The following is a contribution to the JREF's ongoing blog series on skepticism and education. If you are an educator and would like to contribute to this series, please contact Bob Blaskiewicz .

One of the most entertaining and impressive critical thinking lessons we can teach our students involves convincing them that their nervous systems can fool them. We often hear believers in the paranormal exclaim in their defense, "I saw it with my own two eyes!" or, "I know what I heard!" Anyone who understands the fallibility of the human nervous system knows that such statements are hardly convincing evidence. Luckily, there are some fun and interesting ways to teach people about why this is the case.

Although our brains and their adjoining nerves do their best to provide us with a clear and accurate depiction of the world, the human perceptual system is far from perfect. Not only is it limited in what information it can gather (e.g., most types of electromagnetic energy are beyond our perceptual range), but it also sometimes makes mistakes with the data it can collect. A good example of this is a phenomenon known as pareidolia, a perceptual error in which random, meaningless images or sounds are given apparent significance.

Your nervous system is bombarded with information from the environment every moment of every day. As this happens, sensory nerves dutifully collect information about your surroundings and send signals to your central nervous system (the brain) where those data are organized and given meaning. Most of the time the brain gets it right, and provides you with a relatively accurate depiction of what is going on around you. At other times, however, the data are incomplete, or the brain struggles to decide upon two competing answers as to what is being detected. Worse, certain evolutionary tendencies can cause your brain to favor some types of answers over others, and get in the way of the truth. It is at these times that we are most likely to experience pareidolia.

Examples of pareidolia from everyday life abound. Although a good number of visual cases have made headlines (e.g., sightings of the Virgin Mary in a bathtub stain, or images of Jesus on a piece of burnt toast), I have found that some of the most entertaining are the auditory pareidolic effects created by listening to song lyrics backward. Often referred to as "backmasking," the practice has a long history but gained its greatest popularity in the mid-1960s, when a rumor began circulating that musician Paul McCartney had died and that a message about his death could be found by playing the Beatles song "Revolution 9" (among others) backward. This report spread like wildfire and had young people all over the world

pushing their record albums backward on their turntables, trying to hear the messages. The rumor claimed that, at a certain point in the song, one could clearly hear a voice saying, “Turn me on, dead man” and “Paul is a dead man, miss him, miss him, miss him.” An even more widely recognizable example is found in the Led Zeppelin song “Stairway to Heaven,” in which a series of oddly worded messages is claimed to manifest during a backward playing of the chorus, most of which are said to be satanic in nature, confirming many parents’ suspicion that the music their children were listening to, and toward which they felt no particular affection, was evil. Since then, many other bands and their songs have been targeted, some of which have been spotlighted in bills proposed by several states to ban albums and/or to require warning labels on albums about the messages they might contain.

The most interesting aspect of this phenomenon is that most of these auditory illusions need a significant amount of assistance before they are grasped by the listener. Jeff Milner’s Backmasking Collection houses some excellent examples and allows the user to not only listen to song clips forward or backward, but also to read both forward and “backward” lyrics which can be separately displayed to test the listener’s ability to guess the messages supposedly contained in each. In my experience with students, hearing the lyrics correctly when the clips are played forward yields a success rate of about 85% (even at a college with a significant percentage of non-native English speakers). Hearing the “backward” message correctly, however, is a feat no one has successfully demonstrated in my tests; only a few of the more prominent “words” could be guessed correctly with any degree of reliability.

Another wonderful example of our brains’ ability to favor linguistic order out of disorder can be found on a web page created by Matt Davis at the Medical Research Council Cognition and Brain Sciences Unit. Dr. Davis uses a form of artificially degraded speech called “sine-wave speech” to determine what features must be present in order for auditory speech to be recognized and understood.

After playing a few of these examples to students, I often ask them if they can think of any sensory misperceptions they have ever made. This is important to me because I know that most of my students cannot imagine themselves actually believing that messages are hidden in popular music, and I want them to relate personally to the phenomenon of pareidolia so that they will be motivated to understand it and have a more reasoned (i.e., compassionate) understanding of how others might be fooled by it. One commonly experienced example is hearing the phone ring while taking a shower or listening to loud music. In this case, your brain erroneously interprets similarities in tones created by the background noise to those created when phones ring. (With the introduction of cell phones and their endless ring tones options, this example may lose its relatablity.)

Providing examples of a phenomenon is a good conversation starter, but a higher scientific goal is to explain why things happen. Challenging students to develop their own theories to explain pareidolia can yield interesting results, but much depends upon their knowledge in areas such as neuroscience, sensation and perception, evolution, and related fields. If time does not permit a lecture on these subjects, asking students to concentrate on two key points can assist them:

1.

Neuroscience and Psychology: Apophenia, the experience of seeing meaningful patterns or connections in random or meaningless data (Brugger, 2001) can explain pareidolia as part of an overarching human tendency. It can be found to decrease, such as in cases of *receptive aphasia*, a neurological condition in which someone loses the ability to understand language in its written or spoken form, showing that our ability to understand language has a neurological basis. Research on language acquisition can be discussed with students to begin understanding how the brain makes linguistic meaning out of specific noises that we call language (see the work of Paul Broca, Karl Wernicke, Noam Chomsky, Erick Lenneberg, and Laura Ann Petitto).

2.

Evolution: What evolutionary advantages might these errors represent? Type I errors (the identification of false data as significant) are preferable to Type II errors (the identification of significant data as meaningless) (Shermer, 2000). Would you prefer a nervous system that is tuned to make errors of a Type I nature, or of a Type II nature? I ask students to consider the advantages and disadvantages of each, and to apply their conclusions to how early humans (and their predecessors) may have evolved pareidolia as a side effect of a survival strategy that might create some annoying mistakes, but has served us well over the years.

Although these activities concentrate on auditory perception and pareidolia, they can easily be modified to address visual perception and pareidolia. Whichever you choose, these can serve as portals into discussion about a wider range of mistakes of perception such as:

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Japanese researcher Chonosuke Okamura's report, "Original Report of the Okamura Fossil Laboratory," in which he described his interpretation of tiny inclusions in polished limestone

from millions of years ago as the preserved fossil remains of tiny humans and other animals, as proof that life on our planet has only changed in size, and not in morphology, over the millennia.

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Images of religious figures and artifacts (the Nun Bun, the Virgin Mary Grilled Cheese Sandwich, etc.), and how people's preconceptions about religion correlate with their ability to find and to believe in the significance of these images.

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Psychologist Konstantīns Raudive's "discovery" of the electronic voice phenomenon (EVP) in the early 1970s, and his belief that these were the voices of disembodied spirits.

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The mental status test known as the The Rorschach Inkblot Test, and other such "projective tests" rely upon patients' reports of pareidolic phenomena to evaluate their thoughts and feelings.

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