Thinking Scientifically About Pseudoscientific Medicine: The Dangers of Untested Treatments and How to Avoid Them

By Oliver Flynn

Adviser: Dr. Bryan Fantie, Psychology

Spring 2011

General University Honors

SPA Political Science and CAS Psychology

Abstract

The paper explores the importance of scientific thinking when evaluating claims, especially those of so-called "alternative" medicines. It argues that when armed with the right questions, anyone can see through the false promises offered by these pseudoscientific, untested, and often unsafe treatments. After establishing a set of science-based strategies for examining alternative medicine claims, it tests these strategies against a number of today's most popular alternative treatments including homeopathy and chiropractic. Lastly it offers basic solutions to the perceived lack of critical thinking among the general population.

Introduction

In 2009, 53-year-old Floridian Leslee Flasch passed away from rectal cancer. Treatments had failed, and the disease had gradually spread throughout her bones, tissue, muscles, and skin. Leslee died in agony and could barely sit ("Cancer," 2009).

On its face, Leslee Flasch's story sounds like many other tragic tales of people who battle cancer every year. Many people die of cancer annually, but an increasing number are receiving life-saving and time-sensitive treatments that catch the cancer early, stop its spread, and remove it from the body. The saddest part of Leslee's story is that she too could have been one of those survivors. Instead, however, Leslee chose to forgo modern and advanced cancer treatment in favor of an alternative approach: She turned to a special regimen of diet and supplements that promised to be a more "natural" cure to her horrible affliction ("Cancer," 2009).

Leslee's heart-breaking story is one of a woman who would do anything to get rid of her cancer. However, like an increasing number of Americans ("More seek," 2011), Leslee fell prey to a harmless-sounding but ultimately fatal "alternative" treatment. The treatment made empty promises. It touted itself as "natural" and as a viable alternative to modern Western medicine. However, the treatment had never been tested for its effectiveness. No doctor had recommended the treatment or prescribed it to Leslee, but she had found it on her own and chosen it over surgery and chemotherapy.

How did Leslee fall for what seems to many people such an obvious scam? How many others like Leslee are there? What are some of these treatments that prey on the ill and the desperate? Is there some way of thinking or some set of questions that people can learn to ask in order to protect themselves from the hollow promises of alternative medicine treatments?

This paper seeks to answer the above questions and more. After dismantling a few of the erroneous arguments pseudoscientists use to promote their products, it aims to construct a simple set of rules, based in science, for use when evaluating what are, at their roots, scientific claims (this medicine or treatment will heal a patient). It will also explore a number of alternative treatments that are popular today and will test the set of scientific rules against them. Lastly it will offer some policy changes that should be implemented in order to help people learn to protect themselves from schemes that can cost them both their wealth and their health.

Seeing Through the Ruse

Choosing which claims to trust and which to dismiss is a critical part of our lives, particularly when it comes to making important decisions regarding our health and well-being. When assessing a claim, before one even begins to attempt to verify the facts, one can check for the presence of some of the more obvious logical fallacies commonly used. These fallacies share similar aims of appealing to emotion rather than intellect, distracting from the facts of the claim, and holding no scientific weight. The following is just a sampling of the myriad logical fallacies used in formal debate, but they are the most applicable to alternative medicine claims.

1. Argument from Authority

Watch any late-night paid programming and one will see offers for a number of products ranging from cleaning supplies and grills to diet pills and workout videos. What almost all of these commercials have in common is that the product is being pitched to the consumer by a well-recognized personality or an "expert" who viewers are likely to trust. With a workout video, the endorser or salesperson may be a former athlete or model. With cleaning supplies, perhaps a star of a home improvement television show. In the case of diet pills, supplements, and other alternative medicines, the product is often endorsed by someone with a medical degree. All of these infomercials, including those containing real medical doctors, are relying on the logical fallacy known as the argument from authority.

The argument from authority is defined by the testimony of an "expert" in a field that is either only tangentially related to the topic at hand or is unrelated. This testimony is supposed to convince the audience of a position without the arguer needing to cite any relevant facts or evidence ("Argument," 2011). Dietary supplements, therapeutic treatments, and other alternative medicines are often endorsed by people with an MD degree. However, this degree does not imply a relevant level of expertise on topics such as the effectiveness of treatments. These experts attempt to conflate medical doctor (which is a professional degree required to be a physician) and PhD "doctor," which implies a high level of scholarship and research into a particular topic. The simple fact of someone having an MD does not qualify them to judge whether or not a treatment has been scientifically shown to be effective. The science speaks for itself on such matters. The argument from authority in this context is "just trust me, I'm a doctor."

2. Personal Anecdote

A second logical fallacy that relates to many claims we see on a daily basis, including in marketing for products such as alternative medicines, is the use of personal anecdotes or "testimonials." Personal anecdotes are powerful because people hear first-hand the experiences of another person who they can (ideally) relate to. These stories are often emotional and credit the product being endorsed with saving people from bad situations or otherwise changing their lives. It is this emotional appeal, coupled with the salience of hearing a first-hand account, that is the strength of the personal anecdote. This emotion alone can convince people of a position not only when there is no evidence but even when there is evidence to the contrary.

Carl Sagan, in his book, *The Demon-Haunted World: Science as A Candle in the Dark*, tells a story of his friend, a psychiatrist, who came to believe that the alien abduction stories told by his patients were true (Sagan, 1997). The powerful and emotional personal anecdotes convinced the psychiatrist, who originally did not believe that alien abductions were possible, that the patients could not have made their stories up. Sagan's tale is one of a generally rational man who nevertheless comes to believe something extraordinary without consulting sources of scientific value.

An example of an alternative pseudoscientific treatment product which relies on personal anecdotes is the Body Pure detoxifying foot pads ("Body Pure," 2011). This product, according to its web site, claims to help the body unleash its own abilities to improve blood circulation, repair the immune system, and prevent premature aging. It does this through the use of adhesive pads which are stuck on the soles of the feet to supposedly draw toxins out of the body through the skin. The product is endorsed by a “doctor” whose degree is in dentistry (see the argument from authority). At the very top of the main page is a link to a page of user testimonials. The claims made in these anecdotes include feeling happier, free of fatigue, being newly clear of toxins from plastic, and being cured of foot calcifications. Each testimonial came from an individual “average Joe” with no listed expertise or qualifications. These testimonials are not scientifically valuable.

3. Appeal to Tradition

The appeal to tradition is another favorite logical fallacy of those who seek to market alternative treatments and remedies. It is most often used with products that claim to have ancient origins, especially China and Japan. The fallacious argument made is that because a product or practice is inspired by or traces its origins back to ancient East or Southeast Asia, it therefore holds intrinsic value as a product of that region's traditions. Acupuncture is a prime example of a traditional Chinese treatment which is given value simply because of how old it is and the area from which it originated. Chinese medicines center around the idea of the cosmic law, or “Tao,” the positive force of “Yin,” the negative force of “Yang,” and the flow of energy between the two called “Qi.” (“Traditional,” 2011). This philosophy is over 2,000 years old, which is older than modern science itself. Though these forces of Tao, Yin, and Yang have not been operationally defined (defined in a way that makes them measurable and useful to science), and even though Qi has neither been observed nor measured, never mind manipulated in an experiment, acupuncture is incredibly popular today around the world. Part of this is because acupuncture is trusted because it is so old. Its popularity may also be due to personal anecdotes, arguments from authority, and other logical fallacies.

Part of the appeal to tradition is the idea that “if it worked for them, it will work for us.” However, it is a mistake to assume that just because the ancient Chinese practiced acupuncture, for example, it actually worked. Other ancient practices such as blood-letting fell out of fashion because they not only did not work but they were also dangerous to the patients. However they were popular for many years and were used on people for all kinds of illnesses. Acupuncturists today promote the practice for the treatment of a range of conditions, including acne, asthma, carpal tunnel, depression, smoking cessation, fatigue, infertility, and tinnitus (“Medical,” 2011). The few claims that have been tested, however, lack scientific support (Riet, 1990; White, 2000).

Derksen's Sins of Pseudoscience

Before one can define scientific thinking, one must learn a little about what scientific thinking is not. Investigations that attempt unsuccessfully to be or pretend to be scientific are classified as pseudoscience. Sometimes an individual honestly endeavors to do scientific research and reach factual conclusions based in sound science. However, they may fall for any of a number of traps that undermine the integrity of an otherwise scientific investigation. Other times, a person has an agenda or a goal, and they see science as a powerful way to swing opinions (or profits) in their direction. These people may pretend to use science, but their claims can be exposed as falling into many of the same traps as the failed scientist. Both of these examples demonstrate pseudoscience.

In his 1993 paper, A. A. Derksen outlined what he called the seven sins of the pseudoscientist. These “sins” are some of the major traps that aspiring scientists or impostors often fall into.

1. Lack of Decent Evidence

The first sin of pseudoscience is a plain lack of evidence to support the claim. True scientific claims stand or fall based on their supporting evidence. It does not matter who created the claim or how popular it is for it to be scientifically valid and supported. A pseudoscientific claim by definition fails to stand on the evidence available for it either because the evidence is flawed or because it is simply not there. Because good evidence is missing, pseudoscientists rely on any number of the above discussed logical fallacies to win supporters for their claim. Again, a scientific claim stands or falls based on its own evidence, regardless of who or how many people believe it. However, not everyone is well-versed in a topic enough to be able to critically evaluate the evidence for a claim. Luckily there are six more sins that anyone who is a careful enough investigator will be able to spot.

2. Unfounded Immunizations

An unfounded immunization, according to Derksen (1993), is when a researcher “immunizes” their claim for certain dissenting evidence by declaring the evidence irrelevant or invalid. Another term for this is the confirmation bias. The confirmation bias is when someone tends to remember or use evidence that supports their claim but forgets about or ignores evidence to the contrary. People fall for this bias on a daily basis, and it is one of the ways that prejudices against others are maintained. For example, if I believe that Sue is a lazy individual, I am likely to remember all the times where Sue acts in a lazy manner. I might notice every time she forgets an assignment or comes to class late. However, if I then hear that Sue wakes up at six o'clock in the morning, runs three miles to the local homeless shelter, and volunteers for two hours before school each day (all of which is evidence against the claim that Sue is lazy), I am likely to forget about this evidence or dismiss it as uncharacteristic of who I "know" Sue to be. Confirmation bias can and does affect our every-day lives, so not only is it important to be aware of it but it is crucial to watch out for it when conducting scientific research or experiments.

3. Assigning Significance to Coincidences

Another natural human tendency is to assign significance to coincidences. This is another sin of pseudoscience which is especially relevant to our daily lives, not just to faulty science. Humans have a natural desire to find causal relationships between events that happen close together in time or within a similar context. This can be evolutionarily beneficial, for example if a person eats a new kind of food for lunch and then has stomach pain all night, they are likely to avoid that food in the future. Though they do not have a substantial body of evidence to show that it was the specific food that caused the illness, they assign causation to the food and avoid it in the future. What if the food did not cause the illness, however, and the fact that both events happened on the same day was a coincidence? In some situations this could be ultimately detrimental. Let us take the opposite of food poisoning, a home remedy. If someone is severely unwell and decides to create and consume a concoction of ingredients in an attempt to get well again, they may attribute their sudden coincidental recovery to the concoction. Though the potion they created had no impact on their illness, the person might assign a cause-effect relationship to the recovery and the consumption of the home remedy. They may suggest this remedy to their friends who are also afflicted by illness. Though the spread of this home remedy may be ultimately harmless, it is easy to imagine a situation where the remedy in fact contains ingredients that cause their own side effects in high enough doses or exacerbate the symptoms of certain illnesses. Worse, if people choose to take the remedy over seeking medical attention, they could allow their condition to worsen. It is very important that people learn to avoid assigning significance to coincidences. Not only is it unscientific but it can lead to superstitious and even harmful practices.

4. The Magic Method

The magic method refers to a problem with the way a pseudoscientist conducts their research. The example given by Derksen is Freud's method of free association (Derksen, 1993). Freud used free association as his principal tool for research. The practice was not based in scientific theory, so its results were effectively meaningless. However, the method "worked" in so far as it produced the results that Freud wanted. Because Freud knew what he wanted to study and what he wanted to find through his investigations, he used free association because it helped him find what he wanted to find. The flaw with the magic method, then, is that the scientific process is conducted backwards. Instead of constructing a test based in scientific theory and then reporting on the results, whatever they were, and correcting the method and hypothesis if results were inconsistent, Freud started with a method he (mistakenly) assumed was correct and then used it to find the results that he knew he wanted. The magic method works hand-in-hand with the confirmation bias of sin number 2.

There are other examples of the magic method, including phrenology. Phrenology was developed in the 1790s by German physician Franz Joseph Gall ("Phrenology," 2011). By falling for the confirmation bias, Gall found a correlation between his patients' intelligence and the degree to which their eyes bulged from their heads. He theorized that bumps on the skull corresponded to larger brain areas within, and through feeling the scalp thought he could determine someone's personality. Phrenology became so popular that it was used at job interviews to determine if someone was compatible with the position for which they were applying. Phrenology is flawed because, like free association, the theory behind the method is flawed. Skull bumps do not correspond with brain shapes, and brain shapes do not correspond with personality (at least not on the level of the brain's outer texture).

5. The Insight of the Initiate

As one of the most well-known early psychologists and pseudoscientists of all time, Sigmund Freud provides clear examples for a number of Derksen's sins of pseudoscience. The sin of the insight of the initiate is another one of them. This pseudoscience trap is a way of dealing with skeptics who question the validity of the research. The idea is that in order to understand the research process and the significance of the data, one must already believe that the theory is correct. In the context of Freud, he claimed that opponents could not appreciate his theory or his results and could not see the significance of sex in free associations because their own repressed childhood sexuality prevented them from doing so. In this way, he used his theory to discredit those who did not believe his theory.

Similar arguments are used for other pseudoscientific practices such as seeing into the future, communicating with the dead, and dowsing for buried resources. Practitioners argue that believing in the process is part of what makes it work. Skeptics are therefore unable to replicate the results of the pseudoscientists because they have not opened their minds enough to the possibility that the theory is true.

6. The All-Explaining Theory

The sixth sin of pseudoscience, according to Derksen (1993), is the adherence to an all-explaining theory. The concept behind this trap is that when a pseudoscientist develops a theory, they stretch it out and attempt to use it to explain a broad range of diverse phenomena. Freud fell for this trap when he made preoccupation with sex the center of this theory. To Freud, anything a patient said or thought was the product of their insecurities about sex and their struggles with sexuality and sexual attraction. If a patient complained of dreams about being naked, Freud would explain it as the product of insecurities about sex. However, if a patient claimed to not be having any dreams at all, Freud would attribute this to repressed sexuality and sexual insecurities.

Alternative treatments such as chiropractic, acupuncture, and homeopathy also fall for the all-explaining theory. Using one simple technique (though each uses a completely different one), they claim to be able to prevent and cure a wide and diverse array of illnesses and conditions. This is partly because they overgeneralize the cause of illness and disease. To an acupuncturist, illness comes from an energy imbalance which acupuncture can solve. To a chiropractor, illness comes from trapped energies that result from a non-aligned skeleton (“Acupuncture Meridians,” 2011; “Chiropractic,” 2011).

7. Uncritical and Excessive Pretension

The seventh and final sin of pseudoscience may not at first glance appear to be a flawed attempt at scientific reasoning but rather an overabundance of pride on the part of the pseudoscientist. Uncritical and excessive pretension is described as when pseudooscientists assign incredible value to their theory (Derksen, 1993). They place it on a pedestal as a grand and world-changing theory or finding. They claim that it is more reliable than their evidence suggests.

Scientology is an example of a pseudoscience (though it is a recognized religion around the world) that suffers from uncritical and excessive pretension. A central part of Scientology is undergoing “auditing” sessions whereby the member effectively sits through a lie detector test. The mechanics of the test are simple: A device measures skin conductance, which correlates with stressful thoughts, some of which are lies and others of which are secrets. The pseudoscientific aspect of this auditing process is that Scientologists believe that the test actually measures the presence of parasitic alien souls within the person (Ortega, 2008). They suffer uncritical and excessive pretension when they claim (as they do) that Scientology through auditing will change the world and make it a place without crime or mental illness. They claim more specifically that auditing improves IQ, communication abilities, memory, and attention (“Auditing,” 2010). Though this excessive pretension is certainly bad practice, is it significant enough to be considered a quality of pseudoscience? Yes, and here's why: An important part of science is understanding the limitations of a theory, finding, or experiment. At the end of many research papers which contain empirical studies, the authors will include a section specifically to list the limitations of their own study. By pointing out areas where their findings are lacking or may not apply, they are not discrediting their own work. Instead, they are making sure they do not blow their research out of proportion and they are pointing to areas for other researchers to get involved and make the body of science surrounding a topic even stronger. Unlike scientists, pseudocsientists care less about the global body of scientific knowledge and more about their pet theory and the fame and fortune it can bring them.

What is Scientific Thinking?

With a solid understanding of the elements that make certain research, theories, and claims pseudoscientific rather than scientific, one can go about defining what exactly it means to think scientifically. Though not everyone can study for years to become well-versed in scientific topics and able to contribute meaningfully to cutting edge research, everyone can develop the skills necessary to examine a claim and both judge if it appears to be based in science and ask some important questions in order to test the strength of the science behind it.

Scientific thinking relies on two components, one of which is scientific literacy, and the other is critical thinking.

1. Scientific Literacy

Scientific literacy has been defined in a number of different ways. Some definitions focus on actual knowledge of facts and vocabulary related to science and general knowledge about the universe. Others focus on more a conceptual understanding of the scientific process and reasoning skills (Laugksch, 2000; Scearce, 2007). Though knowledge of facts is important for those wishing to specialize in a specific field, the more important definition of scientific literacy for the general public is the conceptual understanding. The general public does not need to do science, just use and understand it. This is more important today than ever because of the highly technological society that exists today (Scearce, 2007). Science has discovered amazing things, from genetic modification and cloning to fire-proof furniture and insulating liquids that don't damage electrical equipment. People must be able to appreciate the science in these things and see through misleading claims behind products such as those which promise to relieve stress and pain through “quantum healing technology” and other such scientific-sounding jargon. This becomes only more important within government, where the creation of responsible policy relies heavily on scientific literacy (Scearce, 2007). Modern issues of climate change, stem cell research, and pandemic diseases can be solved only through science.

When a person is scientifically literate, they have an appreciation for science's aims, its workings, and its limitations, but there is more to it than that (Laugksch, 2000). In 1974, V. M. Showalter integrated 15 years of literature on scientific literacy into a concise definition of the term. The seven dimensions of Showalter's definition listed in his paper are as follows: First, the scientifically literate person understands the nature of scientific knowledge. They understand where it comes from and what makes it valuable. Second, they accurately apply appropriate science concepts, principles, laws, and theories in interacting with the world around them. Third, the scientifically literate person uses the processes of science in solving problems, making decisions, and learning. Fourth, Showalter says, they interact with various aspects of the world around them in a way that is consistent with the values that underlie science, though he does not elaborate on what this means. Fifth, they appreciate the relationship between science and technology and the way they affect other aspects of society. This means they they understand that we use science every day. From putting on eye glasses to watching television, we are constantly interacting with the products of scientific inquiry. Sixth, they develop a richer, more satisfying, more exciting view of the world as a result of science education. Seventh and finally, they develop numerous manipulative skills associated with science and technology (Showalter, 1974).

Of these seven dimensions, the first three are the most important to an average person's scientific literacy. These three dimensions specific address an understanding of the principles of science and the application of those principles when questioning or examining a claim. The others focus more on an appreciation of science on a academic level rather than on a practical one. When it comes to issues of making healthy decisions based in science and avoiding pseudoscientific scams, it is more important to be able to use scientific thinking than to feel positive emotions toward it. As Laugksch notes in the form of a quote from another author, “a few pieces of essential scientific information can mean the difference between health and disease, life and death” (Shen, 1975 quoted in Laugksch, 2000). Appreciating science is a secondary priority.

In conclusion, scientific literacy means understanding what it means to “do science” and appreciating on a practical level the value of research that has been conducted according to the scientific method. It means understanding that scientific endeavors begin with a hypothesis, often grounded in a theory from previous research. It means understanding that scientific experiments are carried out in a rigorous and controlled fashion and that variables are strictly monitored as much as possible. It means that the results of studies stand apart from who conducted them, and they stand along side a wider body of research on the same topic. Scientific research that is carried out correctly can generally be trusted. However, not only should nothing be trusted blindly, but also many pseudoscientists claim to be or have the endorsement of real scientists. Another skill beyond scientific literacy is necessary for thinking scientifically about a claim.

2. Critical Thinking

Critical thinking is a perfect complement to scientific literacy. While scientific literacy involves understanding the process of and the value of science, critical thinking is a disciplined way of examining claims and situations (Paul, 1990). Its goal is to separate out rational and deliberate thoughts from or prejudices, impulses, and customary beliefs. Critical thinkers possess a degree of both skepticism and self-awareness which allows them to step back from a situation, suspend judgment and credulity, and most importantly, *ask the right questions* when faced with a claim. Coupled with scientific literacy, critical thinking allows a person to quickly detect pseudoscientific or otherwise unsubstantiated claims and to avoid scams.

Paul (1990) discusses some hard truths that people must accept in order to successfully engage in critical thinking. These are generally related to debunking the idea of relativism and intellectual equality. Though they may sound elitist, the fact is that some ideas hold up to scrutiny and others do not. The ideas that fail are of lesser value than those which pass through a critical examination. The first flawed idea that people must rid themselves of is that "...Every person's opinion, regardless of how poorly it is supported, deserves equal respect" (Paul, 1990, 13). For example, imagine two competing theories about how the common cold spreads through the population. One claim states that people spread the cold through contact with other people, which allows the transmission of germs from one individual to another. They have examined these germs under a microscope. They have also conducted an experiment where people lived in isolation in a stable environment and did not catch the cold. Another claim states that the cold is spread through angry fairies who infect people who they perceive as deserving of punishment. This is clearly an extreme case, but people still argue that both arguments on their faces are deserving of respect. Though each person may deserve respect (this is a different argument all together), their claims do not, as one is grounded in a scientific theory and the other is not. Paul's second flawed idea is that words mean different things to different people. This cannot be allowed in a situation where people must communicate with each other to scientifically and critically assess a claim. We will return to this idea later when we discuss operational definitions. The third flawed idea is that there can be no intellectual standards because language itself is vague. This relates to the second idea. Again, we must agree on meanings of words in order to communicate effectively. Ambiguity is a problem that can be worked through via mutual agreements. The fourth flawed idea is that intellectual standards are a reflection of gender, race, culture, and historical time period. This means that it is a flawed argument to say that Descartes' claims in the 1600s are just as valuable as ours in the twenty-first century because he lived in a different time. In fact, the opposite is true. Because Descartes lived in a time before established scientific standards, we cannot accept his claims at face value and instead must re-assess his claims and verify them independently. This fourth flawed idea is propped up by the logical fallacies of argument from authority and argument from tradition discussed earlier. There is not "Western science" and "Eastern science" as some alternative medicine practitioners would claim. There is only one scientific method that is universally applicable. Again, this may sound elitist or even ethnocentric, but science is the standard method of inquiry because it works, not because anyone in particular ironed out its principles.

Seven Questions to Ask When Examining A Claim

From a basic understanding of what it means to think scientifically, how scientific thinking is different from pseudoscientific thinking, and how to detect logical fallacies used by pseudoscientists, one can develop seven basic core questions to ask when faced with a claim that purports to be based in science. These seven questions do not require the asker to be an expert in any scientific field, but they allow him or her to assess to some accuracy whether, at first glance, a claim seems plausible or whether it is perhaps a little far-fetched.

1. What are the operational definitions? (What are we measuring and how?)

When faced with a claim that a treatment will "heal" a person or make them "well" again, the first question asked should be, "What are you measuring and how are you measuring it?" Operational definitions are a key part of the scientific method because they allow the researcher and the public to be on the same page regarding what exactly is is that the treatment is doing. The researcher therefore needs to define what the treatment is and what its effects are in such a way that anyone can not only understand the research but can replicate the experiments themselves. Stronger, narrower operational definitions lead to more meaningful conclusions from research (Feigl, 1945). Some operational definitions are easy, such as the definition of the speed of an object being the distance traveled divided by the duration of the travel. But how does one define alertness? If a dietary supplement claims to boost alertness, what do they mean by alertness? Perhaps they mean reaction time on a lexical decision task (press a button if a real word appears on a screen). If the researcher cannot provide strong operational definitions for their claim, there is reason to be skeptical of the integrity of the science behind it.

2. What is the mechanism? (How does this work?)

The second question one must ask to detect a pseudoscientific treatment is, "How does this treatment work?" This is a weaker question, as the mechanisms of science-based treatments such as selective serotonin re-uptake inhibitors (SSRIs) can be very complicated. However, the difference between an SSRI and an "energy medicine" or other alternative treatment is often that the scientist can point to parts of the body where serotonin is found. One cannot consult a book of anatomy and point to the "energy pathways" in the way one can point to veins, arteries, and nerves. If a person promoting a treatment cannot clearly explain how the treatment works, there is reason to be skeptical of it.

3. What findings from previous research support this claim?

No scientific study stands alone. The body of scientific knowledge that exists today is built upon the findings of years of previous research. The supporting research must be relevant to the new research. For example, the research on AIDS medications builds on previous research conducted on how viruses work, how the human immune system works, and how anti-viral medications work. Scientific journal articles often feature a section which explains the scientific background on the topic being discussed. In contrast, there is no scientific background on which to build a theory of healing touch therapies. Human hands have not been shown to expel any special energies, never mind energies that physically change the structure of another human body (unless one counts the kinetic energy transferred through a swift punch!). Often the alternative medicine advocate will attempt to use scientific-sounding jargon such as “quantum mechanics” or “vibrational resonance” as the theoretical backing for a claim. Such a distant connection provides reason to be skeptical of the claim. (For a great example of a healing touch claim that references quantum mechanics, see http://www.quantumtouch.com/).

4. Are there logical fallacies present?

This question is fairly straight-forward. One must be sure to check a claim for arguments from authority, tradition, or personal anecdote which attempt to give undue value to a claim.

5. Are there elements of pseudoscience?

As explained in a previous section, pseudoscience falls for a number of traps which distinguish it from science. These include special treatment and reverence for the theory as well as an over-reaching with regard to the variety of phenomena that the theory can explain. The quantum touch web site referenced above claims that the hands-on healing method can not only cure any human ailment but can also be used on animals and even plants effectively ("About Quantum-Touch," 2011).

6. Does the claim place science as an opponent?

Because unscientific, pseudoscientific, or otherwise unsupported claims are generally dismissed or even ridiculed by scientists, there is a tendency among pseudoscientists to place science as an enemy that is somehow either unable to understand the power of the treatment or is conspiring against it. This strategy often refers to science and science-based medicine with terms such as " traditional western medicine" or "conventional science" or "the scientific establishment" (Neddermeyer, 2006). Placing science as "just another equal tradition" or even as an enemy is an attempt to break its credibility. Science is a method, not a person, group, or other entity with a political agenda. If a claim involves denigrating the scientific method, there is reason to be skeptical of its intellectual honesty.

7. How specific or vague is the claim?

The last question one must ask relates to how detailed and specific the claim is. Similar to operational definitions, a specific claim is easier to understand, work with, and support with well-controlled research experiments. A claim such as, "inhaling helium will raise the pitch of your voice" is sufficiently narrow that we can test it simply be inhaling helium and measuring the pitch of our voices before and after the fact. However, a narrow claim like this is easier to debunk. If the pitch of our voice does not change, it basically destroys the claim. For this reason, pseudoscintific claims are often vague and therefore supposedly harder to disprove. However, a vague claim is also not a powerful one. It is important to be skeptical of a product that makes vague promises.

Some Alternative Treatments Put to the Test: Science or Pseudoscience?

Using the list of seven questions one should ask when faced with a claim, one can put a number of alternative medicines to the test. A few of the more mainstream alternative medicines include chiropractic, acupuncture, and Reiki/bioenergy.

1. Chiropractic

Chiropractors believe that the spine is the most important part of the body both because it is the central column of the skeleton but also because it houses the spinal cord. Since the spinal cord branches out into the nerves of the rest of the body and is the direct path between the brain and the peripheral nervous system, they seek to keep the spinal cord healthy. They believe that a mis-aligned spine can result in the trapping of spinal nerves, which cuts off communication between the brain and the rest of the body ("What is Chiropractic," 2011). This interrupted communication, they believe, is a cause of illness within the body. The job of the chiropractor is to maintain spinal alignment and to help patients deal with stress and other causes of mis-aligned spine (a condition they refer to as "subluxations") ("What is a Subluxation?" 2011). Though chiropractic is largely mainstream at this point, it still counts as an alternative medicine because its claims are not scientifically supported (Jaroff, 2002).

- What are the operational definitions?

The central term in chiropractic treatment is "subluxation," or a mis-alignment of the spine. For this term to have any meaning, however, it needs a strong operational definition. What exactly is a subluxation? How out of alignment must a spine be for it to have subluxations? Are they necessarily all treatable through chiropractic? Does a person with scoliosis, for example, have one subluxation or do they have one for each vertebra within the spine? Currently, no operational definition exists for subluxation (Owens, 2002; Leach, 2003).

⅄ What is the mechanism?

The supposed mechanism of chiropractic is the trapping of nerves within the spine by a mis-aligned spine. However, there's more to it than that. Chiropractors believe that avoiding trapped nerves is important because of what the nerves do. They believe that mis-alignments of the spine stop the body from self-regulating, adapting, and healing ("What is a Subluxation?" 2011). They even go as far as to claim that bad posture can lead to heart damage, though they do not explain how (Gandhi, 2011). A search for scientific journal articles relating bad posture to organ damage or impeded healing mechanisms showed no results.

⅄ What findings from previous research support this claim?

Though chiropractors today are frantically carrying out research in order to find support for their claims, the fact is that the practice of chiropractic was not born from scientific investigation but from pseudoscientific practices. Chiropractic was started in 1895 by a Canadian called D. D. Palmer. Palmer was a "magnet healer" (he literally placed magnets on people's bodies in an attempt to cure their ailments) until one day he met a deaf man with a crooked spine. Palmer reportedly cured the man's deafness by pushing the spine back into alignment ("The History of Chiropractic," 2011). Over the next few years, Palmer single-handedly invented chiropractic.

⅄ Are there logical fallacies present?

The story of the origins of chiropractic clearly display the fallacy of personal anecdote.

Chiropractic did not develop through scientific studies but through people reporting that they felt better after a chiropractic session. In addition, the logic of chiropractic falls for the fallacy of begging the question. Chiropractors claim to promote health by aligning the spine, but it is not scientifically established that a non-aligned spine causes illness.

⅄ Are there elements of pseudoscience?

Chiropractic suffers from the presence of a number of elements of pseudoscience. First, the mis-aligned spine idea is an all-explaining theory. Chiropractors believe that any number of body ailments and diseased are rooted in the mis-alignment of a person's spine. By simply keeping the spine aligned, they believe that they can boost the immune system, lower stress, heal the body's organs, etc (Jaroff, 2002). Another element of pseudoscience is a clear lack of scientific support. Though chiropractors have set up a number of international organizations, rigorous chiropractic schools, and chiropractic journals, the fact remains that there is a lack of scientific support for their specific claims surrounding the nature of the spine and its relationships with the nervous system, immune system, and internal organs.

⅄ Does the claim place science as an opponent?

Not all chiropractors place science or science-based medicine as an opponent. Some describe chiropractic as a strategy for wellness, while other forms of medicine focus on quelling sickness and disease ("What is Subluxation," 2011). However, a large number of chiropractors do urge their patients to avoid scientifically-endorsed practices such as immunization and fluoridation of drinking water because they introduce unnecessary chemicals into the body and are redundant when coupled with chiropractic treatment (Jaroff, 2002).

⅄ How specific or vague is the claim?

The claims of chiropractic are quite specific: A straight spine leads to a healthy body. However, they become more vague when trying to explain the mechanisms involved or define the difference between a straight spine and a mis-aligned spine.

In conclusion, chiropractic treatment does not appear to be based in science. From its sketchy history to its unclear mechanism to its plain lack of scientific support, chiropractic treatment does not appear to be a safe and effective solution to any medical problem and especially does not appear to be an alternative to science-based medicine.

2. Acupuncture

The traditional Chinese practice of acupuncture is reportedly over 2,000 years old (“Acupuncture,” 2011). The practice involves inserting needles a short distance into the body at certain specific points depending on the ailment reported. These needles supposedly stimulate certain energy pathways, freeing up any blockages of energy and helping the body return to a normal functioning state.

⅄ What are the operational definitions?

There are a number of terms within acupuncture. Yin is the good force, Yang is the bad force, Tao is the universal energy, and Qi is the energy that acupuncturists claim flows through all living things (“Traditional,” 2011). Though acupuncturists describe their practice in these terms, these energies have neither been specifically defined nor observed. These energies are not supposed to be taken metaphorically. Indeed, the acupuncture points around the body specifically correspond to different energy pathways and different organs around the body (“Our Interactive,” 2011).

⅄ What is the mechanism?

The mechanism for acupuncture is tiny needles around the body influencing the flow of invisible, undefined, unobserved energies around the body. According to one explanation, Inappropriate emotional responses and environmental factors can block Qi, make it too hot or too cold, too weak or too strong. Acupuncture targets the meridians in the body, or sites where energy gathers and corresponds to specific body organs, and it restores the balance ("Channels," 2007). This mechanism has not been scientifically supported.

⅄ What findings from previous research support this claim?

There is no research that supports claims for the existence of energy pathways or meridians around the body. However, there is research showing that placing needles in the body can have an effect on a patient and make them "feel better." This effect is known as the placebo effect, and it is present in many kinds of both alternative and mainstream treatments. The placebo effect makes people feel better simply by taking a "medicine" regardless of whether the medicine has any active ingredients or not. Placebo pills are used as control in almost all drug trials to separate the placebo effect from the drug's actual effects. A damning finding for acupuncture is that people feel better after acupuncture whether the needles are inserted into "real" acupuncture points or "fake" (non-traditional) points (Moffet, 2009). This calls into question the entire basis for acupuncture and the entire back story surrounding its mechanism.

⅄ Are there logical fallacies present?

The biggest logical fallacy present in acupuncture is the argument from tradition. The fact that acupuncture dates back to China over 2,000 years ago is a major selling point for acupuncture. However, the simple facts of its age or its origin do not indicate that the treatment is necessarily safe and effective. Also, since scientifically-controlled results of acupuncture studies are inconclusive with regard to its effects on patients, acupuncture relies heavily on personal anecdotes in order to spread its customer base.

⅄ Are there elements of pseudoscience?

Not only does acupuncture suffer from a distinct lack of supporting evidence, which is one element of pseudoscience, but it also falls for the all-explaining theory trap as well. No matter what a person's ailment, whether they are physically sick, emotionally depressed, fatigued, or even too sexual (“Channels,” 2007), a session of acupuncture promises to make things right once more.

⅄ Does the claim place science as an opponent?

Acupuncture does not explicitly appear to place itself in opposition to science-based medicine. It does not appear that acupuncturists advise people to stay away from medications or vaccines like some chiropractors do. However, by claiming to treat and cure problems it has not been shown to effect, acupuncture undercuts science-based medicine and makes it appear as an equal alternative to acupuncture. This is quite dangerous for someone with a serious illness who chooses acupuncture over medical treatment.

⅄ How specific or vague is the claim?

Acupuncture claims are quite specific. Acupuncturists make specific claims about where to place needles, what they correspond to in the body, and what ailments they can treat. While this may be more intellectually honest than a vague claim of generally “promoting wellness,” it does make the claims easier to dismiss as more studies come back with inconclusive results.

In conclusion, acupuncture markets itself based on the logical fallacy that because it is old, it necessarily must have some value and its claims must have some validity. Though acupuncture, like chiropractic, is quite mainstream today, it suffers from a distinct lack of solid supporting evidence. Like many treatments, however, the placebo effect from acupuncture is strong enough to keep patients coming back for more and recommending it to their friends.

3. Reiki/bioenergy

Reiki or bioenergy healing is a Japanese practice intended to promote relaxation and stress reduction "What is Reiki?" 2011). Also known as bioenergy healing, Reiki is a hands-on technique where a practitioner lightly touches the patient to help them balance their energies, reduce stress, enhance their immune system, and boost their alertness and concentration ("Services: Reiki," 2011).

⅄ What are the operational definitions?

Reiki literally means "universal energy," and it is this energy which Reiki claims to tap into in order to help the patient. However, nobody has been able to operationally define this universal energy. What is it? Where does it come from? Though Reiki practitioners discuss universal energy and the benefits of connecting with it, they cannot say what exactly it is.

⅄ What is the mechanism?

The mechanism of Reiki is "light touch" on a patient to balance his or her energies ("Services: Reiki," 2011). By having balanced energies, the patient is claimed to have lower stress and a stronger immune system, among other benefits. Reiki practitioners cannot explain fully how their hands have such power over the universal energy, but some claim it is channeled by their intentions ("Reiki Healing," 2011).

⅄ What findings from previous research support this claim?

Reiki does not have any scientific support, as it is based in an ancient Japanese spiritual practice. There is no scientific evidence for a universal energy (whatever that means), not is there evidence that humans have the power to manipulate the energy with their hands or otherwise "boost" a person's immune system by lightly touching them.

- Are there logical fallacies present?

Reiki relies heavily on the logical fallacies of argument from tradition, misuse of personal anecdote, and argument from authority. A number of sources which promote Reiki and bioenergy healing visibly tout the qualifications of their practitioners, which is usually a PhD in a tangentially-related or even unrelated subject ("Services: Bioenergy," 2011; Nudel, 2011).

- Are there elements of pseudoscience?

Reiki suffers from a lack of evidence much like all other pseudoscientific claims. It also suffers from the pseudoscientific trap of the insight of the initiate. A Reiki practitioner claims to be able to feel the energies of themselves, the universe, and the patient and claims the ability to channel these energies to promote well-being. However, in order to feel these energies, one must first believe that they exist. A skeptic cannot be shown the energies. Instead, they must feel them for themselves. This attempts to shift the burden of proof away from the Reiki practitioner and is a clear indicator of a pseudoscientific practice.

- Does the claim place science as an opponent?

Reiki and bioenergy healing do not explicitly place science as an enemy. Instead, it is happy to identify as a complementary treatment that works along-side science-based medicine ("Reiki," 2011).

- How specific or vague is the claim?

The defining characteristic of Reiki, it seems, is how incredibly vague all of its claims and explanations are. The practice is designed to treat the mind, body, and spirit and foster all around healing and well-being by eliminating blockages and restoring balance in a person's energy system (“Services: Reiki,” 2011). But what does any of that mean? Descriptions of the practice are vague, how it is supposed to work is vague, and what it treats is described in very general terms such as “balance” and “well-being.” Scientific claims are specific and direct so that people other than the original researchers can understand the research and replicate the experiments and findings. Pseudosciences thrive on vague general claims because they are so difficult to argue against meaningfully.

In conclusion, Reiki's claims are vague and its supporting evidence is absent. Though Reiki does not appear to really do anything other than provide the patient with time to relax, it is probably not harmful. However, with Reiki sessions costing $85 for an hour (“Services: Reiki,” 2011), the financial cost inflicted on a patient who chooses Reiki could easily lead to problems of their own.

Public Policy Changes for A More Critical, More Scientific Population

Alternative medicines, pseudoscientific remedies, and other untested treatments pose a serious danger to the population not just of the United States but of the world. They purport to be safe, effective solutions to a range of serious ailments and diseases, yet their positive effects are often very little beyond they placebo effect. There are two fronts from which to attack the problem of pseudoscientific medicines and protect the general public. One of these fronts is the federal policy level, and one is at the state level.

The federal regulatory agency that exists to monitor the safety of food and drugs is the

FDA, or Food and Drug Administration. Though the FDA did not get its name until 1930, the agency's functions began back in 1906 with the passage of the Pure Food and Drugs Act, which was introduced to prevent the mis-labeling of food and drug products ("History," 2010). Today the FDA protects public health by scientifically testing and approving drugs, medical devices, food products, cosmetics, and "products that emit radiation" ("What We Do," 2010). They also regulate the marketing of tobacco products. However, the FDA does not regulate products classed as "dietary supplements." These products count as neither food nor drug and are therefore marketed freely and without any regulatory scrutiny. This massive loophole in the FDA's jurisdiction is how alternative medicines find their way onto the market. From diet pills to herbal remedies, alternative medicine products apply to be counted as dietary supplements and then go on sale without any scientific testing to make sure that they are even safe, never mind effective.

People who are looking to buy dietary supplements should be better informed that the products they are looking at have received to testing to ensure their safety. A better long term solution, however, is to close the loophole that exists in the FDA's jurisdiction and give them control over which dietary supplements reach the shelves. FDA approved food and drugs have survived a long and rigorous process to ensure their safety and effectiveness. Supplements, on the other hand, can have deadly effects and still reach the shelves. In fact, quite often a dietary supplement is pulled from shelves for being dangerous and even lethal to people who take it. The most high-profile case recently was that of ephedra. Ephedra was a stimulant used in dietary supplements that promised to boost energy and help weight loss. However, the plant extract also increased blood pressure and constricted blood vessels in users, and this led to a number of adverse side effects and even deaths (“Ephedra,” 2011). Despite opposition from the dietary supplement industry, the federal government banned ephedra in 2004. If the product had been regulated by the FDA in the first place, it would have likely uncovered such negative side effects and either regulated it closely or banned it outright before it hit the shelves.

The second front from which to protect the public and help them make healthy decisions about alternative medicines is at the state level, specifically within the public school curriculum. According to studies of scientific literacy among United States adults, in 2006 only 35% participants were considered scientifically literate (Scearce, 2007). In addition, critical thinking is not taught to the extent that it should in our schools (Paul, 1990). This leads to a population that is largely unable to protect itself against pseudoscientific scams. In addition, civic scientific literacy is the cornerstone of informed public policy (Laugksch, 2000). Because governments are appointed by the people and are thus responsible to them, it is necessary for the people to be scientifically literate critical thinkers in order to keep policy makers passing constructive, science-informed policies. The process of becoming a scientifically literate public begins in the schools, and science educators have a duty not only to instill the abilities of scientific and critical thinking into their students, but they must also be more openly critical of research or claims that are not scientific in nature. More knowledgeable citizens are better able to effectively negotiate their way through society (Laugksch, 2000).

Conclusion

When put to the test, mainstream alternative medicines and practices fail to stand up to scientific scrutiny, skepticism, and critical analysis. By establishing a clear understanding of what it means to think scientifically, one can set up a number of questions to ask when assessing a claim. If the claim fails the test, then it is likely based not in science but in pseudoscience and should be dealt with more cautiously.

A staggering number of people around the world practice and receive alternative medicines and treatments every day, and the number is growing (Rettner, 2011). Some of these treatments may be harmless (though often expensive), but others can cause severe health risks, dangerous side effects, and unintended drug interactions with other medicines. It is of vital importance that people understand how to ask the right questions of alternative medicines and therapies if they are to do what is best for their health, their wallet, and the health of their families. A greater public appreciation for science would ideally result in fewer cases like Leslee Flasch's, where a woman died painfully and needlessly because she chose to take alternative medicines rather than seeking science-based cancer treatments.

When someone falls for an alternative medicine scam, it is not always because they are unintelligent. Like Carl Sagan's friend who believed in alien abductions, otherwise rational and skeptical people can be swayed by compelling arguments and emotional stories. However, people with a sufficiently high awareness of the value of science and with a sufficiently disciplined critical thinking ability should be better able to protect themselves from falling for unsubstantiated claims. One does not need to be a scientist for critical thinking alarm bells to go off in one's mind when one hears the claims of a pseudoscientist.

What about the practitioners of alternative medicines and those who promote and market them? Are they exploiting the weak and preying on the hopes of the desperate? Some undoubtedly are. Many of the people who endorse alternative medicines have PhD degrees in scientific fields and should know better than to believe what they're saying. Others probably just have the best intentions and want to help people. This latter group, if given a better understanding of the rigors of science, could possibly come to abandon alternative medicine. However, with hour-long therapy sessions costing patients around $100 for an hour, such a lucrative business is undoubtedly hard to leave.

People need to empower themselves to be able to make science-based choices when faced with a decision between tested and untested medical treatments. However, doctors, science teachers, and the government also must play a greater role in promoting science, skepticism, and critical thinking. Currently, the scientific community is too lax on speaking out against scam pseudoscientific treatments. The National Institutes of Health (NIH) provides “unbiased” information on alternative medicines, but this should not be their goal. Instead, groups, organizations, university professors, and government agencies that value science must be more openly critical of peers and colleagues who choose to promote pseudoscience. Our lives really do depend on it.

Works Cited

"About Quantum-Touch." Quantum Touch. 2011. Last Accessed April 28, 2011. URL: http://www.quantumtouch.com/

"Acupuncture." NIH Medicine Plus. April 21, 2011. Last Accessed April 29, 2011. URL: http://www.nlm.nih.gov/medlineplus/acupuncture.html

"Acupuncture Meridians Pathways of Chi Energy." Healing With EFT. 2011. Last Accessed April 26, 2011. URL: http://www.healing-with-eft.com/acupuncture-meridians.html

"Argument from Authority." Wikipedia. April, 2011. Last accessed April 25, 2011. URL: http://en.wikipedia.org/wiki/Argument_from_authority

"Auditing (Scientology)" Wikipedia. December 29, 2010. Last Accessed April 27, 2011. URL: http://en.wikipedia.org/wiki/Auditing_(Scientology)

"Body Pure." Wise Choice Health, Inc. 2011. Last accessed April 25, 2011. URL: http://www.bodypurenow.com/

"Cancer patients turning to alternative remedies." Alternative Medicine on MSNBC. June 8, 2009. Last accessed April 25, 2011. URL: http://www.msnbc.msn.com/id/31088185/ns/health-alternative_medicine/

"Channels or Meridians in Acupuncture – The invisible Pathways of Qi." Holistic Online. 2007. Last Accessed April 29, 2011. URL: http://www.holisticonline.com/acupuncture/acp_meridians.htm

"Chiropractic." Wikipedia. April 24, 2011. Last Accessed April 26, 2011. URL: http://en.wikipedia.org/wiki/Chiropractic

Derksen, A.A. "The Seven Sins of Pseudo-Science." Journal for General Philosophy of Science.

1993. Vol 24. No 1. pp 17-42. URL: http://www.jstor.org/stable/25170950

Laugksch, Ruediger. “Scientific Literacy: A Conceptual Overview.” Sci. Ed. 2000. Vol 84. pp 71-94

“Ephedra.” Wikipedia. April 19, 2011. Last Accessed April 28, 2011. URL: http://en.wikipedia.org/wiki/Ephedra

Feigl, H. “Operationism and Scientific Method.” University of Minnesota. 1945.

Gandhi, Neha. “7 Myths about Bad Posture, Dispelled.” Ladies' Home Journal. 2011. Last Accessed April 28, 2011. URL: http://www.lhj.com/health/pain-management/backpain/7-myths-about-bad-posture-dispelled/

“History.” US Food and Drug Administration. July 29, 2010. Last Accessed April 28, 2011.URL: http://www.fda.gov/AboutFDA/WhatWeDo/History/default.htm

Jaroff, Leon. “Back Off, Chiropractors!” Time, Inc. February 27, 2002. Last Accessed April 28, 2011. URL: http://www.time.com/time/columnist/jaroff/article/0,9565,213482,00.html

Leach, Robert A. The Chiropractic Theories: A Textbook of Scientific Research. Lippincott Williams & Wilkins. 2003.

“Medical Acupuncture in Modesto, CA.” Modesto Acupuncture. 2011. Last Accessed April 25, 2011. URL: http://www.modestoacupuncture.com/

Moffet, Howard H. “Sham Acupuncture May Be as Efficaciou as True Acupuncture: A Systematic Review of Clinical Trials.” The Journal of Alternative and Complementary Medicine. 2009. Vol 15. No 3. pp 213-216

“More seek alternative medicine therapies, study shows.” Alternative Medicine on MSNBC. February 1, 2011. Last accessed April 25, 2011. URL:

http://www.msnbc.msn.com/id/41370413/ns/health-alternative_medicine/

Neddermeyer, D. “Holistic Healthcare versus Traditional Western Medicine.” Ezine Articles. February 4, 2006. Last Accessed April 27, 2011. URL: http://ezinearticles.com/?Holistic-Healthcare-versus-Traditional-Western-Medicine&id=139585

Nudel, M. and E. Nudel. “Bio-Energy Healing.” Self Growth. 2011. Last Accessed April 29, 2011. URL: http://www.selfgrowth.com/articles/Nudel1.html

Ortega, Tony. “Scientology's Crushing Defeat.” Village Voice. June 24, 2008. Last Accessed April 27, 2011. URL: http://www.villagevoice.com/content/printVersion/487758/

“Our Interactive Acu-Point Model.” Qi Journal of Traditional Eastern Health and Fitness. 2011. Last Accessed April 29, 2011. URL: http://www.qi-journal.com/AcuModel.asp

Owens, Edward F. “Chiropractic subluxation assessment: what the research tells us.” Journal of the Canadian Chiropractic Association. 2002. Vol 46. No 4. pp 215-220

Paul, Richard W. “Critical Thinking: Identifying the Targets.” From Critical Thinking: What Every Person Needs to Survive in A Rapidly Changing World. By Jane Willsen and A.J.A. Binker. 1990.

“Phrenology.” Wikipedia. April 25, 2011. Last accessed April 26, 2011. URL: http://en.wikipedia.org/wiki/Phrenology

“Reiki.” National Center for Complementary and Alternative Medicine. March 24, 2011. Last Accessed April 29, 2011. URL: http://nccam.nih.gov/health/reiki/

“Reiki Healing Health Benefits.” Reiki for Holistic Health.” 2011. Last Accessed April 29, 2011. URL: http://www.reiki-for-holistic-health.com/

Riet, G., Kleunen, J., and P Knipschild. “Acupuncture and chronic pain: A criteria-based meta analysis." Journal of Clinical Epidemiology. 1990. Vol 43. No 11. pp1191-1199. URL:http://www.sciencedirect.com/science?_ob=ArticleURL&_udi=B6T84-4CPMC8T-2B&_user=986260&_coverDate=12%2F31%2F1990&_rdoc=1&_fmt=high&_orig=gateway&_origin=gateway&_sort=d&_docanchor=&view=c&_acct=C000049872&_version=1&_urlVersion=0&_userid=986260&md5=72701e5d205b87e4219909b771262078&searchtype=a

Rettner, Rachael. "More seek alternaive medicine therapies, study shows." Alternative Medicine on MSNBC. February 1, 2011. Last Accessed April 29, 2011. URL: http://www.msnbc.msn.com/id/41370413/ns/health-alternative_medicine/

Sagan, Carl. The Demon-Haunted World: Science as A Candle in the Dark. Ballantine Books. 1997.

Scearce, Carolyn. "Scientific Literacy." ProQuest Discovery Guides. 2007.

"Services: Bioenergy." The Mindfulness Center. 2011. Last Accessed April 29, 2011. URL: http://www.themindfulnesscenter.org/bioenergy.php

"Services: Reiki." The Mindfulness Center. 2011. Last Accessed April 29, 2011. URL: http://www.themindfulnesscenter.org/reiki.php

Showalter, V. M. "What is united science education? Part 5. Program objectives and scientific literacy." Prism II. 1974.

"The History of Chiropractic." World Chiropractic Alliance. 2011. Last Accessed April 28, 2011. URL: http://www.worldchiropracticalliance.org/consumer/history.htm

"Traditional Chinese Medicine." Traditional Medicine Network. 2011. Last Accessed April 25, 2011. URL: http://www.traditionalmedicine.net.au/chinmedc.htm

"What is Chiropractic?" Your Spine. 2011. Last Accessed April 28, 2011. URL: http://www.yourspine.com/Chiropractic+Care/What+Is+Chiropractic.aspx

"What is Reiki?" Reiki.org. 2011. Last Accessed April 29, 2011. URL: http://www.reiki.org/faq/whatisreiki.html

"What is a Subluxation?" Your Spine. 2011. Lat Accessed April 28, 2011. URL: http://www.yourspine.com/Chiropractic+Care/Invasive.aspx

"What We Do." US Food and Drug Administration. November 18, 2010. Last Accessed April 28, 2011. URL: http://www.fda.gov/AboutFDA/WhatWeDo/default.htm

White, A.R., Rampes, H, and E. Ernst. "Acupuncture for smoking cessation." University of Exeter. 2000. URL: http://www.ncbi.nlm.nih.gov/pubmed/12076375/