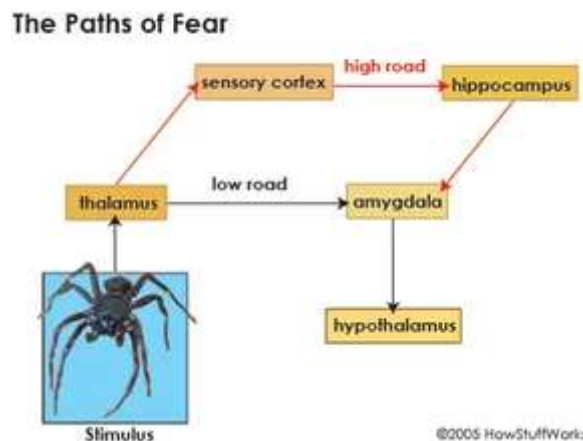


- **Thalamus** - decides where to send incoming sensory data (from **eyes**, ears, mouth, skin)
- **Sensory cortex** - interprets sensory data

- **Hippocampus** - stores and retrieves conscious memories; processes sets of stimuli to establish context
- **Amygdala** - decodes emotions; determines possible threat; stores fear memories
- **Hypothalamus** - activates "fight or flight" response

The process of creating fear begins with a scary stimulus and ends with the fight-or-flight response. But there are at least two paths between the start and the end of the process. In the next section, we'll take a closer look at how fear is created.

Creating Fear



Creating fear is a process that takes place in the brain and is completely unconscious. Learn about the process of creating fear and the paths of fear.

The process of creating fear takes place in the brain and is entirely unconscious. There are two paths involved in the fear response: The **low road** is quick and messy, while the **high road** takes more time and delivers a more precise interpretation of events. Both processes are happening simultaneously.

The idea behind the low road is "take no chances." If the front door to your home is suddenly knocking against the frame, it could be the wind. It could also be a burglar trying to get in. It's far less dangerous to assume it's a burglar and have it turn out to be the wind than to assume it's the wind and have it turn out to be a burglar. The low road acts first and asks questions later. The process looks like this:

The door knocking against the door frame is the stimulus. As soon as you hear the sound and see the motion, your brain sends this sensory data to the thalamus. At this point, the thalamus doesn't know if the signals it's receiving are signs of danger or not, but since they might be, it forwards the information to the amygdala. The amygdala receives the neural impulses and takes action to protect you: It tells the hypothalamus to initiate the fight-or-flight response that could save your life if what you're seeing and hearing turns out to be an intruder.

The high road is much more thoughtful. While the low road is initiating the fear response just in case, the high road is considering all of the options. Is it a burglar, or is it the wind? The long process looks like this:

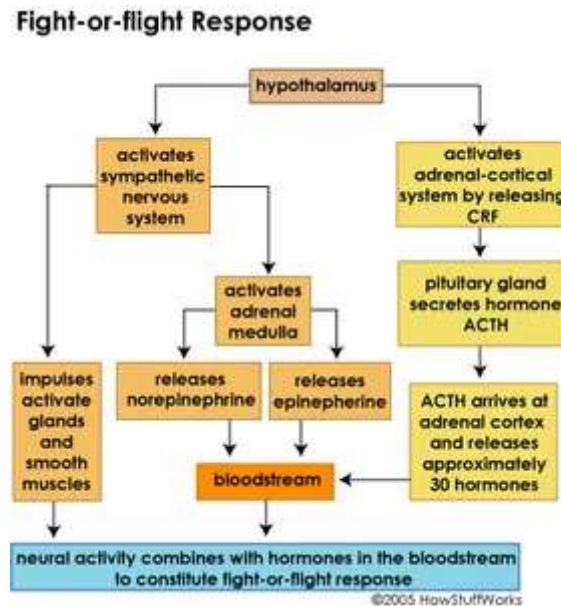
When your eyes and **ears** sense the sound and motion of the door, they relay this information to the thalamus. The thalamus sends this information to the sensory cortex, where it is interpreted for meaning. The sensory cortex determines that there is more than one possible interpretation of the data and passes it along to the hippocampus to establish context. The hippocampus asks questions like, "Have I seen this particular stimulus before? If so, what did it mean that time? What other things are going on that might give me clues as to whether this is a burglar or a wind storm?" The hippocampus might pick up on other data being relayed through the high road, like the tapping of branches against a window, a muffled howling sound outside and the clatter of patio furniture flying about. Taking into account this other information, the hippocampus determines that the door action is most likely the result of wind. It sends a message to the amygdala that there is no danger, and the amygdala in turn tells the hypothalamus to shut off the fight-or-flight response.

The sensory data regarding the door -- the stimulus -- is following both paths at the same time. But the high road takes longer than the low road. That's why you have a moment or two of terror before you calm down.

Regardless of which path we're talking about, all roads lead to the hypothalamus. This portion of the brain controls the ancient survival reaction called the fight-or-flight

response. In the next section, we'll take a closer look at the fight-or-flight response.

Fight or Flight



To produce the fight-or-flight response, the **hypothalamus** activates two systems: the sympathetic nervous system and the adrenal-cortical system. The sympathetic nervous system uses nerve pathways to initiate reactions in the body, and the adrenal-cortical system uses the bloodstream. The combined effects of these two systems are the fight-or-flight response.

When the hypothalamus tells the sympathetic nervous system to kick into gear, the overall effect is that the body speeds up, tenses up and becomes generally very alert. If there's a burglar at the door, you're going to have to take action -- and fast. The sympathetic nervous system sends out impulses to glands and smooth muscles and tells the adrenal medulla to release epinephrine (**adrenaline**) and norepinephrine (noradrenaline) into the bloodstream. These "stress hormones" cause several changes in the body, including an increase in **heart** rate and **blood pressure**.

At the same time, the hypothalamus releases corticotropin-releasing factor (CRF) into the pituitary gland, activating the adrenal-cortical system. The pituitary gland (a major **endocrine gland**) secretes the hormone ACTH (adrenocorticotrophic hormone). ACTH travels through the bloodstream and ultimately arrives at the adrenal cortex, where it

activates the release of approximately 30 different hormones that get the body prepared to deal with a threat.

The sudden flood of epinephrine, norepinephrine and dozens of other hormones causes changes in the body that include:

- heart rate and blood pressure increase
- **pupils** dilate to take in as much light as possible
- veins in skin constrict to send more blood to major muscle groups (responsible for the "chill" sometimes associated with fear -- less blood in the skin to keep it warm)
- blood-glucose level increases
- **muscles** tense up, energized by adrenaline and glucose (responsible for goose bumps -- when tiny muscles attached to each hair on surface of skin tense up, the hairs are forced upright, pulling skin with them)
- smooth muscle relaxes in order to allow more oxygen into the **lungs**
- nonessential systems (like digestion and **immune system**) shut down to allow more energy for emergency functions
- trouble focusing on small tasks (brain is directed to focus only on big picture in order to determine where threat is coming from)

All of these physical responses are intended to help you survive a dangerous situation by preparing you to either run for your life or fight for your life (thus the term "fight or flight"). Fear -- and the fight-or-flight response in particular -- is an instinct that every animal possesses.

Why Do We Fear?

If we couldn't be afraid, we wouldn't **survive** for long. We'd be walking into oncoming traffic, stepping off of rooftops and carelessly handling poisonous **snakes**. We'd be hanging out with people who have tuberculosis. In humans and in all animals, the purpose of fear is to promote survival. In the course of human **evolution**, the people who

feared the right things survived to pass on their genes. In passing on their genes, the trait of fear and the response to it were selected as beneficial to the race.

During the 19th-century debate surrounding evolution, the "face of fear" -- that wide-eyed, gaping grimace that often accompanies sheer terror -- became a talking point. Why do people make that face when they're terrified? Some said God had given people a way to let others know they were afraid even if they didn't speak the same language. Charles Darwin said it was a result of the instinctive tightening of muscles triggered by an evolved response to fear. To prove his point, he went to the reptile house at the London Zoological Gardens. Trying to remain perfectly calm, he stood as close to the glass as possible while a puff adder lunged toward him on the other side. Every time it happened, he grimaced and jumped back. In his diary, he writes, "My will and reason were powerless against the imagination of a danger which had never been experienced." He concluded that the entire fear response is an ancient instinct that has been untouched by the nuances of modern civilization [\[ref\]](#).

Most of us are no longer fighting (or running) for our lives in the wild, but fear is far from an outdated instinct. It serves the same purpose today as it did when we might run into a lion while carrying water back from the river. Only now, we're carrying a wallet and walking down city streets. The decision not to take that shortcut through the deserted alley at midnight is based on a rational fear that promotes survival. Only the stimuli have changed -- we're in as much danger today as we were hundreds of years ago, and our fear serves to protect us now as it did then.

Darwin had never experienced the bite of a poisonous snake, and yet he reacted to it as if his life were in danger. Most of us have never been anywhere near The Plague, but our heart will skip a beat at the sight of a rat. For humans, there are other factors involved in fear beyond instinct. Human beings have the sometimes unfortunate gift of **anticipation**, and we anticipate terrible things that *might* happen -- things we have heard about, read about or seen on [TV](#). Most of us have never experienced a [plane](#) crash, but that doesn't us from sitting on a plane with white-knuckle grips on the armrests. Anticipating a

fearful stimulus can provoke the same response as actually experiencing it. This also is an evolutionary benefit: Those humans who felt rain, anticipated **lightning** and remained in the cave until the storm passed had a better chance of not getting struck with thousands of volts of **electricity**. We'll look at ways in which we are conditioned to fear in the next section.

Fear and Excitement

If you enjoy horror movies, you know that fear can be exciting. Many people enjoy being afraid -- the arousal that comes with the fight-or-flight response can be pleasurable and can even mimic sexual arousal. It's no wonder so many people go to see scary movies and ride **roller coasters** on dates.

There is actual scientific evidence that supports the fear-attraction connection. Psychologist Arthur Aron conducted a study using the very common fear of heights. Aron had one group of men walk across a 450-foot-long, unstable-feeling bridge suspended over a 230-foot drop; he had another group of men walk across a perfectly stable-feeling bridge over the same height. At the end of each bridge, the men met Aron's very beautiful female assistant. She asked each subject a set of questions related to an imaginary study and then gave him her phone number in case he wanted more information. Of the 33 men who'd walked across the stable bridge, two called the assistant. Of the 33 who'd walked across the swaying bridge, nine called. Aron concluded that the state of fear encourages sexual attraction.



Classical Conditioning



Fear conditioning is why some people are afraid of rats and dogs.

CHINA PHOTOS/GETTY IMAGES

The circuitry of the fear response may have been honed by evolution, but there is also another side to fear: **conditioning**. Conditioning is why some people fear **dogs** as if they were fire-breathing monsters, while others consider them part of the family.

In the 1920s, in what is probably not one of psychology's finest moments, American psychologist John Watson taught an infant to fear white rats. "Little Albert" had no fear of the laboratory's test animals. He showed joy at the sight of the white rats especially and always reached out for them. Watson and his assistant taught Albert to be terrified of white rats. They used Pavlovian (classical) conditioning, pairing a neutral stimulus (the rat) with a negative effect. Whenever Albert reached for one of the rats, they created a terrifyingly loud noise right behind the 11-month-old child. Not only did Albert very quickly learn to fear the white rats, crying and moving away whenever he saw one, but he also started to cry in the presence of other furry animals and a **Santa Claus** mask with a white beard.

Like Little Albert's fear of white rats, a person's fear of dogs is most likely a conditioned response. Perhaps he was bitten by a dog when he was three years old. Twenty years later, the person's brain (the amygdala in particular) still associates the sight of a dog with the pain of a bite. We'll take a closer look at some common fears in the next section.

Common Fears

A Gallup Poll conducted in 2005 reveals the most common fears of teenagers in the United States. The top 10 list goes like this:

1. Terrorist attacks
2. Spiders
3. Death
4. Failure
5. War
6. Heights
7. Crime/Violence
8. Being alone
9. The future
10. Nuclear war

Most of these basic fears are carried into adulthood. Other common fears include public speaking, going to the dentist, pain, [cancer](#) and [snakes](#). Many of us fear the same things -- so are there such things as universal fears?

Some studies show that humans might be genetically predisposed to fear certain harmful things like spiders, snakes and rats -- animals that once posed a real danger to human beings because they were poisonous or carried disease. Fear of snakes, for example, has been found in people who have never even been in the presence of a snake. This makes sense if you think about fear as an evolutionary instinct embedded in the human consciousness. This idea of the universal fear is supported by such reputable sources as popular television: NBC's "Fear Factor" offers a weekly \$50,000 prize to the contestant who can perform tasks like sticking his head into a box filled with hundreds of spiders and eating a blended rat smoothie.

The idea is also supported by scientific research. Psychologist Martin Seligman

performed a classical conditioning experiment in which he showed subjects pictures of

certain objects and then administered an electric shock. The idea was to create a phobia (an intense, irrational fear) of the object in the picture. When the picture was of something like a spider or a snake, it took only two to four shocks to establish a phobia. When the picture was of something like a flower or a tree, it took a lot more shocks to get a real fear going.

But while there may be "universal fears," there are also fears that are particular to individuals, communities, regions or even cultures. Someone who grew up in the city probably has a more intense fear of being mugged than someone who has spent most of his life on a farm. People living in South Florida may have a stronger fear of [hurricanes](#) than people living in Kansas, and people in Kansas probably have a deeper fear of [tornadoes](#) than do people in Vermont. What we fear says a lot about our life experience. There is a phobia called *taijin kyofusho* that is considered in the psychiatric community (according to the [DSM IV](#)) to be a "culturally distinctive phobia in Japan." *Taijin kyofusho* is "the fear of offending other persons by an excess of modesty or showing respect." The intricate social rituals that are part of life in Japan have led to a Japanese-specific fear.

Experiencing fear every now and then is a normal part of life. But living with chronic fear can be both physically and emotionally debilitating. Living with an impaired immune response and high blood pressure causes illness, and refusing to participate in daily activities because you might be confronted with heights or social interaction doesn't make for a very fulfilling life. So what can we do about our fears?

Phobias

A phobia is an intense and persistent fear that is not based on any rational sense of imminent danger and prevents participation in activities that might arouse it. There are three main types of phobia:



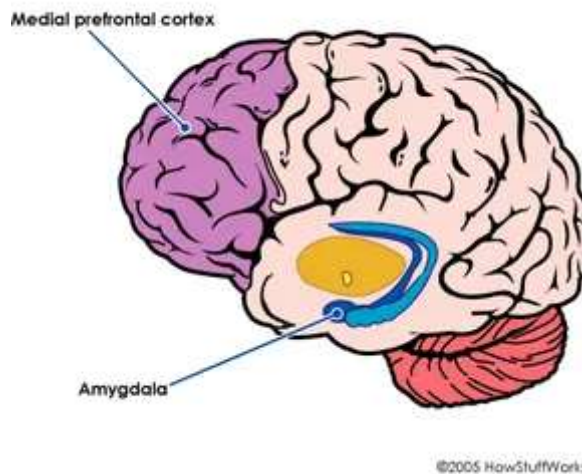
Agoraphobia: fear of places where escape might not be easy or where help might not be readily available if something bad happens

Social phobia: fear of encounters with other people

Specific phobias: fear of a particular thing or situation, such as snakes, public speaking, heights or the sight of blood

Overcoming Fear

Fear Extinction and the Brain



Studies have shown that rats with damaged amygdalas will walk right up to cats [\[ref\]](#). Most of us aren't too keen on the prospect of going at our amygdala with an ice pick, though. So scientists are exploring other ways to overcome fear.

Fear extinction

Whereas Little Albert learned to fear white rats in the 1920s, rats learned to fear a simple noise more than 80 years later. Scientist Mark Barad of UCLA performed an experiment in which he and his team combined a noise with an electric shock. They would play the tone and then immediately apply a shock to the metal floor of the rats' cage. It was classical conditioning, and it didn't take long for the rats to brace themselves for the shock as soon as they heard the sound. At that point, their amygdalas paired the sound

with the shock, and the sound created a fear response. The researchers then began the process of fear-extinction training, in which they made the sound but did not apply the shock. After hearing the sound very often without the shock, the rats stopped fearing the noise.

Fear extinction involves creating a conditioned response that counters the conditioned fear response. While studies situate the amygdala as the location of fear memories formed by conditioning, scientists theorize that fear-extinction memories form in the amygdala but then are transferred to the **medial prefrontal cortex** (mPFC) for storage. The new memory created by fear extinction resides in the mPFC and attempts to override the fear memory triggered in the amygdala.

Most behavioral therapies for fear extinction focus on **exposure**. For instance, therapy for a person with a fear of snakes might involve visiting a snake farm repeatedly and taking small steps toward touching one. First, the person might get within 10 feet of the snake and see that nothing terrible happens. Then he might get within 5 feet of the snake. When nothing terrible happens within 5 feet of the snake, he might get close enough to touch it. This process continues until new, fear-extinction memories are formed -- memories that say "snakes are not going to harm you" and serve to contradict the fear of snakes that lives in the amygdala. The fear still exists, but the idea is to override it with the new memory.

Fear Disorders

According to the [National Institute of Mental Health](#), 19 million people in the United States alone suffer from mental illnesses that involve irrational fear responses. These disorders include generalized anxiety disorder, panic disorder and post-traumatic stress disorder.



r-extinction Medication

Scientists have learned that inhibiting a protein called **NMDA** (N-methyl D-asparate) in the amygdala inhibits fear extinction. They reasoned, then, that stimulating that protein might stimulate fear extinction. Studies show that the **antibiotic** D-cycloserine (well-known for treating tuberculosis) might be helpful in fear extinction by assisting the action of NMDA [ref]. This type of approach would be beneficial when paired with behavioral therapies that attempt to create fear-extinction memories.

The idea is not to replace exposure therapy, but to speed it up. This hypothesis was played out in a study on rats who'd been conditioned to associate a bright light with a foot shock. When the light was presented repeatedly without the shock, the rats who'd been injected with D-cycloserine unlearned their fear much faster than those who were going the natural route. The antibiotic also achieved results in a study of people with a fear of heights. Following virtual-reality sessions designed to expose individuals to heights in a safe environment, the people who'd been given the antibiotic exposed themselves to heights in the real world twice as often as the subjects who did not receive the drug.

This type of research is very promising for people who are under the control of debilitating **phobias** and anxiety disorders. But what about those of us who just get butterflies before delivering a presentation or have trouble getting close enough to the thirtieth-floor balcony to check out the view?

Eight Practical Tips

The Prevention magazine article "What are you afraid of?: 8 secrets that make fear disappear" offers these tips for dealing with everyday fears:

1. **It doesn't matter why you're scared.** Knowing why you've developed a particular fear doesn't do much to help you overcome it, and it delays your progress in areas that will actually help you become less afraid. Stop trying to figure it out.

2. **Learn about the thing you fear.** Uncertainty is a huge component of fear:

Developing an understanding of what you're afraid of goes a long way toward erasing that fear.

3. **Train.** If there's something you're afraid to try because it seems scary or difficult, start small and work in steps. Slowly building familiarity with a scary subject makes it more manageable.
4. **Find someone who is not afraid.** If there's something you're afraid of, find someone who is not afraid of that thing and spend time with that person. Take her along when you try to conquer your fear -- it'll be much easier.
5. **Talk about it.** Sharing your fear out loud can make it seem much less daunting.
6. **Play mind games with yourself.** If you're afraid of speaking in front of groups, it's probably because you think the audience is going to judge you. Try imagining the audience members naked -- being the only clothed person in the room puts *you* in the position of judgment.
7. **Stop looking at the grand scheme.** Think only about each successive step. If you're afraid of heights, don't think about being on the fortieth floor of a building. Just think about getting your foot in the lobby.
8. **Seek help.** Fear is not a simple emotion. If you're having trouble overcoming your fear on your own, find a professional to help you. There are lots of treatments for fear out there, and no good reason not to try them under the guidance of someone with training and experience.

For more information on fear and related topics, check out the links on the next page.

Lots More Information

Related HowStuffWorks Articles

- [How the Brain Works](#)
- [Emotions Quiz](#)
- [Human Senses Pictures](#)
- [How Panic Attacks Work](#)
- [How Hypnosis Works](#)
- [28 Phobias and Their Definitions](#)
- [Can you really scare someone to death?](#)



Great Links

- [AllPsych Online - Phobias: Causes and Treatments](#)
- [Psychology Today: Anxiety After 9/11](#)
- [The Phobia List](#)
- [Science News Online - Fear Not: Scientists are learning how people can unlearn fear](#)
- [Stresscure: How To Conquer Public Speaking Fear](#)

Sources

- "Anxiety After 9/11." Psychology Today.<http://health.yahoo.com/centers/anxiety/2031>
- The Brain From Top to Bottom.http://www.thebrain.mcgill.ca/flash/i/i_04/i_04_cr/i_04_cr_peu/i_04_cr_peu.htm
- Chillot, Rick. "What are you afraid of?: 8 secrets that make fear disappear." Prevention, May 1998 v50 n5 p98(7).
- Cowley, Geoffrey, et. al. "Our Bodies, Our Fears." Newsweek International, March 3, 2003 p40.
- Dadis, Glyn. Review of "Fear: A Cultural History." TheAge.com.<http://www.theage.com.au/news/Reviews/Fear-a-cultural-history/2005/05/06/1115092634475.html?oneclick=true>
- DuPont, Caroline M., Dupont, Robert L., DuPont Spencer, Elizabeth. "The Anxious Brain." The Anxiety Cure: An Eight-Step Program for Getting Well. Wiley, 1998. ISBN 0471247014.
- "Fear and the Amygdala." Society for Neuroscience: Brain Briefings.<http://www.sfn.org/content/Publications/Brainbriefings/fear.html>
- "Fear Factor." NBC.com.http://www.nbc.com/Fear_Factor/index.shtml
- "Fight-or-Flight Response." McGraw-Hill Higher Education.http://highered.mcgraw-hill.com/sites/0072562463/student_view0/abnormal_psychology_image_gallery.html

Gersley, Erin. "Phobias: Causes and Treatments." AllPsych

Online.<http://allpsych.com/journal/phobias.html>

- Livermore, Beth. "The lessons of love." Psychology

Today.<http://cms.psychologytoday.com/articles/pto-19930301-000028.html>

- "The Nervous System: Organization." The Biology

Web.20102/Bio%20102%20lectures/Nervous%20System/nervous1.htm

- Robinson, Victoria. "What gives you goosebumps?" Science World, October 18, 1996 v53 n4 p18(2)

- Travis, John. "Fear Not: Scientists are learning how people can unlearn fear."

Science News Online.<http://www.sciencenews.org/articles/20040117/bob9.asp>

- "What Frightens America's Youth?" The Gallup Organization. March 29, 2005.<http://www.gallup.com/poll/content/default.aspx?ci=15439>

