A Passionate Discussion with Al Seckel

Al Seckel is a leading authority on visual illusions, and the author of several books on this topic. He has lectured extensively throughout the world at many prestigious universities and conferences. He is passionate about science, education, and philanthropy, and is a member and contributor to The Edge Group.

Epstein: Al, you are an interesting guy. What have been some of the areas that you are most passionate about?

Seckel: That would depend upon the time of my life. Formerly, and for a good part of it, my passion was specifically confined to discovery, and the pleasure of finding things out, specifically in theoretical physics and then in cognitive neuroscience. Now, my thoughts are directed more on trying to help move the needle forward in a qualitative way on the health of this planet, although I still take a great pleasure in playful and productive recreations of the mind.

Epstein: And other passions?

Seckel: Ha, one could say that my life has been consumed by passion in many different areas. The pursuit of excellence in thought, achievement, craft, not only in my own work, but also in the work of others is perhaps my greatest passion. I am drawn to excellence and avoid myopia. Another great passion of mine is in reforming educational systems, specifically in thinking skills, creativity, and innovation.

Epstein: So, you're a guy of passions?

Seckel: Very much so and personally I can really only relate to similar passionate people of quality and substance. It's always difficult for me to carry on a conversation when it is not passionate, interesting, or meaningful. This makes me somewhat intense. I certainly know that this may not always be everyone's cup of tea.

When I was in my teenage years, I was very influenced by the writings of the English philosopher Bertrand Russell, who in the preface of his three-volume autobiography described a life of passions: 1. The search for knowledge; 2: The search for love; and 3: the need to do something about the suffering of the planet. The first two passions sent him towards the heavens, but the unbearable suffering of humanity always brought him crashing back down to Earth. I would say that I have resonated with these three passions for almost my whole adult life.

Epstein: Back to thinking skills...why do you think these are so important? Are they something that can be taught?

Seckel: First of all, I think that for the most part, public educational systems, religious institutions, governments, all elements of mass media and communication, and even our families, teach us *what* to think rather than *how* to think. Propaganda and manipulative techniques are used for both good and evil purposes. In spite of what many people think, they aren't just confined to the people in black hats.

As individuals and as a society we have not learned how to ask the right questions: to separate the essentials from the non-essentials, and get to the heart of a problem. We also take a very surface approach to things, where we become very much like a stone that randomly skips across the surface of the water, never going into any depth. Essentially, we are a society of parrots, who for the most part repeat what is said and written. Well, the devil is in the detail, and context is the most important and essential part of information, and when you don't have the right context (where it is presented incorrectly or withheld), you will come to incorrect conclusions.

Parroting, rather than solving, is a severe mental handicap when dealing with the various problems of the world or any other problem, personal or otherwise.

I have noticed that many well-meaning groups out there are constantly "raising awareness" about this or that particular global or local issue, but these same groups don't couple these issue with any specific tractable, scalable, and practical solutions. What is put out there is often surface and vague: "We need to do something about Darfur," "We need Peace now!," "Imagine," or "We need to do something about global warming," etc. Ok, I as a concerned citizen want to do something about global warming. I don't want all those polar bears to die in 50 years, and so what do I do? Do I turn on my air conditioner? Do I set the oven to a lower temperature when I am cooking a chicken? Do I buy a recyclable bag at the grocery store. Do I buy a Prius? What can I do???

Epstein: How do you address this problem?

Seckel: Well, first of all, I do believe that many people are well meaning and want to do something "meaningful," but just don't know what to do. Last year, I helped get the excellent movie "Home" premiered in Los Angeles. This was a remarkable bit of filmmaking that really provided a remarkable vision of the evolution of our planet and the problems we face. After the audience viewed the film, I could see they were all tremendously moved. The first question asked of the director/producer Yann Arthus-Bertrand was, "What can we do?" I watched the entire momentum of the audience come to a full stop as Yann answered, "I don't know. I am just a filmmaker."

I remember way back to one of my first days at Cornell University, when I went to my advisor, the late astronomer Tommy Gold, and asked him what problem I should be working on. He immediately peppered me with a series of directed questions

about my specific abilities in math and physics. After listening to my responses, he then said, "Ok, with that skill set, you can work on this or that, but on these other problems, don't even go there." At that time, I had to have the problems well defined for me, and in a way that matched my particular skill set. A similar approach would may work today, were various advocacy groups need to present various problems in a way that will match a person's or group's particular skill set.

Epstein: I do see a lot of people and institutions lately taking up the rallying cry for sparking innovation and creative solutions.

Seckel: That's all fine and good, but in reality, I think that this is a little bit misdirected, as many of the "solutions" to various problems are already in existence, but for whatever reason they are stuck in the pipeline.   There are many reasons why they may be stuck, a lack of financing, a seasoned management team, proper exposure (they are not even on the menu), etc. Simultaneous to sparking innovation and creativity, we need to "unstick" those solutions that have not progressed past the solution stage into the practical implementation stage. In the real world, if a solution isn't implementable, tractable, scalable, and sustainable, it isn't really a meaningful solution.

You need a complete alphabet to form words, sentences, and thought, not a partial alphabet. Solutions are only part of the alphabet.

Epstein: Getting back to our earlier discussion, wouldn't you say that today, we have progressed into an Age of Information? The web, electronic means of communication, has made information so much more accessible and freely available than ever before.

Seckel: We have progressed in our technology and knowledge, but not always in the area of insight and wisdom. It is said that we live in an Age of Information, but I believe that we are rapidly transitioning from an Age of Information to an Age of Misinformation, and in many cases, outright disinformation. I have many friends and associates in high tech who are constantly rabbiting on about the efficiency, the immediacy, and the quantity of information. I rarely, if ever, hear them talk about the *quality* of information, much less maintaining that quality. No one wants to be the self-appointed censor.

Yes, we have access to more information, but we also have far more access to misinformation and disinformation. It used to be that information pipelines were expensive, and so you had filters at the top. For example, the peer review process, where you ostensibly had a group of disinterested experts and specialists, who could verify and replicate experiments and information, before it got published, allowed one to have, depending upon the journal, a degree of confidence in what was published. Of course, this process was not foolproof, but it certainly reduced the din of unreliable results and conclusions. The same was true in medicine and journalism, as well as any scholarly field. When you had a respected news anchor

like Walter Cronkite conclude his broadcast with, "And, that's the way it is", you had a degree of confidence. Of course, we knew that he wasn't foolproof and mistakes could be made, but at least there was a professionally trained staff, who had gone through due diligence in checking and verifying information, before it went out at Cronkite's vetted broadcast. Again, as I say, none of these checks and balances is foolproof. Even seasoned reporters like Dan Rather and Bob Woodward have gotten badly deceived.

Epstein: What is different about the information today being processed on the web?

Seckel: The world-wide web has allowed information pipelines to become relatively inexpensive, if not free. This has in turn allowed for far greater access to freely contribute and receive information. The combination of these two elements has led to what I call, a vast "democratization of information, "where "the good, the bad, and the ugly," all gets placed equally on a level playing field. Just look at some of the websites devoted to physics or astronomy, including some of the "educational" ones. They can be a complete disaster, where even fundamental terms like energy, power, inertia, etc. are incorrectly defined.

Epstein: This type of poor quality information is rampant in textbooks as well, so there is nothing new in terms of misinformation being created and spread.

Seckel: That is absolutely correct, our informational age didn't create, nor does it have a monopoly on misinformation or disinformation; however, it is the scale and access to and contribution to informational pipelines that is different today. You want to be a journalist? Never mind, the Columbia School of Journalism or any other professional training, etc., just start a blog or be an aggregator of information and collected opinions like Arianna Huffington's site. You want to offer up medical advice, just create a website. On and on it goes. Now, anyone can be anything or everything, just by access to those pipelines.

I know that this goes against the mainstream of American thought and fairness that all ideas are equal, but actually they aren't. They are based on merit, not on fairness or popular opinion. In addition to this, I alluded previously to the fact that information was presented in a shallow and immediate way. I am not a fan of the increasing use of twitter for example, because you have to reduce informational content (if there is any at all) to 140 characters or less, and other than notifications and trivia, this doesn't allow for the inclusion of proper context, and so, the propensity to misuse it is definitely there.

Epstein: What about the idea of information being self-correcting when it is out there, being checked by the masses.

Seckel: A lovely and romantic concept, which unfortunately doesn't work in principle. My friend Jimmy Wales tried this when he founded Wikipedia. That was

supposed to be a self-correcting system. Wikipedia, in spite of the various checks and balances that they had to incorporate, is a disaster and unreliable as a resource. I have heard a number of people state that statistically, Wikipedia as a primary source of information has as many errors as *the Encylopedia Brittanica*. I don't know where this information comes from, but I don't view the *Encyclopedia Brittanica* as a primary source either. It would be helpful if people started understanding the difference between primary, secondary, and tertiary sources for information.

Epstein: You talked about necessity of practical solutions and implementing them, so what are you going to do about this problem, which is "practical and sustainable"?

Seckel: The problem is quite complex, and naturally there are many different approaches that one will need to take. I don't have a practical "solution" to all these problems, but as I have stated before, one needs to start with tractable solutions. What I mean by "tractable," is a solution that can be implemented within five years and will have a meaningful and sustainable result. I hope that it will scale as well. Now, that's the general view, but on the practical implementable side, I am now working very closely with my good friend Caprice Young, who is an absolute dynamo as a nationally respected reformer in educational circles. Caprice helped grow the charter school system in this country, and has served on numerous boards, on both a local and national level, and she has the experience, passion, and knowledge to get things implemented on a national level. So, Caprice and I are now partially funded to put together a massive interactive website on thinking skills to be incorporated into school curriculums, along with interactive lesson plans and programs.

Epstein: Tell me about this website. Thinking skills? That's a very broad term.

Seckel: Yes, it is a broad term. Most people think thinking skills means "critical thinking, " but actually the skill-set of critical thinking is only one part of the larger issue of thinking skills, which involve many aspects of thought, including creative thought.

Epstein: Tell me about the site and what you are trying to accomplish:

Seckel: It will be divided into the following areas:
   (1) Perception: Learning the basics about the human perceptual system and
       various perceptual blinders and filters for building up beliefs and opinions;
       (2) Propaganda (or critical thinking): how to recognize and determine
       whether statements made in a variety of situations are valid on a prima facie
       basis, and the basic techniques of manipulation; (3) Context: the most
       essential and important part of information; (4) The Scientific Method: How
       to test the validity of claims, what constitutes proper controls, what does not.
       How to ask the right questions, etc.; and finally (5) Creativity and Innovation:

Providing the methods for eliminating mental blocks to thought, creativity, and practical solutions.

Epstein: So, how will this work?

Seckel: Each section will be largely interactive and will have many examples. There will also be an emphasis to make it fun, delightful, and surprising, along with many AHA! moments so as to carry the student through on his or her own accord. That this will be fun to interact with, and external pressure is not necessary to finish the program. Again, it is not offered as a "complete" solution, and I am not so naïve as to think you can just "teach" the world to be rational and develop necessary thinking skills, but it is a start, an arrow among a quiver of arrows needed...

Epstein: Won't all this critical thinking cause people to become cynical?

Seckel: It is not our goal to have people become unduly suspicious or cynical of what they hear and read, but just more aware of how careful one has to be in coming to conclusions, as well as the need for clarity and exactness in thinking. Critical thinking is necessary, but also has its limitations too. I know plenty of professional skeptics, who fall into their own trap of negating things unnecessarily, because of a pattern of critical thinking at the expense of finding out what is really happening. Thought and imagination need to be somewhat tethered.

Epstein: Where did you develop some of these thinking skills? Did they come from your parents?

Seckel: Oh, like everyone else, I used to parrot, and on occasion, still do; however, one of the most helpful lessons I learned was when I was a freshman at Cornell. In high school, I was a great fan and admirer of the works of the English philosopher and mathematician Bertrand Russell. When I came across his books on mathematical philosophy: *An introduction to Mathematical Philosophy* and *Principles of Mathematics*, I found them to be absolutely delightful. I then found out that he wrote on other topics and came across his book "Why I am not a Christian." I read this, and he voiced opinions that I had always held, and then, I started to read more and more of his writings on a wide range of topics. His appeal to rationality and grounded science, as well as his clever, clear, and witty writing style appealed to me. His opinions as a course became my opinions.

So, in high school I would rattle off his opinions, sounding so erudite to my peers, teachers, etc. Of course, I was quoting a Nobel Prize winning and respected philosopher! Everyone was impressed with how brilliant I was! Naturally, I tried this successful approach when I arrived at Cornell, but that's when I immediately ran into trouble. I took a popular course in the History of Ideas in Western Civilization, which was attended by about 300 students. So, when the professor brought up a particular topic, which I knew from Russell's insights, I threw myself into it, hoping to impress the professor and the class. However, as soon as I finished

parroting Russell, the professor said to me, and in front of the entire class, "Oh yeah? What about…. And what about this?" Well, I was dumbstruck, because Russell hadn't discussed either this or that, so it was completely embarrassing to me, and I realized right then and there that my knowledge way down deep was shallow and I didn't have to go very deep at all. I had to derive knowledge and conclusions myself. That history of science professor, L. Pearce Williams, became my close advisor and friend during my four years there. He was a great inspiration to me. We are still in touch. A few years back my then Cornell President Jeffrey Lehman invited me to return to Cornell to give the Presidential Lecture. I dedicated my talk to Pearce, which brought tears to his eyes. It is nice to give back and appreciate what you have been given.

It was also from Peace that I learned that you need the help of informed people, who can offer sound criticism and advice. People who take the autodidactic approach often run into trouble, because there is no one, who can help provide guidance, your own mental blinders get in the way.

Epstein: This parroting approach is also a problem in how many people learn mathematics in high school.

Seckel: Very much so. Students learn a series of steps of how to arrive at an answer without much of an understanding of how they got there. This is how I honed my skills in math and physics, as I just spent endless hours deriving everything I could.

Epstein: Who were some of your other inspirations in thought and thinking skills?

Seckel: I was extremely fortunate through a good part of the 1980's to be very close to Richard Feynman. We spend many hours together almost every other day discussing all manner of topics from quantum computing to vision to aspects of theoretical physics. There were three of us in his very close inner circle, and it was an exceptional time. For a number of reasons, he liked me, and we had a lot of fun together, including camping trips, house visits, dinners, etc. I gained an exceptional box of tools from being with him.

Epstein: Yet, you moved away from theoretical physics?

Seckel: Well, this was back in the 80s, when Caltech's John Schwartz and others were developing string theory. One of the other three members of our Feynman circle was Michael Douglas, who was Schwartz's ▮▮▮▮. student. Mike was an exceptional physicist and we would discuss it at length, but at that time, string theory was all in this horrible light cone gauge, and I found it personally very difficult to see the physics of what was going on anymore. From what I could see, it seemed like too much of a mathematical trick with no possible way to experiment.

Feynman and I discussed it too, and we shared similar prejudices. Of course, Murray Gell-Mann would have none of our discussions and thought we were just being stubborn, "idiotic," and sticking to the "old stuff."

In fact, since that time, Michael, who has become a prominent string theorist and I have kept up a long standing and very friendly feud about the validity of string theory, and whether it was in fact either a proto-science or a pseudoscience. My good friend Shelly Glashow and I also shared the same prejudices (and we also talked about it at length), as well as many of my physicist friends who were first-rate astrophysicists or general relativists.

Mike later discovered that there are roughly 10^{500} solutions, and I immediately called him up and congratulated him for bringing down the theory as not being parsimonious. One time Shelly Glashow was staying with me, and Mike was visiting Caltech on sabbatical, and so both Shelly and I roped Mike into going down to the local pub and having it all out. At the end of the discussion, Mike said, "Yeah, there are definitely problems, but we basically hope to work all this out."

Because of Murray Gell-Mann's staunch advocacy, string theory became the "in" thing, and started to zap up all the fine new minds, but it didn't really matter for me, because I got seriously ill with leukemia in 1990, and dropped out of physics and anything else, for that matter, for a few years.

Epstein: And your thoughts about string theory now?

Seckel: Honestly, I have not kept up with it, like I used to do in the old days, and so, there has been tremendous progress. I often get some catch up lessons when my friends Lisa Randall, Sean Carroll, John Schwartz, or Mike Douglas come by and visit. A few months ago, I actually hosted at my home a very prominent group of international string theorists, who were at Caltech and UCSB for a conference. So, I got completely surrounded, and we had some good discussions then, and I will say, for the record, I am much more open to the possibilities now than I used to be, but I wouldn't be as strident now in my attacks as Lee Smollin has been recently in his books. The funny thing is that I just don't find it internally satisfying.

Epstein: What do you mean, "internally satisfying"?

Seckel: Well, it has to do with an internal "feeling" of beauty and elegance. I try to avoid such "emotional" terms in discussing physics. It is actually a rather interesting and I believe deep topic, Why is it that our sense of beauty and elegance form such a useful tool for discriminating between a good theory and a bad theory, and a related issue, which is why are the fundamental laws of the universe self-similar?

I had put these questions to Feynman back in the 80s, and his response was that "It was "God dam useless to discuss these things. It's a waste of time." Dick always had an immediate gut-wrenching approach to philosophical questions.

Nevertheless, I persisted, because it certainly was to be admitted that he had a strong intuitive sense of the elegance of fundamental theories, and might be able to provide some insight rather than just philosophizing. It was also true that this notion was a successful guiding principle for many great physicists of the twentieth century including Einstein, Bohr, Dirac, Gell-Mann, etc. Why this was so, was interesting to me.

We spent several hours trying to get at the heart of the problem and, indeed, trying to determine if it was even a true notion rather than some romantic representation of science.

We did agree that it was impossible to explain honestly the beauties of the laws of nature in a way that people can feel, without their having some deep understanding of mathematics. It wasn't that mathematics was just another language for physicists; it was a tool for reasoning by which you could connect one statement with another. The physicist has meaning to all his phrases. He needs to have a connection of words to the real world.

Certainly, a beautiful theory meant being able to describe it very simply in terms of fundamental mathematical quantities. "Simply" meant compression into a small mathematical expression with tremendous explanatory powers, which required only a finite amount of interpretation. In other words, a huge number of relationships between data are concisely fit into a single statement. Later, Murray Gell-Mann expressed this point well, when he wrote, "The complexity of what you have to learn in order to be able to read the statement of the law is not really very great compared to the apparent complexity of the data that are being summarized by that law. That apparent complexity is partly removed when the law is formed."

Another driving principle was that the laws of the universe are self-similar, in that there are connections between two sets of phenomena previously thought to be distinct. There seemed to be a beauty in the inter-relationships fed by perhaps a prejudice that at the bottom of it all was a simple unifying law.

It was easy to find numerous examples from the history of modern science that fit within this framework (Maxwell's equations for electromagnetism, Einstein's general-relativistic equations for gravitation, Dirac's relativistic quantum mechanics, etc.,), but Dick and I were still working away at the fringes of the problem. So far, all we could do was describe the problem, find numerous examples, but we could not answer what provided the feeling for great intuitive guesses.

Perhaps, our love of symmetries and patterns, are an integral part of why would embrace certain theories and not others. For example, for every conservation law, there was a corresponding symmetry, albeit sometimes these symmetries would be broken. But this led us to another question: Is symmetry inherent in nature or is it

something we create? When we spoke of symmetries, we were referring to the symmetry of the mathematical laws of physics, not to the symmetry of objects commonly found in nature. We felt that symmetry was inherent in nature, because it was not something that we expected to find in physics. Another psychological prejudice was our love for patterns. The simplicity of the patterns in physics was beautiful. This does not mean simple in action - the motion of the planets and of atoms can be very complex, but the basic patterns underneath are simple. This is what is common to all of our fundamental laws.

It should be noted that we could also come up with numerous examples where one's sense of elegance and beauty led to beautiful theories that were wrong. A perfect example of a mathematically elegant theory that turned out to be wrong is Francis Crick's 1957 attempt at working out the genetic coding problem (Codes without Commas). It was also true that there were many examples of physical theories that were pursued on the basis of lovely symmetries and patterns, and that these also turned out to be false. Usually, these were false because of some logical inconsistency or the crude fact that they did not agree with experiment.

The best that Dick and I could come up with was an unscientific response, which is, given our fondness for patterns and symmetry; we have a prejudice — that nature is simple and therefore beautiful.

I published some of these issues on the edge website back in 2001, and later, in 2009, when I was discussing with my close friend physicist Murray Gell-Mann possible topics for discussion at TED, I suggested this as an interesting topic, and he agreed. His talk expanded on this theme and is well worth listening to:

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Epstein: So, you went into the study of perception from theoretical physics?

Seckel: Yes, after my recovery from leukemia, which knocked me out for several years, my abilities to do complex mathematics were severely impaired, and I have never recovered my mental abilities from that prior to my leukemia. Nevertheless, when I recovered, I was still interested in Big Questions. The mysteries surrounding the brain were something that interested me. My interest also stemmed out of substantive discussions that I had previously with Dick Feynman about David Marr's book on vision. We had never been able to answer some of the questions that Marr raised.

Feynman had given me a very good toolbox, and I thought I would apply it to the study of the brain. This is very similar to the approach that Max Delbrück had in inspiring theoretical physicists to look into biological problems in the mid 1940s. Delbrück had lengthy discussions with Erwin Schrödinger, who of course, wrote the

classic book *What is Life*? based on his discussions with Delbrück. A good number of physicists, who were tired of their work being applied to the science of death in making atomic bombs, read this book, and applied rigorous hard-core scientific principles to biological systems, which gave rise to the science of molecular biology. This led to some hope that such an approach would work.

In theoretical physics, when you are trying to get at the fundamental issues of the universe, you don't just confirm and reconfirm the things that have already been confirmed. You look at the so-called quirky areas, those areas that seem a little hard to fit in. That's where you scratch, and are liable to find things that are interesting.

Epstein: So, how did you apply this to the study of the brain?

Seckel: So, I asked myself, "What is the brain mainly concerned with?" Well, it is devoted to visual perception. It was also helpful that we had by that time the beginnings of understanding of the visual system and pathways from studying the macque monkey.

So, I asked myself, "What is the quirky area of visual perception?" The answer was visual illusions. I was very lucky, because when I started, the timing was opportune, as multimedia toolboxes were just developing and being marketed. I still had to constantly push the boundaries of all available software.

This was in the early 1990s, and so, I was the very first person to comprehensively investigate and dissemble various illusions to see how they operated, and what were the critical parameters for making them work. Of course, scientists have been studying illusions seriously since the late 19th century, but they didn't have the box of tools that we were developing.

I embarked on a rigorous task of collecting, saturating, and analyzing myself in the subject. I managed to get amazing results, so much that no one had seen before. It was like taking the cork out of the bottle…it all flowed out. In this process, I was greatly supported in the Caltech laboratory of Christof Koch and later Shin Shimojo, and I started actively collaborating and speaking at universities all over the world., and to disseminate my work through websites, books, and collaboration. At that time, the rigorous study of illusions was unfamiliar to people. Now, this approach is used in vision science and perception laboratories all over the world, there are even conferences devoted to it, but back then, it was minimal at the very best. It is hard to believe now, because the study of visual illusions as a means of understanding perception and the visual process has proliferated so much.

Epstein: What is so special about visual or perceptual illusions?

Seckel: Illusions are a very nice window into how the brain perceives, because they can reveal the hidden constraints of the perceptual system in a way that normal

perceptual processes do not. For the past 17 years I have been working on trying to understand the various mechanism that mediate perception, and in specific cases, when possible, what are the neuronal correlates of visual illusions. My extensive database and knowledge of illusions became also very handy, because when Caltech would have, for example, a visiting professor from MIT, speaking about brightness illusions, and what he thought were the underlying mechanisms, he would have worked it out from only a very limited sampling available to him. "Oh, these brightness illusions are caused by the intersection of Y and X junctions, etc. However, I would be able to point out brightness illusions that had the same effect, which violated his Y and X junction rule, and so, both my comprehensive compilation of innumerable effects and the saturation of trying to understand their underlying mechanisms became a very powerful tool for understanding some basic elements of perception.

Epstein: Is this what you are still working on still today?

Seckel: No, not as much anymore, although I still do contribute, because my daughter Elizabeth works in the laboratory of Vilaymar Ramachandran, and is publishing papers with him, and so, I can now enjoy kibitzing and suggesting ideas. For many years, I went around to various universities giving talks on these effects and underlying mechanisms; however, now, I want to take it to the next level, into a "take away" for the audience, and how the underlying mechanisms relate to the Nature of Belief, and steps that we can take to help problem solve.

Epstein: Aren't you writing a book on this topic?

Seckel: Yes. This is one of the books I am currently working on, and I have shifted my lecture talk to this focus, and my insights have been so far, well received.

Epstein: Can you tell me the thrust of your talk and book? I have seen your talk and it is quite remarkable.

Seckel: Thanks. Oh, it's a little difficult to present it powerfully without the aid of some of my demonstrations, but luckily one can go see 1/4th of the talk, because of imposed time constraints, which I gave at TEDX USC last year. The link can be found here:

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However, the basic thrust of my talk is trying to understand the various constraints and filters of the human perceptual system, and how it even applies to the nature of how we form our beliefs and opinions. We may not be as free as we think we are in building up our core beliefs and perceptions of the world.

Most people tend to take vision and perception for granted, because it comes to them so easily. After all, we appear to build up a seamless mental and apparently exact representation of this visual rich three-dimensional world that we inhabit and navigate. Of course, this leads to the trivialization that the eye/brain is like a camera, which records incoming light information, but the brain interprets, where as the camera records, and that is a very big qualitative difference.

The perceptual system is really a framework for allowing you to successfully inhabit and survive in our world. Over millions of years of evolution, the human perceptual system has basically evolved a "bag of tricks," which exploits the regularities of our environment, and allow us to have a fairly accurate representation of our world.

In our physical world, physicists have shown that underneath all this apparent complexity of the universe are basic fundamental laws and interactions that are repeated over and over again. The universe is constrained by hidden laws, but yet, there is tremendous complexity. In the same way, the complexities of human perception, are governed by a set of rules that operate beneath your level of awareness.

The human perceptual framework, in very general terms, can be divided in three divisions, which feed and interact back and forth with each other.

(1) The building up of the fundamental scene, i.e, form, brightness, color, motion, etc.
(2) The meaning of the scene, which relates to tagging and labeling objects, and what is salient about the scene
(3) The building up of a core belief system.

It is my thesis that all of these divisions operate through rules that operate beneath your level of awareness, and that you have no mental control over these rules, and that you have no mental control over these rules. Your perception is very context dependent. . It takes very little information to flip a perception one way or another by switching surrounding context.
Furthermore, incoming information is perceptually mapped onto the existing framework in way that is supportive, even if that information is contradictory, inconsistent, or unusual.

All human beings have the same underlying perceptual system (obviously neglecting damage or individual differences), but yet somehow they come up with different beliefs. This was interesting to me.

Epstein: How does all this relate to the Nature of Beliefs?

Seckel: As I mentioned, it is about perceptual mapping. Once a framework is in place, we tend to map to that framework in a supportive way.

Epstein: Can you give some examples to clarify?

Seckel: Let us start with the building up of a fundamental scene. When I show you an image of an impossible figure, let us say, an impossible figure, you make a mental representation of this figure as a three-dimensional object, even though conceptually you know that it is completely impossible.

Epstein: Why is that?

Seckel: For your entire lifetime, you have interpreted two-dimensional perspective drawings into three-dimensional mental representations. There are rules that have been developed by your perceptual system for doing that. You can't stop using those rules, even when faced with a figure that is clearly impossible. The rules will overtake the conceptual part, and you will continue to "map" it in a way that is consistent with that framework. Also, just think, when you make a perceptual mistake, i.e, trip on a curb, knock over a glass, etc., your world doesn't go suddenly out of focus, and your perceptual system adopts a new set of internal rules, it just continues doing what it did before.

Now, let us look at a Core Belief, something that really defines a person's way of interpreting the world. Let's take the example of a magical thinker versus a non-magical thinker. Both the non magical thinker and the magical thinker can easily navigate the world, but they "map" the world that they navigate in very different ways.

Let us show both the non-magical thinker and the magical thinker same photograph of a young girl pulled out of the rubble in Haiti, and ask them what it represents.

Of course, both can identify and discern the young girl being pulled out of the rubble, but that is where the commonality stops.

The non magical thinker will look at this photo and say, Well, Haiti is on a known fault line, the houses are poorly constructed, an earthquake happened, thousands of people were killed and injured, and even after ten days, statistically it is highly probably that a child will be pulled out of the rubble alive. No divine intervention is necessary, and there is no "proof" of that. In fact, they may go on to state, that it actually indicates evidence "against" the idea of divine intervention, because there was no intervention to save the thousands were actually were hurt or killed, why the neglect, and come in to save just one. It doesn't make sense....

The magical thinker will look at the same photo and see evidence "in favor" of divine intervention, and state that this shows the Miracle of God's benevolence, etc. They will completely ignore the factors that the non magical thinker has put forward. So, rather than "weaken" their belief, it tends to support and embolden their belief.

Faced with obvious contractions or falsehoods to belief systems, the brain is quite

adept at coming up with ways to keep that core belief intact. After all, it is there to have you be successful. It isn't necessarily there to be the Truth police. Sometimes your perceptions mesh with Reality and sometimes they don't. This is why I define Reality as that which exists independently of your beliefs or perceptions..

So, at some point you have that life defining experience. It convinced you to make that most Personal of all decisions - something that would govern the rest of your life and serve as your moral compass. Subsequent to that experience, the rest of your life experience has reinforced your guiding principles. You are constantly "reaffirmed" in what you see about you.

Now, you come into contact with someone who does not share your core beliefs. You have to spend the weekend with them in close quarters, and decide to have "it out," but in a very amicable way. You both present yourselves in the most articulate manner possible, self-satisfied that you could not have done a better job! Not only did you present the information that made you embark on that principle in the first place, but you presented much additional evidence, just to put the argument over the top...

What does the other side do? Shake their head. He/she will have none of it... In fact, rather than "weakening" your opponent's side, you find out you have "emboldened" them! There is a Big Disconnect.

Epstein: Can you provide any relevant examples of this today?

Seckel: Yes, actually with the current Climate Change debate. About twenty years ago, I was very actively involved in the creation science/evolution debate. I debated creationists, and put together an amicus brief on behalf of 72 Nobel laureates before the Supreme Court. Without exception, every creation scientist was a Fundamentalist Christian. There was a Core Belief behind their views. There was nothing in the fossil record, the robust findings of astronomy, geology, biology, chemistry, physics, etc., etc., which would change their views to accept evolution over a literal interpretation of the Bible. They would quote passages out of context from the evolutionists to support their views. They would accept minority points of view.

All this indicated to me a Tremendous Similarity to the climate change skeptics, and in this case, some of them were quite intelligent and articulate about other areas. In this debate, I noticed something very unusual... Part of the lay public was arguing a so-called "controversy" in science, at a level of detail, which you seem to need a ▓. or tremendous technical and scientific expertise to combat. They would quote reports, studies, cycles, weather patterns, and in a detailed way. They were passionate! They would accept minority findings, quote scientists out of context, and leap on anything that would support their framework.

Ahh, what is the similarity to the creation scientists? I asked myself what is the Core

Belief of the climate skeptics? It wasn't too difficult to discover that they are Libertarians. What is the Core Belief of the Libertarian? They *do not* like Government Regulation, Government Intrusion, or any invasion of their individual Rights. That's it. Notice, that the climate change skeptics, *accept* all the findings of the climate scientists that the world is getting warmer, and accept all their work, regarding other contributors to that warming except one! -- that there is a significant contribution by Humans. IF the climate change scientists are correct, that humans have been a significant factor, it means regulations at a massive scale, which goes completely against their Core Belief system. I have tested this hypothesis very extensively now. In arguing with any climate change skeptic, I ask them if they are a libertarian. Their immediate response is "Yes, but what does that have to do with anything?" Well, everything actually....

If you read in the paper about about a "think tank" that has shown that the climate change scientists are wrong, and look up the "think tank" on the internet, what do you find, but that they are a Libertarian think tank. Penn Jillette and Teller, two magicians, who I know well, and have a popular series debunking all sorts of shame science and pseudoscience, did a program which blasted climate change science. Why? Penn is a very outspoken Libertarian advocate. Same thing was the case with the science fiction author, now deceased, Michael Crichton, who is frequently referred to. Bjorn Lomborg, author of the Skeptical Evironmentalist, the Holy Bible of the climate skeptic movement, also is an avowed libertarian. Anytime, you find someone or some institution critical of climate change in the news, just do a google search or investigation, and you will find that they are liberatarian.

It is easier for them to attack the science of human induced climate change, rather than to change their Core Belief Principles. They are not even conscious that they are doing this. It is a part and parcel of the human perceptual system.

This is why I think that the whole climate change is misplaced, by arguing arcane issues in science. The attack should be focused on the underlying Belief System, not the "science" behind the skeptics. This will be the most persuasive argument to those who are "sitting on the fence."

Epstein: Do you still see your colleague Christof Koch? What do you think of his work on consciousness and free will.

Seckel: Yes, Christof is not only a colleague, but also a very close friend, and he has been absolutely terrific and tireless in his support of my research over many years. We have enjoyed endless discussions on a myriad of topics. Of course, he is incredibly bright, knowledgeable, and extremely quick. He is just my style. He will sometimes stay at my house in Malibu, and we will take long walks together arguing in the hills. We are great and supportive foils for each other.

Epstein: Have you given much thought to his work on consciousness?

Seckel: It would be better defined as "awareness." Yes, I have had many discussions with him, as well as with our dear departed friend and colleague Francis Crick. I have some of my own views on this subject, which I can share, as I have already presented them to Christof.

Epstein: And, they are?

Seckel: Well, one of the issues relates to when a sentient being becomes "aware," and I don't mean "self-aware," which is reserved for very high-level cognitive beings. Christof has been wrestling with the idea of this awareness coming in as a sort of phase transition or perhaps gradually. Into this discussion, comes the idea of when, by "definition" does something become "aware"?

It is my belief that these sorts of conundrums are just semantic, and I view awareness that progresses gradually to more and more rich states. The example that I like to use is defining whether someone is "rich" by the number of pennies that they have. Suppose they have 100 million pennies. Does that make them rich? Well, if you say yes, well, if you remove one penny, are they no longer "rich"? At what point after removing pennies does the person go from a rich state to a non-rich state? Now, just substitute individual neurons for individual pennies and ask yourself the same question about awareness.

Christof does excellent hard-core neuroscience. Everyone knows that, but I also find that he can get quite muddled when he starts thinking in philosophical terms as opposed to scientific ones. I find that he falls easily into philosophical or semantic traps.

Epstein: Can you elaborate further in terms of your use of the word "richness" when applied to awareness, perhaps using the comparison between a human being and another sentient animal?

Seckel: Ok, well take my dog and myself. Is my dog "aware"? I would argue definitely yes, but my dog just has a much more impoverished "awareness" than I do. For example, when I look around this room, not only do I perceive basic shapes, color, brightness, and motion, but I also tag and label things too, based on my experience. My perception of the world in terms of those fundamental qualities allows me to successfully navigate the world and not constantly trip and bump into things. Now, my dog can do this too. She doesn't walk into walls, fall down the stairs, and knows how to get about quite easily.

Now, in addition to these basic building blocks of perception, as I said, I label and tag the scene, based on my level of experience, so once the basic forms are built up, I can identify and label, "Oh, that's a chair, that's a telephone, that's a computer, that's a dish, pen, etc." My dog, however, sees the same objects, but doesn't tag and label them the same way. She has no understanding or awareness of the name or utility of

a chair, telephone, computer, or pen. However, there are certain things that are meaningful that she has labeled. For example, she knows and understands to a limited extent her leash, her dish, my bed, my car, and so on. So, her perception of the world, as I see it, is much more impoverished than mine, and hence her awareness is less rich. Think of the plug being pulled on HAL in the movie 2001 as he gradually looses his mental abilities.

Epstein: So you don't believe in any sort of phase transition for awareness?

Seckel: Well, actually, I do. I believe in both a phase transition, as well as gradual awareness.

Epstein: When in your opinion does the phase transition take place?

Seckel: I have been advancing my own argument, as yet unproved, but based on my own thoughts in perception. It has to do with a split that we have between our "conception" of something and our "perception" of something. Under certain circumstances, especially, in the awareness of perceptual illusions, our conception may be ok, but our perceptions are fooled. In many types of robust illusions, no amount of conceptual knowledge or experience will override your faulty perception. For example, you may perceive two areas as entirely different colors, but in reality they are absolutely identical. You will be tricked *until* this fact is brought to your awareness, by information, testing, whatever. In other words, you need the "awareness" to actually know that you are fooled, that there is a split between these two different mental modalities.

I believe that "awareness" comes in when there is such a split. In some lower animals, for example, you can show them the same perceptual stimulus over and over again, along with the reveal, and they will be fooled every time. Other animals, once there is "awareness" that their perceptions have been fooled by the stimulus, will not be fooled again. A scarecrow, at first fools the birds, then the birds learn that it isn't animate, and they perch on it repeatedly. There are numerous research papers now coming out that demonstrate that some lower animals have can discern illusions, including bees, as in the work done by my friend and colleague Beau Lotto. My thesis is by no means proven, and the issue is far more complex than this suggests, but for me it is one possible starting point for discussion.

Epstein: What have been some of your most recent discussions?

Seckel: Lately, Christof has been working on a book on free will. Of course, there have been endless books devoted to this book from a philosophical and moral point of view, but Christof is trying to understand it from a neuronal point of view, although once again he gets boggled down in philosophical conundrums. He has worked on his book at my home, and so, we have had plenty of animated discussions...

Epstein: Conclusions?

Seckel: I don't know about conclusions. Christof is of the opinion that free will is an "illusion," i.e, that we really don't have it. It really comes down to some basic semantic definitions of "free choice," and so on. I have heard his arguments, but as I have said to him, it reminds me of a joke about Niels Bohr, who used to have a horseshoe over his door. When asked why, he replied, "It is to bring me good luck." Naturally, his physicist friends were incredulous over his maintaining even the presence of such a superstition, and so they proceeded to question him about it. Bohr responded, "Well, I know all that, but I am told that it will bring me good luck even if I don't believe it." Well, that's the same way I feel about the "free will" argument. I have heard the arguments against it, but I still believe that we have it!

Epstein: How can we get at the bottom of this discussion?

Seckel: Well, of course, we need to have some proper experiments, but this is such a difficult area to properly test. Now, I have actually thought of some original ways to experimentally test whether we have "free will," or as I would say "free choice," which I have suggested to Christof, and that I hope my daughter will carry out soon in Rama's lab. I don't know what it will prove or not, but it should be interesting to see the results.

Epstein: Can you describe the difficulties?

Seckel: Let us keep the discussion to "free choice." You may have a strong preference, for example, for chocolate ice cream, but really have a strong dislike for vanilla ice cream. Given the free choice, of which to pick, when offered, your preferences, context, will always guide your choice. So, is that free choice? Is there any freedom, given the same exact situation, to make a different choice? Well, herein lies one of the problems. Suppose you make a choice, well, you can't "reset" your internal memories/experience, so that it never happened, and see if you will make a different choice. As time moves forward, each situation becomes unique. And, although you picked chocolate this time, maybe next time, you will want to thwart the process because of your previous pick, and choose vanilla. My suggestion was to somehow circumvent those memories and experiences.

Epstein: How can you do this?

Seckel: You can't really, because of existing prior memories, which influence your next decision by context. However, there are people who suffer from severe retrograde amnesia, and who are unable to retain new memories. It is always a blank slate for them. There are certain types of "free choice" examples, such as a particular type of maze, which has many forks, and a path forward or backward from the goal that is basically impossible to work out in a short time frame. So, you allow the subject to solve the maze, each fork will represent a choice that has no obvious, subtle, or hidden preference. See the path the subject takes, then remove

the maze, let the memory vanish, and present the same maze again. Will the subject take the same path? I predict that the subject won't, which to me suggests that there is a certain amount of choice in the matter. Of course, most things are quite constrained by contextual and complex elements. I am just interested to see what will happen in such an experiment.

Epstein: Finally, one last question. Do you believe in any supernatural entity or God?

Seckel: No, never ever have, but then He or She doesn't believe in me either.

Epstein: Thanks for the interview.

Seckel: You are very welcome.

Please note: As a rule, opinions expressed by my subject interviewee do not necessarily reflect my opinions or belief. These interviews are only meant to foster further thought and discussion about ideas and people that I find interesting.

Jeffrey Epstein, patron of the sciences.