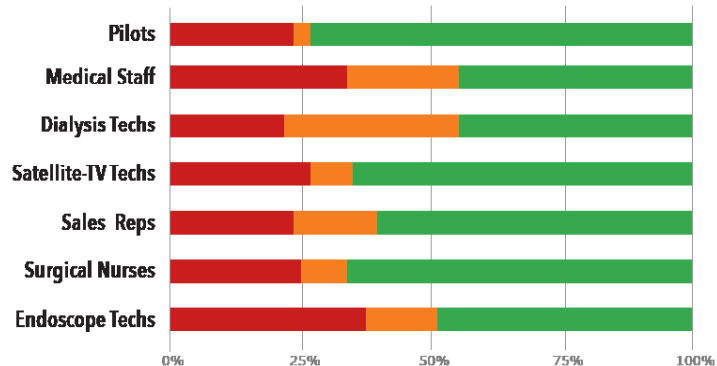


Confidently Held Misinformation

Amplifire has made some remarkable discoveries about a phenomenon that we call *confidently held misinformation*. The graph displays the initial knowledge for workers in 7 very different industries. Notice the similar amount of **misinformation** in each industry, from doctors to nurses, to satellite TV technicians. It's nearly always between 25% and 35% before Amplifire eliminates it.

The graph raises important questions: Is there something about human nature that's causing this universal pattern across industries? Is the nature of information itself partly to blame?



We all have a sense of what information is, but the formal definition is extraordinary strange and wonderful: "Information is a reduction in uncertainty" said Claude Shannon in 1948. One of the world's most creative intellectuals, he conjured up the idea of the first electronic computer, the mathematics of information, and this concise but strange definition.

Why didn't Shannon state the idea of information more positively? Couldn't he have simply said that information is an increase in certainty? No, because Information Theory is an entropic theory of information. You can think of information like energy—it wants to dissipate. Like energy, information sometimes comes together and is stored in a concentrated fashion such as a pattern of neurons in the human brain, the words in a book, or the DNA in every one of your cells. The forms are varied but information always manifests as something physical, tangible, and real.

Given that uncertainty is a general tendency throughout the universe like entropy, it is not surprising that uncertainty is common in people. But how does the confidently held misinformation, the far more dangerous cousin of uncertainty, that we see in this graph arise? When people forget, why doesn't their information simply revert to plain uncertainty? Where does their confidence come from? This is a hard question, and the answer appears to lie in our human psychology.

Confidence is an attractive trait that is desired by people everywhere. People who possess it

" The bias to claim greater accuracy than is warranted may be a self-serving bias to appear more expert and authoritative—basically to bluff, and according to the theory of self deception, the best deceiver is the one who believes his own deception. "

—Steven Pinker (personal correspondence)

have "self-assurance, assertiveness, poise, courage, boldness, mettle, and nerve". Because of its attractive qualities confidence may be just the kind of personal trait that would be useful to project to others. Even when confidence is not justified, it nevertheless gives off an aura of expertise and authority—just the kinds of thing to attract friends, mates, and power. In a nutshell, it conveys status.

And that is, perhaps, how the naturally occurring uncertainty in the world becomes confidently held misinformation. Uncertainty is unattractive, while confidence is supremely attractive. In most cases, the bearer of false confidence won't be fully aware of their own self deception because awareness would serve to lessen the ability to convince others of one's 'boldness, poise, and nerve.' These are the first graphs that we know of to demonstrate this phenomenon.

Perhaps this would be more comical than dangerous except for one thing—confidence is how people decide to act in the world. The brain sends up a signal from the unconscious into consciousness that gives us the confident feeling that the action we are about to perform is the right action. That's why it's perilous when confidence does not align with what's true.

Eliminating Confidently Held Misinformation

Intuition would tell you that confidently held misinformation should be hard to correct because confidence implies strong memory storage and a robust retrieval pathway. The memory trace of fired and wired neurons that form the representation should be more resistant to change than with other conditions of memory such as doubt and ignorance. Experiments clearly demonstrate intuition is wrong and that, in fact, when confidently-held misinformation is corrected, the new information is correctly retrieved and recalled in the future with higher fidelity. But only for awhile.

This effect is called hyper-correction and has been shown in empirical experiments by researchers like Butterfield, Mangels, and Janet Metcalfe, a former post doc with the Bjorks. There are two current explanations. First, misinformation is surprising and, hence, attention is focused on the information. Attention is a key ingredient in successful learning.

Second, it's likely that someone who is misinformed is already somewhat familiar with the domain of knowledge in question. Recent experiments by Metcalfe show that in many cases, people who are misinformed apparently knew the correct information all along. In this case, the misinformed revelation serves to strengthen retrieval pathways of the correct information that is already present.

A third reason comes from psychology. The reason that misinformation causes salient attention is because misinformation manifests the possibility that a confidently held piece of wrong information may lead to injury or embarrassment sometime in the future. When confident errors happen, people suffer a perceived injury to their status in the eyes of peers. Status is one of the great motivating forces in human nature and is likely one of the reasons that misinformation creates a high level of attention to the information and the metacognitive feelings about it.

Recently, Amplifire received some interesting data from Dartmouth where they are using our system in medical education. The students who were confident and wrong on over 40% of their medical knowledge when they started with Amplifire, ended up attaining the highest average score of 97% on the final.

Using Misinformation as a Learning Technique in Amplifire

Finding misinformation is one of the unique aspects of the Amplifire process. The answer key, with its focus on confidence, makes people state their confidence level about their current knowledge. Once confidence is associated with a person's answer, then the system can classify which answers are misinformed.

Metacognition produces the feeling of knowing. It occurs in a region of prefrontal cortex that measures memory strength. It can also produce the dangerous "illusion of knowing." According to Robert Burton, a neuroscientist at UCSF, the feeling of knowing is a core emotion similar to love, fear, sadness, or hate. Only recently has the feeling of knowing been considered in this context—as the emotion of information. In this new context, we express our feelings of doubt, certainty, or ignorance in phrases like: "I'm not sure," "I haven't a clue," or "I'm totally positive,"

The deeper evolutionary perspective tells us that the feeling of knowing is of utmost importance because it leads directly to behavior. It is an adaptive mental feature for creatures that receive sensory input from the environment and then need to act correctly to survive and prosper. Before they act, they first must make a prediction of the likely outcome based on their feeling of knowing.

For any educational technology to be effective in today's distracting reality, a key requirement is salience. A learning technology cannot rely solely on student's top-down executive processes and conscious attention. Rather, it must be able to command bottom-up processes and direct attention away from the distractions and into the learning.