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**Where is the Skeptic Exercise Physiologist?**   
Tommy Boone, PhD, MPH, MAM, FASEP, EPC   
Professor and Chair  
Department of Exercise Physiology   
College of St. Scholastica   
Duluth, MN 55811

Skepticism is essentially non-existent in exercise physiology!  What a statement.  Is it true that exercise physiologists, who are researchers at heart, simply don’t debunk bad science?  Is it possible because either they don’t read the research or they simply choose to look the other way?  Better yet, how could the integrity of research get lost or so poorly understood?  Is it logical and right that researchers should know better than to publish an article with obvious flaws just to get it in print?  Obviously, these are very important questions for all professionals who strive to think critically and who believe they are on top of their science.

Possibly, part of the problem is the unquestioned belief in science.  Surely no one would purposefully alter research findings or make up data just to get tenure or to get an article published!  Well, unfortunately, the reality is that some researchers do just that.  They are so driven to get their point of view across that they are willing to publish their views even when their work is premature or wrong.  What is also hard to understand is that, when the majority of the researchers in a given field fail to recognize the findings as lacking, inappropriate, or just plain wrong, the published work often goes unchallenged for years if not decades.  Interestingly, if someone was to disagree with the published findings, without the majority to back the person, he/she may find him or herself on the outside looking in if not completed disregarded.

Hence, the noble tradition of thinking like scientists has come up short in creating intellectual steps in critical reflection.  Too many scientists are too interested in publishing their work, and they appear equally motivated to leave bad science to itself.  In the end, research can be and is frequently research for research sake.  In fact, I must confess at times to being guilty of similar thinking.  Most college professors don’t become professors without a significant list of publications.  As a result, it appears that many college teachers don’t take the time away from their busy research efforts to teach students about skeptical research or how to think.  Instead, they teach students what to think because it is easier and accepted.  To find time outside of class to address the weaknesses of published research isn’t a priority.  Instead of questioning what is written and why authors present their thinking as they do, the student is left to believe the content as written.  The question of whether the content is a fair and reasonable representation of the topic investigated isn’t addressed, yet an unknown percent of what is published is absolute nonsense!  It seems reasonable to argue, therefore, that the peer-review process should screen out bad research, bad thinking, and manuscripts designed to confirm the authors’ bias from good research.

Without critical reflection, whatever is published is considered good research and thus acceptable and/or proven statements of fact.  As previously stated, the student is not likely to think the content could be wrong.  Few, if any, students are prone to disbelieve a published account of science!  The idea that the content in the article might be wrong or that the authors might have mis-represented the conclusions is not questioned.  In other words, there is a major failure in teaching students to think for themselves.  And, yet science is so necessary and important that everyone seems to have forgotten that it is created by colleagues who are subject to problems in thinking like anyone else.  If they are not ethical, then the science is unethical. This is the crux of this article.  The unquestioning faith in published articles needs examination.  Carl Sagan ([1](http://faculty.css.edu/tboone2/asep/SkepticExercisePhysiologists.html#1.)) said it best, the need for critical thinking is “nothing less than our survival – because baloney, bamboozles, bunk, careless thinking, flimflam and wishes disguised as facts are not restricted to parlor magic and ambiguous advice on matters of the heart.”

Traditionally, being healthy is so important that students are told what not to do.  Abstain from smoking, don’t drink alcohol, avoid fatty foods, and get regular exercise are the obvious statements of good intentions.  Those who don’t change their lifestyle are left feeling worried if not guilty.  While it is logical that moderation appears to be the key to most views about individual health and health in general, seldom are students taught to keep an open mind toward opposing views.  This is an unfortunate outcome because students are set up to see only one side of a controversial issue.  The nature of critical thinking demands the opportunity to examine all the facts to solve problems and make decisions.

*Taking Sides* is a book that encourages a better understanding of the subject of cause and effect ([2](http://faculty.css.edu/tboone2/asep/SkepticExercisePhysiologists.html#2.)).   It contains 38 articles arranged in 19 pro and con pairs.  Each pair addresses a controversial issue in health and society.  In addition to presenting the accepted thinking about health sensitive and complex disease-related topics, students should be encouraged to study and understand the points made by the opposition.  Not only do students need clear thinking to judge the statements of newspapers, books, teachers, doctors, and other healthcare personnel, it is important that exercise physiologists have the ability to think clearly, to know the difference between opinion and facts, and to know when to take action to solve differences in thinking.

As professionals, exercise physiologists must not become so attached to an idea that it becomes the only approach to an issue (e.g., the role of cholesterol in causing heart attacks).  Ruchlis ([3](http://faculty.css.edu/tboone2/asep/SkepticExercisePhysiologists.html#3.)) said that, “People who believe strongly in an idea often become so attached to it that they bend and twist any facts that cast doubt on the idea.  This ‘mindset’ or bias (prejudice that inhibits judgment) is often subconscious and so deeply embedded that most people are unaware of its influence on their reasoning.”   The point is that “doing what is assumed to be right” doesn’t always translate as being factual, appropriate, or right.

While honest errors will always happen, and while some errors happen for the wrong reasons, all college professors should be driven to correct factual errors.  After four years of college, students should have a good understanding of reputable science and reliable ways to think and argue about the accuracy of facts.  Professors, therefore, shouldn’t teach just one side of an issue, especially under circumstances where that particular side confirms an embedded belief.  Students deserve more, society expects more, and all department chairs should hold their faculty accountable for teaching their biased opinion masquerading as “fact.”  Just, as an example, if a professor stands up in front of class and says that cholesterol causes coronary artery disease, is it true?  Must the department chairs accept the professor’s way of thinking and lecturing?

The short answer to both questions is “no.”  Ruchlis ([3](http://faculty.css.edu/tboone2/asep/SkepticExercisePhysiologists.html#3.)) says, “It is not necessarily true that if one event always follows another then the first event is the cause and the second event is its effect.”  The danger of an absolute and unyielding mindset is that everyone starts to think exactly the same, which is a major mistake.  Professors, students, and the public sector should join in the common belief that learning what to think should never take the place of learning how to think.  Learning what to think is only the beginning of learning from reading books, journals, and so forth.  It seems that everyone knows what to think.  That is, according to Glenberg et al. ([4](http://faculty.css.edu/tboone2/asep/SkepticExercisePhysiologists.html#4.)), they have the illusion of knowing whereby they think they understand but don’t and, perhaps, even worst, they may never realize they have a problem thinking correctly and therefore a need to learn how to think.

Having said this, it is time that the language professors use to discuss causation should be updated, particularly with regard to coronary artery disease.  The truth is, aside from discussing causation to prevent disease, the idea of knowing helps everyone feel more in control and bring about desirable outcomes and avoid undesirable ones ([5](http://faculty.css.edu/tboone2/asep/SkepticExercisePhysiologists.html#5.)).  But, what if the idea of knowing (and hence the prevention of an undesirable outcome) is based on an incorrect causal inference?  The consequences of unclear thinking and for not knowing the real causes are potentially very troubling, if not dangerous.

“It ain’t so much the things we don’t know that get us into trouble. It’s the things we know that just ain’t so.”  --  Artemus Ward

When lecturing on risk factors for coronary artery disease, professors may understand that there are simply too many unanswered questions for what causes a myocardial infarction (heart attack) but students only know what is brought to their attention.  Without placing equal emphasis on a discussion of the “unknown causes” of heart attack, students fail to grasp the language of causal inference.  Clearly, not every person who suffers a heart attack has elevated low-density lipoprotein cholesterol.  It is important therefore that students are taught the distinction between necessary and sufficient causes.  An incorrect causal inference can have considerable emotional and mental consequences.

Zechmeister and Johnson ([5](http://faculty.css.edu/tboone2/asep/SkepticExercisePhysiologists.html#5.)) state that “a necessary cause is one without which the effect cannot occur.”  When speaking of high cholesterol being a necessary cause of coronary artery disease (and thus a heart attack), a heart attack will not occur unless cholesterol is elevated.  If it is possible to have a heart attack in the absence of high cholesterol, then high cholesterol is not a necessary cause and, therefore, not *the* cause of a myocardial infarction.  Exercise physiology professors should think some more about causality.  It isn’t a failure in thinking to admit that decades of research have resulted only in the identification of different conditions associated with coronary artery disease.  Certainly the covariation of high cholesterol and incidence of heart attacks needs continued study because, at the present time, the strength of the correlation (i.e., the relationship between the two) is not strong enough to predict who will have a heart attack.  Unfortunately, there are numerous plausible alternative causes including, but not limited to, cigarette smoking, high blood pressure, genetics, inflammatory conditions of the coronary arterial wall, and dozens upon dozens of other potentially cause-and-effect relationships.

Exercise physiology professors are aware of the pitfalls in publishing inappropriate conclusions in their research.  However, few of the professors appear to understand the pitfalls in drawing conclusions about cause and effect.  The most obvious pitfall occurs when lecturing on risk factors for heart disease.  It extends to drawing conclusions that may lead the professor to seeing covariation that is not there.  Chapman ([6](http://faculty.css.edu/tboone2/asep/SkepticExercisePhysiologists.html#6.)) has referred to this error in thinking as illusory correlation.  The error stems from many factors; the most important of which is someone (such as a colleague or a professor) being told about the degree of relationship to expect ([5](http://faculty.css.edu/tboone2/asep/SkepticExercisePhysiologists.html#5.)).   Students, colleagues, and readers who are told what to think are predisposed to see covariation that doesn’t exist.

“Learning without thought is labor lost.  Thought without learning is intellectual death.”  -- Confucius

There is also the pitfall of “the before-after argument” where professors fail to acknowledge coincidence and natural causes as plausible explanations for an assumed relationship between the variables.  The problem stems from the observation that individuals who have had heart attacks may have elevated cholesterol.  In other words, the research (or professor) argues that the presence of the high cholesterol is responsible for the heart attack.  For all anyone knows, the heart attack may have resulted from one of a dozen different variables or a complex combination of anyone of them with other known or unknown variables.  Interestingly, most exercise physiologists probably understand this point, but it is not widely believed or taught.

What needs explanation is why so many exercise physiologists persist in teaching questionable beliefs as absolute statements of fact.  Part of the reason is clear at the outset.  Exercise physiologists are not taught how to teach.  Rather, it is assumed that anyone with the doctorate degree can teach.  Erroneous beliefs like this plague the teaching profession.  They are not all professionals interesting in teaching!  Instead of providing their students with clear information that would enable them to “think” better, it is easier (and possibly deliberate) to argue the status quo points of view.  This is a tragedy since it fails to support straight thinking that is required for good teaching.  It is likely the reader has read about similar views elsewhere.

According to Gilovich ([7](http://faculty.css.edu/tboone2/asep/SkepticExercisePhysiologists.html#7.)), “The most likely reason for the excessive influence of confirmatory information is that it is easier to deal with cognitively.”  This view in itself is a sufficient reason to move forward in a better understanding of the implications of confirming one’s bias.  For example, once information is mis-identified yet perceived as a real association, it is integrated and explained in accordance with the exercise physiologist’s prior thinking, theories, and beliefs.  Unfortunately, since exercise physiologists are taught very early during their academic programs that high cholesterol causes heart attacks, their entrenched beliefs shape their thinking and teaching in the face of evidence that states otherwise.  As previously stated, on closer inspection, it is clear that the adoption of information as undisputed facts discredits the notion of straight thinking.

“I know it is true that high cholesterol causes heart attacks.”  “I know that regular exercise lowers blood pressure.”  “I am convinced that cardiac rehabilitation results in regression of coronary artery disease.”  What these statements have in common is that students often cite them after hearing the statements made by professors in support of their beliefs.  “I am convinced that the sports massage increases running economy.”  I know somebody who is trained in meditation, and who can voluntarily lower oxygen consumption during steady state submaximal exercise.”  These statements represent the person’s belief, which is either based on good evidence or a conviction that the beliefs are correct.

Although many of the beliefs are based on good intentions, straight thinking and good teaching require more.  Believing strongly in a popular relationship between two variables does not constitute the scientific method.  As Gilovich noted in his book ([7](http://faculty.css.edu/tboone2/asep/SkepticExercisePhysiologists.html#7.)), *How We Know What Isn’t So*, “People exhibit a parallel tendency to focus on positive or confirming instances when they gather, rather than simply evaluate information relevant to a given belief or hypothesis.”   The end result is that people, including students and professors, do not use all the scientific information available to them.  The hazards of drawing conclusions solely from information that confirms one’s beliefs can be seen in the passing of mis-information. Thus, students who are given only one side of the relationship between two variables aren’t likely to think clearly and in a factually correct manner.  This problem of hidden or absent data is a major discrimination against the true effectiveness of college teaching.

Another, often-neglected point is the treatment of information as though it is “the” way and the “only way” to think about what is important research, the future of exercise physiology, and so forth.  Hence, to think differently is viewed as completely unjustified or potentially closed-minded.  How dare you think differently!  On closer inspection, though, the question of whether any idea has the right to not be critically scrutinized is often unnoticed and complicated by the assumption of knowledge associated with advanced degrees or academic positions.  Obviously the issue is complex because it is appropriate to associate an increased understanding of new information with advanced study.  Yet, it is entirely inappropriate behavior to not struggle with the notion of what is right regardless of academic distinction and/or influence.

Exercise physiologists are justified in allowing their beliefs and instincts to influence their skepticism of those who have built their careers on the backs of possibilities with and without serious merit.  All this is to say that when a doctorate prepared exercise physiologist has declared what is the appearance of the only desirable research direction and, thus the only means to advance exercise physiology, it is plausible that the word dysfunctional may be appropriately applied without bias.  An interesting example of the expectations of some who may not even be exercise physiologists yet profess nonetheless to write about exercise physiology is the idea that exercise physiologists are suppose to harness new technologies including biochemical techniques, radioisotope and imaging technologies that enable “gene-expression profiling to assess gene-expression patterns in cells and…determine changes due to…physiological…interventions.” ([8](http://faculty.css.edu/tboone2/asep/SkepticExercisePhysiologists.html#8.))

The point here is not that research designed to identify the genes associated with a disorder may correct the condition or that such technology is bad.  Rather, the question is whether the responsibility of exercise physiologists and the profession of exercise physiology are only important if it is dedicated to scientific and health-related problems.  It may be time within the field of exercise physiology to carve out its own view of usefulness within the public sector.  For certain, the future of exercise physiology is not dependent upon “…laboratory training that spans molecular biology through integrative systems physiology….” ([8](http://faculty.css.edu/tboone2/asep/SkepticExercisePhysiologists.html#8.))

The commonsense psychology is obvious.  The future of exercise physiology lies not in providing a voice to the NIH and other funding agencies.  Its future exists with an understanding of the infrastructure necessary to professionalize exercise physiology.  Research per se, however important, simply isn’t enough to ensure that the emerging profession of exercise physiology (vs. the traditional thinking of a scientific discipline) survives.  It is time to emphasize professionalism along with the emphasis on research because the false consensus of the latter cannot establish a profession.  Unfortunately, the collective inexperience of exercise physiologists in understanding this point is partly responsible for the present reality of undesirable financial conditions and other employment issues.  Why so many fail to appreciate this point is a serious question that needs answering.

To be fair, all research is important.  But, the tendency to state that only one type of research is relevant is questionable.  Explaining this to PhDs isn’t easy and, in fact, is contrary to the bloodletting that is part of doctorate training.  Simply stated, the aura of plausibility, that is, exercise physiologists who believe a particular way because their mentors taught them to believe a certain point of view, is important but it shouldn’t control one’s thinking.  Similarly, there is the issue of why aren’t more college professors teaching students about the fallibility of marketed “scientific” products (i.e., the published manuscript).  The emphasis on whatever is published must be right is wrong for all kinds of reasons but, in particular, because publications are in reality products marketed for specific publications.  The effectiveness of the author bears directly on promotion and tenure and, thus the net effect is generally positive.  Indeed, it is not always positive though!

The continued problem of receiving filtered thinking is compounded by the lack of having learned how to think about alternative issues, possibilities, and strategies.  At first glance, a person may say “yes, but it is easily corrected”.  The statement certainly would not be endorsed by someone who has taken the time to study the problem.  To start thinking about how to think, to start teaching about how to think, and to start thinking therefore about the future of clear thinking and, in particular, as it relates to exercise physiology, the next step is to grasp what we cannot grasp which is embedded in the following piece:

“My eyes already touch the sunny hill, going far ahead of the road I have begun.  So we are grasped by what we cannot grasp; it has its inner light, even from a distance – and changes us, even if we do not reach it, into something else, which, hardly sensing it, we already are; a gesture waves us on, answering our own wave.”  --  Rainer Maria Rilke

It is important then, to appreciate that exercise physiology students must be taught how to uncover similarities and differences between good and not so good research findings.  Students must be taught how to recognize contradictions and inconsistencies in the authors’ sentences, paragraphs, and conclusions.  The oversimplifications of findings or the publishing of findings that are easily accepted and the conclusions from published work that are not justified without having evaluated the credibility of sources quoted do not constitute critical thinking.  Exercise physiologists, as teachers, therefore, must be held accountable for increasing the students’ ability to think.

For example, do something in class that will encourage the students to remember what is important.  Tell a joke that approximates the reality of the lecture content.  Similarly, alternating fast and slow speech may help break up the lecture into parts that cause students to listen more closely and hence think more.  Don’t assume students automatically can engage in problem solving or that they can reason correctly.  Years of bad teaching or no teaching have left many students hopelessly lost about how to think.  Teach students how to analyze problems and issues that require the development of specific strategies to “read between the lines” and, thus to get at what the author(s) didn’t say in the manuscript.  Bear in mind however, getting students to a “constructive discontent” point of view isn’t easy.  In most classrooms, it is a major hurdle to jump because students have difficulty in questioning the authority of science.  Students interpret published articles as “the” information; the author(s) are “the” experts and so students are not likely to question the content.  Knowing how to probe into whether the content is sound or whether the conclusions are correct isn’t taught because, generally, professors do not challenge research findings in front of their students.  So, learning to think isn’t something done out loud in class.  Students are not usually afforded the opportunity to hear the professor think out loud.  Paul ([9](http://faculty.css.edu/tboone2/asep/SkepticExercisePhysiologists.html#9.)) believes they should think out loud.  Thinking aloud in front of students encourages an understanding of how to think through problems.  Stated somewhat differently, but equally as effective is Miller’s point of view ([10](http://faculty.css.edu/tboone2/asep/SkepticExercisePhysiologists.html#10)):

“The teacher who questions, who tries to find relationships, differences, and analogies, who shows facility in simplifying, elaborating, substituting, varying, and combining; the teacher who shows enthusiasm and appreciation for discovery; the teacher who demonstrates imagination and curiosity and encourages these qualities in others – this teacher by his own attitude and intensity produces conditions in which students can be as creative as they are able.  This teacher awakens students’ capabilities.”

Straight thinking is helpful in recognizing shared bias by trying to identify the main point and, hence the relevance of all that surrounds an issue.  Sadly, too few professors and most students fail to understand this point and, thus the roots of poor thinking lead directly to a lack of open-mindedness.  Professors and their students must not only be able, but also be encouraged, to consider the strengths and weaknesses of opposing points of view.  Students live in a world where they need to construct meaning from ideas based on assumptions differing from their own.  In short, they have an undeniable right to develop good thinking skills but, if the professor isn’t a skeptic him- or herself, students are not likely to learn how to think since it requires a new way of approaching health, fitness, and rehabilitation problems.

Professors have the responsibility to prepare and assist students to learn what has been learned and to continue the search for truth.  Dispensing information by itself has little to nothing to do with how to think.  Professors understand this point, but there isn’t an organizational analysis of the problem and, yet the professor is exactly the person who should create an environment in which genuine learning can occur.  Why it isn’t reality is part of the continuous problem of lack of emphasis on professionalism, in general, and the lack of attention to integrity in thought and action, specifically.  In short, it is utmost important that all the evidence is analyzed, including information that may demonstrate that the original evidence was flawed.  Professors must help their students to distinguish between the significant and the trivial, to check authoritative sources for information, and to keep in check the tendency to place unbounded faith in views expressed by others.

Unfortunately, professors seldom teach students about suppression of evidence and the failure to consider both sides of an issue even when failure to do so is dishonest, intolerable, and unethical ([11](http://faculty.css.edu/tboone2/asep/SkepticExercisePhysiologists.html#11.)).  Scientific misconduct is more than just mis-representing published data; it is also the underreporting of scientific information during the teaching of a subject.  Students simply cannot make good judgments about the validity of an idea or the results of a particular study without an adequate account of all the evidence.  Thus, to permit an informed judgment about the validity of published data, it is important that “disappointing” or “uninteresting” results are given equal analysis.  It is surprising that so few exercise physiologists have made an attempt to help their students make better decisions, particularly with regard to the tendency to dichotomize research into those with positive results and those with negative results.  Students should understand that research manuscripts ought to be interpreted on the basis of whether they have been well executed, not whether they have positive results ([12](http://faculty.css.edu/tboone2/asep/SkepticExercisePhysiologists.html#12.)).

To help students think critically about research findings, professors will have to “read more and consult a variety of books and/or journals….they will no longer be able to teach the popular (or biased) belief, however well-founded.  Instead, teachers will teach students how to think; they will teach them to scrutinize old and/or contemporary ideas for new insights” ([13](http://faculty.css.edu/tboone2/asep/SkepticExercisePhysiologists.html#13.)).  The problem is that there seems to be an assumption that professors are predisposed mentally and psychologically to be critical thinkers.  Shaking the foundation of the professor’s education (or the lack of it) to think critically is a challenge to the integrity of the doctorate programs of study.  Yet, there seems to be no end to the number of PhD exercise physiologists who profess to be excellent teachers.  When asked, “what-if” questions or the “it’s as if” statements, professors just don’t get it.  Their reply is, “But, stroke volume always plateaus at 50% of VO2 max” or “but, CO2 rebreathing is problematic….”  They can’t get beyond what they were taught and, seemingly, are expected to teach and yet they must learn to shift perspectives on data and/or events if they are to move on to benefit the profession.

This kind of behavior is common, but it is not right.  The lack of knowing how to teach is always a transgression against the methods of teaching, never purposely against the body of knowledge.  Perpetrators always think they know how to teach and, therefore, do so without troubling themselves with their own misconduct.  The reason is obvious enough.  The business of how to teach and to conduct critical thinking lectures is not a given. The fact is hardly no one responds to the notion that a certain percent of the doctoral students are not prepared to teach.  In truth, this seems exactly to have been borne out.  The reluctance to talk about it is a form of self-protection, and a process that has become the standard.  No one is interested in becoming a whistleblower, and so the legitimacy of the academic programs is not challenged.

Clearly, the credibility of the doctorate programs is universally accepted; an idea that strikes at the heart of the value of an education.  While an excellent education is the fundamental step to understanding honest errors and even deception, the lack of teaching how to think undermines the entire set of values on which the educational enterprise rests.  Anyone who attends a college or university is at risk of not knowing how to think if professors are not taught the conduct, value, and mechanisms of straight thinking.  Having said this, it is equally noteworthy that one half of the top 50 research institutions in the United States have had fraud investigations ([14](http://faculty.css.edu/tboone2/asep/SkepticExercisePhysiologists.html#14.)).  While fraud, alleged fraud, and deception in teaching are not new in science or in exercise physiology, the point is that even unintentional mis-representation of lecture content is unacceptable.  As a result, it reasonable to conclude that college professors of exercise physiology should adhere to the following principles of fairness and responsible reporting of content and research findings during course lectures.  Professors should:

1. Be aware of the importance of providing vigorous leadership in the pursuit of critical thinking.
2. Ensure that every lecture is presented with absolute confidence that the content is presented with all issues, that is, the extent to which is possible.
3. Treat alternative thinking with equal respect to the contemporary view by colleagues.
4. Be sensitive to the students’ views on issues that differ from the text and/or lecture notes.
5. Seek to always present course content and the interpretation of research data with maximum objectivity.

Professional integrity in teaching is the act of maintaining excellent. It is critical to upholding a high teaching standard despite the need to present disappointing data or controversial results.  To maximize the learning process, the presentation of “all” the data versus “some” or “a biased version” of the data by the professor must be an integral part of the professors’ job and the students’ educational program.  Similarly, authors who publish research articles need to present the same disappointing data to maintain the right view of science when read by students, colleagues, and others.  Take, as an example, the work of Benson et al. ([15](http://faculty.css.edu/tboone2/asep/SkepticExercisePhysiologists.html#15.)) who apparently believed that their subjects could control the autonomic nervous system during exercise.  Interestingly, this is a common belief held by many exercise physiologists.  They seem to believe that by practicing the elicitation of the relaxation response at rest, then, it can then be elicited equally as easily during exercise and therefore decrease oxygen consumption (VO2).  The reduction in VO2 is interpreted as an increase in running economy, given that the same amount of work can be done with less oxygen  (and hence less energy).  The problem is that there are only a few studies across several decades of research in this area that have demonstrated a reduction in submaximal steady-state VO2 ([16](http://faculty.css.edu/tboone2/asep/SkepticExercisePhysiologists.html#16.)).

Benson’s work was published in 1978 in the *Journal of Human Stress*.  The title of the manuscript is “Decreased VO2 consumption during exercise with elicitation of the relaxation response.”  It is easy to imagine that athletes can learn to control the physiologic response to exercise.  The down side, however, is that athletes and others may have been misled.  The illusion of the mind possessing more control over the physiology of exercise than actually is the case is a problem.  The fact that the title appears to market the study and the fact that the authors are nationally known scholars appears to help position the manuscript for publication.  Clearly, publishing is important and Harvard is no exception with its unambiguous pressures to publish.

So, what is the problem?  The title is too leading. There is therefore the possibility that the title, stated, in effect, as an alternative hypothesis, sets the readers’ acceptance for an outcome that may not be correct.  Without getting too involved in a critical analysis of the paper, several factors are obvious problems:  First, the authors used a one-tailed paired t-test to compare the mean values of the experimental period with those of the control periods.  Sprinthall ([17](http://faculty.css.edu/tboone2/asep/SkepticExercisePhysiologists.html#17.)) states, “The advantage is that we do not have to obtain as high a t value to reject the null hypothesis as we do when using the two-tail t table.”  Although the calculation of a one-tail t test is identical to that of the two-tail t-test, the distinction between the two t-tests is that the one-tail t-test can demonstrate statistical significance when otherwise a significant difference would not exist.  In fact, after re-calculating the VO2 data presented in Table 1 of Benson and colleagues’ study, using the more appropriate analysis of variance with repeated measures test, there is no statistical difference between the treatment condition and the two controls.  In other words, the subjects’ elicitation of the relaxation response during the fixed submaximal exercise did not result in a decrease in VO2.  As difficult as it may be to point out, there is also the ethical question of whether researchers suddenly switch to the one-tail t-test just to get the rejection of the null hypothesis.

Second, there is the possibility that certain data were not presented to allow for an easier support of the basic premise that the subjects’ were able to decrease VO2 and, therefore, increase exercise economy.  This point is obvious given that the authors report no change in respiratory quotient (RQ), but failed to report whether the treatment had an effect on the volume of carbon dioxide produced (VCO2).  Given that RQ and, in actuality, RER (i.e., respiratory exchange ratio) is determined by dividing VCO2 by VO2, the authors had the VCO2 data for each of the three conditions.  Failure to report the data raises doubt that the treatment had any significant effect on VCO2.  From the authors’ view, another non-significant result wouldn’t sit as well as the idea of one significant change (i.e., VO2) in three variables (with RQ and heart rate staying the same).  That is, had the VCO2 values been reported with no change and, therefore, the no change in the product of VCO2, that is, expired ventilation (VE) and the fractional expired carbon dioxide (FECO2), the idea of VO2 being significant would not have been as easily accepted by the reader.  While these comments are speculations, they provide information about the manner in which the manuscript was marketed for publication, which is not too dissimilar from other such scientific publications.  This is exactly the reason students need to learn how to read between the lines to determine the degree to which they want to embrace the conclusions of a particular research article.

Consider the data published by Abdulhadi and colleagues ([18](http://faculty.css.edu/tboone2/asep/SkepticExercisePhysiologists.html#18.)) in the *Archives of Physical Medicine and Rehabilitation* journal.  The conclusion presented in the 1996 article appears incorrect.  For example, the authors concluded “A statistically significant finding in this study was the improvement in oxygen cost when either a half-inch or a one-inch shoe-lift was added to the contralateral foot of an immobilized extended knee.”  The authors’ results are based on an overall average walking efficiency (VO2, ml/kg/m) at a comfortable walking speed (CWS) for four different conditions: a) normal walking with no knee immobilizer and no shoe-lift; b) knee immobilizer but no shoe-lift; c) knee immobilizer and half-inch shoe-lift; and d) knee immobilizer and one-inch shoe-lift.  The statistical analysis demonstrated that the oxygen cost for walking with the knee immobilized unilaterally in full extension was significantly greater by an average of 20% compared to normal walking (p = .002).  This finding seems reasonable given the increased effort to swing the immobilized, fully extended lower limb forward in the swing phase of the subjects’ walking.  But, then, the authors state that oxygen cost was significantly less (11% vs. 20% above that of normal walking) for the half-inch shoe-lift.  The question, here, is whether the authors are comparing the half-inch shoe-lift to normal walking or to the knee immobilized condition without a shoe-lift?  Obviously, as the statistical results suggest, if the significant reduction with the half-inch shoe-lift is compared to normal walking without the knee immobilized, then the results do not support the conclusions.  Similarly, this is true for the comparison of the one-inch shoe-lift (where a significant reduction in oxygen cost was reported to be 12% vs. 20% above that of normal walking).

Without corroborative evidence from other published articles, the findings in the two studies just described appear questionable.  This is straightforward logic.  To write a research study, the authors must be persuasive as well as correct to persuade the readers to take it seriously.  It is the readers’ responsibility to judge whether the content in the published article makes sense.  Questions often used by readers to determine in what way or to what degree an article makes sense may include some of the following:

1. What part of the article doesn’t make sense?  Is it the introduction, results, discussion, and/or conclusion?
2. What is the author saying or trying hard not to say?
3. Are the references used in the introduction good and/or appropriate for the purpose of the study?
4. Are additional references used in the explanation of the findings?
5. Are there other reasons for the findings the author has not discussed?
6. Have the authors offered an opportunity to view the data from a different perspective or does the article appear to be a marketed product?
7. What are the good and bad parts of the article?
8. Is the article organized and, to what extent, does its organization (or the lack of it) influence the readers’ support of (or failure to support) the authors’ conclusions?
9. How do the findings change the readers’ work and professional implications?
10. What are the consequences of not believing the authors’ findings?
11. What kind of statistical analysis was used in the study?
12. What are the consequences of having used the wrong type of statistics?
13. What are the implications of too few subjects in the study?
14. Have the authors achieve their purpose using traditionally recognized principles of scientific research and writing?
15. Have the authors published similar articles, and do the articles’ findings agree or disagree?
16. Are the authors’ data presented to allow the readers the opportunity to analyze them?
17. Is the study’s design too complex and unnecessary for illuminating the research question?
18. Are there good reasons to believe that the findings are based on honest claims?
19. How could the readers evaluate the findings in the study?
20. Have the authors distorted the results?
21. What are the implications for the findings supporting the granting agency?
22. Are the opposing views adequately addressed?
23. What is left unexplained in the study?
24. How has the study changed the readers’ thinking?
25. How can the reader reconcile what has been concluded in the article?

These are just some of the questions adapted from Paul’s ([9](http://faculty.css.edu/tboone2/asep/SkepticExercisePhysiologists.html#9.)) thinking about the logic of persuasive writing.  Clearly, research writing is a form of persuasive writing.  Authors are required (if they want anyone to take the article seriously) to entertain the questions, ideas, relationships, and claims that are used to support their work.  Their interpretation of the data must be sound.  Students need to understand the steps used by the authors to generate the findings and the implications.  Serious flaws in thinking result from misleading ideas presented in published articles.  Students need skills to understand the “scientific method” and the “reasons” why authors publish articles as they do.  Professors ought to devise scenarios within the classroom for the cultivation of fair-mindedness and intellectual integrity.  To achieve this end, however, professors should teach their students how to think independently.  To become aware of this important directive, professors will need to become more skeptical of pseudo critical thinking that encourages flawed thinking.

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