



# EdgeScience

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Current Research and Insights

**Stellar Consciousness**

**Bioculturalism**

**Semantic Pathologies**

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**Why EdgeScience?** Because, contrary to public perception, scientific knowledge is still full of unknowns. What remains to be discovered—what we don't know—very likely dwarfs what we do know. And what we think we know may not be entirely correct or fully understood. Anomalies, which researchers tend to sweep under the rug, should be actively pursued as clues to potential breakthroughs and new directions in science.

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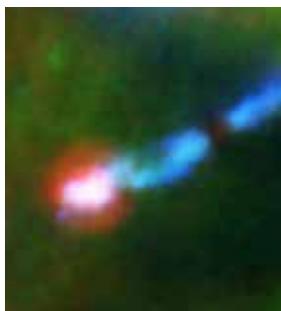
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# CONTENTS

## 3 THE OBSERVATORY *Semantic Pathologies and the "Laws" of Nature* By Michael Reddy

## FEATURES

## 8 *Bioculturalism: What Modern Medicine Misdiagnoses* By Frank Bures



## *Stellar Consciousness: Can Panpsychism Emerge as an Observational Science?* By Gregory L. Matloff

# 15



Cover image: The Eagle Nebula, M16, through the Hubble Telescope in 2014. Credit: NASA/ESA/Hubble Heritage Team (STScI/AURA)/J. Hester, P. Scowen (Arizona State U)

Michael Reddy

# Semantic Pathologies and the “Laws” of Nature

**M**ainstream science has strong social, financial, institutional, and even political drivers. While this is not part of its preferred public image, many educated people understand it. Research is by no means simply an observational and cognitive endeavor. I contend it is also a linguistic endeavor. Even in cases where findings can be reduced to mathematical equations, there are underlying presuppositions, metaphors, and models that get expressed in human language. I want to suggest and present evidence that English, by and large the lingua franca of world science, creates bias. Speaking in certain ways is in a reciprocal relationship with thinking in certain ways. What if the apparatus we use in our language to speak about scientific findings strongly favors the social, financial, institutional, and political drivers?

Let’s begin with the simple premise that what science discovers is recurrent patterns of behavior in the world around us. Yes, there may be reasons later to qualify or nuance that.<sup>1</sup> Still, as a first approximation, let it suffice. Even when these regularities have very wide scope, are not obvious, and have long gone unnoticed—they are still simply patterns recognized and verified. But the origin of the whole scientific endeavor took place in, and merged with, a deist worldview. The struggle between the emerging method of empirical observation and the authoritarian church split what had been a more unified, living, organic cosmos into life and spirit on the one hand, and dead mechanism on the other (Merchant, 1990). But the creator ruled both, in analogous ways, with the divine “law.” One commonly heard cliché is that Newton felt he was explaining the ways of God to man. What’s important here is that significant ways in which we speak about scientific findings are unfortunately still rooted in this historical worldview.

Consider the difference in the following

- (1a) There are many *laws* of nature.
- (1b) There are many *patterns* in nature.
  
- (2a) That breaks the *second law* of thermodynamics.
- (2b) That doesn’t fit with the *second pattern* of thermodynamics.

There is a shift in force and implication between the (a) and the (b) versions of these English sentences. The (b) versions are much more open in feeling and suggest nothing of a vaguely “criminal” nature involved in coming up with findings that “don’t fit.” The data diverges somehow but is in no way associated with “lawbreaking.” It’s perfectly possible to load

these (b) utterances with more social opprobrium, using words like “oppose,” “violate,” “flout,” or, as in (3)

- (3b) Don’t think you can *defy* the *second law* of thermodynamics.

I want to suggest that regular blind use of this kind of expression steadily undercuts the otherwise widely acknowledged understanding that scientific findings remain a tentative “observed so far” kind of truth. Such use is what’s called a “semantic pathology.” These are instances in which two or more ideas that are important to distinguish are lumped unnoticed together in the same linguistic expression. Calling scientific findings “laws” conflates the notion of “regulated by authority” with “observed patterns.” It muddles prescription with description. While patterns of profound importance are uncovered and persist so far in our investigation of our world, it is problematic that we still teach and talk of those patterns as “laws of nature.”

## The Conduit Metaphor— A Central Semantic Pathology

During my 11 years at the University of Chicago and Columbia (1967–1978), I jump started a branch of what is now called cognitive science (Wikipedia, 2010; Lakoff and Johnson, 1980, 1999). The term and the interdisciplinary approach did not exist at the time. I took some serious flak in doing so and ultimately walked away from academics. Still, what I had done was discover and document a pervasive, underlying, metaphorical framework in English that serves as our default explanation for how linguistic communication succeeds or fails. These “dead” metaphors comprise a folk model that is patently false. And yet, barring vague terms or unnatural circumlocutions, there is no easy way to speak on the subject without falling into its trap of mistaken entailments.

Here’s what the folk model says we do using language. The writer or speaker first puts her or his meanings or feelings into the words. The words then carry these across to the reader or listener, whose job it is now to take out of the words the same meanings or feelings the writer or speaker put there—and thus receive just what was wrapped up and sent over. Language is modeled here as a conduit, a delivery system, one that brings what’s in your head quite literally into mine. So, relative to the writer/speaker, we say

- (3a) Writing teaches you to *put* your *ideas into words* more carefully.
- (3b) Don't try to *pack* too many *thoughts into* too few *words*.

Of the words or groups of words themselves, we say

- (4a) That same *thought is in* several *words* in the paragraph—don't be so redundant.
- (4b) Your *words are hollow—empty promises*. They are meaningless.

Of the reader or listener, we say

- (5a) I can't *get* any coherent *meaning from* his garbled *words*.
- (5b) I *found* a lot of *anger in* those kinds of *words*.

This is just a quick look at the careful explication of data and implications in *The Conduit Metaphor: A Case of Frame Conflict in our Language about Language*. (Reddy, M., 1979) It has been widely referenced<sup>2</sup> as having documented that the primary vision the English language has of its own workings is that meanings are put “right there in the words.” If they are, of course, communication ought to be pretty straightforward and work more often than not. Failures are going to be more often attributed to the reader or listener, who “could not even get out the meanings I put there.” Or worse yet, we say the receiver cheated and slipped his own ideas into the packages, as in

- (6) I'm sorry, but you are *reading* that *meaning into* my *words*.

Instead, what's really going in linguistic communication is operationally complex and prone obviously—unless we work carefully at it—to failure. After all, words in the simplest sense are squiggles or squeaks. Look at or listen to Chinese or Arabic if you need to renew your perception of this truth. It seems absurd to have to draw attention to this, *but words have no insides*. Coming right out of Shannon and Weaver's mathematical theory of communication (Shannon and Weaver, 1971) also known as “information theory,” words can only function as **signals**. That is, they can only serve as instructions to select and assemble conceptual and emotive structures already present in the receiver's brain.

The resulting assemblies may be novel to the receiver, but must be built from what was already present in the reader or listener's mind. Your ideas and feelings (the **messages**) will literally never get “into” my head or brain, nor mine into yours. Barring psychic transference, which I don't think is active in the vast majority of human discourse—once again—the best that we can do is to send instead instructions to assemble radically internal patterns of neural firings we hope will converge on our own. Obviously, the success of this process is anything but assured.

### “Patterns” versus “Laws” of Nature

With this understanding that the meaning is very definitely not “in the words,” we can now look more deeply at the following.

How does what happens in readers' or listeners' minds differ when they comprehend the (a-“law”) versus the (b-“pattern”) versions of sentences (1), (2), and (3)? Like all linguistic signals, “law” in “law of Nature” begins as a group of marks or sounds. But the relation between these signals and human concepts is never one to one. It's always one to many. So there is a set of possible meanings typically called “senses” of the word that must be sorted through. Based entirely on the surroundings (nearby words, syntactic restrictions, and the whole context of the discourse), the reader or listener must select from the set of word senses which one to use in constructing the meaning. Think of a “word” as just the name we give to a set of possible meanings.

These meanings are typically related but distinct concepts. If you trace the etymology of the “law” set back, the root meaning from which the others spring remains “something prescribed as a regulation,” something “laid down by authority with penalties for violating.” So the brain of the reader or listener must access roughly the following set of concepts to begin the disambiguation process.

- LAW1 (a **civic regulation with penalties for violators**, “*Congress enacted a new law.*”)
- LAW2 (a **whole body of such regulations**, “*Interpretation of the law depends on precedent.*”)
- LAW3 (the **police forces**, “*Run—here comes the law!*”)
- LAW4 (the **combined institutions of police, lawyers, and courts**, “*The wheels of the law turn very slowly.*”)
- LAW5 (a **principle or fundamental truth** that serves as a foundation for a system of truths, “*That's an important scientific law.*”)

For “pattern,” understood as a noun, there are only

- PATTERN1 (a **configuration of lines, shapes, and/or colors**, “*That's a fascinating pattern of graffiti on the warehouse wall.*”)
- PATTERN2 (a **PATTERN1 when used as a model for reproduction**, “*Of course I made the dress from a pattern.*”)
- PATTERN3 (a **characteristic cluster of observed behaviors**, “*That's clearly one of the patterns of teenage life these days.*”)

Obviously, the set for “pattern” is both accurate and neutral. But LAW5 (the principle) sits alone in a set of coercive legal meanings and is a kind of generalization from those roots which arose first in the 17th century.

Perhaps the writer or speaker is indeed a real or crypto deist,<sup>3</sup> and, therefore, actually intends LAW1. Otherwise, describing scientific findings via the term “law” is going to activate initially and inappropriately all the connotations of strict social regulation—because LAW5 (the “principle”) is not “there in the word.” So, data that may in the end simply limit the scope of some pre-existing pattern found in nature is automatically associated at first with “breaking” or “defying” a LAW1. Especially if social, financial, institutional, and political drivers lurk also in the wings. This tends to place honest, hard-working, even brilliant empirical explorers by entailment subliminally

in the role of “criminals.” And historically, we know too well the impact of that. Mainstream scientists who ignore, bury, or demean anomalous data are on this background level being good scientific citizens—defending and enforcing the LAWI’s of Nature and science. After all, it’s so easy to say, and so helpful to entrenched theorists to think: “nature’s laws *govern* the universe.”

### How Much Does Language Influence Thought?

Benjamin Lee Whorf spent some of his life as an inspector for a fire insurance company. Though earlier thinkers had raised questions, the entire 20th century debate around the relation of language to thought seems to have been “sparked” by one experience of Whorf’s. For a fire insurance company, he analyzed circumstances around hundreds of accidental fires. Workers, he discovered, were always careful not to smoke around full barrels of gasoline, but became dangerously careless around empty ones (Whorf, 2015, p. 135). But full barrels have no fumes and don’t present the same degree of danger that “empty” ones do. Because the fumes that “empty” barrels contain are precisely what is flammable. It seemed as if, despite knowledge and warnings to the contrary, reverberations of “empty” in workers’ minds connected strongly with concepts like “powerless,” or “inert”—and therefore safe. An “empty” barrel has “nothing” in it. Too many fires were started this way. It seemed to Whorf that language was confusing their thinking and behavior, and this suggestion fueled much of his subsequent research.

Various versions of what is referred to as the Whorf hypothesis all have to do with the extent to which given languages either constrain or at least influence thought. Interest in this, arguments about, and attempts to gather evidence for and against have waxed and waned since the man died young in the 1941. Most of the work has involved comparing languages, and so this is also referred to as the “linguistic relativity” controversy (Wikipedia, 2001). The hypothesis went out of favor in the ’60’s and ’70’s, but came back quite respectably with studies in the 80’s and 90’s (Lakoff, 1987, pp. 304–337; Gumperz and Levinson, 2015). It’s not that the mind cannot think and perceive reality different from what linguistic structures push it towards, but rather that there are clear paths of least resistance that prevail without special effort.

### Laws and Conduits

Comparing features of the two pathologies discussed so far reveals an interesting interaction. The conduit metaphor in English is hugely powerful because it is productive, pervasive, and largely invisible. Think of “thoughts, ideas, meanings, or feelings” as the **messages** of language and denote those with “M.” Now take all the terms for words and groups of words (“paragraph,” “book,” “speech,” “tweet,” etc). Think of them as the **signals** of language and signify them with “S.” Using these variables, we can isolate “core expressions” of the conduit model that generate untold numbers of different utterances. Here are just a few of the likely still incomplete corpus of core expressions my early research uncovered.

*put M into S* “Try to put those ideas into words”  
*capture M in S* “Capture those feelings in a poem”  
*S conveys M* “His keynote conveyed great ideas”

Against 141 of these, I found only 45 other ways of speaking that avoided these core expressions. And many of the alternatives were vague and/or reverted to the conduit metaphor with the addition some little phrase (See Reddy, M., 2007c for these listings).

Obviously the “laws of nature” pathology, while productive, is not nearly so pervasive. People can also speak, for instance, of “principles,” “truths,” “equations,” “patterns,” “generalizations,” or “regularities.” But “laws” is widely used, very often with extreme dogmatic arrogance.

Cosmologist Sean Carroll comments, “A law of physics is a pattern that nature obeys without exception.” Scientists today take for granted the idea that the universe operates according to laws. . . . Physicist Paul C. Davies comments, “. . . to be a scientist, you had to have faith that the universe is governed by dependable, immutable, absolute, universal, mathematical laws of an unspecified origin.”<sup>4</sup>

And it has another associated aspect that, oddly enough, soon teams up with the conduit metaphor, in such a way as to strengthen it considerably.

Important patterns observed historically in nature give rise to procedures for calculation and prediction. Everyone exposed to science sits at first in classrooms where what are essentially algorithms are handed down as rules that must be followed or else one fails in the subject. One of the greatest blessings of my early education was to have calculus presented to me in terms of its historical development. It was not just a bunch of formulas to memorize and employ. But this typically does not happen.

This means that most scientists begin in a setting where formulas that express the important patterns that are found in nature are experienced pretty much as socially enforced rules. That is, they are LAWI’s in a real sense, not just for calculating, but also for regulating the behaviors that will pass the course. No one typically hastens to point out that these algorithms are human guidelines for successful prediction, as opposed to constraints on the behavior of the universe. But now here comes another supporting linguistic “leak” from the conduit metaphor. In what I called its “minor framework” (Reddy, 2007b) and is now known as the “knowledge as object” metaphor (Hinds and Arvind, 2017), the conduit folk model allows thoughts, ideas, meanings, and feelings to escape from people’s heads and words into an imaginary ambient space. In terms of the core expressions

*M pours out of S* “Passion for their work poured out of every tweet.”  
*M is circulating* “Those memes have been circulating for ever.”  
*M found [a, its, etc] way into* “Angry feelings found their way into the ghetto.”

*kick M around* “We kicked those ideas around.”

In addition to the word sense triggers, then, we have two additional factors contributing to this linguistic pathology. First, the patterns discovered by science are experienced first in classrooms as socially enforced regulations for allowed, proper behaviors, with violations being punished by failure. And second, the algorithms thus learned escape into a metaphorical ambient space via the conduit model of language. These two combine with the social regulation word sense associations involved in comprehending “law” to make doctrinaire behavior far too easy and likely. Namely, people will think of the outside world as subject to and ruled by the current, really only provisional, human algorithms that model its behavior as observed locally so far.

### So How Should We Talk?

But it will not do to say that all the resistance to fair hearings and assimilation of new and anomalous data is based on the social, financial, institutional, political, and now, I hope, well-understood linguistic pressures. When I talk simply about patterns in nature it may seem as if these are isolated configurations of behavior that can simply be tossed out easily if proven wrong. Not so. There are instead clearly patterns based on patterns, indeed better described as amazing, hard won pyramids of interdependent patterns. Findings in physics, for example, underpin formulations in chemistry, upon which biology gets based, and so on. But data now amassing around psychic skills, to mention one area, despite the large amount and high quality of it (Radin, 2006, 2009, 2013), cuts at the very foundations of the current mainstream scientific endeavor. The shift required to actually accept and integrate this is probably greater than the one that put the sun and the center of the solar system.

To be linguistically fair then, the (a-“pattern”) locutions in sentences (1) thru (3) should allow for some adjectival qualifiers. We might say things like

(7a) Nature has many *fundamental patterns*.

(7b) Nature has many *fundamental regularities*.

with other options like “cornerstone,” “foundational,” “central,” “primary,” “major,” “basic,” “widely applicable,” “key-stone,” “bedrock,” and so on. This leads to sentences like

(8a) That *doesn't fit* with the *second foundational pattern* of thermodynamics.

(8b) That would *undercut* the *second major premise* of thermodynamics.

(8c) These findings *undermine* Newton's *third regularity* of motion.

Using terms like “regularity,” “principle,” and “generalization,” it's not hard to see how we could both talk fairly and remove the LAW1 connotations. There can be phrases like: “Boyle's regularity,” “the great conservation principles,” “Dalton's regularity of partial pressures,” “Gauss's regularity,” “Joule's generalizations,” and so on.

### Where Does This Leave Us?

Sometimes pointing certain things out raises as many questions as it attempts to answer. I've made, I feel, a good case here that a failure to evolve perspectives is embedded linguistically in what is for non-deists the “laws of nature” pathology. But how would we go about fostering change in that ubiquitous manner of thinking and speaking? Beyond saying that it involves our educational process and must begin somehow with spreading awareness of the problem—I have no immediate remedies to suggest. It's a daunting task.

But there's a deeper issue here, as well. I've restricted this discussion to a first-order phenomenological perspective here. Words have no insides; literal thoughts and feelings can't “float around”; and only provisionally valid human algorithms cannot bind the cosmos when we see new evidence appearing *en masse*. Coming to clarity, I think, has to start here. But what about the huge body of evidence for psychic phenomena? What of Bengston's “resonant bonding,” where hands on healing spreads to mice in isolated control groups (Bengston and Fraser, 2011)? I think also of Sheldrake's “morphogenetic fields” and his “sense of being seen” and other experiments (Sheldrake, 1995, 2003, 2012). Doesn't the observer effect in quantum physics suggest that human thoughts and behavior might well have some kind of impact on nature's behavior? Something not yet accounted for is happening.

It seems likely that, before too long, we might need a model of the interaction between scientific exploration and patterns of behavior in the world around us that is richer than strict, one-way observation. What if there are patterns in this interaction that allow for and begin to explain how and when influence can go in both directions? But even if human theories should in some way ultimately affect nature's behavior, one thing is clear. The thrust of discovery in so many fields has been in the direction of an evolving, as opposed to a static, universe.<sup>5</sup> So this idea of patterns “out there” fixed for all time and in all places is an article of blind faith and cannot stand.

### ENDNOTES

- 1 This essay offers an additional perspective on parts of two recent *EdgeScience* “Observatory” articles. Henry Bauer (Bauer, 2016) pointed out that evidence is treated very differently after a scientific paradigm is accepted. I'm suggesting that there are also linguistic reasons for that. And James Carpenter (Carpenter, 2015) spoke of the fundamental “orienting construct” of in-out, which parapsychological findings do confuse. I will begin here with the simple assumption that science finds patterns “out there” and come back later to this deeper question.
- 2 In 2007, I received a letter from my brother, William Reddy, professor and chair of the history department at Duke. He had searched the Web of Science and found 354 scholarly/scientific references to my 1979 article spread over 19 different disciplines. This letter is published on my website (Reddy, W., 2007).
- 3 By “crypto deist,” I mean here people who have removed the god, but cling to some mysterious principle of enforcement.

So, the monarch or congress is gone, but the police are still out there arresting anomalous behavior.

- 4 Carroll and Davies are quoted here on a webpage put up for students by an interdenominational Christian organization called “Cru.” See “Scientists Baffled by Laws of Nature.” <http://www.everystudent.com/wires/organized.html>.
- 5 Rupert Sheldrake explores this and other “myths” of science in his book *The Science Delusion* (Sheldrake, 2012, pp. 84-109).

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**MICHAEL REDDY** earned a highly interdisciplinary Ph.D. from the University of Chicago with research that helped found cognitive science. During six years at Columbia he discovered the first coherent schema of underlying conceptual metaphor to be documented in English. Upon leaving academics, he designed and developed business software, became a chief technical officer, and learned from a seven-year apprenticeship in shamanic healing techniques. In 2007, he founded Reddyworks and got further training in coaching, family constellation work, and energy psychology. He currently helps people recover from ancestral and personal trauma; still researches, writes, and teaches; and finds himself returning to his original fascination with the social and scientific impacts of conceptual metaphors. His website is [www.reddyworks.com](http://www.reddyworks.com).



Frank Bures

# Bioculturalism: What Modern Medicine Misdiagnoses

**W**e have a culture. From the inside it isn't always easy to see, but I'd been pulled in and out of it enough times to know for sure. Whenever I came back from overseas, I felt its strangeness as palpably as the day I landed in Italy, or Nigeria, or Thailand. I'd arrive and feel like an anthropologist examining a race of people who ran in circles, who thought bulging muscles were beautiful, and who saw convenience as a kind of birthright.

Of course we had a culture. And if we had a culture, we had to have cultural syndromes—conditions unique to us, which didn't occur elsewhere. But these weren't listed in the back of the *Diagnostic and Statistical Manual of Mental Disorders*, the American Psychiatric Association's catalog of mental illnesses. Some of them were included in the main body of the manual, like anorexia, while others were mentioned elsewhere: repressed memory syndrome, Truman syndrome, type-A personality, pet hoarding.

These were syndromes that other people did not have; they were mental conditions that fed off our loneliness; our obsessions with thinness, with youth, with celebrity, with vulnerability. They were fueled and shaped by the things we believed.

One day, in the midst of my research, I was talking to my wife, Bridgit, when she said, "Well, I got my period. I guess that explains my mood."

I shrugged and asked: "Or does it?"

This was followed by an icy silence. Because the only thing worse than diagnosing PMS is suggesting it might be a cultural syndrome.

"Never mind," I said. "We'll go with 'It does.'"<sup>1</sup>

But I couldn't help myself. For the last few days I'd been reading fascinating research about Premenstrual Syndrome (PMS), the bulk of which suggested that it wasn't caused by a tide of hormones wreaking havoc on a woman's psyche.

The basic idea of PMS (that a woman can't overcome her body) can be traced back 2,500 years to Hippocrates, the father of Western medicine, who believed that certain moods and physical disorders in women were caused by "hysteria" or the "wandering uterus," meaning the organ literally drifted around the body, pulled by the moon, lodging in wrong places, blocking passages, causing pressures. Cures included marriage and intercourse.<sup>2</sup>

This notion endured for eons. But by the early 1900s, medical theories around "hysteria" were beginning to crumble. In 1908, at the meeting of the Société de Neurologie in Paris, Joseph Babinski argued that hysteria was "the consequence of suggestion, sometimes directly from a doctor, and more often culturally absorbed."<sup>3</sup>

Today, hysteria is never diagnosed, except by unwise husbands.

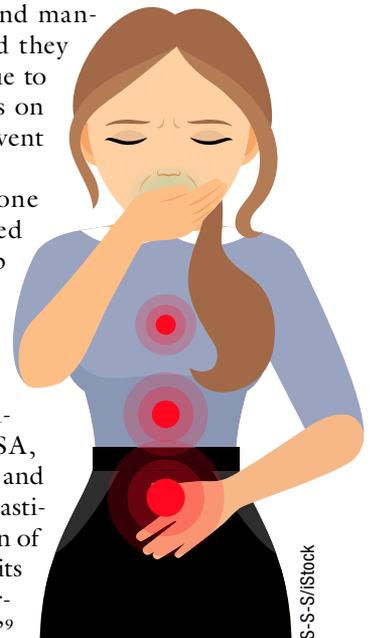
In 1931, however, an American gynecologist named Robert Frank revived the idea in a new guise. He published an article titled, "The hormonal causes of premenstrual tension." Frank described symptoms that occurred in the week before menstruation: irritability, bloating, fatigue, depression, attacks of pain, nervousness, restlessness, and the impulse for "foolish and ill considered actions," due to ovarian activity. Again, the cause was the uterus.<sup>4</sup>

Then in 1953, British physician Katharina Dalton elaborated on this, arguing the condition came from fluctuation of estrogen and progesterone. She called it Premenstrual Syndrome,<sup>5</sup> and soon symptoms grew to include: anxiety, sadness, moodiness, constipation or diarrhea, feeling out of control, insomnia, food cravings, increased sex drive, anger, arguments with family or friends, poor judgment, lack of physical coordination, decreased efficiency, increased personal strength or power, feelings of connection to nature or to other women, seizures, convulsions, asthma attacks, not to mention flare ups in asthma, allergies, sinusitis, anxiety disorders, irritable bowel syndrome, migraines, and multiple sclerosis.<sup>6</sup>

If any of these symptoms occurred in the second half of the menstrual cycle, one had PMS. Estimates of the number of women afflicted ranged from 5 percent to 95 percent.<sup>7</sup>

In the 1980s, three women in the UK were tried for arson, assault, and manslaughter. The three all claimed they had diminished responsibility due to PMS and got reduced sentences on the condition that they underwent hormone treatment.<sup>8</sup>

After that, according to one study, American women flooded doctors with requests for help with their PMS. "Popular groups like PMS Action were founded to promote recognition and treatment of PMS by medical professionals. Private PMS clinics began to appear in the USA, modeled after those in the UK, and progesterone therapy was enthusiastically adopted, much to the chagrin of many gynaecologists who viewed its use as 'unscientific' and 'commercial,' not to mention unlicensed."<sup>9</sup>



Based on all this, the 1987 version of the *DSM-III* included a new category: Late Luteal Phase Disorder (*luteal* refers to the *corpus luteum*, which secretes progesterone). It was proposed as a topic for further research, but despite the absence of such research, it was included in the 1994 edition of the *DSM-IV* under the name Premenstrual Dysphoric Disorder, or PMDD.<sup>10</sup> In 2013, in the *DSM-5*, it was given its own category as a full-fledged mental illness.<sup>11</sup>

Yet neither PMS nor PMDD occur in most cultures.<sup>12</sup> There are no biomarkers to measure them by. No conclusive correlation has ever been found between estrogen or progesterone levels and PMS.

As one study noted, “the more time that women of ethnic minorities spend living in the United States, the more likely they are to report PMDD. Thus, if we are to accept PMDD as a reified medical disorder, then we must also accept exposure to U.S. culture as a risk factor for contracting PMDD.”<sup>13</sup>

If it is a syndrome at all, it’s a cultural one.<sup>14</sup>

None of this would have surprised Lynn Payer, a medical reporter who grew up in Kansas. She studied biochemistry and physiology before going on to journalism school, graduating in 1969. Not long after that, she moved to France, where she lived for eight years and worked as a health correspondent and editor for *The New York Times*. In France, she noticed that when she went to the doctor she got wildly different advice from her doctors in the United States.

At first, as she wrote in her book, *Medicine and Culture*, she thought this was because, “European doctors were less well educated than those in the United States, that their medicine was more ‘primitive.’ As an American with a background in biochemistry, I believed medicine to be a science with a ‘right’ and ‘wrong’ way to treat a disease, and any deviation from the American norm to be ‘wrong.’”<sup>15</sup>

In France, however, she began to encounter conditions that didn’t exist in America or anywhere outside France. If you went in to a doctor complaining about a migraine, there was a good chance you’d be diagnosed with *crise de foie*, or “liver crisis” for which you could get any number of drugs. If you showed symptoms of fatigue, muscle cramps, or hyperventilation, you might be diagnosed with “spasmophilia” and get treated for that.

Other countries had their own maladies. In Germany, if you had low blood pressure, you would be diagnosed with *Herzinsuffizienz* or “heart insufficiency,” and given heart medication, of which Germans took far more than any other nationality in the world. In England, people were frequently diagnosed with “chilblains,” or blotchy red patches caused by constriction of blood vessels due to cold—a condition rarely seen outside of England.<sup>16</sup>

“Often,” Payer wrote, “all one must do to acquire a disease is to enter a country where that disease is recognized—leaving the country will either cure the malady, or turn it into something else.”

America, Payer noted, has a highly mechanistic understanding of the body. This is known as the “biomedical model,” and in our version, we view the body as a machine.<sup>17</sup>

We see our circulatory system as plumbing. We see the brain as a computer. We see our heart as a pump. We think of the body as a car—a metaphor that dates back to the 1920s, when cars first entered our lives.

Likewise, we see the doctor as a mechanic, and illness as the result of a part breaking, which it’s the doctor’s job to repair. If something can’t be explained in mechanical terms, we tend not to believe it’s real. And yet, things are often more complicated than that.

Take carpal tunnel syndrome. Most of us believe this is a purely biomechanical condition: We use a computer too much, hold our wrists the wrong way, and a nerve rubs on a bone. A problem ensues.

But oddly, several conditions nearly identical to carpal tunnel syndrome have come and gone in the past. In the 1830s doctors began to report cases of “writers’ cramp,” or “scriveners’ palsy,” which afflicted an emerging class of clerical workers. They too experienced pain, paralysis, numbness, aching, spasms and stiffness in their hands and wrists, and a “multiplicity of symptoms that could affect workers in unpredictable ways.”<sup>18</sup> The condition disappeared in the late 1800s.

In 1875, a new condition emerged in the *British Medical Journal*: “telegraphists’ cramp,” which caused numbness, stiffness, pain and similar conditions to writers’ cramp. In 1894, one expert estimated that the condition affected 0.5 percent of operators. By 1911, a study in Britain found that it affected 64 percent of operators.<sup>19</sup> Then, a few years later, both the telegraph and its cramp were gone. The case was closed.

Despite the widespread use of typewriters and pens throughout the twentieth century, there were no new hand/wrist syndromes reported until the 1980s, when workers in the meatpacking industry began coming down with “cumulative trauma syndrome,” or carpal tunnel syndrome, with symptoms identical to writers’ and telegraphists’ cramps.

Union newspapers published articles about the dangers of the condition. It became a flashpoint in labor disputes, as workers were being downsized and automated. Union activists worked to raise awareness of the problem. Media outlets reported on the epidemic even as it grew. Soon “the problem of occupational hand and wrist disorders had migrated to a host of other industries, particularly auto assembly, textiles, apparel manufacturing, electronics and newspaper publishing,” wrote Allard Dembe in his study of the condition.<sup>20</sup>

At the same time, Australia was seeing a different pattern. The country had also seen a spike in the number of workers reporting what they called “repetitive strain injuries.” But in 1985, cases plummeted after the Supreme Court ruled it was not a legitimate compensation issue. This prompted an outpouring of opinion suggesting that RSI was primarily psychosomatic, or psychological, not biomechanical.<sup>21</sup>

In either case, repetitive, strenuous movements were part of the cause, but not all of it. Dembe points out other factors in all these conditions: the use of new technologies, social and economic anxiety, media stories about the dangers of repetitive movements, and so on.

Carpal tunnel syndrome can’t be explained in purely mechanical terms because, like PMS and liver crisis and

anorexia and so many other illnesses, it is partly shaped by something in our culture, so it rises and falls with those tides. Since concern about carpal tunnel syndrome has dropped in the United States, so have the number of cases, with a 21 percent decrease in 2006 alone. Keyboards, nonetheless, remain in high demand.

The shortcoming of our mechanistic model is something we've barely begun to come to grips with. For example, when the *DSM-5* was released in 2013, Thomas Insel, the director of the National Institutes of Mental Health wrote: "Mental disorders are biological disorders involving brain circuits that implicate specific domains of cognition, emotion, or behavior." He lamented the fact that when the NIMH set out to determine the biological parameters of these disorders, "It became immediately clear that we cannot design a system based on biomarkers or cognitive performance because we lack the data."<sup>22</sup>

The assumption was that we haven't found biological tests for mental disorders because we haven't looked hard enough. That is possible. Yet it's also possible we lack the data because we're looking in the wrong places.

"The scandal of psychiatry," Arthur Kleinman told me when I called to ask about this, "is that with fifty years of biological research, we've failed to come up with a single biological test that can be used routinely to diagnose patients. Depression, anxiety, schizophrenia—any common psychiatric disorder. It's a scandal because that's where most of the research money has gone. The research money has not advanced the field nearly as much as was hoped clinically."<sup>23</sup>

Why is that? Is it because the best minds at the best universities in the world, with the most money for research, simply don't know where to look? Or is there some piece missing, something else that happens at a level above the cellular one? Is the reason these conditions don't show up on a functional MRI because they are partly cultural? Is it because they are partly psychogenic? Is it because they emerge—in part—from the way we view ourselves and the world?

I have always been puzzled by the fact that mental illnesses occur at different rates around the world. Panic attacks happen everywhere, but they occur in 11.2 percent of people in the United States and only 2.7 percent in Germany. The number of people with Panic Disorder is 4.9 percent in the United States, but only 0.1 percent in Nigeria. Social anxiety disorder averages a 4.8 percent rate in the United States, but only 0.2 percent in metropolitan China and 49.4 percent in Udmurtia, a region in the Russian Federation.<sup>24</sup>

Depression is another example. In America, most people believe depression is the result of a biochemical imbalance, and that the way to fix it is to apply more chemicals. Yet rates of depression also vary across the world; Korea, Taiwan, and Puerto Rico have low levels of depression (less than 5 percent), while in France, Switzerland, and the United States, the levels range between 15 percent and 20 percent.<sup>25</sup> Asian countries tend to have less than European countries.<sup>26</sup> In Korea or Japan, you have a one in fifty chance of suffering major depression in a year. In Brazil, you have a one-in-ten chance.<sup>27</sup> Lifetime prevalence of major depression varies from 6.5 percent in China, to 9.8 percent

in South Africa, to 19.2 percent in the United States.<sup>28</sup> A meta-analysis of studies on postpartum depression across forty countries found prevalence ranging from 0 percent to 60 percent.<sup>29</sup>

These kinds of comparisons are tricky, because of language differences,<sup>30</sup> and because ideas about the body and mind (and spirit) vary widely from country to country. Yet even something as clearly defined as schizophrenia varies greatly: In 1992, a major multiyear study by the World Health Organization found that patients in India, Nigeria, and Colombia had a milder form of the disease and better recovery rates than sufferers in the United States, Denmark, and Taiwan. In the richer countries, 40 percent of sufferers were severely impaired, while in the less industrialized countries, only 24 percent were.<sup>31</sup>

It seems that Payer was right, and that crossing a border might affect the kinds of illnesses you get. One study showed the lifetime prevalence (meaning at least once in your life) of any mental illness varied from 12.2 percent in Turkey, to 20.2 percent in Mexico, to 37.5 percent in Canada, to 48.6 percent in the United States.<sup>32</sup>

All of these conditions appear to be not just biological, but *biocultural*, which is to say, they are shaped by both biology and culture. This is not the same as saying they aren't real. It's saying that, while there is biology at work, there are other links in the chain.

What, then, is the link between biology and culture? What would make one group of people more depressed, more anxious, than another? What makes one people feel like their necks are exploding, another like their penises are vanishing, another like their livers are having a crisis, and another like their wrists are hardening from the inside out?

We all swim in an ocean of stories, of currents—some visible, some hidden. They rise and fall like the tides. Sometimes they wash over us. Sometimes they pull us out to sea. Usually, we sail smoothly along, but we can always feel their pull. That was what I'd felt when I had lived in Italy, when I had traveled in Nigeria, and everywhere I had spent much time: the pull of stories around me, the way that they can be both powerful and contagious, and the way they flow between us. That was how *koro*—the overpowering belief that one's genitals are retracting and will disappear—had spread across Hainan all those years ago: People heard stories about it. They believed them. They feared them. They felt them.

The closer I got to these epidemics, the more I could see the resemblance they bore to another kind of illness I'd come across in my research, known as "mass psychogenic illnesses," in which a group of people are suddenly stricken with a mysterious illness, which they either saw or heard about.

Mass psychogenic illnesses are well known in the scientific literature. They spread through tight knit social groups, affect mostly females, and are common in Asia and Africa. In 2008, at a garment factory outside Jakarta, Indonesia, approximately fifty female workers went into a collective trance, weeping and jerking their bodies. In 2006, thirty women experienced a similar epidemic in a cigarette factory in Java. And again in 2008 in Kalimantan, on the Indonesian side of Borneo, thirty high school students also fell into a collective trance.<sup>33</sup>



Henrik5000/Stock

These happen in our culture as well, and they may even be on the rise. In 2014, thirty students at a Minnesota high school became ill and were hospitalized with what they thought was carbon monoxide poisoning, but for which all tested negative.<sup>34</sup> The cause was psychogenic. In 2013 in Danvers, Massachusetts, two dozen teenagers at an agricultural school started developing strange hiccups and vocal tics that were eventually ruled to be a mass psychogenic illness.<sup>35</sup> In 2011, eighteen girls from a high school in LeRoy, New York, developed uncontrollable facial tics, muscle twitching, and garbled speech.<sup>36</sup> All physical causes were ruled out and the epidemic was declared to be a “psychogenic movement disorder” or “psychogenic parkinsonism.”

These are not usually considered cultural syndromes, but they share key similarities with them: The symptoms are real, they are contagious, and they have some perceived cause at their root. It’s usually poison or pollution in the West and spirits or spells in Africa and Asia. But in every case the process is the same: Victims learn the story, intuit the cause, and the looping begins. The mind starts to affect the body in tangible ways. It’s like a compressed version of storytelling: Observed events, perceived causes, internalized effect.

But it is not just tics and nausea that can flow through us this way. For example, not long after the reunification of Germany in 1990, a national health survey was conducted and it was found that the two regions had starkly different rates of lower back pain, with a disparity as high as 16 percent.

Lower back pain is notoriously complicated. No one is sure what causes it. Risk factors include depression, nicotine dependence, obesity, alcohol abuse, and low social status. East and West Germany were not that different culturally, despite forty-five years of division, yet something was causing West Germans to have more back pain than East Germans.

A decade later that disparity was gone. The rates in East and West had converged. After unification, those in the former

communist country rose steadily until 1996, when they began to track with the rates in West Germany. After that, they moved in unison.

Researchers were baffled, especially since, as they noted, “Between 1991 and 2003, the data show a slow increase in both general life satisfaction and job satisfaction in the East and a continually slow decrease in the West.”<sup>37</sup> So the effects on people’s lower backs should have been the opposite. Other possible factors included selective migration and increased unemployment in the East. But the authors of the paper (titled “Back Pain, a Communicable Disease?”) ultimately suggested another factor: “after reunification, all [the] ‘back myths’ and misconceptions about back pain pervasive in Western societies were immediately disseminated in East Germany.”<sup>38</sup>

The notion of lower back pain spreading from West Germany to East Germany culturally—passing from mind to mind—is hard for people in biomedical cultures to swallow. But that same kind of flow has been seen in other conditions, most notably in the Framingham Heart Study. What’s even more interesting are the paths they take.

In 2007, researchers Nicholas Christakis and James Fowler looked at the health records of 12,067 people in the study and found a strange thing: Obesity did not—as expected—spread geographically. It spread socially: If you had a friend who became obese, your chance of following suit rose 57 percent. This was greater than the effect of a sibling (40 percent) or even a spouse (37 percent). The weight of a neighbor seemed to have no effect. Crucially, the flow was “directional” from people who were named as friends to those who named them and not the other way around.<sup>39</sup> So it wasn’t just a matter of people who knew each other changing their diets and becoming obese at the same time. One person was causing the other to change. One person was *learning* from the other. Obesity, like *koro*, like psychogenic Parkinsonism, like back pain, could be contagious.

Christakis and Fowler went on to examine how smoking spread in a similar way: If a person quits smoking, there is a 67 percent chance his or her spouse would quit smoking—the effect of a friend quitting was 36 percent, while siblings were at 34 percent.<sup>40</sup> Another study of the data found that divorce flowed through the networks, too: If a friend or family member got divorced, your chance of getting divorced rose from 9 percent to 16 percent. If a friend of a friend got divorced, your chance of divorce rose to 12 percent.<sup>41</sup> After the third degree of separation (as with obesity and smoking), there was no effect. Other research has shown that happiness,<sup>42</sup> loneliness,<sup>43</sup> and depression<sup>44</sup> flow this way as well. Christakis and Fowler call this the “peer effect,” while others call it the “interpersonal health effect.” The theorist Gustave LeBon would have simply called it “social contagion,” but in other fields, it’s been described as “observational learning,” or “social learning.”<sup>45</sup>

Placebo expert Fabrizio Benedetti has found that watching someone experience pain (or feel pain relief) has a much larger placebo/nocebo effect than merely being told about it. Watching someone in pain causes “negative emotional contagion,” he writes, which kickstarts the mechanisms that cause pain in the observer as well.<sup>46</sup> Stories we hear are never as powerful as the ones we see.<sup>47</sup> That is the secret of the peer effect,

of social contagion, and of mass psychogenic illness. That's why it's so hard to resist the pull of the cultures we are in.

We watch the people in our lives. We learn the way things go, the scripts, the schemas, the patterns: How to get something at the store. How to talk to someone you love. How to get through your day. How to get through your life. As Dan McAdams says, "people pick and choose and plagiarize selectively from the many stories and images they find in culture to formulate a narrative identity."

Except the stories are not in the culture. They *are* the culture.<sup>48</sup>

Excerpted with permission from *The Geography of Madness: Penis Thieves, Voodoo Death and the Search for the Meaning of the World's Strangest Syndromes*, which will be published in paperback by Melville House in April 2017.

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## ENDNOTES

- 1 Usually the implication of this sort of statement is that PMS is "socially constructed," meaning that it is not real. This is not what I'm saying. If you were to tell a victim of penis theft in Nigeria that he was suffering from a cultural syndrome or that his penis theft was caused by his belief in it, his reaction would be the same anger and disbelief as when you tell an American woman PMS is a cultural syndrome (more specifically, a cultural idiom of distress). This reaction comes from questioning not only a belief, but the very forces holding a person's world together, in these cases meaning biochemistry and magic. It's like telling a Christian there's no God or telling Richard Dawkins there is one.
- 2 Mari Rodin, "The Social Construction of Premenstrual Syndrome," *Social Science and Medicine*, 1992, vol. 35, no. 1, p. 50.
- 3 Ian Hacking, *Mad Travelers: Reflections on the Reality of Transient Mental Illness* (Charlottesville: University Press of Virginia, 1998), p. 72.
- 4 Robert T. Frank, "The Hormonal Basis of Premenstrual Tension," *Archives of Neurological Psychiatry*, 1931, 26, pp. 1053-57.
- 5 Katharina Dalton and Raymond Greene, "The Premenstrual Syndrome," *British Medical Journal*, 1953, 1, p. 1007-14.
- 6 Joan C. Chrisler and Paula Caplan, "The Strange Case of

Dr. Jekyll and Ms. Hyde: How PMS Became a Cultural Phenomenon and a Psychiatric Disorder," *Annual Review of Sex Research*, 2002, 13:1, p. 276.

- 7 Loes Knaapen and George Weisz, "The Biomedical Standardization of Premenstrual Syndrome," *Studies in History and Philosophy of Biological and Biomedical Sciences*, 2008, 39, p. 125.
- 8 Ibid., p. 126.
- 9 Ibid. The media also played a role in this shift with news stories like "Coping with Eve's Curse" and "The Taming of the Shrew Inside of You," among others, that talked about how "hormonal shifts can turn ordinary women into monsters" (Chrisler and Caplan, 2002, p. 286).
- 10 Another complicating factor are pharmaceuticals. In 2000, the company Eli Lilly introduced a drug for PMDD called Sarafem, which was the same drug (fluoxetine) as Prozac, just colored pink instead of green and packaged and marketed differently. As one writer noted, "The side effects of Fluoxetine are: insomnia, anxiety, nervousness, and somnolence. These are similar, if not identical, to some of the symptoms of PMDD" ([healthpsych.psy.vanderbilt.edu/PMDD\\_and\\_Sarafem.htm](http://healthpsych.psy.vanderbilt.edu/PMDD_and_Sarafem.htm)).
- 11 The DSM-5 states, paradoxically: "Premenstrual dysphoric disorder is not a culture-bound syndrome and has been observed in individuals in the United States, Europe, India, and Asia. It is unclear as to whether rates differ by race. Nevertheless, frequency, intensity, and expressivity of symptoms and help-seeking patterns may be significantly influenced by cultural factors" (American Psychiatric Association, *Diagnostic and Statistical Manual of Mental Disorders, 5th Edition* [Arlington, VA: American Psychiatric Publishing, 2013, p. 173]).
- 12 In other cultures, menstruation has a more positive meaning and is described in positive terms. It's not thought of as a debilitating condition that needs medical treatment. For example, on the island of Wogeo, Papua New Guinea, menstruation is seen as so powerful and cleansing that men are expected to menstruate too. They do this by walking into the ocean naked, inducing an erection, pushing the foreskin back, then slicing at the glans on either side with the claw of a crab. When the bleeding stops and the ocean water around the man is clear, he returns to shore, wraps his penis in medicinal leaves, and is considered cleansed. The same word is used for male and female menstruation. (Ian Hogbin, *The Island of Menstruating Men: Religion in Wogeo, New Guinea* [Prospect Heights, IL: Waveband Press, 1996], pp. 88-89). According to Chrisler and Caplan, "World Health Organization surveys indicate that menstrual cycle-related complaints (except cramps) are most likely to be reported by women who live in Western Europe, Australia, and North America. Data collected from women in Hong Kong and mainland China indicate that the most commonly reported premenstrual symptoms are fatigue, water retention, pain, and increased sensitivity to cold. American women do not report cold sensitivity and Chinese women rarely report negative affect" (Chrisler and Caplan, 2002, p. 285).
- 13 Tamara Kayali Browne, "Is Premenstrual Dysphoric Disorder

- Really a Disorder?” *Journal of Bioethical Inquiry*, June 2015, vol. 12, iss. 2, p. 6.
- 14 As Thomas Johnson wrote in his paper, “Premenstrual Syndrome as a Western Culture-Specific Disorder,” “We strive to discover the biological ‘reality’ of PMS, for example, without examining the cultural forces which are attendant in the process of creating that reality. We are willing to see culture-bound syndromes in other cultures when we cannot readily understand their symptom complexes in biomedical terms. Even though there are those who strive to find congruence between bizarre symptom complexes in other cultures and Western biomedical disease entities, there has been an implication that such syndromes are ‘not real.’ Yet we unquestioningly treat our own problematic syndromes, such as PMS, as ‘real,’ striving constantly to find physiological correlates of symptoms” (Thomas Johnson, “Premenstrual Syndrome as a Western Culture-Specific Disorder,” *Culture, Medicine and Psychiatry*, 1987, 11, p. 347). Researchers Lisa Cosgrove and Bethany Riddle found that women who endorsed traditional gender roles experienced more menstrual distress. “One of the most striking results,” they wrote, “was that PMS discourse has gained such cultural currency that women often expect to have PMS” (Lisa Cosgrove and Bethany Riddle, “Constructions of Femininity and Experiences of Menstrual Distress,” *Women & Health* 2003, 38:3, pp. 37–58). In a landmark experiment, Diane Ruble found that women who were misled to believe they were premenstrual experienced more symptoms of PMS than those who were actually premenstrual, but who were misled to believe they were not (Jeanne Brooks, Diane Ruble, and Anne Claris, “College Women’s Attitudes and Expectations Concerning Menstrual-Related Changes,” *Psychosomatic Medicine*, September–October 1977, vol. 39, no. 5, pp. 288–98).
  - 15 Lynn Payer, *Medicine and Culture* (New York, Owl Books, 1996), p. 15.
  - 16 Other unusual conditions: In Italy, you might come down with the “cervicale,” or “cervical,” for which there is no equivalent in any other language (Dany Mitzman, “How to Avoid Getting ‘Hit by Air’ in Italy,” *BBC Magazine*, December 3, 2011). In France, a pharmacist will be familiar with “heavy legs” and can give you grape-seed oil to rub between your ankles and knees (Emma Jane Kirby, “A Curiously French Complaint,” *From Our Own Correspondent*, *BBC News*, December 13, 2008: [news.bbc.co.uk/go/pr/fr//2/hi/programmes/from\\_our\\_own\\_correspondent/7779126.stm](http://news.bbc.co.uk/go/pr/fr//2/hi/programmes/from_our_own_correspondent/7779126.stm)).
  - 17 As Payer wrote, “Anything that cannot fit into the machine model of the body, or be quantified, is often denied not only quantification, but even existence” (*ibid.*, p. 151).
  - 18 Allard Dembe, *Occupation and Disease: How Social Factors Affect the Conception of Work-Related Disorders* (New Haven: Yale University Press, 1996), p. 33.
  - 19 *Ibid.*, pp. 36–39.
  - 20 *Ibid.*, p. 88.
  - 21 *Ibid.*, p. 93.
  - 22 From the National Institute of Mental Health Directors Blog, retrieved November 7, 2014: [www.nimh.nih.gov/about/director/2013/transforming-diagnosis.shtml](http://www.nimh.nih.gov/about/director/2013/transforming-diagnosis.shtml).
  - 23 Interview with the author, July 2013.
  - 24 Roberto Lewis-Fernandez, Devon Hinton, et al., “Review: Culture and the Anxiety Disorders: Recommendations for the *DSM-V*,” *Depression and Anxiety*, 2009, 0, pp. 1–18.
  - 25 Jeanne Tsai and Yulia Chentsova Dutton, “Understanding Depression Across Cultures,” in *Handbook of Depression*, edited by Ian Gotlib and Constance L. Hammen (New York: Guildford Press, 2002), p. 471.
  - 26 *Ibid.*, p. 472.
  - 27 Yulia Chentsova Dutton, Andrew Ryder, Jeanne Tsai, “Understanding Depression across Cultural Contexts,” in Ian Gotlib and Constance L. Hammen, eds., *Handbook of Depression*, 3rd ed. (New York: Guildford Press, 2014), p. 340.
  - 28 Evelyn Bromet, Laura Helena Andrade, et al., “Cross-national Epidemiology of *DSM-IV* Major Depressive Episode,” *BMC Medicine*, 2011, 9, p. 90.
  - 29 Uriel Halbreich and Sandhya Karkun, “Cross-cultural and Social Diversity of Prevalence of Postpartum Depression and Depressive Symptoms,” *Journal of Affective Disorders*, 2006, pp. 97–111.
  - 30 In Hopi, there isn’t a single word for “depression.” Rather, it’s divided into worry sickness, unhappiness; heartbreak, “drunken-like craziness” and “turning one’s face to the wall” (Spero Manson et al., “Depressive Experience in American Indian Communities: A Challenge for Psychiatric Theory and Diagnosis,” in *Culture and Depression: Studies in the Anthropology and Cross Cultural Psychiatry of Affect and Disorder* [Berkeley: University of California Press, 1985], pp. 336–39). In Yoruba, the same word is used for depression, anxiety, anger, and sadness. And in Japanese, the word “jodo,” translated as “emotion,” can also mean lucky, motivated, and calculating (Christopher Dowrick, *Beyond Depression: A New Approach to Understanding and Management*, 2nd Edition [Oxford: Oxford University Press, 2009], p. 131).
  - 31 Ethan Watters’s *Crazy Like Us: e Globalization of the American Psyche* (New York: e Free Press, 2010), p. 137. See also J. Leff, N. Sartorius, et al., “The International Pilot Study of Schizophrenia: Five-Year Follow-Up Findings,” *Psychological Medicine*, 1992, 22, pp. 131–45.
  - 32 “Cross-National Comparisons of the Prevalences and Correlates of Mental Disorders,” *Bulletin of the World Health Organization*, Geneva, January 2000, vol. 78, no. 4: [dx.doi.org/10.1590/S0042-9686200000400003](http://dx.doi.org/10.1590/S0042-9686200000400003).
  - 33 All three examples from Sunanda Creagh, “Mass Trance Afflicts Indonesian Factory Workers,” Reuters/Yahoo News, February 24, 2008.
  - 34 John Croman, “Minnesota School Incident Likely Mass Psychogenic Illness,” *KARE 11 News*, February 8, 2014.
  - 35 Laura Dimon, “What Witchcraft Is Facebook? Mass Psychogenic Illness—Historically Known as ‘Mass Hysteria’—Is Making a Comeback,” *The Atlantic*, September 11, 2013.
  - 36 Robert Bartholomew et al., “Mass Psychogenic Illness and the Social Network: Is It Changing the Pattern of Outbreaks?” *Journal of the Royal Society Medical of Medicine*, 2012, 105,

- pp. 509–12. See also Susan Dominus, “What Happened to the Girls in Le Roy?” *New York Times Magazine*, March 7, 2012.
- 37 Heiner Raspe, Angelika Hueppe, and Hannelore Neuhauser, “Back Pain, a Communicable Disease?” *International Journal of Epidemiology*, 2008, 37, p. 72.
- 38 Ibid. For more, see Raspe, et al., 2008, pp. 69–74.
- 39 Nicholas Christakis and James Fowler, “The Spread of Obesity in a Large Social Network over 32 Years,” *The New England Journal of Medicine*, 2007, 357, pp. 370–79. See also Nicholas Christakis, and James Fowler, *Connected: The Surprising Power of Our Social Networks and How They Shape Our Lives* (New York: Little, Brown and Company, 2009).
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- 41 Rose McDermott, James H. Fowler, and Nicholas A. Christakis, “Breaking Up Is Hard to Do, Unless Everyone Else Is Doing It Too: Social Network Effects on Divorce in a Longitudinal Sample,” *Social Science Research Network*, October 18, 2009. See also “Is Divorce Contagious?” Pew Research Center, October 21, 2013: [www.pewresearch.org/fact-tank/2013/10/21/is-divorce-contagious/](http://www.pewresearch.org/fact-tank/2013/10/21/is-divorce-contagious/).
- 42 Christakis and Fowler found that the spread of happiness flows socially but is also dependent on geography: When you have a friend who lives within a mile who becomes happy, your chance of becoming happy increases by 25 percent. If a sibling who lives within a mile becomes happy, the probability of that happiness passing to you is 14 percent. The effect lasts about a year. If the connection lives more than a mile away, there is no effect (Christakis and Fowler, *Connected*, 2009, pp. 49–54).
- 43 John Cacioppo, an expert in the science of loneliness, partnered with Christakis and Fowler and found that if a person had a friend or family member who was lonely, there was 52 percent chance he or she would be lonely two years later (Christakis and Fowler, *Connected*, 2009, pp. 57–59. Also: John T. Cacioppo, James Fowler, and Nicholas Christakis, “Alone in the Crowd: The Structure and Spread of Loneliness in a Large Social Network,” *Journal of Personality and Social Psychology*, December 2009; 97[6]: pp. 977–91).
- 44 A study of “cognitive style” among college roommates found that after three months, students with a positive or negative attitude began to adopt each other’s attitude. And just six months of living with a roommate with a negative attitude significantly increased the risk of depression (Gerald J. Haefel and Jennifer L. Hames, “Cognitive Vulnerability to Depression Can Be Contagious,” *Clinical Psychological Science* April 16, 2013, cited on NPR, “Gloomy Inking Can Be Contagious,” June 24, 2013: [www.npr.org/sections/health-shots/2013/06/24/193483931/Contagious-thinking-Can-Be-Depressing](http://www.npr.org/sections/health-shots/2013/06/24/193483931/Contagious-thinking-Can-Be-Depressing)). Kindness too can spread socially (James Fowler and Nicholas Christakis, “Cooperative Behavior Cascades in Human Social Networks,” *PNAS*, March 23, 2010, vol. 107, no. 12, pp. 5334–38.
- 45 According to the Cultural Niche theory of evolution, social learning is at the core of humankind’s rapid rise. It’s how we accumulate knowledge over generations and is what separates us from other primates. We have the ability to pass on causal perception without causal knowledge. We can know one thing causes another to happen without knowing how it does. (Do you know how your computer works? Your car?) This is called “abductive reasoning” and it is our strength as a species (as well as—sometimes—our weakness). Social learning is the most powerful transmitter of casual perception and plays a major role in everything from Robin Dunbar’s social brain theory to the placebo effect to the interpersonal health effect. (Robert Boyd, Peter J. Richerson, and Joseph Henrich, “The Cultural Niche: Why Social Learning Is Essential for Human Adaptation,” *PNAS*, June 28, 2011, vol. 108, no. Supplement 2, pp. 10918–25. See also Joseph Henrich, “A Cultural Species: How Culture Drove Human Evolution; A Multi-Disciplinary Framework for Understanding Culture, Cognition and Behavior,” *Psychological Science Agenda* [American Psychological Association], November 2011.)
- 46 Luana Colloca and Fabrizio Benedetti, “Placebo Analgesia Induced by Social Observational Learning,” *Pain*, 2009, pp. 28–34; and Fabrizio Benedetti, “Responding to Nocebos Through Observation: Social Contagion of Negative Emotions,” *Pain*, 2013, 154, p. 1165.
- 47 In a study of 10,000 school students, Catherine Riegler-Crumb investigated the gender gap in girls studying physics, and found that the gap had nothing to do with income, or inner city vs. suburbs or any other typical cause. The only factor that mattered was having more women in the community working in science, technology, engineering, and math. In those communities, girls were just as likely to study physics as boys. (Catherine Riegler-Crumb and Chelsea Moore, “The Gender Gap in High School Physics: Considering the Context of Local Communities,” *Social Science Quarterly*, March 2014, vol. 95, iss. 1, pp. 253–68. Cited on NPR, Shankar Vedantam, “Why Aren’t More Girls Attracted to Physics?” August 9, 2013: [www.npr.org/templates/transcript/transcript.php?storyId=210251404](http://www.npr.org/templates/transcript/transcript.php?storyId=210251404).
- 48 To put a finer point on this, what I mean is that when we use the word “culture” we’re talking about the ecosystem of stories we feel we are part of and that we share with a group of people, either by birth or by choice. By “stories” I mean the full spectrum of causal chains, from the shortest (how to interact with people you meet) to the longest (how the universe came into being). I mean stories about the past, the present, and the future. I mean stories about heroes and villains and ordinary people getting through their lives. I mean stories about the physical and spiritual worlds, stories about luck and love and loss. Because in each story there is some causal force that feels at first possible, then familiar, then real. These causal perceptions—these beliefs—are the missing piece of the bioloop.

Gregory L. Matloff

# Stellar Consciousness: Can Panpsychism Emerge as an Observational Science?

In 2011, I was invited to participate in a symposium at the London headquarters of the British Interplanetary Society (BIS). The subject of this one-day event was the contributions of Olaf Stapledon, a British science-fiction author and philosopher. Stapledon's short masterwork, the 1937-vintage *Star Maker*, is widely cited by scientists and engineers because of his scientific and technological predictions.

I am trained in astronomy, astronautics, and planetary science, but one of my early mentors was Evan Harris Walker, a physicist who is regarded by many to be the founder of the modern science of consciousness research. He was the first to propose a theory of the nature of consciousness tied to quantum mechanics and based on quantitative physical and neurophysiological data.

So instead of lecturing about Stapledon's predictive contributions to astronautics, astronomy, genetic engineering, etc., I decided to examine Stapledon's core metaphysics. Is there any scientific evidence to support Stapledon's opinion that the entire universe is in some sense conscious, and a portion of stellar motion is volitional? Could stars be conscious?

Philosophers have long debated the nature of this elusive quantity, but they have largely failed to even find a definition for consciousness. Most philosophers who have addressed the "hard problem" of consciousness reside in two schools of thought. Those who favor epiphenomenalism are generally of the opinion that consciousness is an emergent property of brain function: it arises in brains when neural networks become sufficiently complex. A competing approach is that of panpsychism: those favoring this view suspect that a field of consciousness (or proto-consciousness) permeates the universe and all matter is, to a certain extent, conscious.

To begin my research effort in preparation for the Stapledon symposium, it was first necessary to consider some means that a universal proto-consciousness field could interact with a star. Whatever goes on in the stellar interior, we can be pretty sure that stars do not have neurons. This would seem to rule out Walker's (1970) theory that conscious thought results from elementary particle wave functions tunneling through the electrical potential well between synapses. Stars certainly do not have microtubules, a component of organic

cells suggested by Lynn Margolis (2001) and Roger Penrose/Stuart Hameroff (2014) to be the seat of consciousness. But some stars are cool enough to have stable molecules in their outer layers. Bernard Haisch (2006) speculates that the interaction of vacuum fluctuations with molecular bonds—the so-called "Casimir Effect"—is an explanation for how a universal proto-consciousness field interacts with matter. Could consciousness enter matter through the Casimir Effect?

For Stapledon's concept that stellar volition contributes to stellar motions to have scientific validity, and a Casimir-molecular basis of consciousness to be reasonable, there must be some observable difference in kinematics between molecule-free stars and those with molecules in their outer layers. From spectroscopic observations performed in the 1930s, the spectral signature of simple molecules (CH and CN) is absent in stars slightly hotter than the Sun (in star spectral classes hotter than F8). Hotter stars have atoms in their upper layers. All stars have plasma (ions) in their interior.

## Stellar Classification

Fully expecting to find no support for Stapledon's metaphysics, I began to investigate observational studies of stellar kinematics. Much to my surprise, I soon uncovered "Parenago's Discontinuity," which is named after Pavel Parenago, a prominent Soviet-era Russian astronomer.

As well as being a very competent astronomer, Parenago was a very wise person. He must have realized that his stellar observations might cut against the grain of Soviet Materialism and result in a long vacation in a very cold and desolate place. So he successfully protected himself by dedicating a mathematical monograph to the most highly evolved human of all time—a fellow named Joseph Stalin!

Parenago had discovered that cooler, less massive, redder stars in our stellar neighborhood revolve around the center of the Milky Way galaxy a bit faster than their hotter, more massive and bluer colleagues. I decided to check this result and soon found some very authoritative sources corroborating Parenago's claim.

## The Stellar Community

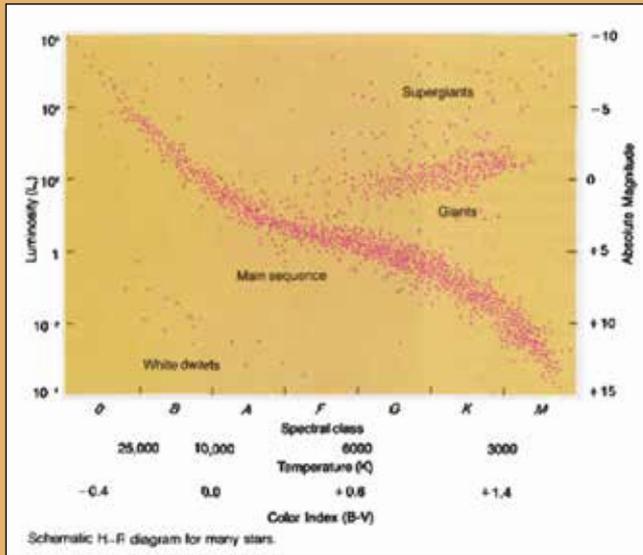


Figure 1. A NASA rendering of the Hertzsprung-Russell (HR) Diagram

In this familiar star classification scheme, note that the left vertical axis presents star luminous output relative to the Sun. The dimmest stars on this diagram emit about 1/10,000 as much light as the Sun. The brightest, near the top, emit as much light as a million Suns. The horizontal axis presents the stellar spectral classes.

Stars are hot beings. The hottest O stars have surface temperatures of about 30,000 degrees Kelvin (K). The coolest M stars have surface temperatures less than 3,000 degrees Kelvin. For comparison, you will experience a temperature of about 300 degrees Kelvin during a comfortable day on Earth.

Note also that the spectral classes are subdivided. The hottest F stars, for example, are classified as F0 stars. The coolest are F9. The (B-V) color indices quantitatively presents the fact that hot, O stars are bluer than cool red stars. The (B-V) color index increases as stars get redder and cooler.

The luminosity classes are also presented on the H-R Diagram. The major luminosity classes are Main Sequence Dwarfs, Giants, Supergiants, and White Dwarfs. Most stars in the sky, including our Sun, emit energy by converting hydrogen to helium and reside on the Main Sequence. Our Sun is classified as a G0 dwarf and is about half-way through its 10-billion-year residence on the Main Sequence. After it exhausts much of its internal hydrogen, it will swell to become a luminous Giant. After “only” another 100 million years or so, it will cross the Main Sequence once again to end its life as a hot, sub-luminous White Dwarf.

Stellar life expectancy on the Main Sequence has a lot to do spectral class and mass. Large, massive O-type stars only live on the Main Sequence for a few million years. The cool, less massive M-stars reside on the Main Sequence for a trillion years or longer.<sup>1</sup>

## Parenago's Discontinuity in Local Dwarf and Giant Stars

In preparing my paper for the Stapledon Symposium, I decided to check recent publications on the kinematics of main sequence dwarf stars in our galactic vicinity.<sup>2</sup> The data come from two sources. The Binney et al. (1997) data points in Figure 2A are from observations of about 6,000 main sequence dwarf stars out to ~260 light years by the European Space Agency (ESA) Hipparcos space observatory. The Gilmore and Zelik (2000) data points are from the 2000 edition of *Allen's Astrophysical Quantities*, perhaps the most authoritative publication in the field of astrophysics.

The velocity discontinuity in Fig. 2A is very sharp for both data sets at (B-V) = 0.45-0.50. This correspond closely to the (B-V) color index of F8 stars. The molecular signatures appear in stars of F8 spectral class and cooler (Matloff, 2011, 2016).

Figure 2B is based on Hipparcos data from thousands of giant stars out to >1,000 light years (Branham, 2011).<sup>3</sup> Although, as Branham discusses, Parenago's velocity discontinuity is evident in this figure, it is not as sharp as in Figure 2A. That is probably because stellar distance estimates are less accurate for more distant stars, and comparison with the reference frame (called the Local Standard of Rest) is less accurate for a larger-diameter sample.

The European Space Agency Gaia space observatory, a successor to Hipparcos, is now on station. The purpose of this spacecraft is to determine positions and motions of ~1 billion stars in the Milky Way galaxy (Matloff, 2012, 2015, 2016). But Gaia final results will not be processed and released for a few years. So I have performed a search for other observational results relating to Parenago's Discontinuity. Francis and Anderson (2009) have demonstrated the existence of this phenomenon in their analysis of 20,574 stars out to about 1,000 light years.

Using a terrestrial 4-meter Schmidt telescope with a 5-degree field of view, Tian et. al (2015) have evaluated the kinematics of about 200,000 F, G, and K stars with heliocentric distances between about 300 and 3,000 light years. Although the error bars seem higher than in the Hipparcos data set, cooler stars with molecules in their upper layers do seem to move more rapidly around the galactic center than hot stars.

## Explanations for Parenago's Discontinuity

Scientists develop competing hypotheses to explain various physical phenomena. The concepts that best succeed in explaining experimental or observational evidence evolve into successful theories. Here are some of the competing hypotheses proposed to explain Parenago's Discontinuity.

One possibility, discussed by Bochanski (2008), relate to the fact that all stars begin their lives within dense gas- and dust-filled birth nebulae.

The density of stars within these comparatively short-lived galactic structures is much larger than within most of the galaxy. Consequently, low-mass stars might be ejected at higher velocities from the birth nebulae by gravitational interactions

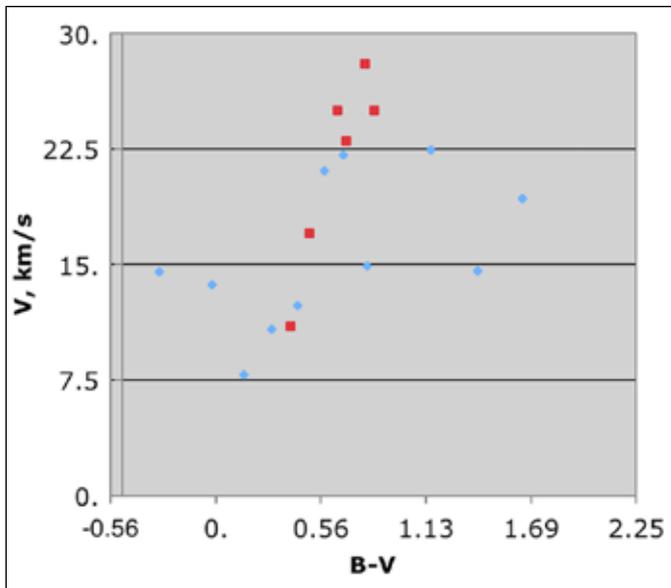


Fig. 2.(A) Parenago's Discontinuity for Main Sequence Stars out to ~260 Light Years. Diamond Data Points are from Gilmore & Zelik (2000). Square Data Points are from Hipparcos Space Observatory Data (Binney et al, 1997).

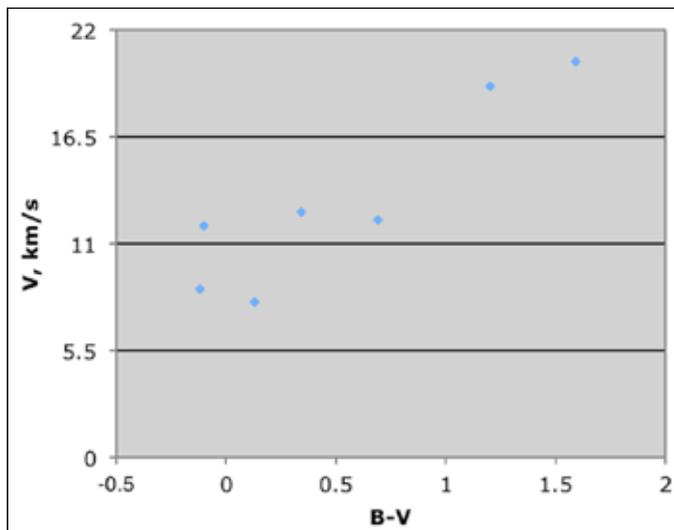


Fig. 2. (B) Parenago's Discontinuity for Giant Stars out to >1,000 Light Years (Branham, 2011).

with other stars than more massive stars. This would certainly result in a higher dispersion in the galactic velocities of a star sample, but it does not explain the systematic velocity difference along the direction of stellar galactic revolution.

A second hypothesis, called Spiral Arms Density Waves, is based upon the fact that dense, diffuse nebula are generally located in the spiral arms of galaxies like our Milky Way (Binney, 2001 and DeSimone, 2004). Consider a nebula with a gas density significantly greater than that of the surrounding interstellar medium. As it drifts through a star field, it might drag along low-mass stars at a higher velocity than high-mass stars.

A problem for advocates of the Spiral Arms hypothesis is the comparative paucity of large diffuse nebula within the present day Milky Way galaxy. I have searched three major compilations of deep-sky objects (Matloff, 2016). Nebula within the present-day Milky Way are too small to affect star motions over a ~500 light-year diameter star sample, such as the one used to prepare Fig. 2A.

But what about the past? Francis and Anderson (2009) suggest that billions of years in the past, characteristics of the Milky Way galaxy may have been different and Parenago's Discontinuity may be caused by streams of old stars. This seems unlikely based upon an estimate of local solar-type main sequence dwarf stars by Mamajek and Hillenbrand (2008). According to their study of 100 stars out to about 50 light years, 15% of the local dwarfs are aged less than 1 billion years, 16% are aged 1-2 billion years, 12% are aged 2-3 billion years, 8% are aged 3-4 billion years, and 14% are aged 4-5 billion years. Only a minority of the stars in their sample are older than the Sun (4.7 billion years). Local main sequence stars certainly do not come from the same birth nebula. And the vast age differences among stars in this local sample seems to argue against the Francis and Anderson (2009) conjecture.

There is a second, perhaps more significant objection to Spiral Arms. For this hypothesis to be correct, there must be a color difference between stars near the leading and lagging edges of the spiral arms of galaxies like our Milky Way. According to an observational study of 12 nearby spiral galaxies by Foyle et al. (2011), no such color difference has been observed.

The hypothesis I propose to explain Parenago's Discontinuity evokes pansychism and galactic self-organization: that consciousness emerges in molecules through an interaction with a universal proto-consciousness field that is congruent or identical with vacuum fluctuations. Stars cool enough to possess upper layers with stable molecules are more conscious than hotter stars and move differently to participate in galactic self-organization.

### How Minded Stars Might Adjust Their Galactic Trajectories

There are at least three ways that a minded, molecule-rich star might adjust its galactic trajectory.

The first possibility is differential electromagnetic radiation pressure. Although photons have no mass, they do have momentum. This means that if a star emitted more of its light in one direction, it would accelerate (in accordance with Newton's Third Law) in the opposite direction. However, observations confirm that the luminous emission from all stars (including our Sun) appears to be isotropic—the same in all directions. It might be of interest to situate a number of in-space solar observatories to check whether there is a preferred direction to solar luminous emissions, from the viewpoint of an observer near the galaxy's center.

A second, more likely possibility, is unipolar jets emitted from young stars. Many infant stars have been observed to emit jets of material (Fig. 3). During the preparation of Matloff

(2012), I was of the opinion that stellar jets tend to be bipolar—with equal jet speed and material outflow in both directions. But unipolar jets from young stars have also been observed (Namouni, 2007).

Consider, for example, a young star that emits 20% of its mass in the first billion years of its main sequence life in a unipolar jet with an average jet velocity of 100 kilometers per second (Matloff 2012, 2015, 2016). If the jet is situated along the direction of the star's motion around the galactic center, the star's velocity in this direction will change by 20 kilometers per second, enough to account for Parenago's Discontinuity in Fig. 2A.

But there is a third, somewhat more controversial alternative: a very weak psychokinetic (PK) force. Because of my friendship with Evan Harris Walker, I had a ringside seat to the infamous controversy between The Amazing Randi and Uri Geller regarding the veracity of experimental PK data. Although I have been privileged to know people on both sides of this controversy, I have nothing new to add to it.<sup>4</sup>

It is easy to estimate how strong a PK force must be to alter a star's circumgalactic velocity by 20 kilometers per second in a billion years. On a more human scale, this is equivalent to a long-lived female runner altering her velocity by 0.2 centimeters per second in a century-long lifespan. I wonder if we could even measure the weak PK force required to accomplish this deed.

I have published two entries on this topic on *Centauri-Dreams*, a blog moderated by science-journalist Paul Glickster. It is interesting to note the passionate responses supporting both sides of the Geller/Randi controversy, decades after the events took place. Hopefully, experimental scientists can move beyond this and conduct experiments to determine whether PK is a physical phenomenon or a magician's illusion.

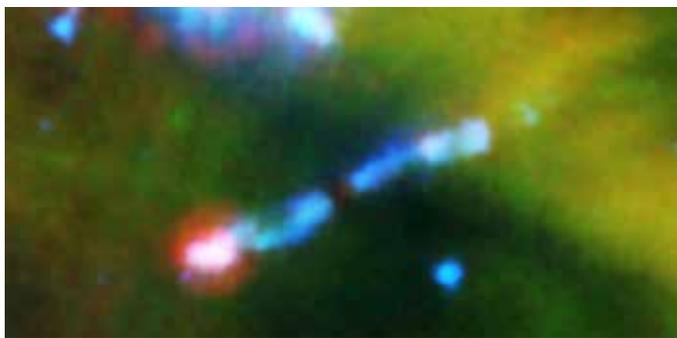


Fig. 3 A young star emitting a jet of material (courtesy NASA).

### Is Panpsychism Emerging as an Observational Science?

In order for a discipline to emerge from metaphysics to become a science, it must satisfy a number of requirements. Evidence must exist, predictions based on the concept must be in place to verify or falsify it, there should be multiple workers in the field, and it must be quantifiable. Does panpsychism as applied to the stellar and galactic universe satisfy these criteria?

### The Evidence

First let's look at the quality of the evidence and how to improve it. A literature search will reveal that the apparent onset of molecular spectral signatures in the upper layers of F8 stars is based upon observations of only a few dozen stars during the 1930s (Matloff, 2016). With all the modern infrared stellar spectral observations by a host of space observatories, it would be very nice if some enterprising specialist in infrared astronomy could check the onset of molecular spectral signatures using observations of many stars.

But there is additional evidence supporting the existence of self-organization at the stellar and galactic levels. Spiral galaxies such as our Milky Way routinely absorb smaller dwarf galaxies in a process referred to as "galactic cannibalism." Ari Maller (2007) wonders how galaxies maintain their spiral shapes after such large "meals."

### Predictions

Now I will present a few predictions that will serve to verify or falsify the Volitional Star Hypothesis as a panpsychic explanation for Parenago's Discontinuity:

- (1) Observations from the ESA Gaia spacecraft will confirm that Parenago's Discontinuity is a galactic, non-local phenomenon.
- (2) There will be a correlation between stellar jet direction/intensity and a star's distance from the galactic center. And as a replacement or adjunct to Prediction (2), some form of weak PK will be verified in replicable experiments.
- (3) Spectral study of many more spiral galaxies will not reverse the negative results so far regarding the Spiral Arms hypothesis.
- (4) Very advanced computers using molecule-sized components will display aspects of consciousness.

### Other Researchers in the Field of Astro-Panpsychism

I am neither the first nor only serious scientist to address the possibility that consciousness pervades the universe. In his classic work on universal self-organization, Erich Jantsch (1980) proposes that the upper layers of stars (where stable molecules will be found) might be conscious.

The renowned British mathematical physicist Sir Roger Penrose, in collaboration with the American anesthesiologist Stuart Hameroff, have developed, as mentioned above, a theory of consciousness that has received some experimental support. They speculate (Penrose and Hameroff, 2001) that neutron stars may be conscious. It may be totally coincidental, but a team led by D. K. Berry (2016) has recently published a paper denoting a fascinating similarity between biological cellular structures and simulated structures in neutron stars.

Writing in a published monograph and a recent issue of the peer-reviewed *Acta Astronautica*, Clement Vidal (2014, 2016), a philosopher on the faculty of the Free University of Brussels, has investigated certain classes of binary stars from a biological perspective. He concludes that these stellar associations satisfy many of the criteria of living organisms.

Clearly, only a few intrepid researchers have thus far investigated the possibility that aspects of panpsychism can be observed in the universe. As the field matures, there will doubtless be others.

### Quantification of Panpsychism

During August 2016, I participated in a workshop related to Yuri Milner's Breakthrough Initiative Project Starshot, at NASA Ames Research Center on Palo Alto California. One of the participants was Greg Benford, a physicist/science-fiction author who has considered panpsychism in several of his novels. During our discussion, Greg mentioned that a problem with scientific panpsychism is that quantification has not been attempted. And quantification is a requirement for panpsychism to emerge as a science.

This difficulty has been addressed by Giulio Tononi (2012a, 2012b), a professor of psychiatry who holds the Chair of Consciousness Science at the University of Wisconsin. Tononi's approach, Integrated Information Theory, is a quantitative approach that treats consciousness as an intrinsic property of any physical system. Consciousness in any system is structured. Its level depends on the level of interconnections allowing the integration of information. A molecule, with a small number of interconnection possibilities, is calculated to have a low consciousness level. A human brain with billions of neurons has a much higher level.

### Panpsychism as a Science

Panpsychism may not yet be at the point at which it can be accepted as a mainstream science. But since it satisfies the above requirements, it certainly can be accepted as a speculative scientific alternative to explain many phenomena on the human and cosmic levels.

I'm glad I have been able to contribute in a small way to the effort to elevate this philosophical debate to the realm of observational science.

### Acknowledgements

This paper could not have been written without my participation in activities of YHouse, a New York City non-profit engaged in the exploration of awareness and consciousness. In particular, I have been inspired by three astrophysicists associated with YHouse: Piet Hut, Caleb Scharf, and Ed Turner. George Musser, also a YHouse participant, provided information on Giulio Tononi's Integrated Information Theory. I thank Olga Ast, who after attending a YHouse function, emailed a description of D. K. Berry et al.'s recent publication.

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### ENDNOTES

- 1 A lot more information regarding the H-R Diagram can be obtained from any college-level astronomy text, such as Chaisson/McMillan (2008).
- 2 As well as being included in the presentation version [which was kindly delivered by Kelvin Long, who at the time was editor of *The Journal of the British Interplanetary Society (JBIS)*], it was included in my first peer-reviewed publication on this topic (Matloff, 2012).
- 3 Details of data reduction to prepare this figure are presented in Matloff (2015).
- 4 An excellent reference regarding the Geller/Randi affair was authored by an MIT physics professor (Kaiser, 2011).

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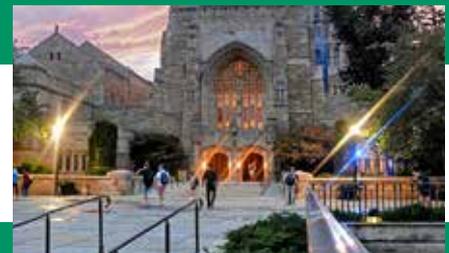
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