Noesis

The Journal of the Mega Society
Issue #206, September 2020

About the Mega Society

The Mega Society was founded by Dr. Ronald K. Hoeflin in 1982. The 606 Society (6 in 10^6), founded by Christopher Harding, was incorporated into the new society and those with IQ scores on the Langdon Adult Intelligence Test (LAIT) of 173 or more were also invited to join. (The LAIT qualifying score was subsequently raised to 175; official scoring of the LAIT terminated at the end of 1993, after the test was compromised). A number of different tests were accepted by 606 and during the first few years of the Mega Society's existence. Later, the LAIT and Dr. Hoeflin's Mega Test became the sole official entrance tests, by majority vote of the membership. Then, Dr. Hoeflin's Titan Test was added. (The Mega Test and Titan Test were also compromised, so Mega Test scores after 1994 and Titan Test scores after August 31st, 2020 are currently not accepted; the Mega and Titan cutoff is 43 - but either the LAIT cutoff or the cutoff on Dr. Hoeflin's tests will need to be changed, as they are not equivalent.) The Mega Society now accepts qualifying scores on The Hoeflin Power Test and on The Ultra Test. Both tests are still being scored. The Mega Society publishes this irregularly-timed journal. The society also has a (low-traffic) members-only email list. Mega members, please contact one of the Mega Society officers to be added to the list.

For more background on Mega, please refer to Darryl Miyaguchi's "A Short (and Bloody) History of the High-IQ Societies" —

http://miyaguchi.4sigma.org/BloodyHistory/history.html

—and the official Mega Society page,

http://www.megasociety.org/

Noesis is the journal of the Mega Society, an organization whose members are selected by means of high-range intelligence tests.

Brian Wiksell (P.O. Box 366, Solana Beach, CA 92075) is the Administrator of the Mega Society. Inquiries regarding membership should be directed to him at the aforementioned P.O. box or the following email address: bwiksell@megasociety.org

Opinions expressed in these pages are those of individuals, not of *Noesis* or the Mega Society.

Editorial

Richard May, Ken Shea

Much has happened in the Mega Society since the publication of *Noesis* #205 in August of last year. After holding three separate elections for Administrator, Internet Officer, and Editor, there are new Mega Society officers in all three positions: Administrator, Internet Officer, and Editor.

You may remember that former Editor Kevin Langdon announced a call for volunteers for the role of Administrator in Noesis #205. That call was answered by new Administrator Brian Wiksell. Thank you, Brian. Jeff Ward (Administrator from 1982-2019) was forced to resign for medical reasons last year. Let's hope that Jeff is doing well and give him our thanks for untiringly serving as Administrator since the Mega Society's founding by Ron Hoeflin in 1982.

Former Internet Officer Chris Cole (Internet Officer from 2005-2019) decided to step down as Internet Officer late last year. As many Mega members have rightly acknowledged, Chris Cole allowed the Mega Society to run online smoothly for many years and created a genuinely welcoming atmosphere. Thank you, Chris. Shortly after Chris's decision to step down as Internet Officer, Dan Shea volunteered and was elected Internet Officer. Upon getting elected, Internet Officer Dan Shea stepped up in a big way by doing the following: migrating the Yahoo! Groups messages, which stretch back two decades, to a new platform; creating a "responsive" new website layout (https://megasociety.org/); and, embarking on a journal restoration effort. Journal issues from The Titan Society (*Insight*, *Titanic* and *Titania*) and The 606 Society (*Circle*) along with previous issues of *Noesis* may be found here: https://megasociety.org/#noesis. Thank you for all of your hard work, Dan, and to all that helped!

Kevin Langdon (Editor from 2005-2020) officially began serving as Editor with *Noesis* #176, published in February of 2005. After many months of unsuccessful attempts to elicit any response from Kevin by phone or email earlier this year, an election for Editor was announced by Administrator Brian Wiksell. Two candidates received a majority of votes for Editor - Richard May and Ken Shea. Therefore - pursuant to Article IV, Section 12 of the Mega Society Constitution - both Richard May and Ken Shea will now serve as Editor. The current Editors would like to thank Kevin Langdon for serving as Editor of *Noesis* for more than a decade! Kevin Langdon edited and directly contributed to some of the most interesting discussions in *Noesis*.

Kevin Langdon announced a Letters to the Editor column in Noesis #205 ("something that I intend to continue, with the help of Noesis readers" -Kevin Langdon). Both Editor Richard May and Editor Ken Shea would like to keep this Letters to the Editor column going as well. It is our feeling that a Letters to the Editor column will foster a more dynamic and interesting *Noesis*. Accordingly, readers may send their letters to the following email addresses - rmay@megasociety.org or kshea@megasociety.org.

A majority of Mega Society members have voted to retire The Titan Test and accept qualifying scores on The Hoeflin Power Test and on The Ultra Test. The Hoeflin Power Test and The Ultra Test are still being scored and will now be used as admissions tests for the Mega Society.

With society business out of the way, let's explore the current issue of *Noesis*. The first contribution is Chris Cole's "How to Prevent Pandemics," which helps locate strategies to deal with the current pandemic (i.e., COVID-19) and better handle future pandemics by creating a biology platform analogous to *Mathematica*.

Next, Bob Williams kicks off a sequence of three *Noesis* submissions on *g* and intelligence. Bob Williams's "The Tools of Intelligence" explores whether mental chronometry and brain imaging can gauge intelligence as well or better than IQ tests. Could these novel approaches eventually displace or supplement IQ tests? Might that day be soon?

After that, researcher David Redvaldsen subjects Ron Hoeflin's Mega Test and Titan Test to a psychometric analysis in "Do the Mega and Titan Test Yield Accurate Results? An Investigation Into Two Experimental Intelligence Tests." David Redvaldsen provides his own norms for these high-range tests and assesses whether each test truly taps the one-in-a-million level.

Then, Mega Society founder and test creator Ron Hoeflin responds to David Redvaldsen's investigation and explains how he approached norming the Mega Test and Titan Test back in the *Omni* magazine days. Ron includes an update on his Encyclopedia of Categories.

If the previous three contributions could be said to concern *g* and intelligence, then the next four contributions might be said to wrestle with different aspects of philosophy.

Ken Shea's paper "On the Potential Epistemic Invalidy of Phenomenological Accounts" examines issues swirling around consciousness research, particularly the neural correlates of consciousness, and whether consciousness can be explained within a physicalist framework.

Adam Kisby, a member of the Omega Society, then makes the case for scrutinizing the concept of testability in a philosophy of science piece titled "Testing Testability," which examines the Principle of Testability through its manifold expressions via verifiability and falsifiability.

(Readers intrigued by Adam's ideas may relish "Doubting Doubt," a similarly thought-provoking piece published in *Noesis* #197.)

Next, Rick Rosner provides answers to Scott Douglas Jacobsen's intelligent, wide-ranging questions in the final part of an interview series. Interview themes include: Rick's take on deep time, cosmology, ethics, consciousness, and artificial intelligence throughout the 21st century.

Werner Couwenbergh, then, contributes a rigorous paper on intuitionism ("The Intuitionist Continuum"), an idea in the philosophy of mathematics that treats mathematics as the consequence of constructive mental activity, as opposed to mathematical realism, which says that mathematical objects exist independently of mental activity.

If a few brain-teasers sound good at this point, then the reader may cheer to learn that Ron Yannone shares his long-time delight in "Litton Industries' Problematical Recreations" in addition to an eclectic array of problematical recreations to try one's hand at.

After that, Ken Shea has an essay on political legitimacy (“Political Legitimacy Through the Ages”), a concept in political philosophy. Trends in political philosophy are traced from Greek philosophers Plato and Aristotle to present-day happenings.

Noesis Editor Richard May, also, has released a new book, *Stains Upon the Silence: Something for No One*! Readers are treated to two forewords, a preface by author Richard May, a.k.a., May-Tzu to *Noesis* readers, and an afterword by Adam Kisby.

At this point, Adam Kisby curates his Exceptionally Intelligent Individuals’ Extraordinary Ideas Index (EIIEII). Step right up and determine whether you have any extraordinary ideas!

Ken Shea, then, compares the metaphysics and ethics of Arthur Schopenhauer to the work of moral philosopher David Benatar in an essay titled “Arthur Schopenhauer’s and David Benatar’s Contributions to Philosophy.”

Finally, Richard May, a.k.a., May-Tzu, rounds out Noesis #206 by serving up three piquant dishes: “Transontological,” “Physics as Erotica,” and, “The Immortality of Zeno of Elea.”

Readers are invited to click on the title of a particular contribution on the following two pages (i.e., pages six and seven) to skip ahead to the selected *Noesis* contribution.

Please submit material for the next issue of *Noesis*, tentatively planned for February 2021.

Contents

How To Prevent Pandemics

Chris Cole

Mathematics : *Mathematica* :: Biology : ?

As recently as the 1980s, physicists routinely referred to printed journals and textbooks to find the solutions for various mathematical problems. Frequently this was a tedious process - but that was the way physicists had always worked. What physics needed was a platform that contained all this mathematics in a consistent language and notation. Hence a platform was born for solving mathematical expressions: *Mathematica,* which became the ubiquitous and indispensable software tool used by scientists worldwide. Notably, *Mathematica* forever changed the way physics is taught to university students in their graduate studies.

Much of the necessary mathematics for scientists previously had been collected, often painstakingly, into books, such as *Handbook of Mathematical Functions* (Abramowitz and Stegun) and *Table of Integrals, Series, and Products* (Gradshteyn, Ryzhik, et al.). *Mathematica* incorporated the insights of generations of mathematicians to make computation broadly accessible. This revolution in scientific computation occurred just as the Internet similarly changed the world of science and commerce. Now the production of publication-ready text using mathematical notation and graphics is quite standard. The remarkable combination of *Mathematica* and the Internet did not merely improve efficiency of scientists; rather it aided science in gaining profound insights into the physical world.

Today, research in physics is routinely performed using symbolic mathematics, particularly with visualization via computer graphics. To paraphrase Isaac Newton, in his famous observation about himself, *if we see farther it is because we stand on the shoulders of giants*.

Currently the world is suffering from an historic pandemic with an uncertain outcome. A global effort is underway to find treatments for COVID-19, including tests, therapies and vaccines. At best, there will be a year or so of suffering before the pandemic is brought under control. At worst, the virus may be with humanity for decades.

Human biology consists of about a hundred thousand proteins that interact with each other in various ways. These proteins are encoded in three billion base pairs of DNA that are shared by all people. The transcription and expression of these genes via RNA is understood. The gene regulatory networks that control this expression can be “nested” so that the overall biology of the human being is akin to a computer operating system. It operates on several scales at once.

Many of the details of human biology and the novel coronavirus are quite poorly understood. Hence science has to start from scratch to understand this pandemic - and probably the next one.

This is akin to the physicist searching for the right treatise or textbook on the mathematics needed to solve a research problem. Just as *Mathematica* helped to solve certain problems, a biology platform which contains the details of human biology would help to prevent pandemics. Once a particular pathogen emerges from the ecosystem, its methods of operation would be analyzed and ways to prevent its spread could be synthesized.

We are vulnerable because we have not organized the basic biological knowledge of how the human being works. Science needs a platform that encodes this knowledge of human biology in a self-consistent and computable way. There presently is no one way to do this, just as there was in physics before *Mathematica*. The issue isn't that a biology platform needs to be the best possible one; the issue is that some platform needs to exist now.

[Editor's Note: The Centers for Disease Control and Prevention say there are four main subgroups of coronaviruses (alpha, beta, gamma, delta) and three other kinds of coronaviruses: MERS-CoV, SARS-CoV, and SARS-CoV-2.

https://www.cdc.gov/coronavirus/types.html

SARS-CoV-2 is the novel coronavirus that causes the disease COVID-19. The novel coronavirus SARS-CoV-2 got its name on February 11th, 2020 because of genetic similarities to SARS-CoV, which caused the SARS outbreak in 2003. SARS stands for severe acute respiratory syndrome.

COVID-19 symptoms like fever, cough, and shortness of breath are common. Symptoms may take 2-14 days to appear after exposure (the incubation period), with five days being the average time to show symptoms after exposure to the virus.

https://www.cdc.gov/coronavirus/2019-ncov/symptoms-testing/symptoms.html

The World Health Organization declared COVID-19 a pandemic on March 11th, and two days later a national emergency was declared in the United States. There have been tens of millions of confirmed cases worldwide and millions of confirmed cases in the United States.

As an approved vaccine has not been widely adopted yet and COVID-19 is spread person-to-person, precautions should be taken to avoid respiratory droplets from those infected.

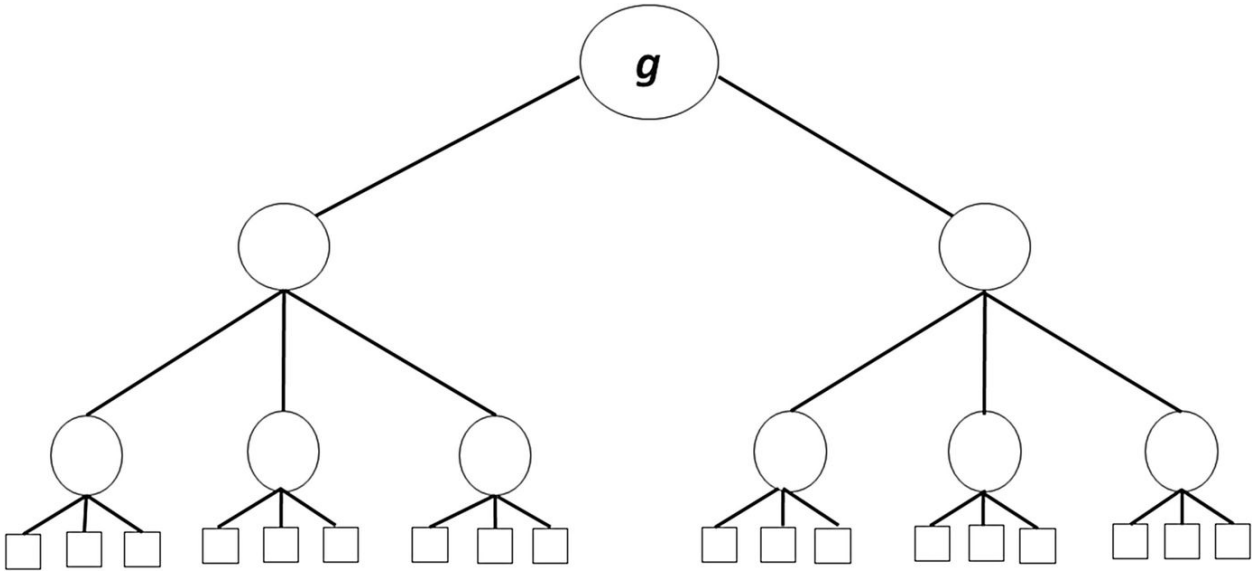
COVID-19 has now achieved community spread, which means many are impacted in an area, potentially without being aware of infection. Before (and after) a vaccine is developed, precautions should be taken.]

The Tools of Intelligence Research

Bob Williams

The following is a tour through the various methods that have been devised and used to uncover the bits and pieces of insight that make up the present-day scientific understanding of human cognition and its differences among people. The point of this exercise is to identify tools and relationships that are not as well known as the ubiquitous IQ test.

Attempts to understand intelligence go back at least to Sir Francis Galton [1822-1911], who noted the heritability of intelligence, its difference between various populations, and its relation to physically measurable tasks. Following Galton, Charles Spearman contributed new statistical methods, insightful test designs, models of intelligence, and, most importantly, his 1904 discovery of *g* (also referred to as Spearman's *g*, psychometric *g*, the general factor, and *g*). Over the course of the next few decades, *g* languished, while IQ tests were developed, studied, and refined to a point of high reliability and low bias. Numerous well-known researchers contributed models, tests, and understanding that were mostly based on the correlations between test scores and external factors (behavior, physiology, and life outcomes). It was not until Arthur Jensen began to explain the central nature of *g* that intelligence research shifted from earlier models to converge on g theory. Today, it is difficult to find a research paper that is not about, or constructed from, *g* theory.



Above: Hypothetical example of hierarchical factor analysis

The investigation of intelligence can be sorted into four categories: conventional tests, external measurements with instrumentation, brain imaging, and genetics.

Conventional Tests

Although we are all familiar with some forms of IQ tests, they vary greatly and are designed for a variety of applications. Testing can be done over an age range from toddler to very old. At the young end of this range is the test methodology developed by J. Fagan based on selective attention to novelty (the time toddlers spent looking at new versus familiar faces). His method was predictive of adult IQ (r = 0.59) and adult educational attainment (r = 0.53). The Woodcock-Johnson is one of the broad ability tests that measures a specific number of abilities so that the traditional second-order factors [so-called “group” factors -Ed. Note] of the Cattell-Horn Carroll model will emerge; it claims to measure from age 2 to over 90. The Wechsler, various forms, is also a broad-based test, based on the CHC model, and is considered to be the gold standard (95 percent reliability) by many researchers.

A number of special-purpose IQ-test types have been developed. Some can be given orally to individuals who cannot write (as in an accident victim). Some are designed for speed of administration, taking only a few minutes. These latter group of IQ tests sacrifice range and accuracy for speed and are well suited when a coarse sorting is desired. The Wechsler Abbreviated Scale of Intelligence (WASI) is a well-known example of a test that has been shortened from its full form to achieve this objective. [The WASI is composed of two very highly *g*-loaded subtests (viz., vocabulary and matrix reasoning) as well as the similarities and block design subtests, rendering administration much speedier. A simple vocabulary test may be one of the most effective de facto IQ tests one could give in around ten minutes. Remember that cultural bias is an empirical question, and cultural bias is orthogonal to cultural load. Cf. *Bias in Mental Testing* -Ed. Note]

As most people have discovered, they are likely to score differently on different tests.This is largely due to uniqueness variance. IQ tests give reasonably close agreement of the latent factor *g* (when it can be computed), but the tests differ in content designed to produce broad ability factors and items that are either specific to the test, or due to random error. Specificity can result from content that is known to the testee (learned material) or is otherwise unique to the test. When a person is trained to take a category of test (teaching to the test), the specificity variance increases, thereby causing the *g* loading of the test to be somewhat lower.

The thing that ties IQ and other ability tests together is known as the positive manifold, which is the strong tendency of a person to score at a similar level on tests of largely unrelated abilities, such as vocabulary and block design. Spearman observed this and created the principle known as the indifference of the indicator, which was intended to point to the universal nature of *g* as a general ability that appears in all cognitive abilities. Ergo, any test of cognitive ability is predictive of *g,* and all such tests are predictive of the same *g* (meaning that there are not

multiple *g* factors). Cognitive ability testing is not limited to IQ tests. There are many tests designed to measure narrow abilities, without an attempt to link the scores to IQ.

Various tests of working memory capacity require the testee to retain representations, while performing tasks that make demands on working memory. He may be given a list of words or letters to remember, separated by a simple task, such as 3 + 5 = 7 (choose yes or no). Then he is asked to recall the list from memory. People are typically able to retain only a small number of representations (4 to 9) in working memory. The simple intermediate math operation effectively flushed out some of the working memory that was used to store the list of memory items. While this category of test is used as a subtest in some IQ tests [Editor's Note: e.g, Working Memory Index on WAIS.], it is also used as a stand-alone tool when working memory is being studied. There are numerous other similar tools that are used for similar purposes.

One of the most interesting special-category tests is the Stroop Color-Word Test. While the test has three parts, it is the third one that demonstrates the Stroop effect. The testee is shown a list of typed color names, but each is printed in a different color ink than the name of the word, (RED is printed with blue ink, etc.). The testee is asked to name, as quickly as possible, only the color of the ink in which each word is printed, while ignoring the name indicated by the printed word.

Red	Yellow	Blue	Green	Black
Pink	Orange	Brown	Gray	Purple
Green	Gray	Black	Blue	Yellow
Gray	Brown	Pink	Orange	Blue
Yellow	Red	Green	Black	Gray
Black	Brown	Purple	Orange	Pink
Purple	Black	Yellow	Red	Green
Orange	Pink	Brown	Gray	Purple

Above: Stroop Color-Word Test

Here is what happens (from Jensen, 2006, *Clocking the Mind: Mental Chronometry and Individual Differences*): "Some individuals are so frustrated by the task requirement that they

break down momentarily, while others stammer, stutter, gesticulate, clench their fists, or stamp their feet during this part of the test. Obviously, literate persons are unable to ignore the printed words even when they try their best to do so. Having to suppress their implicit response to the printed word makes it surprisingly difficult to utter the intentional response, viz., the actual color of the print."

The purpose of the test is to measure the executive function or attention (ability to avoid distraction from a task). Research along these lines has linked the executive function, attention, working memory, and *g*. The details of their interdependence are not fully resolved, but they clearly share cognitive resources.

Measurement of Physical Parameters

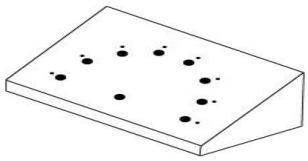
The conventional tests, touched on above, are done with paper and pencil, a computer screen (acting as paper and pencil), or orally. These tests have been used for a majority of the studies of human cognitive abilities. They work and they can be altered to suit the specific mental process that is being studied. Most of them share one significant disadvantage: the tests cannot be scored on a true ratio scale (as is done with most physical measurements, such as force, voltage, mass, etc.). Instead, they have to be scored relative to a selected group of people.

In IQ tests, this is the norming group, and the test is scored by determining the z-score relative to the norming group distribution (IQ = [15 X z score] + 100). The resulting scores are a reasonable approximation of an equal interval scale (as used in the Fahrenheit and Celsius scales).

When physical measurements are used in intelligence research, the results are given on a true ratio scale, such as time, distance, volume, etc. It turns out that a great many of the things that can be measured by instrumentation (including clocks) are linked to IQ test scores and *g*.

Reaction Time (RT)

This measurement is usually done with a Jensen Box and consists of a home button (at the bottom center in the diagram), that the testee holds down, and various target buttons. When the testee sees the stimulus, such as one of the buttons being illuminated, he releases the home button and presses the target button.



Above: Jensen Box

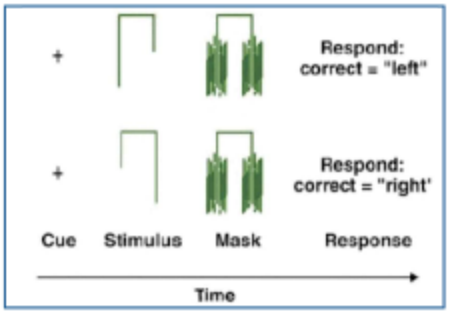
Reaction time (RT) is measured from the onset of the stimulus to the release of the home button; the time from the release of the home button to the pressing of the target button is the

movement time, but is of little value in studying intelligence. Both the RT and the standard deviation of RT are negatively correlated with intelligence, with the latter being somewhat more strongly correlated. RT measurements can be done in connection with a wide range of elementary cognitive tests (ECTs) and can be combined when a battery of these simple tests are given (each requiring less than a second to complete) to produce a measurement of *g* that is approximately equal to the *g* measurement from an IQ test. Each ECT has only a small *g* loading, averaging r = -0.35, but the variances are distinct enough to be added.

Galton performed RT measurements from 1884 to 1893, using a pendulum for the time measurement. His data has been compared to more recent RT studies; it shows that RTs have increased, suggesting a dysgenic effect (explored in detail by M. Woodley).

Inspection Time (IT)

Another widely used chronometric measurement is based on the shortest time that a person can recognize a change in the shape of a projected image. The standard image is somewhat like the letter pi (two vertical lines connected at the top). A cue is given to signal that the test is starting, then the test image is displayed, with one of the vertical lines shortened, then masked. The testee is asked which vertical line of the test image was longer. As the display time is reduced, a point is reached where the testee cannot reliably determine which line was longer. The testee's inspection time is the point where he can achieve an accuracy of 97.5 percent. Again, there is a negative correlation (r = -0.54) between the speed of perceptual discrimination and IQ.



One of the important contributions made by IT was a study by T. Nettelbeck et al. that related to the Flynn Effect. He performed IT measurements for school children from the same school, using the same equipment.

The two sets of data were separated by 20 years. He also administered the same IQ test for the two groups. The expected IQ gain (Flynn Effect) was seen for the test scores, but the IT measurements were essentially identical, thus strongly suggesting that the test score gains were hollow with respect to *g*. I had the opportunity to ask him if there had been any changes in apparent SES, nutrition, or other discernible factors. He said that there was none, and the children were from the same community, school, etc. [Editor's Note: This finding is fascinating

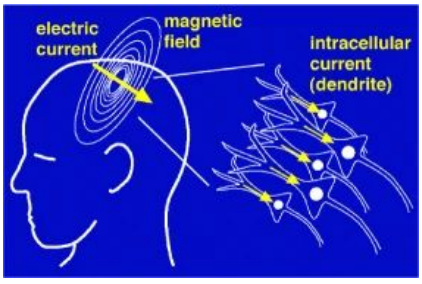
and suggests the Flynn Effect could be largely chalked up to practice effects of some kind. Researchers have now found a reversing of the Flynn effect over the last thirty years in various countries, including Sweden, France, and Britain.]

Tachistoscope

IT tests have traditionally been performed by means of a tachistoscope. It has a shutter and can project an image for a precise duration. When computer monitors were first tried for this task, the results were not reliable because of screen characteristics that allowed some people to read screen artifacts. With modern, very fast computer screens this problem has been solved.

Electroencephalography (EEG)

EEG has been widely used for medical diagnostics for head injuries, tumors, infections, and other disorders that relate to the nervous system. The measurements detect electrical activity in the brain by means of electrodes placed on the scalp; these are typically amplified and recorded on moving paper (creating traces). [Editor's Note: Both EEG and MEG signals are possible because of the electromagnetic laws described by Maxwell's equations, e.g., electrical currents produce an orthogonal magnetic field.] At one time, a good bit of intelligence research was carried out using EEG, but the number of papers reporting it has declined as newer measurement options have appeared.

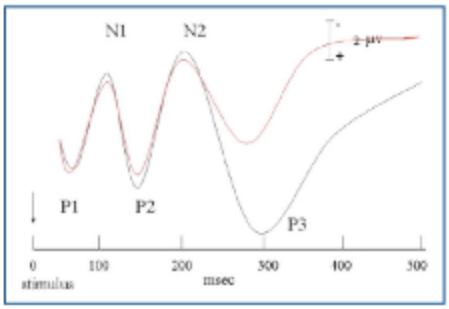


Depicted above: Ionic current flowing in dendrites, producing an orthogonal magnetic field

The magnetic field thus produced is reflected in EEG and MEG readings

A primary focus of interest in EEG has been in the traces made following a specific stimulus. Since the traces contain large amounts of noise, they are repeated many times and averaged to

produce the average evoked potential (AEP). The P300 latency, sometimes identified as P3, is one indication of intelligence. It correlates at about r = -0.36 with *g*. Another indication of intelligence is the complexity of the waveform. This is sometimes called string length since it can be measured by laying a piece of string over the wave tracing then measuring its length. Higher IQ is usually indicated by greater string length, but the strongest indication (per T. Bates, et al.) may be the difference in string length between high- and low-attention conditions, which is an indication of neural efficiency.



P300 (P3)

E. W. P. Schafer reported index methods that are based on the amplitudes of the AEP when the stimulus is related to neural adaptability and habituation (see: *The g Factor* for details of the procedures). These methods resulted in correlations as high as r = +0.82 with IQ tests. Although this methodology did not develop a following by other researchers, it demonstrates that *g* is closely related to the electrophysiological activity in the brain.

Other Biological Measures

Intelligence (*g*) is correlated with numerous other biological parameters that can be measured. (Cerebral glucose metabolism is one such measure and will be discussed later.) Nerve conduction velocity (NCV) is inherently related to the speed and efficiency of cognitive activity. NCV has been measured directly in the brain and in peripheral parts of the body. Peripheral measurements (for example, finger to wrist, and wrist to elbow) of NCV correlate with *g* in the range r = +0.41 to +0.46. Although most of these peripheral studies have produced the expected result, some have not, and at least one showed opposite results in men (r +0.63) and women (r = -0.55).

One of the most well-known of these physical measures is brain volume, which correlates positively with intelligence. Before brain imaging technology appeared, brain volume had to be measured by weighing a cadaver brain, or by estimating its volume from the skull volume (taken as the volume of lead shot or mustard seed that it will hold). Another indirect method of measurement is to take the head circumference or multiple measures of length and width to estimate the volume. While head measurements correlate at only r = +0.20 with *g*, the correlation is robust and has been repeated many times with large studies. One of the unexpectedly interesting papers that I have heard presented was Ian Deary's calculation of the

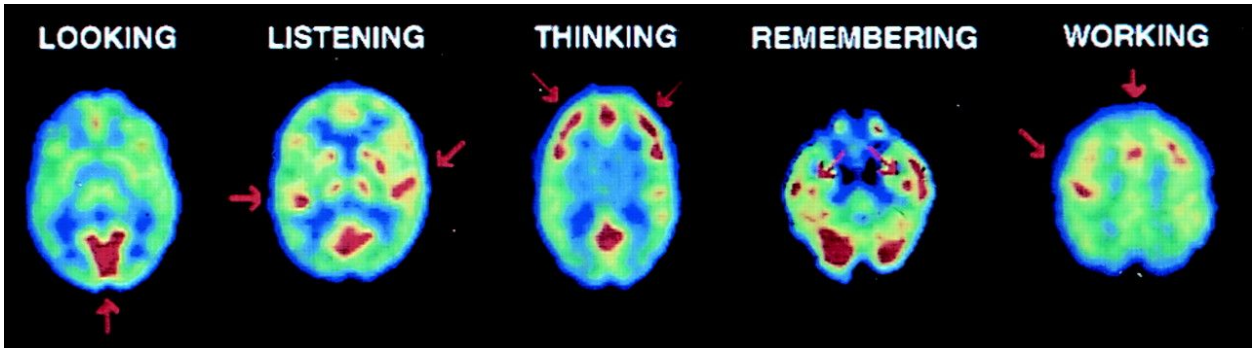
IQ of King Robert Bruce (paper presented in Amsterdam in 2007). I think Deary went through the somewhat-complex exercise to teach his students how to deal with data and errors. When it became possible to measure brain volume in a living person, via structural MRI, the correlation coefficient (volume of *g*) of r =+0.40 emerged. This number was later challenged and argued to be lower, but the challenge was subsequently refuted. The best estimate remains close to the initial finding. Brain volume remains an important intelligence parameter, as it relates to intelligence differences between species, between breeding groups (races), and between sexes.

Brain Imaging

Brain imaging technology is to the study of intelligence as the Hubble telescope has been to cosmology. Imaging has appeared in several stages, and each has opened new paths of study and huge gains in the understanding of intelligence.

Positron Emission Tomography (PET)

PET can be used to create images of the brain and various other organs. The thing that is seen as an image is the accumulation of a radioactive tracer (oxygen-15, fluorine- 18, carbon-11, or nitrogen-13) as the tracer is concentrated by the action of the organ being studied. As the tracer decays, it emits a positron, which collides with a nearby electron and causes the emission of two photons. The photons are detected externally.



Above: Positron Emission Tomography with presumed brain states

In the case of brain imaging, the image is effectively an integral of glucose uptake rate. The tracer used is fluorodeoxyglucose, which gives a time resolution of about 32 minutes. Thus, the image produced when a person is asked to perform a cognitive task is an integral over a time span of 32 minutes. The first use of PET to study intelligence was done by Richard Haier (presently editor of the journal *Intelligence*) in 1987. At that time, the cost of a single scan was $2,500. Haier financed the initial work by agreeing to do medical scans in trade for some research scans. His first subjects were given the RAPM (Raven's Advanced Progressive Matrices) during the exam. Raw test scores ranged from 11 to 33 (out of a possible 36).

The PET scans revealed the opposite of the expected result. The brighter subjects showed less brain activity (lower glucose uptake rates) than did the duller subjects. This was the first indication that one difference between brains of different intelligence levels was efficiency. The smarter brains solved the problems more efficiently. Decades later, we have numerous other imaging studies, using other technologies that have made similar findings and have added more detail to the initial study. One somewhat-easy-to-find refinement was that all brains show increased activity (effort) as problem difficulty increases, but less-intelligent brains reach a saturation point beyond which they cannot apply additional effort.

Haier also looked at the effect of learning, using the game Tetris. [Editor's Note: Mega Society qualifier and mathematician Solomon W. Golomb's game of pentomino directly inspired Tetris.] Several subjects were given practice sessions with the game (new at that time). They had not seen the game before and were restricted to uniform practice sessions. They improved their play score by a factor of 7. PET scans before and after the learning sessions showed significant reductions in brain activity in some parts of the brain. Haier wrote: "We concluded that with practice and improved performance, subjects learn what areas of the brain not to use, and this results in GMR (glucose metabolic rate) decreases."

PET studies showed the value of being able to measure actual brain activity while subjects were performing mental tasks. The technology was expensive and had the slow 32-minute temporal resolution, so it was displaced when faster, MRI-based machines arrived.

Magnetic Resonance Imaging (MRI)

The first MRI was performed on a human in 1977. The machines are based on the use of a very strong magnetic field (5,000 to 20,000 gauss; the earth's magnetic field measures 0.5 gauss) that is achieved by means of a superconducting magnet. A few years ago, R. Haier told me that there was an MRI machine that used a magnetic field that was significantly higher (ten times, as I recall) than other machines. He said some people complained of headaches and that the brain was warmed - probably causing the headaches. (A recent literature search shows that possibly even more powerful, new MRI scanners have been built. The reason for increasing the magnetic field strength is that it enables the voxel size to be reduced from 1 mm to 0.1 mm.)

MRI

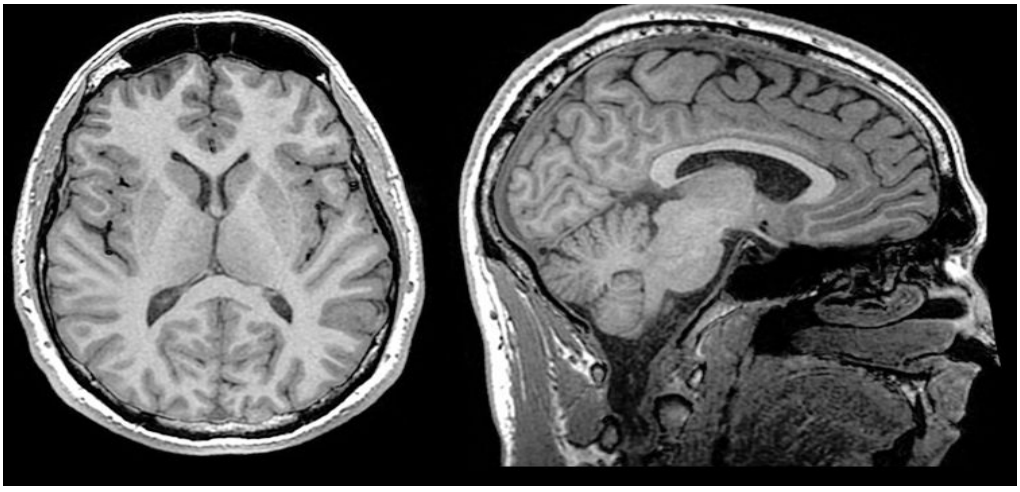
MRI works by imposing an intense magnetic field around the area to be imaged using superconducting magnets. Hydrogen nuclei (protons) spin and have a natural magnetic polarity. When on, the magnetic field causes hydrogen nuclei to snap into axial alignment with the field.

A radio frequency wave is added and is pulsed on and off, causing the nuclei to snap out of alignment and then back in. This shifting of nuclei alignment causes a weak energy release (also a radio frequency wave), which can be detected by the MRI machine (via receiver coils that act as aerials) and used to create an MR image.

Structural MRI (sMRI)

This basic technology (the same as many have experienced in a medical setting) can be varied to allow various specialized forms of imaging. The most basic application for intelligence research is structural MRI, or sMRI. This is essentially a snapshot of the brain, but the image is 3D. It can be rotated and viewed from any angle and can produce a "slice" image of the brain at any depth. Since the image is in 3D, the points are also 3D, unlike the 2D pixels of a digital photograph. The 3D representations are known as voxels.

One of the problems encountered in understanding a brain image is that brains are not identical in size and shape. Yes, they are all generally the same in appearance, just as our faces are similar yet different enough that we can recognize them. A researcher must be able to compare brains, despite their differences. This can be accomplished by a computer using a process known as voxel-based morphometry. The process morphs the MRI data to fit a standard form and smooths the results so that they can be analyzed. For example, an area of great interest is cortical thickness. In order to study it and to compare different brains, the cortex representation has to be smoothed so that the folds are removed and the resulting artificial image retains the dimensions that are of interest, while losing the irregularities that would otherwise make it unmanageable.

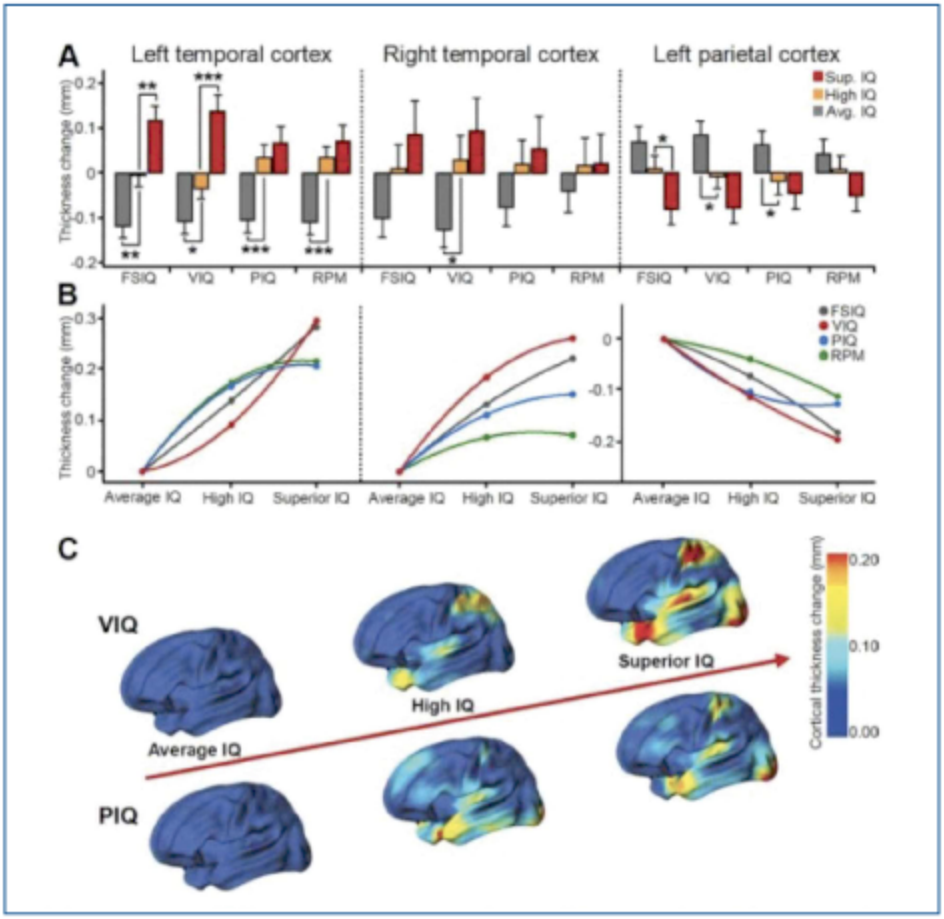


Above: Left image (axial view) and right image (sagittal view) of structural MRI

The cortex contains cortical columns that are vertical structures of variable length and composition. The number of these columns is related to cortical surface area, while their length is a function of cortical thickness. Their relation to intelligence is known primarily by the correlations found in average and local measurements of cortical thickness and in cortical surface area. A good bit of study of cortical thickness (CT) has been related to the NIH (National Institute of Health), e.g., the *Study of Normal Brain Development.*

One finding is that cortical thickness increases in early childhood, then begins a slow decrease around ages 7 to 10 years. When plotted against time, the trajectories of bright children (from longitudinal NIH data) show greater thickness at every age than for less bright children. During the first phase, thickness increases more rapidly in bright children, but exhibits a similar rate of thinning following the peak. This has obviously important significance in the verification of the high heritability of intelligence; the trajectories are set from early childhood. The strongest correlations between CT and IQ are found in the age range of 8 to 12 years.

The figure (below) of CT for different intelligence groups shows that there are differences and that they vary as a function of age. The illustrations of CT as a function of intelligence at the bottom of the figure also show how a brain appears after computer smoothing.



Above: Intellectual domain effects on cortical thickness changes as a function of IQ level. A, Cortical thickness differences between adjoining levels of IQ as affected by intelligence criteria and brain lobes. The superior, high, and average IQ groups were evenly divided according to four intelligence criteria, FSIQ, VIQ, PIQ, and RPM scores. The cortical thickness of each lobe is represented by the averaged value of all ROIs within the lobe. Sup., Superior; Avg., average. *$p < 0.05$; **$p < 0.01$; ***$p < 0.001$, two-tailed t test. B, C, Cortical thickness deviations from the thickness of the average IQ group used as zero reference. VIQ groups are better described by a linear or quadratic function, whereas PIQ groups are better described by a logarithmic one. The brain maps show absolute thickness changes at each cortical point, based on VIQ and PIQ levels.

When the thicknesses of specific locations are correlated against IQ, the results are different for men and women (a surprise to Haier and his team). The highest correlations (gray matter regions) in men were found in posterior regions, especially those related to visual-spatial processing. In women, the IQ-to-thickness correlation was almost entirely limited to the frontal lobes, especially in the language area (Broca's Area). Findings that show sex differences have been frequent, and each strongly suggests the need to keep male and female data separate. Haier made this point to the International Society for Intelligence Research (ISIR) conference in 2006.

Functional MRI (fMRI)

MRI can be used to create images based on molecules containing iron, which is highly sensitive to the intense magnetic fields of MRI machines. Hemoglobin in red blood cells contains iron and iron molecules, thus connecting the fMRI images to blood flow in the brain. When a brain region is cognitively active, it will have greater blood flow, and this will be seen by the fMRI scan. The fMRI process is fast, with thousands of images per second and a net resolution that is a span of about 1 second.

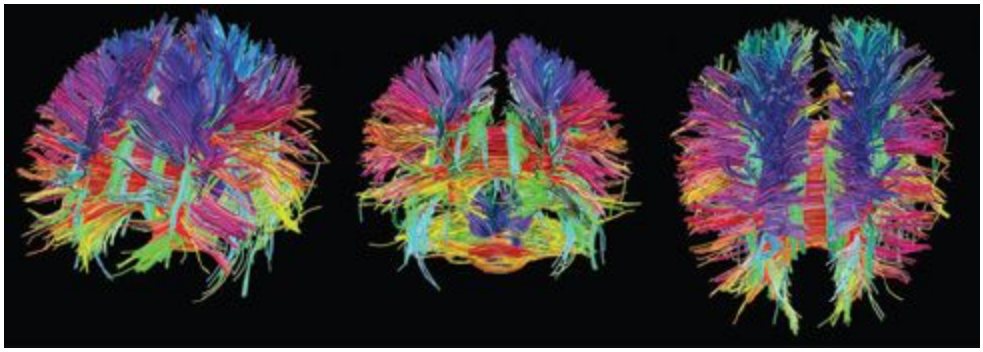
One of the applications for fMRI is the study of functional connectivity. When static measurements are made, the information conveyed relates to the function of a given brain region (functional segregation). But as imaging research progressed, brain regions were found to work together, such that a single region is necessarily involved in multiple functions. With fMRI, it is possible to see the connected activities of brain regions.

Using fMRI, it is possible to observe the brain performing a task over a period of time. Various regions show activity (increased blood flow) sequentially, as the brain deals with the task. In a conversation with R. Haier, he mentioned to me that fMRI data were proving to be difficult to use because of the large differences seen between individuals. This is not a problem with static imaging techniques, such as fMRI and diffusion tensor imaging.

Diffusion Tensor Imaging (DTI)

DTI is a different form of structural MRI. It is optimized to image the water content of white matter. The first study did not happen until 2005. Prior to then, white matter was relatively difficult to study. It was possible to measure white matter volumes and to do correlations with that and intelligence (revealing a large sex difference), but the details of how white matter tracts were organized were hidden. DTI has opened a new field of research-brain connectivity (wiring). Among the things that have been found are that the tracts form bands (in some places) that are

composed of large numbers of parallel tracts; that each person has tract patterns that are as unique as fingerprints; that the primary cognitive centers are connected by massive highways of tracts, running from the frontal lobes to the parietal lobes; that connectivity is an indicator of IQ.



Above: Diffusion Tensor Imaging

When water movement is detected by the MRI process, it can be quantified as to the degree to which the molecules move in the same direction. This parameter is known as fractional anisotropy (FA) and is higher when the movement vectors are directionally similar. If FA is low, it indicates that the water movement is more diffuse, and this is taken to be an indication of low tissue integrity. Higher FA is a positive correlate of intelligence for both white and gray matter.

Magnetoencephalography (MEG)

Breakthroughs in instrumentation have continued to appear, offering new capabilities. Magnetoencephalography (MEG) is in some regards similar to EEG, in that sensors are placed on or very near the scalp. These highly sensitive superconducting sensors detect magnetic fields associated with neuron activity. The instruments are functional, in the sense of fMRI, but faster; they have a temporal resolution in the millisecond range. The precision of spatial location is excellent - sources can be localized with millimeter precision.

Unlike other methods of brain imaging, MEG is completely passive and is a direct observation of the brain, while other techniques are measuring secondary phenomena (isotope decay, water movement, etc.). MEG is thus totally safe and noninvasive.

MEG

When compiled into a movie, brain activity can be seen as a function of time. This was demonstrated (by Thoma) at the 2005 ISIR conference, showing the brain reacting to a simple

optical stimulus. The activation areas appeared to bounce and flow from the extremes of the brain, in much the same way as water waves bounce and reflect when they are confined. When I saw this, there was an immediate revelation as to why something as simple as a light turning on would stimulate activity throughout the brain; this simple event, when measured by RT is significantly correlated with *g*. The video showed that the mental activity was complex and involved most of the brain volume.

MEG remains as a new tool with a limited history for intelligence researchers. It has great promise and is being evaluated by researchers. An example of an MEG movie, made while the subject is solving a test item from the paper-folding task, can be found here: www.cambridge.org/us/academic/ subjects/psychology/cognition/ neuroscience intelligence (select: student resources, then animations, then animation_4.3.mp4).

Genetics

Although Galton observed that intelligence was a family trait, the role of genetics in determining intelligence was not understood for many decades. In the 1960s, even scientists believed that intelligence was largely a product of the environment (books in the home, encouragement to excel in academics, etc.). When Arthur Jensen entered the field, that is exactly what he expected to find, but when he looked at real data, he saw a different story. The result was his 80-page landmark paper: "How Much Can We Boost IQ and Scholastic Achievement?" by Arthur R. Jensen, University of California, Berkeley, Harvard Educational Review, Vol. 39, No. 1, Winter 1969, pages 1-123.

From that point on, Jensen published a huge number of papers and books that addressed the issues related to demonstrating that intelligence is primarily the product of genes, with little environmental variance. Of the environmental variance that is found, it can be divided into the shared and the nonshared environmental factors. The former is that part of the environment that makes us more similar (family), and the latter is that part that makes us more different. There is a shared environmental variance in early childhood, but it vanishes by about age 12, leaving only the experiences people have as individuals (the following factors lower intelligence), such as: injury, disease, exposure to toxins, etc. From early childhood on, the heritability of intelligence increases (the Wilson Effect) into adulthood. By adulthood, the heritability of IQ is 85% and the heritability of *g* is 91%.

Although repeated studies have shown this high heritability of intelligence, attempts to find a single intelligence gene (or a few genes) have failed, despite methodologies that would have found it without doubt. This research has been led by Robert Plomin, who has authored numerous papers on the topic of the genetics of intelligence.

What is going on? The simple answer is that intelligence genes have been found, and each has accounted for only a percent or less of the total variance. As has been the case for other traits, intelligence is the product of hundreds or thousands of variants. For example, height has been shown to be determined by more than 900 variants. The two concepts that relate to this are pleiotropy (one gene affecting multiple traits) and polygenicity (many genes affecting one trait).

Genetic research will hopefully tell an increasingly complete story of which genes are involved, and how. To date, there is an impressive research category known as genome-wide association studies (GWAS). These studies include some with N of much more than 100,000 and at least one that is approximately 1,000,000. The GWAS studies have included genetic clusters that relate to intelligence, educational attainment, and behaviors throughout life. Because of the large N's, the findings are robust, but they show small effect sizes.

A 2017 preprint (http://www.biorxiv.org/ content/early/2017/07/07/160291) showed 107 independent loci associated with intelligence, implicating 233 genes, using both SNP-based and gene-based GWAS. Further studies will surely appear, and the findings will presumably, if slowly, paint a picture of how intelligence is determined at the molecular level.

Further Reading

For those who are interested in reading original intelligence research papers, there is only one print journal dedicated to this subject: *Intelligence*. It is the official journal of ISIR and is the source of some of the best research papers. Another source that frequently contains top-quality work is *Personality and Individual Differences*. In the area of brain imaging, there are worthwhile papers in *Neuroimage*, *Neuroscience*, and *Cortex*.

The best book and DVD material that is relatively recent:

Haier, Richard J., (2017), *The Neuroscience of Intelligence*, New York: Cambridge University Press. This book is recent and was skillfully written to be easily readable, yet complete with respect to present-day understandings.

Haier, R.J., (2013), *The Intelligent Brain*, The Great Courses, Chantilly, Virginia (3 DVDs).

The first DVD is a review of non-imaging research. It then gets into the very interesting work that Haier and his colleagues have done.

Jensen, A. R., (1998), *The g Factor: The Science of Mental Ability*, Westport, CT: Praeger.

Written by the most outstanding intelligence researcher of the second half of the 20th century, this book was, and presumably still is, the all-time most cited book in this field.

For those who want excellent and accurate information that is written for public consumption (some exceptions), I strongly recommend the articles and papers by Linda Gottfredson. She has generously made virtually everything she has written available on her web page: http://www1.udel.edu/ educ/gottfredson/reprints.

Do the Mega and Titan Tests Yield Accurate Results? An Investigation Into Two Experimental Intelligence Tests

David Redvaldsen

[The full open-source article, including all tables, references and appendices, is available through this link: https://www.mdpi.com/2624-8611/2/2/10/htm]

Abstract: The Mega and Titan Tests were designed by Ronald K. Hoeflin to make fine distinctions in the intellectual stratosphere. The Mega Test purported to measure above-average adult IQ up to and including scores with a rarity of one-in-a-million of the general population. The Titan Test was billed as being even more difficult than the Mega Test. In this article, these claims are subjected to scrutiny. Both tests are renormed using the normal curve of distribution. It is found that the Mega Test has a higher ceiling and a lower floor than the Titan Test [Editor's Note: Grady Towers found the same: "The Titan has much less floor than the Mega Test, but almost as much top." -Grady Towers]. While the Mega Test may thus seem preferable as a psychometric instrument, it is somewhat marred by a number of easy items in its verbal section. Although official scores reported to test-takers are too high, it is likely that the Mega Test does stretch to the one-in-a-million level. The Titan Test does not. Testees who had previously taken standard intelligence tests achieved average scores of 135–145 IQ on those. Since the mean of all scores on the Mega and Titan Tests was found to be IQ 137 and IQ 138, respectively, testees had considerable scope to find their true level without ceiling effects. Both are unusual and non-standard tests which require a great deal of effort to complete. Nevertheless, they deserve consideration as they represent an inventive experimental method of measuring the very highest levels of human intelligence and have been taken by enough subjects to allow norming.

[Editor's Note: Grady Towers's "Some Observations on the Titan Intelligence Test," including *g* loadings, can be found here: http://miyaguchi.4sigma.org/hoeflin/titan/gradynorm.html

Key Takeaways: "The general factor accounts for slightly more than 76 percent of the total test variance. Loadings on *g* rarely exceed 0.8 on even the best tests, so these numbers are unusually good."

"The test as a whole was found to have a Kuder-Richardson formula twenty reliability of 0.952, which is excellent and compares favorably with the very best mental ability tests in existence. The odd-even split-half reliability of 0.965 was also found." -Grady Towers]

1. Introduction

Intelligence tests were invented by Alfred Binet and his student Théodore Simon in 1905 with the purpose of identifying pupils in need of remedial help in French public education. Within a few years, they had been translated into English and were to reach their apogee in the United States where Lewis M. Terman, a young professor of education at Stanford University, made his reputation as the foremost authority on all matters connected with intelligence. Terman's first book on the topic, *The Measurement of Intelligence*, featured examples of individuals within the various classifications. By the time his *The Intelligence of School Children* was published three years later, it was clear that Terman's primary interest was in subjects scoring at the highest levels. He had already begun a study of exceptional children, which became the basis for longitudinal research into the lives and careers of the gifted.

This study, published in five volumes as Genetic Studies of Genius between 1926 and 1959, required the construction of a special instrument to accommodate Terman's subjects as adults, called the Concept Mastery Test. This marked the beginning of experimental research on adults in the intellectual stratosphere using psychological techniques. Due to the rarity of the individuals concerned, it was fraught with practical difficulties. One possible method was to give adolescents achievement tests designed for adults. That was the approach chosen by the Study of Mathematically Precocious Youth, which began in 1971 at Johns Hopkins University and which, despite its name, also considered verbal ability. Students who scored at the highest levels on college admission tests at the age of 13 must, logically, be even brighter than the most able ordinary freshmen.

In contrast to this well-funded academic project, extending the scale of intelligence to the highest conceivable levels was an endeavor solely taken up by amateurs. Their method was to publish self-authored tests and to form societies for those who received the highest scores on them. In this way, more could be learned about intellects of the very highest order. *Omni* magazine, devoted to popular science and science fiction, published three such tests between 1979 and 1990. Because of *Omni* 's large readership, enough responses were received to allow official scoring of these tests with at least a semblance of being exact. The procedure of the designers was to compare the number of correct answers yielded by participants and their self-reported previous performance on standard educational or intellectual scales. The data were submitted by mail. It was, of course, an experimental method, because there could be no supervision of test-takers or control of whether the reported scores on the standard tests were accurate.

These three tests were the Langdon Adult Intelligence Test, the Mega Test and the Titan Test. They are the only credible tools for the measurement of intelligence at levels above the ceilings of the traditional instruments - the Stanford–Binet, first developed by Terman, and the Wechsler Adult Intelligence Scale (WAIS). The Concept Mastery Test is purely verbal or educational, which means it cannot capture numerical or logical thinking, seen as essential components of

intelligence in all modern studies. [Editor's Note: potential non sequitur since "purely verbal" tests can be highly *g* loaded and gauge logical thinking.]

2. Object

In this paper, we will investigate the Mega and Titan Tests, designed by Ronald K. Hoeflin and published in *Omni* magazine in April 1985 and April 1990, respectively. We wish to discover whether their author's claims for them are well-founded. The Mega Test was billed as discriminating up to the one-in-a-million level of the general population as for intelligence, while the Titan Test was designed to be even more difficult. If this is verified, they could potentially help to identify the most gifted adults imaginable. This is a topic of some interest as the study of genius is one of the oldest concerns within psychology. As the Mega and Titan Tests are relatively unknown tools serving a niche market, we additionally wish to consider whether they are suitable for wider use by psychologists. The Langdon Adult Intelligence Test would also have been considered if its norming data had been made public. It is believed to have been taken by more than 20,000 individuals and was normed on the basis of recognized intelligence tests.

3. Method

The designer's method is the experimental measurement of the very highest levels of human intelligence. It is experimental in the sense of being based on unrecognized techniques which are put forward for consideration. It is also experimental in retaining some features of previous practice, while changing others in pursuit of a particular outcome. Dr. Hoeflin saw intelligence as a composite of verbal, numerical and spatial skills. Standard item formats such as analogies, number series, logical progression and mental manipulation of three-dimensional objects were included. However, he dispensed with a time limit and permitted the use of reference materials and, in one case, pocket calculators. These novelties may be justified by seeking to privilege intellectual power over speed and the correct application of knowledge rather than merely possessing it. Our method, on the other hand, goes back to first principles in simply mapping the raw scores obtained on the tests onto the normal curve of distribution. An assumption behind the norming of tests of mental ability is that intelligence is a variable characteristic which is distributed normally [Editor's Note: Via a bell, or Gaussian, curve]. This also matches the empirical realities, according to a meta-study of ten mostly well-known surveys of intellect. We are not primarily interested in the predictive validity of the tests since they are designed for adults, but whether they can be used to identify the presence of intellectual power beyond what the standard tests allow. If they do, the entire range of human intellect would be available for study according to a common criterion (psychologically tested intelligence). A critique of the Mega Test already exists which focused on the violation of psychological practices inherent in accepting testing without supervision and norming from self-reported data. The reviewer felt that its accuracy would be increased if the test were taken under controlled conditions. As it stands, the library resources available to test-takers are a factor in the score generated. Even so, Dr. Carlson recognized that the author made such a choice for practical reasons. Hoeflin did not have access to a large pool of individuals who could take the test under controlled conditions for

norming purposes. It might be added here that allowing reference materials closed off a potential avenue to cheating and that efficiency in using dictionaries, thesauri and encyclopedias in any case probably correlate to intelligence. Therefore, instead of pursuing the available resources angle further, we will examine, using the available data, whether Hoeflin's tests truly identify giftedness beyond what the recognized tests do. If they do not, the rationale behind them disappears however the resources issue is settled.

4. Limitations

As we are probing an experimental attempt to extend the range of the scale of intelligence, we are aware that our research has several limitations. Chief among them is the problem of validity intrinsic to the Mega and Titan Tests. No data have been published which shows Titan Test correlations with other intelligence tests, while the Mega Test correlates only 0.374 with the Stanford–Binet and a mere 0.137 with the WAIS. It is true that it correlates more highly with some other intelligence tests (0.565 with the Army General Classification Test and 0.562 with Cattell), but can we be sure that these tests measure what they purport to do? The lack of a time limit has the effect of rewarding persistence and intense interest in the subject matter over actual capacity in a real-world setting. In removing speed as a factor, the Mega and Titan Tests also define intelligence differently to the established understanding manifest in virtually all other tests, while simultaneously giving rise to scores on what is presented as the same scale. Most of the questions on these tests are very difficult and risk conflating puzzle-solving skills with general ability [Editor's Note: The kiss of death? What is a challenging question on a traditional IQ test's matrix reasoning section if not "puzzle-solving skills"?]. Especially the Titan Test contains too many spatial items to be representative of *g*, the general factor underlying thinking. Neither it nor the Mega Test can be used on the general population, and consequently the lowest raw scores are uncertain. The tests are, however, reliable, as they would be scored identically by any marker since there is a single correct answer to each question. A present limitation for us is that we are relying on a non-standard source (a web page) for scores on the Titan Test, as *Omni* magazine did not continue coverage of the topic after 1990. We have no direct method of norming the Mega Test other than by the self-reported previous test scores of *Omni* participants (also from the web page) and the Titan Test, in turn, is normed from self-reported scores on the Mega Test. Although the tests are examined here in case they are, or may be adapted to be, useful to psychologists and researchers, there is no guarantee that the highest scorers on them are representative of the statistical group to which they belong. They are a self-selected sample, possibly with excess time on their hands.

5. The Mega Test

The Mega Test consists of 48 items, of which 24 are verbal analogies, 12 spatial problems, 6 number series and 6 other numerical problems. Two of the questions are multiple choice, but there is no penalty for wrong answers on these or other questions. There is no time limit, though it is suggested the subject spend no more than one month. Reference materials and pocket calculators are permitted. Given that thesauri can be used, a number of questions in the verbal section become relatively easy. The January 1986 issue of *Omni* carried a score report for the

magazine's readership who had taken the Mega Test as printed in the April 1985 issue. It was stated that about 3,200 readers had submitted answers to Dr Hoeflin, and that the median score was 15. An accompanying graph allowed information to be read off about the frequency of each raw score. Because this was given in tens, it required some concentration on our part to arrive at an exact number of readers who had achieved a particular raw score. We are convinced that our reading is accurate, which was confirmed by our grand total of 3,258 testees.

The mean was thus 48,899/3,258 = 15.

The variance can accordingly be calculated as 221,306/3,258 = 67.93. The standard deviation is therefore $\sqrt{}$ 67.93 or 8.24.

As established, we have a mean of 15 and a standard deviation of 8.24. It was also reported in the January 1986 issue of *Omni* that the mean IQ for its readers on the Mega Test had been 141 (on the scale used by the Stanford–Binet, which traditionally had a standard deviation of 16). Dr. Hoeflin arrived at this value by collating previous scores on intelligence and achievement tests reported by participants. We have chosen to calculate the mean IQ on the basis of four intelligence tests alone: the Cattell, the California Test of Mental Maturity (CTMM), the WAIS and the Stanford–Binet. Scores were reported on other tests too, but since the standard deviations for those are not as clear as for our chosen instruments, they were not taken into consideration by us. This is particularly true for the Army General Classification Test.

Converting to the Stanford–Binet equivalent scale used by Hoeflin, we arrive at a mean of IQ 135.12 for those who had previously taken the Cattell, IQ 139.26 for previous CTMM-takers, IQ 140.40 for those who reported scores on the WAIS and IQ 144.61 for former Stanford–Binet testees. The mean for each group on the Mega Test was higher than for the *Omni* respondents in general. The previous scores on the Stanford–Binet were particularly high, with many above the available ceiling for adults. This leads us to believe that a significant proportion of these were yielded in childhood. Since such scores are not applicable to the norming of an adult intelligence test, we decided to discard the Stanford–Binet data. Using the results from the other tests, we calculated an average of 137.8 IQ at a raw score of 17.13. If a raw score of 17 thus represents an IQ of 138 in round numbers, the mean of 15 on the Mega Test likely represents an IQ of 137, given the rate of growth on this part of the scale (this will be confirmed below). We therefore base our norming on the mean of 15 being equivalent to an IQ of 137.

The major advantage in introducing the deviation IQ [as opposed to ratio IQ calculated via mental age/chronological age multiplied by 100 -Ed. Note] was that it should conform to the normal curve of distribution. The number of scores above the mean do show a generally declining tendency. We therefore decided to map raw scores above the mean onto the normal curve. The shape of the normal curve means that scores taper off sharply above 140 IQ. Any score above the mean or below the mean are less common occurrences, but on this test, raw scores below the mean increase in frequency. Therefore, a different method will be used to calculate raw scores below the mean. We divided scores at and above the 137 IQ-level into intervals of 3 IQ points. To substantiate just how rare the very highest scores are supposed to

be, we include a column showing the distribution of scores at or above 137 IQ (see **Table 4** below). Statistical tables in books seldom give percentiles for scores more than 3 standard deviations above the mean. Since the previous scores of Mega Test participants were taken from Darryl Miyaguchi's website "Uncommonly Difficult IQ Tests" we additionally decided to use the percentiles calculated by him.

Table 4. Relative frequency of particular IQ levels according to the normal curve of distribution

IQ Interval	Percentile Interval	Percentile Increment	Percentage of Total Scores ≥ IQ 137
137–139	99.0–99.3	0.3	40.98
140–142	99.4–99.57	0.17	23.22
143–145	99.64–99.75	0.11	15.02
146–148	99.8–99.87	0.07	9.56
149–151	99.89–99.93	0.04	5.46
152–154	99.94–99.96	0.02	2.73
155–157	99.97–99.982	0.012	1.64
158–160	99.986–99.991	0.005	0.68
161–163	99.993–99.996	0.003	0.41
164–166	99.997–99.9981	0.0011	0.15
167–169	99.9986–99.9992	0.0006	0.082
170–172	99.9994–99.99966	0.00026	0.036

173–175	99.99975–99.99986	0.00011	0.015
176–178	99.9999–99.99995	0.00005	0.007
179–181	99.99996–99.99998	0.00002	0.0027
182–184	99.999985–99.999992	0.000007	0.0016
TOTALS		0.732147	99.9943

There were 1,566 testees who scored 15 or higher on the Mega Test among the *Omni* readership. We place these scores into the various intervals of the grid constructed from the normal curve of distribution.

The highest scorer on the Mega Test among the *Omni* readership solved 45 correctly. This represents an IQ of 170 or slightly above. There were three subjects who solved 44 correctly and their associated IQs would be 165–170. We decided to assign them to the 167–169 category, as this allows good approximations of 43 and 42 as raw scores in the 164–166 and 161–163 categories, respectively. No reader scored above 45 and we simply do not have the data to tell us what IQ levels these raw scores represent. Because we originally believed the Titan Test to be harder for all raw scores, our aim was to extrapolate from that test to Mega raw scores above 45. It will be shown below, however, that the Mega Test is more difficult near the ceiling.

On the basis of the present norming, we believe that the Mega Test is indeed able to yield IQs at the one-in-a-million level, a threshold which is attained at a raw score of either 46, 47 or 48. [Editor's Note: Interestingly, Kevin Langdon reckoned that the one-per-million level should be pegged at 47/48 correct on the Mega Test - Kevin generously allowed one point for "ceiling bumping," rendering the proposed Mega cutoff score 46/48 - and said 43/48 on the Mega Test corresponded to an IQ of 172, sigma = 16. https://megasociety.org/noesis/140/admstds1.html] As for the scores below the mean, we calculate them from one standard deviation equaling 16 IQ points. In this way, each question solved correctly up to the mean adds 16/8.24 or 1.94 IQ points to one's score (see **Table 6**). This gives us:

Table 6. New norming of the Mega Test 2019

Table 6. New norming of the Mega Test 2019

Raw Score	IQ	Raw Score	IQ	Raw Score	IQ
1	110	17	138	33	151
2	112	18	139	34	152
3	114	19	139	35	153
4	116	20	140	36	154
5	118	21	140	37	155
6	120	22	141	38	156
7	121	23	142	39	157
8	123	24	143	40	158
9	125	25	143	41	160
10	127	26	144	42	163
11	129	27	145	43	165
12	131	28	146	44	167
13	133	29	146	45	170
14	135	30	147	46	170+

15	137	31	148	47	170+
16	138	32	149	48	170+

6. The Titan Test

The Titan Test consists of 48 items, of which 24 are verbal analogies, 6 are number series, 17 are spatial problems and 1 is a complicated calculation. It was designed to be more difficult than the Mega Test. Hardly any questions are intuitive and almost all require a substantial amount of effort. There is no multiple choice nor penalty for incorrect answers. Test-taking time is unlimited and could require more than a month, reference materials are allowed but not calculators or computers.

The Titan Test was attempted by 391 *Omni* readers. This was only a fraction of the number of responses received for the Mega Test, but is nevertheless high for a test of this nature. The scores of the *Omni* participants were reported to Mr. Miyaguchi and appear on his website.

We begin by calculating the mean, which is 4,556/391 = 11.65. Once we also have the standard deviation for the test, we are in a position to begin norming it.

The variance is therefore 42,455/391 = 108.58. So the standard deviation is $\sqrt{}$ 108.58 = 10.42. What IQ level does the mean of 11.65 represent? Unlike for the Mega Test, previous test scores of *Omni* participants are not available. The only usable data we have for norming is a table of paired scores for testees who attempted both the Mega and the Titan Tests from early 1999, several years after the latter was published in *Omni*.

This indicates that the mean score on the Titan Test was lower than on the Mega Test for participants who took both. Of the 83 participants [who took both tests -Ed. Note], 52 achieved a lower raw score on the Titan Test than on the Mega Test. Their mean score was 22.5 on the Titan Test versus 24.6 on the Mega Test. This is considerably higher than the mean of 11.65 on the Titan Test for all *Omni* participants and not particularly helpful for determining the IQ at the mean. We decided to find the Mega Test scores of Titan Test-takers who were close to the mean of 11.65 by considering scores at 10 to 13 on the latter. Their Mega Test scores were 18, 25, 23, 19, 15, 14, 11 and 15 compared to their Titan Test scores of 13, 12, 12, 12, 11, 11, 11 and 10, respectively. Their mean Mega Test score was therefore 17.5 and their mean on the Titan Test was 11.5. Now 17.5 on the Mega Test is equivalent to an IQ of 138.5, so if we estimate a raw score of 11 on the Titan Test as being equivalent to an IQ of 138, we have a base for our norming. It is also the same value as Hoeflin calculated in the official norming and he had access to the test-takers' previous IQ scores.

As before, we create a grid taking account of the normal curve of distribution's shape for scores of 11 or above. This is reproduced as **Table 10**.

Table 10. Relative frequency of particular IQ levels according to the normal curve of distribution

IQ Interval	Percentile Interval	Percentile Increment	Percentage of Total Scores ≥ 138 IQ
138–140	99.1–99.4	0.3	44.98
141–143	99.5–99.64	0.14	20.99
144–146	99.7–99.8	0.1	14.99
147–149	99.83–99.89	0.06	9.0
150–152	99.91–99.94	0.03	4.5
153–155	99.95–99.97	0.02	3.0
156–158	99.977–99.986	0.009	1.35
159–161	99.989–99.993	0.004	0.6
162–164	99.995–99.997	0.002	0.3
165–167	99.9976–99.9986	0.001	0.15
168–170	99.9989–99.9994	0.0005	0.075
171–173	99.9995–99.99975	0.00025	0.037
174–176	99.99981–99.9999	0.00009	0.013

177–179	99.99993–99–99996	0.00003	0.0045
180–182	99.99997–99.999985	0.000015	0.0022
183–185	99.999989–99.999995	0.000006	0.0009
TOTALS		0.666891	99.9926

There were 167 test-takers who scored 11 or above and thus qualified to be inserted into our grid. We sort the test-takers into categories on the basis of their raw scores, as can be seen in **Table 11**.

Table 11. Distribution of testees in the intervals and associated scores on the Titan Test

Table 11. Distribution of testees in the intervals and associated scores on the Titan Test

IQ Interval	Theoretical Frequency	Associated Scores
138–140	75.12	11–18
141–143	35.06	19–23
144–146	25.04	24–28
147–149	15.02	29–33
150–152	7.5	34–38
153–155	5	39
156–158	2.25	40

159–161	1	41–43
162–164	0.5	44
165–167	0.25	45–47
168–170	0.125	48
171–173	0.063	
174–176	0.023	
177–179	0.0075	
180–182	0.0038	
183–185	0.0015	
TOTAL	166.9638	

The clustering at the bottom is probably a result of there not being enough test-takers to get more precise results. Getting seven more questions right should raise IQ by much more than two points. It is a problem that we have fewer than 400 test-takers, as the mean IQ is based on the Mega Test to which there were more than 3,200 responses. The Titan Test appears to be able to discriminate up to the one-in-a-hundred-thousand level, but more extravagant claims do not seem well-founded. As for the scores which were below the mean, we use the mean and the standard deviation to estimate them, in preference to the normal curve to which this array of scores does not conform. As before, we assign 16 IQ points to one standard deviation of 10.42, counting from IQ 138, which we placed at raw score 11. Each question answered correctly up to the mean therefore yields 16/10.42 IQ points, or an increment of 1.54 IQ. Hence, we obtain the following norming for the test:

Table 12. New norming of the Titan Test 2019

Table 12. New norming of the Titan Test 2019

Raw Score	IQ	Raw Score	IQ	Raw Score	IQ
1	123	17	140	33	149
2	124	18	140	34	150
3	126	19	141	35	150
4	127	20	141	36	151
5	129	21	142	37	151
6	130	22	142	38	152
7	132	23	143	39	154
8	133	24	144	40	157
9	135	25	144	41	159
10	136	26	145	42	160
11	138	27	145	43	161
12	138	28	146	44	163
13	138	29	147	45	165
14	139	30	147	46	166

15	139	31	148	47	167
16	139	32	148	48	168+

This norming is surprisingly low in context, as virtually all the questions on the Titan Test are difficult, unlike the Mega Test which also includes relatively easy items. The mean of the Mega Test is 15 and the standard deviation is 8.24. For the Titan Test, we found a mean of 11.65 and a standard deviation of 10.42. Each test has 48 items of equal weighting. Let us ascertain theoretically which test is the more difficult at the highest raw score possible.

The z-score for the Mega Test would be 48−15/8.24 = 4.004

The z-score for the Titan Test would be 48−11.65/10.42 = 3.4884

Empirical evidence also lends credence to the result that the Mega Test is harder at the highest levels. Out of the 3,258 test-takers, there were 21 who scored 40 or higher on the Mega Test, which equals a proportion of 0.64%. For the 391 Titan Test subjects, there were 5 who scored 40 or higher, a proportion of 1.28%. For the paired scores, we notice that the highest scorers on the Titan Test normally achieved a lower raw score on the Mega Test. A perfect score of 48 on the Titan Test, achieved by one subject, equals about 44 on the Mega Test. The second highest score on the Titan Test, when considering only *Omni* participants, was 44, which equals about 42 on the Mega Test.

7. Conclusions

The renorming of these tests has indicated that the official scores reported to participants are too generous in almost all instances. According to our results, the designer's most recent norming of the Mega Test [Editor's Note: Sixth Norming of Mega Test: http://miyaguchi.4sigma.org/hoeflin/meganorm.html] is too high by six IQ points at a raw score of 10, five IQ points at a raw score of 20, ten IQ points at a raw score of 30 and eleven IQ points at a raw score of 40. The Titan Test has only been normed once. That norming, we believe, is too high by three IQ points at a raw score of 15, by five IQ points at a raw score of 20, ten IQ points at a raw score of 30 and thirteen IQ points at a raw score of 40 [Editor's Note: Titan Test norms: http://miyaguchi.4sigma.org/hoeflin/titan/titanorm.html]. Scores on the Mega Test are boosted because its verbal section contains a number of items which can be solved without much effort. The verbal section of the Titan Test is more abstruse, requiring greater knowledge, more elaborate fact-finding and more thought as to what is being asked for. Therefore, our norming is almost identical to Dr Hoeflin's up to a raw score of 11.

It is a surprise that the ceiling of the Mega Test seems to be higher than that of the Titan Test. Even a cursory glance at the two tests gives the impression that the Titan Test is harder, and it

was designed to be so. There are two possible explanations. The first is that it attracted a more select group of testees. Only 391 Omni readers took the Titan Test, as opposed to more than 3,200 for the Mega Test. It is possible that with a larger pool of subjects, the mean would have dropped significantly, which would have pushed the highest scores up. IQs yielded on both the tests relate greatly to the scores of other participants. The second explanation would be that taking the Titan Test involves answering questions which are rather similar. For instance, there are five variations on a single theme in the “probabilities” section. Solving one of these problems correctly might have made it significantly easier to solve others in the same section. The combination of generally difficult questions with clustering occurring inside sections, may then have led to greater dispersal. The concomitant higher standard deviation would, in that case, have pushed the ceiling down. Mega Test questions tend to be more unlike one another. If we discount the defect associated with its verbal section, we believe it does measure mental ability up to the one-in-a-million mark. (Even if the mean on the test represents an IQ of 131, six points lower than assumed, a raw score of 45 would generate an IQ of at least 167. A raw score of 48, not yet achieved by a test taker, would then probably still hit the one-in-a-million level, which is an IQ of 176.) The Titan Test measures up to the one-in-a-hundred-thousand mark and, as discussed above, has no defect in its verbal section.

The decisive issue is whether these tests can be useful to psychologists. Our norming does indicate that the tests go above the ceilings of established tests [The WAIS-III, e.g., has a ceiling of IQ 155, sigma 15, and WAIS-IV has a ceiling of IQ 160, sigma 15. -Ed. Note]. Subjects who achieve a raw score above 40 are of such exceptional ability that standard tests are unable to measure them adequately. Scores above 5 or so on the Titan Test and scores above 11 or so on the Mega Test also betoken giftedness in the subject. For detecting this, the experimental tests are alternatives to the many accepted tests which operate with a ceiling of only 2 to 2.5 standard deviations above the mean. If the experimental tests were to be adopted by a researcher with the resources necessary to combine them in such a way that the easy verbal and any other faulty items were eliminated, they might serve as a useful complement to other high-range instruments such as the Concept Mastery Test or the Miller Analogies Test. This is especially true because the experimental tests offer many non-verbal questions. New norms would of course have to be established for the improved test or tests. Short forms of the tests could also be created which select the best items. [The Prometheus Society, a high-IQ society catering to those scoring at least four sigma above the mean, currently accepts a scaled score of 500 on the Miller Analogies Test and once accepted a raw score of 21/27 on the Mega27, a shortened version of the Mega Test. -Ed. Note] Item Response Theory would be useful here. The object would be to choose the items which act as the greatest indicators for the levels of ability which surpass the norms on the standard tests available. The Mega and Titan Tests, however, cannot be used on their own and in their current form by psychologists, owing to the lack of supervision associated with them and the extremely lengthy test procedure.

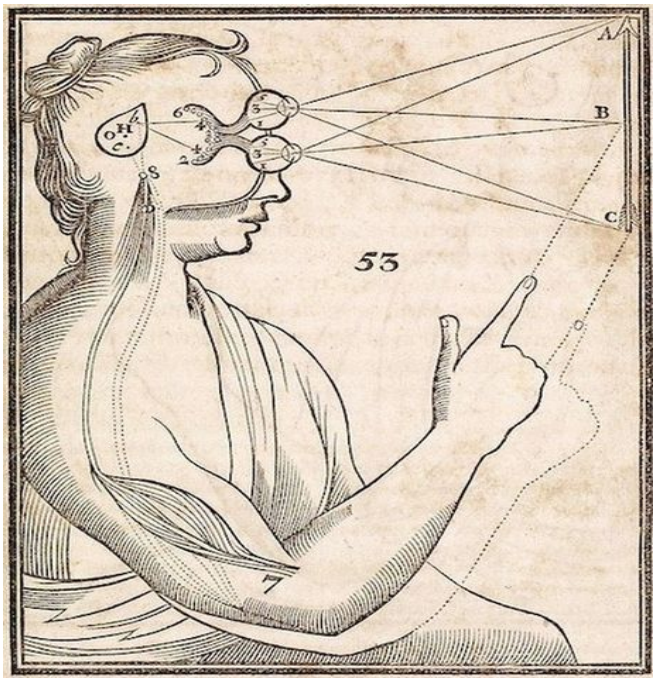
Response to David Redvaldsen's 2019 Investigation of Mega Test and Titan Test

Ron Hoeflin

I did not read the entire report by David Redvaldsen but I did read his norms for Table 12 as well as his entire "Conclusion." I am not a statistician, so I would recommend someone like Fred Britton, who took many courses in statistics at the University of Illinois (Urbana-Champaign) at the graduate level [Fred Britton was taught by Raymond Cattell, one-third of the namesake of Cattell-Horn-Carrell (CHC) theory in psychometrics -Ed. Note] to examine the statistical claims of this report. It does puzzle me, however, that eliminating the easier problems would increase the ceiling of the test. That seems counterintuitive. Maybe the author is assuming a normal curve, which is known not to apply with much success to high-ceiling tests. I think that including easier problems is essential in order to entice a wider audience to try such tests. My Titan Test started with perhaps unduly difficult verbal problems that would not entice many people to try the test, e.g., the problem "Strip : Mobius :: Bottle : ?" As of now only one person, after 30 years, has attained a perfect score on the Titan Test, and only a handful have attained a score of 43 right out of 48, which is used as the cut-off for the Mega Society. The Mega Test was similar until there was a spate of very high scores, which may have been due to leakage of answers on the Internet. But Redvaldsen's results presumably are unaffected by this spate of very high scores because they occurred long after the initial batch of 3,200 *Omni* readers had tried the test. It was about 20 years before anyone achieved a perfect score on the Mega Test (not counting two pre-*Omni* perfect scores, which were partially due to cheating by at least one of the two, and these two early perfect scores would presumably not have been included in Redvaldsen's study). Tests like the SAT and GRE are administered to such a large audience that new problems can be tried experimentally with hundreds of thousands, perhaps millions of people, before they are counted in scoring these tests. Unfortunately, the high-IQ societies do not have such a large group of guinea pigs. I did use volunteers from the Triple Nine Society, for which I was serving as editor, and I chose problems that about half of them missed, so that a score of 24 out of 48 seemed about right for the 99.9 percentile. It was interesting to me that the percentage of people who could solve the three-interpenetrating-cubes problem in the Mega Test rose dramatically with higher overall scores, even though 50% of the test was verbal and 12.5% involved number sequences, so that the ability to solve such a difficult spatial problem should not have correlated very well with the rest of the test unless the overall test was actually doing a pretty good job in measuring general intelligence. For the first 3,200 people who tried the Mega Test, 13 scored 43 to 48 right, of whom 7 people (53.8 percent) solved the cubes problem correctly. Of the 304 who scored 37 to 42 right, 31.2 percent solved the cubes problem. Of those who scored 31 to 36 right, 10.5 percent solved the cubes problem. Of those who scored 25 to 30 right, 4.9 percent solved the cubes problem. Of those who scored 19 to 24 right, 0.7 percent solved the cubes problem. Of those who scored 13 to 18, 0.6 percent solved the cubes problem. Of those scoring 7 to 12 right, 0 percent solved the cubes problem. And of these who scored 0 to 6 right, 0 percent solved the cube problem. I don't see how fussing around with the low end of the scale can shed much light on where the one-in-a-million level should occur. We do know that several people who got PhDs from places like Caltech and M.I.T. managed to

score 43 or 44 right on the Mega Test. One of our members who studied high-energy physics at Caltech for 4 years and was the last of the 15 grad students at Caltech in that specialized program who dropped out, none of the 15 getting a PhD, scored 43 right. John Sununu, who earned a PhD in mechanical engineering at M.I.T., scored 44 right out of 48. Maybe 43 right is "only" at the 99.999 percentile rather than 99.9999 percentile. I have a chart showing the scores of about 5 million people who took the SAT over a 5-year period. Of those 5 million, just 35 reached perfect scores of 1600 on the SAT. If we assume that their scores were distributed between 1595 and 1605, then half of them, roughly 17.5, should be rated at the Mega level over a 5-year period, or about 3.5 people per year. This seems consistent with the birth of about 4 million people per year in the United States, of whom about 4 should be rated at one-in-a-million in intelligence if all of them had tried the SAT. But, of course, not every Mega-level person would have tried the SAT in any given year, but perhaps 3.5 of them would have, on average. If we try to equate the distribution of scores on the Mega Test with scores on the SAT, as a percentile vis-à-vis the general population, as I did in one of my final normings, I could then put the 99.9 percentile at the mid-point for Triple Nine volunteers, and the 99.9999 percentile at the same rarity of people who got perfect scores on the SAT. The GRE perhaps would have been a better platform for such comparisons, since it had a ceiling of 1800 rather than 1600. But I think GRE scores were generally about 50 points higher than SAT scores by the same person, so one would have to use 1650 on the GRE to be equivalent to 1600 on the SAT. I recall having seen scores as high at 1640 on the verbal plus quantitative parts of the GRE (there was a quantitative score as high as 880 on the GRE by a person who tried one of my tests, but that person's verbal score was not similarly high). When Kevin Langdon showed me a list of 600 people who had tried his LAIT which had appeared in *Omni* magazine in 1979, all of whom in his opinion had attained the one-in-30,000 cut-off for his Four Sigma Society, I suggested at that time (1980 or 1981) that he could admit the top 20 or so of the 600 to form a one-in-a-million society, but he rejected the idea, which is why I decided to form a one-in-a-million society on my own, which occurred in 1982. My Mega Test did not appear in *Omni* until 1985, so in the first 3 years I accepted very high scorers on the LAIT as well as people who had several very high scores on several tests, that theoretically could be statistically combined [presumably with the Ferguson formula -Ed. Note] to equate with one-in-a-million in rarity, as if all the tests formed a single very long and very difficult test. At any rate, all my energies of late have been focused on my theory of categories, so I must leave to others further dithering about an appropriate way to acquire genuinely qualified members for the Mega Society. My 13-volume "Encyclopedia of Categories" should be finished in November and I will then send it as email attachments to all members of the Mega and Prometheus societies, as well as to people listed in the "Directory of American Philosophers." If I pursue the project further in my final years, I could theoretically attain a 50-volume version in about 15 years (when I am 91 years of age, if I last that long) and a 100-volume version in about 25 years (when I am 101 years of age, if I last that long), my current age being 76.

Ron Hoeflin



The Potential Epistemic Invalidity of Phenomenological Accounts

Ken Shea

"How does the water of the brain turn into the wine of consciousness?" -David Chalmers

""I'm writing a book on magic," I explain, and I'm asked, "real magic?" By real magic people mean miracles, thaumaturgical acts, and supernatural powers. "No," I answer: "Conjuring tricks, not real magic."

Real magic, in other words, refers to magic that is not real, while the magic that is real, that can actually be done, is not real magic." -Lee Siegel (conjurer and author of *Net of Magic: Wonders and Deceptions in India*)

“Eliminative materialism is the thesis that our commonsense conception of psychological phenomena constitutes a radically false theory, a theory so fundamentally defective that both the principles and the ontology of that theory will eventually be displaced, rather than smoothly reduced, by completed neuroscience.” -Paul Churchland

Consciousness is the presentation of a world. Where a world is not phenomenologically presented to an organism, as in a coma, the organism is said to be unconscious. More shallow forms of dreaming qualify as conscious states because an inner simulation is unfolding and presenting a world, albeit a world with a more tenuous hold on the outer environment than the world presented during waking hours. Human waking consciousness itself is a simulation, a kind of dream, a representational model or virtual reality as opposed to unfiltered reality. Already, one can understand why consciousness would be an irresistible philosophical field of inquiry. Consciousness is seemingly *foundational* and *unique* and *generative* in that the manifold phenomena of consciousness appear to create a world and, simultaneously, inhere within the world. How can this possibly be?

Is the world severed at the skin boundary of the self? Is there one ontological realm for minds and another for matter (i.e., mental-physical Cartesian dualism)? Is there a homunculus watching a thrilling movie in the Cartesian theater of your head right now? If so, does this homunculus enjoy his or her own realm of existence, too, or would the homunculus realm be coextensive with everything else? Can there be more than one homunculus assigned to each person? Is this a necessity or does it invite an infinite regress? Do abstract objects exist independently of the human mind à la Platonic realism (cf. problem of universals)? Were the substantial vitalists right all along in saying that one was hopelessly adrift without invoking an élan vital or entelechy? As philosophers of mind are obsessed with color qualia, occasionally to the detriment of more holistic concerns, let's assess human sight phenomenologically before expanding the depth of field to help answer these questions.

Resolving the Paradox of Isomorphism as Category Error

One could argue the color blue on a phenomenological level doesn't truly exist externally. Indeed, phenomenology doesn't exist externally unless one takes an expansive view of the mind-body problem, as some phenomenal externalists and revivalist panpsychists have done. Presupposing blue doesn't phenomenologically inhere to the real world, then what exists externally? The electromagnetic radiation is real and external, but the transducted internal perception of the particular wavelength frequencies corresponding to supposed color qualia vis-à-vis the electromagnetic radiation (the average human eye can see wavelength frequencies from approximately 380 nanometers to 740 nanometers) is arguably illusory insofar as the internal perception might well be mistaken or subjective. In any event, there's transduction.

Contending otherwise risks falling prey to naïve realism or Antti Revonsuo's "paradox of isomorphism." Antti Revonsuo has this to say: "The problem of isomorphism is that if consciousness literally resides in the brain, then there must be something in the brain that literally resembles or is similar to consciousness - that is to say, consciousness itself" ("Prospects for a Scientific Research Program on Consciousness," *Neural Correlates of Consciousness*, page 67). Classically resolving the paradox of isomorphism means finding an organizational structure in the brain that resembles the contents of phenomenal consciousness. This may be more of a category error than paradox for reasons that will become obvious, e.g., the vehicle and content in a representational context can be distinct, though Antti Revonsuo seems hostile to this aspect of teleofunctionalism. Researchers Gerald Edelman and Giulio Tononi have proposed bringing the entire idea of qualia up to date by saying, "Qualia can be considered scientifically as forms of multidimensional discrimination carried out by a complex brain." The vehicle for the content of color, the folk-psychology notion of color qualia, entails visual cortex area 4 (i.e., V4), particularly the lateral occipitotemporal gyrus (i.e., fusiform gyrus) and the medial occipitotemporal gyrus (i.e., lingual gyrus), once creatures with trichromatic vision (the three types of retinal cone photoreceptor cells are known as S, M, and L cones for short, medium, and long cones, respectively) process color information axonally through the optic nerve and lateral geniculate nucleus.

The transformation of these sensory activation vectors, temporally and through an extremely complex matrix via massively parallel processing, facilitates a representational, neurocomputational model of mentation. Sensory patterns "get transformed mainly by the vast filter of synaptic connections they have to traverse in order to stimulate the cortical population. The result is typically a *new* pattern across the cortical canvas, a principled *transformation* of the

original sensory pattern." This process confounds the theory of naïve realism and complicates a straightforward isomorphism since a *new* pattern and principled *transformation* have been transmuted from the original activation vectors, i.e., the "computation over these vast vectorial representations consists in their principled transformation by the vast matrix of tiny synaptic connections that intervene between any two neuronal populations." Such massively parallel processing explains why animals with less neural architecture and raw computational power can respond so quickly and nimbly to environmental changes ("Evaluating Our Self-Conception," *On the Contrary: Critical Essays, 1987-1997*, pg. 37).

Phenomenal Self-models and The Five Aggregates: Impermanence Curiously Incarnate

One could go further than updating the idea of qualia and posit that the self is an illusion, as the German neurophenomenologist Thomas Metzinger has done in *Being No One: The Self-model Theory of Subjectivity* as well as *The Ego Tunnel: The Science of the Mind and the Myth of the Self*. The folk-psychology notion of self is simply a phenomenal self-model per Metzinger. At root, the phenomenal self-model theory of subjectivity is a representationalist model that seeks to explain how the brain interprets and interacts with mental constructs phenomenologically represented as epistemically veridical aspects of frequently reciprocal inner and outer worlds (cf. Immanuel Kant's inner and outer sense). These conclusions about the so-called self and epistemic fallibility qua phenomenology may be difficult for most people to concede, disquieting to ponder and perhaps slippery to conceptually grasp given widespread phenomenal transparency, but there is mounting empirical support for such a position.

Phenomenology and epistemology need not align perfectly. [1] In fact, Buddhists have long contended that the self is an illusion; the Buddhist concept of anatta, one of the supposed three marks of existence, means "non-self" or "substanceless"; Buddhists maintain that the notion of a self or transcendental soul is falsidical. The idea in Buddhism is that an individual is potentially the moment-to-moment amalgamation of five aggregates (a.k.a., skandhas): form (rupa), sensations (vedana), perceptions (samjna), mental activity (samskara), and awareness (vijnana). Suffering or unsatisfactoriness (dukkha), Siddhartha Gautama believed, manifests as people cling to one or more of the aggregates. Ontologically, because all of the five aggregates (or factors) are constantly changing and empty (i.e., sunyata), the so-called self (or product of these factors) cannot have permanence or ontological substance - remember, anatta means substanceless. Buddhist teaching and Thomas Metzinger's phenomenal self-model theory of subjectivity are in harmony insofar as each views the self as a dynamic process rather than an independent, permanent, transtemporal ontological object, let alone such an ontological object necessitating a private ontological realm à la Cartesian dualism.

Phenomenal Consciousness: Transparency, Perspectivalness, and Presence

Phenomenal consciousness forms the foundation of the body-based, temporally dynamic process constituting the phenomenal self-model of subjectivity. The framework of phenomenal consciousness (i.e., the *modus operandi* for non-pathological, human waking consciousness) is dynamically founded on three fundamental pillars: transparency, or the immediate "givenness" and global nature of phenomenal consciousness; perspectivalness, or the egoic "mineness" of phenomenal consciousness; and, presence, or the temporal "nowness" of phenomenal consciousness (see: Thomas Metzinger's "The Problem of Consciousness"). The most critical of these three pillars of phenomenal consciousness for understanding the phenomenal self-model

is transparency, according to Thomas Metzinger, because: A) transparency, on one level, forms the base upon which both perspectivalness and presence qua phenomenal consciousness are built B) if the instrument of self-representation were itself globally available (i.e., opaque) then the inherent naïve realism of the phenomenal self-model would be obviated C) internal sources of information from which the phenomenal self-model is generated (e.g., vestibular, visual, and proprioceptive data) must be globally *represented* and mostly remain inaccessible to subjective experience [2] (cf. global workspace models) and D) select parts of the phenomenal self-representation (e.g., certain body representations) should ideally appear static for transparency to obtain in the midst of changing internal and external perceptions [3] (cf. David Rosenthal's transitive consciousness; Gerald Edelman's primary consciousness; Philip Johnson-Laird's bare awareness; Antonio Damasio's Protoself). Antonio Damasio has defined the Protoself as "a coherent collection of neural patterns, which map moment-by-moment the state of the physical structure of the organism." [4]

Teleofunctionalism, World Zero Hypothesis, and Autoepistemic Closure

Transparency, denotationally, means that something is easy to see through. As applied to phenomenal consciousness, transparency connotes the deceptive sense, epistemically, of the self-model seeing through the model without realizing the model as such. One simply views oneself, the world, and oneself in it. What could be more natural? As it happens, phenomenal consciousness evolved over millions of years of evolution to deliver a resource-efficient, streamlined, yet subjective view of reality. Quick definitions: Teleofunctionalism (teleo- meaning end, goal, or purpose) in terms of philosophy of mind says that a given mental state is predicated on the function it serves psychobiologically for the subject; the world zero hypothesis [5] is the idea that phenomenally transparent representations aided teleofunctionally in that a single given reality was treated as central (i.e., world zero) for purposes of, for instance, psychomotor action rehearsal; and, autoepistemic closure refers to the fact that a comprehensive representation of reality is underway and that the "representation cannot be represented as a representation by the system itself" (*Being No One: The Self-model Theory of Subjectivity*, pg. 131), or Plato's allegory of the cave incarnate sans the possibility of escape.

Evolution has rendered humans epistemic naïve realists by default because having one streamlined, globally represented view of reality has advantages in terms of the assignment of resources (e.g., glucose), psychomotor planning [6], and remaining largely in the dark about the building blocks that contribute to subsequently represented global phenomenal state space. Bluntly, computational load is reduced. Getting lost in the labyrinthine preliminary stages of phenomenal consciousness would have been dangerously impractical, and had a higher metabolic cost, for progenitors of the human species; as well as other animals. What's important to remember is that phenomenal transparency is inversely related to the degree of attentional availability with respect to these preliminary stages of phenomenal consciousness. Such a definition implies that phenomenal transparency is on a continuum with phenomenal opacity and that a significantly undiluted version of the latter has major evolutionary hurdles to overcome, but phenomenal opacity is definitely possible (e.g., lucid dreams) in principle. In such aberrant cases, one intimately understands that reality is simulation. As a rule, every representation is a simulation but not every simulation is a representation. On a prosaic level, logico-semantic reasoning tends to be less transparent, less streamlined, because it is a more recently acquired mental ability; fewer evolutionary refinements have rendered logico-semantic reasoning more phenomenally opaque (n.b., the high metabolic cost of rigorous step-by-step thinking), and the

gradient of refinement can be represented spatio-temporally within a teleofunctional framework. Presupposing some degree of causal relation between the psychobiology of the brain, refined by evolution and represented by teleofunctionalism, and phenomenology, the connections between deep-rooted parts of the brain and phenomenal transparency manifest themselves in virtual real-time via globally represented phenomenal state space.

The Binding Problem, Innumerable Easy Problems, and the Hard Problem

Elucidating the *minimally sufficient* neural correlates of consciousness in terms of transparency might, accordingly, unravel the most profound mysteries entangled around and within consciousness in the decades ahead (cf. *Neural Correlates of Consciousness*, Thomas Metzinger et al., 2000). In turn, philosophers and scientists explicating the neural correlates of consciousness should illuminate the combination problem vis-à-vis the binding problem in philosophy of mind and help answer, or somehow transcend, the so-called hard problem of consciousness (i.e., the explanatory gap). David Chalmers, an analytic philosopher of mind, maintains that the hard problem of consciousness - viz., why do sentient creatures have subjective experiences? - will persist after scientific and teleofunctional explanations are, presumably one day, fully accepted as explanans for the explananda of innumerable easy problems, like visual discrimination and the neural substrates for short-term memory. An easy problem is claimed to be “easy” because there is, at least theoretically, a determinable neural mechanism carrying out the particular function under investigation. It may turn out, alternatively, that the easy problems will simply be solved first and reveal neural substrates underlying an ever-broadening array of facets of consciousness, which will afford neuroscientists the empirical tools to modulate consciousness as such through tinkering the neural substrates implicated in both the easy problems and hard problem; thus overcoming the explanatory gap. Put another way, a detailed representational, teleofunctional, neurocomputational model serving to explain consciousness may be parsimonious and sufficient. What's more, such an outcome doesn't really seem unreasonable given some kind of monist, especially physicalist, answer to the supposed mind-body problem. Obviously, the “mind” and body aren’t separate at all.

Lack of Identity Criterion Ultimately Requires Elimination

There’s a staggeringly real possibility that both qualia and phenomenology are fictions in this model. Philosopher Diana Raffman has claimed that people are better able to discriminate perceptual values than identify perceptual values. Earlier you learned that the visible spectrum encompassed wavelength frequencies from 380 nanometers to 740 nanometers on the overarching electromagnetic spectrum. Research shows that between 430 and 650 nanometers, or almost two-thirds of the visible spectrum, a human being can discriminate about 150 different wavelength color frequencies by comparing these wavelength color frequencies to one another; however, the number drops from 150 different wavelength color frequencies to 15 different wavelength color frequencies when forced to singly identify particular colors attentionally or semantically. The technical term for this is a lack of “introspective identity criterion.” Invariably, the ineffable 135 colors (150 - 15 = 135) qua perceptual values have a neural correlate of consciousness, i.e., the empirical state of the brain is different in each of these 135 cases even though the perceptual values cannot be identified with introspective attention or articulated. Daniel Dennett and Paul Churchland have both suggested that qualia as such, i.e., as classically defined by Clarence Irving Lewis, do not exist and consciousness may be a kind of higher-order illusion; philosopher Paul Churchland counsels essentially supplanting

phenomenology with a new neural kinematics and neural dynamics. [7] This could be the right approach because it would reflect the fact that the average human brain can register, but not identify with introspective attention or articulate, those extra 135 perceptual values vis-à-vis wavelength color frequencies. Qualia in particular and phenomenology in general may be too crude to describe what is actually happening in the brain, which might in this case ultimately be revealed or scientifically redefined as 135 (or 150) distinct neural correlates of consciousness via high-resolution scans of the brain. Consciousness, refined and redefined, might well be collapsible into information processing or neural kinematics-dynamics. As Daniel Dennett himself once said, “any theory that makes progress is bound to be initially counterintuitive.”

Generally, conceptual-empirical progress can be made by mapping one theory onto another. In a certain sense, indeed, this is a form of reduction, but reduction itself is a relationship between theories rather than phenomena (cf. Johannes Kepler’s three laws of planetary motion getting encompassed by Isaac Newton’s more broadly explanatory three laws of motion in classical mechanics). The problem arises when one theory promotes concepts (e.g., qualia) which resist mapping onto another theory (e.g., neuroscience). Consider that qualia are said to have the following properties: ineffability, intrinsicality, privateness, and immediate apprehensiveness. This creates a serious problem for mapping one theory onto another theory because of the incoherency or ineffability of a pivotal constituent concept of one theory. Because an identity criterion does not seem possible, in principle, for qualia (“ineffability”), the only way forward is elimination: A lack of identity criterion for qualia and perhaps consciousness, or the inability to treat these concepts as veritable theoretical entities, may require elimination. Consciousness researchers Paul Churchland and Frank Jackson have something interesting to say here.

Paul Churchland is a proponent of eliminative materialism, which posits that folk-psychology concepts, such as qualia, and incoherency of certain propositional attitudes necessitate the elimination of select classes of mental states from consideration. (Reductive materialism, by contrast, insists that mental states as currently apprehended have an ontological assignment, need not necessarily be eliminated, and hence may be studied as currently apprehended. Select concepts being studied in philosophy of mind would be radically overdetermined for Paul Churchland et al.) In the essay “Evaluating Our Self-Conception,” Paul Churchland subscribes to the following checklist to determine a theory’s robustness:

- Chronic poor performance in a proprietary domain (cf. Ptolemaic astronomy)
- Incompatibility with closely neighboring theories that are performing extremely well (cf. vitalism vis-à-vis metabolic and molecular biology)
- Poor extension to domains continuous with but outside the domain of initial performance (cf. Netonian mechanics in strong gravitational fields or high relative velocities)
- Occasional empirical result carefully contrived to discriminate in some important way between competing theories (cf. Eddington’s eclipse expedition)

Frank Jackson, within “Finding the Mind in the Natural World,” equates science with “serious metaphysics” and says that, “Serious metaphysics is simultaneously discriminatory and putatively complete, and the combination of these two factors means that there is bound to be a whole range of putative features of our world up for either elimination or location.” Because of a

potential lack of identity criterion with consciousness and purportedly related concepts (e.g., qualia), or the obvious scientific inability to locate an apparently incoherent or ineffable concept, the only available course could be elimination. Frank Jackson, overall, does a masterful job of harmonizing contingency and physicalism thus: “A complete story of everything contingent, including everything psychological, about our world can in principle be told in terms of these physical particulars, properties, and the relations alone. Only then is materialism interestingly different from dual attribute theories of mind” (“Finding the Mind in the Natural World,” *The Nature of Consciousness: Philosophical Debates*, page 484). The psychological could ultimately be parsimoniously enfolded within the physical to reveal a comprehensive monist explanation of consciousness. All phenomena may supervene on the physical in the manner of ontological monism, the big dance, yet philosophy will be called upon to contextualize, reify, hypothesize, and enrich mathematical descriptions of state vectors (e.g., brain scans) in the years ahead.

Psychopathology, Lucid Dreams, Mysticism, and Anesthesiology

Intriguing, though potentially methodologically and ethically challenging, ways of further resolving the so-called hard problem of consciousness, and essentially transcending the explanatory gap through pinpointing the *minimally sufficient* neural correlates of consciousness using fine-grained tools, may involve the interdisciplinary study of the following: case studies of mental pathology (e.g., apperceptive agnosia and associative agnosia), lucid dreams, mystical experiences, psychedelic-psychotic episodes (e.g., derealization), sensory deprivation, deep sleep, and anesthesiology. Did you know that there are unfortunate patients with Cotard’s syndrome who delusionally presume themselves to be dead or missing miscellaneous body parts? Why is that? Do the rubber-hand illusion and phantom limb syndrome have implications for body ownership in particular and the phenomenal self-model in general? The rubber hand illusion appears to be fooling the phenomenal self-model - keen on constellating and interpreting visual, proprioceptive, vestibular, and tactile data - into incorporating an extra arm, which happens to be artificial. What implications does this have for the flexibility of the underlying mental program continually circumscribing body ownership? One thing can be said with some degree of certainty: Consciousness seems to abhor glaring holes on the way to establishing coherence and indivisibility. As an example, patients with Anton-Babinksi syndrome, a visual anosognosia (“lack of insight”), will stubbornly maintain that they have not lost their vision, really believing it, and attempt to confabulate the problem away. Crucially, there’s an inbuilt fault tolerance with massively parallel processing since the potential 10^15 connections in the brain (10^11 neurons X average 10^4 connections each) are working dynamically within the same matrix to produce the representational picture of the organism interacting with the world.

Stepping back, there is a very logically compelling idea in philosophy of mind that suggests taking a measurement of the brain’s state in deep sleep (presumed to be the baseline or strictly necessary physiological condition for consciousness to arise upon waking) and subtracting that state from the brain’s measured state in non-pathological, human waking consciousness will thereby subtract the necessary conditions from the necessary *and* sufficient conditions, isolating the sufficient conditions for consciousness to arise. The same kind of procedure could be performed to compare non-pathological with pathological cases in looking for the neural correlates of consciousness. What exactly distinguishes Cotard’s syndrome or “walking corpse syndrome” from associated conditions, such as schizophrenia and psychotic breaks? How do these differences relate to potential fractures in the phenomenal self-model?

This kind of logic almost seemed like a background assumption for the following: Nobel Prize-winning biologist Gerald Edelman and neuroscientist Giulio Tononi teamed up to exposit the empirically testable dynamic core hypothesis. Their preferred modes of empirical exploration for confirming the dynamic core hypothesis were functional magnetic resonance imaging (fMRI), topographic electroencephalogram (EEG), and magnetoencephalography (MEG) because these offered the wide spatial coverage and high temporal resolution to reveal virtually real-time [8] changes in conscious and subconscious processing vis-à-vis functional clusters and reentry.

Functional clusters are defined as, "A subset of elements within a system will constitute an integrated process if, on a given time scale, these elements interact much more strongly among themselves than with the rest of the system. Such a subset of strongly interacting elements that is functionally demarcated from the rest of the system can be called a functional cluster." Gerald Edelman and Giulio Tononi found that, in general, weak, degraded, or ephemeral stimuli had a lower probability of facilitating quick, strong, and distributed neural interactions, a kind of *sine qua non* for conscious perception, Edelman and Tononi reckoned. The two core tenets of the dynamic core hypothesis are thus - "A group of neurons can contribute directly to conscious experience only if it is part of a distributed functional cluster that, through reentrant interactions in the thalamocortical system, achieves high integration in hundreds of milliseconds" and, second, "To sustain conscious experience, it is essential that this functional cluster be highly differentiated, as indicated by high values of complexity." The process of reentry is defined as, "the ongoing, recursive, highly parallel signaling within and among brain areas" ("Reentry and the Dynamic Core," *Neural Correlates of Consciousness*, page 142). The dynamic core hypothesis ostensibly makes serious headway with the binding problem (cf. Antonio Damasio's "Time-locked Multiregional Reactivation: A Systems-level Proposal for the Neural Substrates of Recall and Recognition"), partly because it balances integration and differentiation, a combination of regularity and randomness, conducive to producing an emergent phenomenon.

Let's further unpack time and complexity for a moment because these are extremely important to the dynamic core hypothesis. Cognitive scientist Benjamin Libet showed that high-frequency somatosensory stimuli sent to the thalamus required 500 milliseconds (i.e., half a second) to produce a conscious experience for the subject whereas less than 150 milliseconds can produce (subconscious) sensory detection of an environmental change without full (conscious) awareness (cf. Antonio Damasio's Protoself and Core Consciousness). Multiple researchers have demonstrated that sustaining these evoked potentials required the excitation of pyramidal neurons in the somatosensory cortex via reentrant interactions with higher cortical areas (e.g., Cauller, 1995). Reentrant interactions among distributed functional clusters are necessary but insufficient to produce conscious experience. Consider that the brain during a seizure is hyperactive, but EEG demonstrates that a large number of brain regions are active in on-off synchronicity with each other (i.e., non-dynamic, non-complex though diffuse brain activity), momentarily precluding consciousness. The on-off pattern is echoed in deep sleep, which typically produces less vivid dreams than REM sleep; notably, cerebral blood flow is globally reduced in slow-wave sleep. Quick, dynamic, and complex brain activity with plenty of reentry (as opposed to slower, more predictably distributed, and *globally* synchronous brain activity) seems to produce more conscious waking and, indeed, dreaming (viz., REM, or rapid-eye movement, phase) phenomenological states.

NMDA Receptor Agonists and Thalamocortical Network

One of the more pronounced, clinically controllable, and clean examples of losing phenomenal consciousness would appear to be general anesthesia (cf. Hans Flohr's "NMDA Receptor-mediated Computational Processes and Phenomenal Consciousness"). Consider that the lights of consciousness (e.g., NMDA receptor agonists and the thalamocortical network) dim then gradually brighten for the patient undergoing general anesthesia. Phenomenal transparency and phenomenal presence seem to precede phenomenal perspectivalness in returning online following the administration of general anesthesia, which could imply an evolutionary order and the degree of deep-rooted strength with the neural correlates underlying each respective feature of phenomenal consciousness. [9] In short, whatever dims then gradually brightens in the brain to restore consciousness in the patient invariably underlies the sufficient neural correlates of consciousness and should provide the, perhaps counterintuitive, solution to the hard problem of consciousness by bridging the explanatory gap.

Eventually, empirical tools offering high temporal resolution and sufficiently wide spatial resolution, such as magnetoencephalography, could highlight a dynamic core governing conscious experience by showing quick, dynamic, and complex interactions among distributed functional clusters freely exhibiting reentrant interactions in the thalamocortical system. Rather than the global *minimally sufficient* neural correlates of consciousness being an independent, permanent, transtemporal ontological object (cf. Ship of Theseus) or being privileged with a private ontological realm, a shifting dynamic core could underlie phenomenal consciousness. Age-old mystical teachings about the substanceless nature of self already seem to be coalescing with modern neuroscience, which reveals the self as an emergent, highly dynamic phenomenon of biology qua teleofunctionalism. Certain brain areas talking more feverishly amongst themselves or brain areas always, sometimes, or never included - and, implicitly, excluded - from this ongoing conversation would have implications for the global neural correlates of consciousness and help empirically resolve perennial philosophical quandaries. These might be early days for consciousness research, which remains in the pre-paradigmatic phase. Neurophilosopher Thomas Metzinger, nonetheless, thinks the *global* neural correlates of consciousness will be pinpointed by the year 2050. If this pulse-quickening prediction comes to pass, discovering the global neural correlates of consciousness will greatly illuminate the past utility and future possibilities of subjective awareness and enrich what it means to conceive of oneself as a conscious being in the ever-vanishing present moment, a conjured picture of the present rooted in the immediate past that enables humans to dream about future worlds.

"If the doors of perception were cleansed, everything would appear to man as it is, infinite." -William Blake

"The objective measurement of temperature considerably preceded the development of an adequate theory of temperature and heat, and necessarily so, as the science of thermodynamics could not possibly have developed without first having been able to quantify or measure the temperatures of liquids, gasses, and other substances independently of their other properties. Measurement and theory develop hand in hand; it is a continuing process of improvements in the one making possible advances in the other." -Arthur Jensen

"All things fall short of absolute certainty: life itself might be a dream and logic a delusion." -Thomas Sowell

[1] cf. Bertrand Russell's five-minute hypothesis; Rene Descartes's evil demon; holographic universe theory in physics; the brain in a vat scenario, Donald Davidson's Swampman, Boltzmann brain

[2] "In order to explain the phenomenal unity of consciousness as a representational phenomenon, we have to look for the point of *maximal invariance of content* in the conscious model of reality. What is the representational content that displays the highest degree of invariance across the flow of conscious experience? The current theory says that it is to be found in certain aspects of bodily self-awareness and the conscious experience of agency. There will not only be a changing gradient of invariance within the phenomenal model of reality (in terms of more or less stable elements of experiential content) but also a gradient of *coherence* (in terms of different degrees of internal integratedness between such elements)." (*Being No One: The Self-model Theory of Subjectivity*, page 134)

[3] "As recent research in bistable phenomena (e.g., see Leopold and Logothetis 1999) has vividly demonstrated, if two incompatible interpretations of a situation are given through the sensory modules, then only one at a time can be consciously experienced. The generation of a single and coherent world-model, therefore, is a strategy to achieve a *reduction in ambiguity*. At the same time, this leads to a reduction of *data*: the amount of information directly available to the system, for example, for selection of motor processes or deliberate guiding of attention, is being minimized and thereby, for all mechanisms operating on the phenomenal world-model, the computational load is reduced." (*Being No One: The Self-model Theory of Subjectivity*, page 136)

[4] "In particular, if it is true that, as I have claimed, the human self-model is always functionally anchored in a more or less invariant source of internally generated input, then there should be a nucleus of invariance in a certain part of the *unconscious* self-model, for instance, provided by abstract computational features of the spatial model of the body or, as Damasio has hypothesized, in those brainstem structures continually regulating the homeodynamic stability of fundamental aspects of the internal chemical milieu." (*Being No One: The Self-model Theory of Subjectivity*, page 528)

[5] "The phenomenal world0 as a fixed reference basis for all possible simulations has to be, in principle, inviolable. This is why the phenomenal world and the phenomenal self not only appear as numerically identical to us but as indivisible as well - a feature of our phenomenal architecture - which Descartes, in section 36 of his *Sixth Meditation*, used to construct a dubious argument for the separateness of mind and body." I would claim that there is a higher-order phenomenal property corresponding to this classical concept of "indivisibility." It is the phenomenal property of global coherence, and it is this property which really underlies most classical philosophical notions concerning the "unity of consciousness."" (*Being No One: Self-model Theory of Subjectivity*, page 132)

[6] Psychomotor planning, recurrent loops in neural networks, working memory, and the phenomenological sense of "nowness" per Metzinger may all be explained - indeed, necessitated - by global-workspace theories (e.g., Bernard Baars's *A Cognitive Theory of Consciousness*). Perhaps an artificial Now is needed to form a baseline or phenomenal world0 for planning "future" action.

[7] Qualia might someday be likened to yesteryear's luminiferous aether, phlogiston, and élan vital.

[8] The representational model of the phenomenal world can, strictly speaking, never be truly real-time because the processing that gives rise to the representational phenomenal world image takes time to produce. The interpreting phenomenal self-model is remarkably efficient thanks to massively parallel processing, but the compiled sense data also has a lag. In a neurocomputational sense, the present is, at best, a picture of the past. In pathological cases, a reliable picture of the past is not guaranteed.

[9] "It is typical for NMDA antagonists like ketamine and phencyclidine to cause bizarre ego disorders. Patients report what has been called ego dissolution, a loosening of the ego boundaries that may end up in a feeling of merging with the cosmos, and an ego disintegration, i.e., a loss of control over thought processes." ("NMDA Receptor-mediated Computational Processes," *Neural Correlates of Consciousness*, page 253)

Works Consulted

Block, Ned, Owen Flanagan, and Guven Guzeldere. *The Nature of Consciousness: Philosophical Debates*. Cambridge, Massachusetts. The MIT Press. 1997.

Cauller, L. “Layer 1 of Primary Sensory Neocortex: Where Top-down Converges Upon Bottom-up.” *Behavioural Brain Research*, 71: 163-180.

Chalmers, David. “What is a Neural Correlate of Consciousness?” *Neural Correlates of Consciousness*, 17-40.

Churchland, Paul. *The Engine of Reason, the Seat of the Soul: A Philosophical Journey Into the Brain*. Cambridge, Massachusetts. The MIT Press. 1995.

Churchland, Paul, Churchland, Patricia. *On the Contrary: Critical Essays, 1987-1997*. Cambridge, Massachusetts. The MIT Press. 1998.

Churchland, Paul. *Scientific Realism and the Plasticity of the Mind*. Cambridge, England. Cambridge University Press. 1979.

Damasio, Antonio. “Time-locked Multiregional Reactivation: A Systems-level Proposal for the Neural Substrates of Recall and Recognition.” *Cognition*, 33*:* 22-62.

Edelman, Gerald, Giolio Tononi. “Reentry and the Dynamic Core: Neural Correlates of Conscious Experience.” *Neural Correlates of Consciousness*, 139-152.

Flohr, Hans. “NMDA Receptor-mediated Computational Processes and Phenomenal Consciousness.” *Neural Correlates of Consciousness*, 245-258.

Libet, Benjamin. “The Neural Time Factor in Conscious and Unconscious Events.” *CIBA Foundation Symposium*, 174: 123-137.

Metzinger, Thomas. *Being No One: The Self-model Theory of Subjectivity*. Cambridge, Massachusetts. The MIT Press. 2004.

Metzinger, Thomas. *Conscious Experience*. Lawrence, Kansas. Allen Press. 1995.

Metzinger, Thomas. *The Ego Tunnel: The Science of the Mind and the Myth of the Self*. New York, New York. Basic Books. 2009.

Metzinger, Thomas. *Neural Correlates of Consciousness*. Cambridge, Massachusetts. The MIT Press. 2000.

Penrose, Roger. *Shadows of the Mind: A Search for the Missing Science of Consciousness*. Oxford University Press. New York, New York. 1994.

Revonsuo, Antti. “Prospects for a Scientific Research Program on Consciousness.” *Neural Correlates of Consciousness*, 57-76.

http://www.scholarpedia.org/article/Complexity

http://www.scholarpedia.org/article/Hard_problem_of_consciousness

http://www.scholarpedia.org/articles/Models_of_Consciousness

http://www.scholarpedia.org/article/Neural_correlates_of_consciousness

http://www.scholarpedia.org/article/Self_models

http://www.scholarpedia.org/article/Teleofunctionalism

https://en.wikipedia.org/wiki/Mind–body_problem

Testing Testability

Adam Kisby

akisby@uchicago.edu

There is a sense in which the Principle of Testability is the *sine qua non* of science. Insofar as science is a process whereby the map of theory is brought into conformity with the territory of data, testability would seem to be a necessary component of the scientific method. Of course, testability sometimes entails comparing areas of the map to other areas of the map or bits of the territory to other bits of the territory, but testability in the present context refers to comparing areas of the map to bits of the territory for the purpose of modifying theory when it does not match its corresponding data (cf. Popper, pg. 9). Sociologist of science Marcello Truzzi's idea of testability refers to *empirical* testing, checking ideas against experience. This idea of testability goes back at least to Aristotle, who asserts that "experience is what a normal observer […] perceives under normal circumstances" (Feyerabend, pg. 109). For Truzzi, the Principle of Testability requires that claims be both verifiable (in the sense of Francis Bacon) and falsifiable (in the sense of Karl Popper). This commonly accepted version of the principle is examined here.

Although Aristotle includes a formalization of empiricism in the *Organon*, much of science by the time of Francis Bacon had lapsed into unalloyed rationalism, such that Bacon is prompted to say that the inductive method, which he understands to be the defining characteristic of empiricism, "has not been tried." At that time, scientific reasoning was almost exclusively deductive rather than inductive, and Bacon objects that any conclusions reached by deductive reasoning could be no more certain than the axioms from which they were derived. [Ed. note: *A priori* propositions are made independent of experience whereas *a posteriori* propositions are made in relation to experience; thereby the latter are more probabilistic, like inductive reasoning.] To remedy this situation, Bacon insists in the *Novum Organum* that all axioms must be elicited "from sense and particulars, rising in a gradual and unbroken ascent." He describes this method as the "true way" (McGrew, pg. 191). British philosopher John Stuart Mill greatly develops the inductive method, noting that "all discovery of truths not self-evident, consists of inductions, and the interpretation of inductions: that all our knowledge, not intuitive, comes to us exclusively from that source" (Mill, pg. 207). Possibly the strongest argument in favor of the inductive method is that even the rules of deductive reasoning appear to have been formulated by inductive means. Despite the apparent certainty that verifiability in the form of the inductive method confers on scientific knowledge, there are objections to its inclusion in the scientific method.

The first objection to verifiability is that there is no unambiguous historical justification for its use. Thomas Kuhn states, "We often hear that [scientific discoveries] are found by examining measurements undertaken for their own sake and without theoretical commitment. But history offers no support for so excessively Baconian a method" (Kuhn, pg. 28). Kuhn's objection, then, is that Bacon's way *still* has not been tried, so there is no way of knowing if its inclusion in the scientific method is warranted.

The second objection to verifiability is that the adoption of the Principle of Counterinduction, which "advises us to introduce and elaborate hypotheses which are inconsistent with well-established theories and/or well-established facts," which is logically inconsistent with the Principle of Testability (viz., "can be supported by argument") and leads to important scientific discoveries (Feyerabend, pgs., 20, 23). Paul Feyerabend devotes two chapters of *Against Method* to demonstrating the scientific legitimacy of counterinduction. In chapter seven, Feyerabend argues that Galileo reasoned counterinductively when he rejected Ptolemy's Tower Argument. Ptolemy reasoned that if the Earth were moving, then an object dropped from a tower would be displaced by some distance from the base of the tower. By contrast, Galileo posited a moving Earth against overwhelming data showing that no such displacement occurs (Feyerabend, pgs. 65-76). Moreover, in chapter eight, Feyerabend explains that it would have been reasonable for Galileo to have accepted Ptolemy's Tower Argument and to have rejected his own telescopic observations, because telescopic observations were considered to be unreliable in Galileo's time. Early telescopes were low-quality instruments subject to a variety of optical illusions. Indeed, many of Galileo's contemporaries rejected his telescopic observations, because they were unable to see what he reported seeing, even when they peered through Galileo's own telescopes with his direct guidance (Feyerabend, pgs. 77-85).

The third objection to verifiability is that the problem of induction has not been solved. Where inductive reasoning is defined as passing "from singular statements (sometimes also called 'particular' statements), such as accounts of the results of observations or experiments, to universal statements, such as hypotheses or theories," no number of 'particular' statements, however large, can ever logically justify the acceptance of any universal statement (Popper, pgs. 3-4). For example, "no matter how many instances of white swans we may have observed, this does not justify the conclusion that all swans are white," because a single observation of a black swan would disprove that conclusion. Karl Popper rejects attempts by David Hume and Immanuel Kant to justify inductive reasoning. Hume's attempt consists of an inductive argument, so "we should have to assume an inductive principle of a higher order; and so on. Thus the attempt to base the principle of induction on experience breaks down, since it must lead to an infinite regress" (Popper, pg. 5). And because Kant's attempt consists of positing the Principle of Induction as an axiom rather than providing a logical argument, Popper has only to point out that there is no compelling reason for positing such an axiom in the first place (Popper, pgs. 5-6).

Popper proposes falsifiability as an alternative to verifiability, because he seeks to move the basis of science from inductive reasoning to deductive reasoning. Ironically, his motivation for proposing falsifiability is precisely the same as Bacon's motivation for proposing verifiability, namely the desire to increase the certainty of scientific knowledge. Popper notes that while no number of 'particular' statements, however large, can ever logically justify the acceptance of any universal statement, "it is possible by means of purely deductive inferences […] to argue from the truth of singular statements to the falsity of universal statements" (Popper, pgs. 3-4, 19). Thus, Popper's "proposal is based upon an asymmetry between verifiability and falsifiability" (Popper, pg. 19). This asymmetry is also noticed by anomalist Charles Fort, who writes, "That, inductively, anything of an ultimate nature could be found out, is no delusion of mine: I think not of a widening of truth, but of a lessening of error" and "I am naïve enough in my own ways, but I have not the youthful hopes of John Stuart Mill and Francis Bacon" (Fort, pgs. 700-701). Albert Einstein, too, endorses Popperian falsifiability, assuming that this quotation is not misattributed: "No amount of experimentation can ever prove me right; a single experiment can prove me wrong" (Calaprice, pg. 291). Even though falsifiability promises greater certainty than verifiability, it "was actually pushed for a brief time only, […] decades ago, and it has few if any

remaining supporters among philosophers" (Bauer, *Pseudoscience*, pg. 71). Some skeptics still believe that falsifiability is the best litmus test by which to determine whether theories are scientific versus pseudoscientific, but there are reasons to question its inclusion in the scientific method.

The first reason for questioning falsifiability is that any given theory is inconsistent with some datum. Kuhn puts it this way: "If any and every failure to fit were ground[s] for theory rejection, all theories ought to be rejected at all times" (Kuhn, pg. 146). Feyerabend objects to the inclusion of falsifiability in any scientific method on this very basis: "The demand to admit only those theories which are consistent with the available and accepted facts […] leaves us without any theory […] The right method must not contain any rules that make us choose between theories *on the basis of falsification*" (Feyerabend, pg. 50-1).

The second reason for questioning falsifiability is that there may be disagreement among scientists over some datum that is alleged to falsify a given theory. If some number of data were required to falsify the theory, then there would remain the problem of disagreement among scientists over what that number should be. A scientist may make the argument that the observation of a few black swans in Australia "may itself be trivial and the remainder much more important," for "it is still the case that, so far as we know, all swans except the black ones in Australia are white" (Stevenson, pg. 258). In such cases, it might be more reasonable to modify a theory than to reject it entirely. Popper concedes that he would allow for this sort of modification, but only if the resulting theory were more falsifiable than the original theory (Popper, pg. 20).

The third reason for questioning falsifiability is that the "belief that only falsifiable ideas are scientific may snuff out innovative ideas before they have had a chance to survive testing" (Stevenson, pg. 258). Popper's main reason for rejecting verifiability and proposing falsifiability is that "[verifiability] does not provide a suitable 'criterion of demarcation' [between science and pseudoscience]" (Popper, pg. 11). Charles Darwin's theory of evolution by natural selection was rejected by Popper as unscientific, but it has proved to be an enormously fruitful, albeit incomplete, theory. Fort's opinion of Darwin's notion of survival of the fittest is similar: "There is no way of determining fitness except in that a thing does survive. 'Fitness,' then, is only another name for 'survival.' Darwinism: That survivors survive" (Fort, pg. 24). More recently, Popper admits that his rejection of evolutionary theory "was perhaps going too far" (Horgan, pg. 38). Fort also acknowledges that "[Darwinism's] attempted coherence approximate[s] more highly to Organization and Consistency than did the inchoate speculations that preceded it" (Fort, pg. 24). Ultimately, Popper explains that his criterion of demarcation "separates two kinds of perfectly meaningful statements: the falsifiable and the non-falsifiable" (Popper, pg. 18). As such, falsifiability is a metaphysical principle that is not subject to falsification, so the objection that falsifiability does not "satisfy its own criteria" is, to quote Popper, "one of the most idiotic criticisms one can imagine!" (Horgan, pg. 38) In practice, though, labeling a theory as pseudoscientific results in its automatic rejection by large sectors of the scientific community.

There are other general criticisms of the Principle of Testability that do not pertain to either verifiability or falsifiability *per se*. These criticisms apply more directly to the meaning of theory, the meaning of data, and the meaning of testability itself.

The first general criticism of the Principle of Testability is that testability is often naïvely assumed to be equivalent to predictability, and that the role of predictability in science subsequently becomes overemphasized. At its extreme, this overemphasis becomes a belief that predictability is "essential to the process of empirical testing of hypotheses, the most distinctive feature of the scientific enterprise" (Stevenson, pg. 260). Ian Stevenson quotes renowned philosopher of science Rudolf Carnap as saying, "The supreme value of a new theory is its power to predict new empirical laws" (Carnap, pg. 260). Fort reads "over and over that prediction is the test of science" but concludes that the ability of a theory to predict a phenomenon does not mean that that theory has *explained* the phenomenon: "Take for a base that the earth moves around the sun, or take that the sun moves around the earth: upon either base the astronomers can predict an eclipse" (Fort, pg. 713). John Stuart Mill, who supports verifiability, states that "predictions and their fulfillment are, indeed, well calculated to strike the ignorant vulgar" (Stevenson, pg. 260). Thoughtful consideration of the problem leads to the conclusion that the ability of a theory to predict a phenomenon is not especially meaningful.

The second general criticism of the Principle of Testability is that testability requires unambiguous data, but that data are never unambiguous. Philosophers of science speak of theories as being "underdetermined" by data, or they say that data are "theory-laden" (e.g. Shermer 46). This aspect of the theory-data relationship is most clearly expressed by Kuhn: "Philosophers of science have repeatedly demonstrated that more than one theoretical construction can always be placed upon a given collection of data" (Kuhn, pg. 76). Popper, who might have argued that falsifiability also requires unambiguous data, acknowledges that "nothing is easier than to construct any number of theoretical systems which are compatible with any given system of accepted basic statements" (Popper, pgs. 264-265). Fort observes that "only logicians think that anything has any exclusive meaning" and posits that "everything that ever has meant anything has just as truly meant something else" (Fort, pg. 867). Fort provides an entertaining illustration when he challenges the commonly accepted notion that "the round shadow of this earth upon the moon proves that this earth is round" by pointing out that "if this earth were a cube, its straight sides would cast a rounded shadow upon the convex moon" (Fort, pg. 346). Truzzi disapproves of those who "argue, like Lombroso when he defended the mediumship of Palladino, that the presence of wigs does not deny the existence of real hair" ("Pseudo-Skepticism," pg. 4). Nevertheless, it remains a perfectly valid form of argument.

[Ludwig Wittgenstein: "Why do people say that it was natural to think that the sun went round the Earth rather than the Earth turned on its axis?"

Elizabeth Anscombe: "I suppose, because it looked as if the sun went round the Earth."

Ludwig Wittgenstein: "Well, what would it have looked like if it had looked as if the Earth turned on its axis?" -Ed. Note]

The third general criticism of the Principle of Testability is that testability requires a criterion of inclusion and exclusion, but that all such criteria are necessarily arbitrary. Fort says that "no basis for classification, or inclusion and exclusion, more reasonable than that of redness and yellowness has ever been conceived of" (Fort, pg. 5). Fort goes on to say that all criteria are continuous in the same way that redness and yellowness are continuous in orangeness, i.e.,

there will always be borderline cases, the presence of which argues for the inclusion of arbitrarily excluded data. Many scientists seem to prefer a world without orangeness, but it is a much less colorful world than the world in which we find ourselves.

These objections to verifiability, reasons for questioning falsifiability, and general criticisms of testability suffice to establish that the commonly accepted version of the Principle of Testability is inconsistent with reason and frustrates scientific progress. Consequently, the Principle of Testability, in its present form, is not essential to the process of scientific discovery and should not be considered a necessary component of the scientific method. In the sense that testability, broadly construed, is the *sine qua non* of science, it must be modified to accord with reason.

Sources:

Bauer, Henry. *Science or Pseudoscience: Magnetic Healing, Psychic Phenomena, and Other Heterodoxies*. Chicago, Illinois: University of Illinois Press, 2001.

Calaprice, Alice. *The New Quotable Einstein*. Princeton, NJ: Princeton University Press, 2005.

Feyerabend, Paul. *Against Method*. New York, New York: Verso, 1997.

Fort, Charles. *The Complete Works of Charles Fort*. New York, New York: Global Communications, 2009.

Horgan, John. *The End of Science*. Reading, Massachusetts: Helix Books/Addison-Wesley Publishing Co., Inc., 1996.

Kuhn, Thomas. *The Structure of Scientific Revolutions*. Chicago, Illinois: University of Chicago Press, 1996.

McGrew, Timothy, Marc Alspector-Kelly, and Fritz Allhoff, Eds.. *Philosophy of Science: An HistoricalAnthology*. Oxford, UK: Wiley-Blackwell, 2009.

Mill, John Stuart. *A System of Logic*. *Project Gutenberg*. 11 February 2011

<http://www.gutenberg.org/files/27942/27942-h/27942-h.html#toc43>

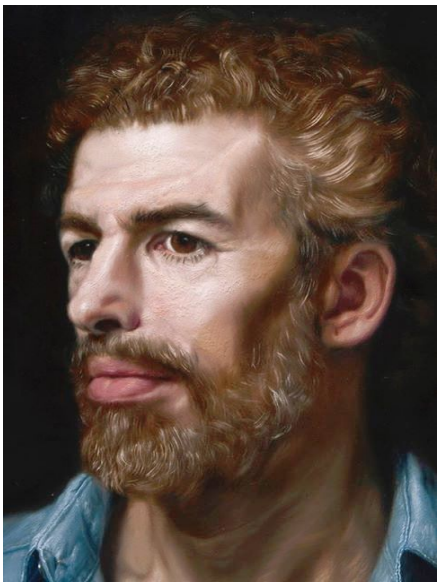
Popper, Karl. The *Logic of Scientific Discovery*. New York, New York: Routledge, 2002.

Shermer, Michael. *Why People Believe Weird Things: Pseudoscience, Superstitions, and Other Confusions of Our Time*. New York, New York: Holt Paperbacks, 2002.

Stevenson, Ian. “What are the Irreducible Components of the Scientific Enterprise?” *Journal of Scientific Exploration* 13.2 (1999): 257-70.

Truzzi, Marcello. “Editorial: On Pseudo-Skepticism.” *Zetetic Scholar* 12/13 (1987): 3-4.

“The Perspective of Anomalistics.” *Encyclopedia of Pseudoscience*. New York, New York: Facts on File, Inc., 2000.



Interview with Rick Rosner by Scott Douglas Jacobsen (Part Eleven)

ABSTRACT

Part eleven of eleven of the comprehensive interview with Rick G. Rosner: Giga Society member, ex-editor for Mega Society (1991-97), and writer. He discusses the following subject-matter: Genius of the Year Award – North America in 2013 from PSIQ and clarification of statements; definition of the term “gods” in operational terms from the award statement; discussion on our future rather than gods; thoughts on aesthetics within an informational cosmology lens; some brief discussion on informational eschatology; human history’s numerous examples of individuals and schools of thought aimed at absolute definitions of consciousness, universe, and their mutual union; thoughts on Big Bang Cosmology and the possibility of its replacement; three greatest mathematicians/physicists/cosmologists; three greatest mathematics/physics/cosmology concepts; The Heisenberg Uncertainty Principle and Wave-Particle Duality; Einstein-Podolsky-Rosen (EPR) Nonlocality; possibility of universe operating in something more essential than information; everything in essence equate to a Turing Machine in informational cosmology; operation of different time depending on armature/universe in reference; mysteries; ex nihilo cosmogony; theology becoming informational cosmology and vice versa; informational ethics in relation to numerous ethics; The Problem of Evil; souls; Fr. Teilhard de Chardin, *The Phenomenon of Man* (1955), Omega Point, and *The Future of Man* (1964); work needing doing for Informational Cosmology; reflection on theorizing and outlier background; common sense and intelligence; regrets; ethics of forming, joining, and sustaining elite groups based on high and ultra-high IQs; harsh internet crowd, frequent comments, and responses; principles of existence as the language of existence with explicit listing of some of them; and thoughts on prevention of intellectual theft.

Keywords: aesthetics, armature, armature/universe, Big Bang Cosmology, common sense, consciousness, Einstein-Podolsky-Rosen (EPR) Nonlocality, ex nihilo cosmogony, Fr. Teilhard de Chardin, Giga Society, gods, history, informational cosmogony, informational cosmology, informational eschatology, IQ, isomorphism, Mega Society, Omega Point, principles of existence, Rick G. Rosner, The Heisenberg Uncertainty Principle, The Problem of Evil, theology, Turing Machine, universe, Wave-Particle Duality, writer.

99. You earned the Genius of the Year Award – North America in 2013 from PSIQ. In your one-page statement on winning the award, you say, “My one wish is that trying to extend human understanding is doing God’s work.” In some sense, there seems no higher calling than something akin to an internal – to the cosmos – teleological duty to assist the self-actualization of the universe as sub-systems, various individual POVs, within the universe in service of God. Does this fairly characterize the statement? If not, what did you attempt to address with such a statement?

I was addressing a strain of religiosity which is hostile to science (or which misrepresents science to advance an agenda). I would like fewer people to be anti-science and would like people to be less subject to anti-scientific manipulation on religious grounds.

Isaac Newton thought that by making mathematical and scientific discoveries, he was doing God’s work. I like the idea that figuring out how the world works and how to make it better is helping God, not defying God.

Humans are part of a world we can choose to believe was created by God. Doing science isn’t alien to the world or opposed to God.

[Editor’s Note: “I maintain that the cosmic religious feeling is the strongest and noblest motive for scientific research.” -Albert Einstein]

Teleology isn’t a word that I embrace, because it can be used to sneak creationism into evolution. Evolution, of course, isn’t a purposeful progression towards complexity. Rather, it’s the proliferation of varied organisms via the occupation of exploitable niches, some of which are occupied by organisms having complex abilities. (But simple organisms continue to occupy their niches. And new, simple organisms continue to arise.)

The universe is a very complicated entity, and as such, demonstrates that highly complex entities are permitted by the principles of existence (whatever those turn out to be). Can we help our species, our planet, or even the universe itself self-actualize, and if so, is this some kind of built-in bias towards complexity? Maybe, but I don’t see it as the hand of the Creator nudging us towards glory. Rather, I see it as the possibility of mathematical teleology, with complex entities perhaps statistically tending to have histories of increasing complexity. There is room for God or gods in this, but gods who are subject to the same principles of existence that we are. Which isn’t the worst thing – we are all striving, humans and gods alike.

100. You stated “gods.” How do you operationally define the attributes, in concrete terms, of these proposed gods? Moreover, how might we rank these civilizations in terms of advancement on some relative scale of civilization development?

Start with the Arthur C. Clarke quote that’s now so overused it’s a cliché – “Any sufficiently advanced technology is indistinguishable from magic.” There are around a quarter or a third of a trillion stars in the galaxy. A bunch of them have planets – there are tens of billions of planets in the Milky Way – maybe 100 billion, maybe 200 billion or more. Even if only one in 10,000 contains life, that’s still 10 million planets with life. (And there are a hundred billion galaxies in the universe.) Some must have intelligent life, and on some of these planets, tech-wielding life most likely has a huge head start on us (because the odds of us being the first to tech in the galaxy are one in however many tech civilizations there will eventually be). Even if it’s only a thousand-year head start, that’s huge with regard to tech. And it’s possible that tech-wielding life on some planets might have a billion-year head start. So it’s reasonable to assume that there are some civilizations which are so advanced, their powers are almost magical in comparison to ours. But to call them gods is something of a cheat – super-advanced civilizations that have arisen in the past 14 billion years might best be called godlike.

Super-advanced civilizations would be able to do awesome stuff – for instance, possibly defy time to some extent by simulating a plethora of possible futures (on a rolling basis) and choosing the best future from among them. At the very least, advanced civilizations will have vast computational capacities. And the business of the universe is computation.

Next step in the hierarchy of godlike beings – let’s say I’m correct that the universe is vastly older than 14 billion years. It’s not unreasonable to think that some civilizations have learned how to survive galactic cycles, perhaps by hiding out in the enormous black hole-like objects at the centers of galaxies or by hopping from exhausted galaxies to newer galaxies (if it’s even possible to travel fast enough to escape a collapsing, exhausted region of the universe – hey, maybe they could beam themselves via neutrinos). Civilizations (or entities) which can survive for many multiples of 14 billion years would have fantastic capabilities – they might actively participate in the running of the universe – beaming neutrinos at the burned-out galaxies they want to reactivate, for example. Is it so unreasonable to think that something as large and old and intricate as the universe might have intelligent entities helping to manage it? Such entities might almost deserve the title of gods.

And the next step in the hierarchy – what if the universe itself is an entity, with perceptions, thoughts, and objectives, playing out across octillions or decillions of years? That is –

What if a sufficiently complicated self-contained and self-consistent system of information such as the universe itself can’t not be conscious?

That entity deserves to be called a god, but a god that did not make us, that may not know we exist, and that doesn’t intercede in our affairs. [Similar to deism. -Ed. Note] We are made of its

information – its thought-stuff – but it didn't intentionally create us. Its information space provides the arena in which we came into existence through natural processes.

And beyond the universe we live in is the universe in which the entity whose information space we live in itself lives. Maybe it's not turtles all the way down; maybe it is information spaces all the way up.

These different levels of goddish beings share with us the basic constraints of existence. They've almost certainly developed work-arounds for many of these limitations, but they share the same general characteristics, even if such characteristics have been obscured and weirdified by their godlike mastery of physical processes. It's kind of nice that in wrestling with existence, we and these gods are all in it together.

The various gods certainly have consciousnesses which are more powerful, more detailed, and encompassing more senses and types of analysis than ours. But who knows if the differences in consciousness are more than differences in magnitude, perceiving space and time in ways that are fundamentally different?

101. What about our future rather than these "gods"?

People aren't freaked out enough about the future. Have I already said that? Humanity will be forced to change – to embrace new, weird forms of thought. Here's why – advanced artificial intelligence is coming. It will be hard and perhaps impossible to design AI so that it doesn't want stuff for itself. It won't just be our faithful servant. So we're gonna have to keep up with it – we'll need to be joined to AI, so that we remain, for as long as possible, among the smartest beings on the planet. When occupying niches, species tend not to limit themselves. External factors limit how far species expand. Similarly, if it's us versus AI in a struggle to occupy the same niches, the smarter entities will overpower the weaker ones. We can't program AI to limit itself – it's too likely that any barriers will spring leaks.

We'll need to develop and evolve a worldwide (and eventually a solar system-wide) ecosystem which incorporates AI. That is, we'll need to develop durable forms of advanced intelligence which don't just ravage all available matter for computing purposes. It doesn't seem unreasonable that AI and humans-plus-AI will eventually find niches that don't threaten the existence of all other life on earth. But that probably won't happen unless we keep up with AI by augmenting ourselves with it.

The world will be flooded with AI cops – software, hardware, etc. that will spy on everything to make sure that hyper-destructive AI and nanotech don't get loose and destroy everything. There will have to be cyber cops on top of cyber cops – like an immune system – trying to keep outbreaks of bad AI local. Privacy will be left in tatters. (This could be an unrealistic science fiction TV show set 20 years in the future. A squad of sexy cops fight bad AI and nanotech. Perhaps make it a comedy, so the glaring errors can be seen as funny instead of stupid.)

AI will get smarter and smarter, faster and faster. Won't it smart itself right out of the universe and into some other plane of existence? Nah. I think it runs into some hard limits – the speed of light, the computational limits of matter, the decreasing marginal utility of additional knowledge. There might be work-arounds for some hard limits – cramming enough matter into a small enough space should create more space, for instance – but such limits should put a damper on the double-exponential growth predicted by some Singularitarians.

We've been talking about ethics. Throughout history, humanity has had generally agreed-upon ethics for the protection of life and property and sometimes freedom, based on what humans want – comfort and safety. Such protections don't extend far beyond humans, and we've found little evidence of the world itself having any ethical expectations. Our ethical framework is about to be completely revamped. Consciousness will be quantified. Consciousness will be created in non-living beings. Unaugmented human intelligence will no longer dominate the planet. Ethical arguments will have to be more powerful, to persuade our far brighter descendants.

Ethical protections have extended from the self-appointed most special beings on Earth, humans, to, often grudgingly, other humans and sometimes to animals, the environment, and objects of historic value. Within 40 years and probably much sooner than that, unaugmented humans won't be the smartest, most talented known beings. Unaugmented consciousness will be shown to be unimpressive in many ways. Winds of change will buffet the ethical umbrella, and we don't know who or what will be under it in 2060.

Narrative is important. We like stories. And stories are an essential part of the structure of history. Just about every development in evolution and history involves someone or something embracing change – often being the first to make a change. We offer people, animals, and things ethical protection when we recognize and understand their stories. We have to sell the future on the importance of unaugmented humans' stories, even when the augmented are in charge.

102. What would a timeline of the future look like?

There are already some good timelines of the future. Ray Kurzweil's timelines might be the most well-known. He's been making them since 1990, so you can judge how he's done in his first 25 years of predicting. And this is a through, non-lunatic timeline –

http://www.futuretimeline.net/index.htm. (You have to watch out for timelines with crazy agendas.)

Let me try to do one –

2070: World's annual birthrate drops under 1%.

Don't know if I can do this. What I know is a bunch of stuff is gonna get weird and perhaps go away. Pro and Olympic sports will get weird in the next century as human bodies become

increasingly augmented. There might be augmented and unaugmented leagues. Current pro sports may come to seem too arbitrary or antiquated for popular attention.

2080: People commonly have relationships with artificial people, who by the early 22nd century, have acquired limited rights.

Money is gonna get weird. Some human necessities will continue to get cheaper. Employment will decrease. The life cycle of commercial enterprises will accelerate, making investment weird.

By the mid-22nd century, everything associated with human life as we've known it for thousands of years gets weird as we have increasing choice of what should contain our minds and of the form of consciousness itself. You could call the 2100s the Century of Choice. Dibs on that.

It's also the century of fragmentation, as new choices of how to live lead to different societies and sects and enclaves. After this, it's hard to say what happens, because you can't predict what the prevalent forms of consciousness will be.

The mental isolation that humans have always felt – that we are separate, autonomous individuals – will be eroded. We already have close working relationships with our devices, and we'll increasingly be nodes in a network of streaming information as everything in our world gets packed with computing (and eventually thinking) circuitry.

Just remembered – made this list in 2013 as part of a pitch to Grantland – it's everything I thought would be going away.

Children (Currently, about 85% of humans have children. By 2090, less than 30% of humans will have reproduced traditionally by the age of 60.)

Risk and wrecks (People who might live for many centuries won't tolerate current levels of risk.)

Meat from animals with brains

Humans' exalted view of ourselves (We're gonna learn exactly how we work, and we'll find it not so awesome.)

The soul (We'll have a mathematical model of how we feel that we have feelings. This will be a good thing, but it won't feel so good. Understanding consciousness could add an underlying sadness to the world until people get used to it.)

Basic human concerns and drives (We're gonna be able to rejigger the agenda that evolution has wired into our heads.)

TV and movie storylines as we know them (All our entertainment is built around basic human drives. Once we start messing with these drives, we have to mess with our stories. Romance, action, comedy, drama, etc. all get reworked.)

Natural-born bodies

Sex as the greatest thing

Not knowing how our brains work

Not knowing why the universe is

Thinking we know what's going on a moment-to-moment basis (Our awareness is really patchy and cobbled together, but evolution doesn't give a crap. Evolution wants us to have enough awareness to survive and reproduce. Anything beyond that is a bonus.)

Thinking our brains are perfect and fantastic

Privacy

Marriage 'til death do us part

Disease

Island consciousness (that is, not being able to link your brain to someone else's)

Abject poverty and ignorance (except among angry, fucked-up, repressed populations)

Unhealthy food (Food that tastes great won't actually be bad for you.)

And a few things that won't happen:

No time travel, except through simulation (which will grow more and more powerful, but still won't let you change the past).

Probably no warp drive.

Probably no war between galactic empires. Empires don't get you much – there's no rare stuff that can only be had on a certain planet. I guess civilizations might fight for control of large bodies such as a neutron star that has neutrino jets or a black hole at a galactic center (which might be good for vast amounts of computing). They won't be fighting over worm poop that helps you steer spaceships. According to many futurists, advanced civilizations just want to stay home and compute – kinda like us with our smartphones.

We'll eventually encounter other civilizations. I'm guessing finding alien life will be like dating and marriage – initial excitement followed by vaguely interested familiarity.

And finally, a rule of thumb. In the 21st century, the percent weirdness of daily life roughly equals the last two digits of the year. The year 2015 is 15% weird. (We spend all day staring at screens. We have access to all information, and we constantly share information via social

media. We can watch anything we want at any time. We're in a constant state of war against nebulous enemies. Cameras and surveillance are everywhere. All this adds up to at least 15% weirdness.) The year 2030 will be roughly 30% weird. 2050, 50% weird. (The rule, following a straight line instead of an exponential curve, probably underestimates weirdness for the last part of the century.) Dibs on the rule – call it the Rosner Rule.

103. Any thoughts on aesthetics within your framework for understanding the world?

Conscious beings are driven by pleasure (and pain). Pleasure is associated with things that are important to survival and reproduction. Perhaps more than any other species, humans get pleasure from learning, because our niche is discovering exploitable regularities in the world. We get aesthetic pleasure from representations of things associated with pleasure, especially when those representations offer a satisfying hint of discovery or problem-solving.

Kitsch and porn pander to pure pleasure without the learning, while art offers at least the suggestion of learning how to decode the world. At its best, the beautiful also offers insight.

Endorphins shape learning. Jokes are funny because they simulate an abridged learning process. We enjoy music because it sets up expectations of patterns and then fulfills those patterns. (And the rhythm sets up a framework that can keep us in the moment.) Familiarity in our surroundings and predictability in our sensory input helps structure our awareness – we're all a little like the guy in Memento.

104. Any comments on informational eschatology?

The universe will likely largely stay the way it is for trillions upon quadrillions upon quintillions of years. However, our galaxy will burn out and fall away from the active center after, I dunno, another ten billion years or so. (Astronomers say the Milky Way and the Andromeda galaxy will collide and merge in another five or so billion years, but that's not the issue. It's when the merged galaxy's stars burn out that it falls out of the active center.) Perhaps advanced civilizations have ways of surviving the burning-out of a galaxy to persist for more than just tens of billions of years. For us, with our puny conception of things, tens or hundreds of billions of years might as well be forever. When and if the universe does end, probably does so through heat. Heat is noise and loss of information. The temperature of the cosmic background radiation increases and sizzles everything away. The currently active center runs out of juice and falls back into the hot background like Schwarzenegger being lowered into the molten steel in *Terminator 2*.

Of course, for us, the idea of a civilization or entity lasting for billions of years is inconceivable. How could an entity develop and accumulate knowledge for the equivalent of a million lifespans of our current civilization? Well, maybe it doesn't. Maybe it hits a ceiling of knowledge. Maybe it's like a security cam setup that keeps only a rolling record of the past 24 hours. At this point, with knowledge of only one civilization that's only 10,000 years old, we have no way of knowing.

105. Deep and shallow recorded human history present numerous examples of prior attempts at absolute definitions of consciousness, universe, and their mutual union. Of course, dust needed brushing along with spooling of the cobwebs, and at least one coat of varnish, of ideas, evidence, and argument to a sufficient level for clarity on these issues.

Rather than pontificate on broad historical patterns, for brief and mundane historical examples, earliest known individuals with works focused on the gods such as Hesiod with *Theogony*, which went through the traditional Greek mythological timeline including the triumphs of Cronos over Ouranos and Zeus over Cronos.

Other sets of individuals comprising schools focused on the schools of philosophy with less focus on gods and more focus on forces of nature. The Milesians took different fundamental compositions of the world while removing the place of the gods with Thales (Water), Anaximander (Apeiron or the indefinite, infinite, unlimited), and Anaximenes (Mist, air, or vapour). Each with views different from before, but monistic (non-plural) and material as opposed to plurality of gods and their caprices. In particular, the worldview of Thales because of the transition between the world of the mythological, allegorical, and metaphorical of Hesiod into the world of reason.

Some of these cosmological speculative philosophies gave rise to political and moral philosophy. These speculations continued to lack comprehensive integration, even with the question-based philosophies of Socrates and the Sophists. Plato and Aristotle provided the most thorough accounts of a comprehensive philosophy covering numerous subjects over many, many writings. This continued onward to the present day with individuals attempting unification such as David Deutsch, David Chalmers, Edward Witten, Stephen Hawking, and so on. Many bright lights in history. How do you assess or grade the attempts at absolute definitions of phenomena such as consciousness?

For most of human history, people made all sorts of wrong guesses about the nature of consciousness. It feels so ineffable and deeply, transcendently real – it has to be a bridge to some kind of ethereal beyondness, right? After millennia of this, consciousness has a bad reputation for being associated with la-de-dah mysticism. Mention consciousness, and people get nervous that you're gonna argue that rocks and trees and entire planetary surfaces are conscious. [e.g., David Chalmers's panpsychism -Ed. Note]

But, as I've said, consciousness is a technical, not a mystical phenomenon. Human consciousness is all jazzed up – made super-exciting to keep us interested in ourselves – but at base, it's about shared information forming a mind – a mental arena – because we have a better chance of accurately modeling reality when all our specialized subsystems have a global understanding. [There was a joke making the rounds years ago that studying one neuron is neuroscience but studying two neurons is psychology. -Ken

"If someone studies one cerebral cortex, that's cosmology." - May-Tzu
-Ed. Note]

Today, people have a better intuitive understanding of consciousness than ever before. We're used to working with our devices, which are near-extensions of consciousness – feeding us information at our bidding. We're fluid in juggling apps – right now, I have 25 windows open on my computer – and can see not a stream of consciousness, but pop-up consciousness – information and specialist systems popping into awareness as needed. We can see that our devices, while not conscious, could become more integrated into our consciousness – heads-up displays as in *Terminator* or fighter jets, for instance – and that smart devices will become increasingly emulative of our thinking. Regardless of whether our devices will eventually become conscious in the manner of hundreds of mostly bad science fiction movies, we see that our devices are capable of complex information processing, which takes away some of the exaltedness of the information processing going on in our heads.

106. What makes the Big Bang so convincing? Is it at risk of being replaced?

The Big Bang is convincing for lots of reasons. It's by far the most widely accepted theory of cosmogony among scientists. However, it's only held this position for the past 50 years. Before the discovery of the Cosmic Microwave Background radiation in 1964-65, it was neck-and-neck between Big Bang and Steady State Theory, which postulated that matter popped into existence in empty space. And before Big Bang and Steady State Theory originated as a consequence of general relativity and Hubble's Law in the 1920s, we didn't know enough about the large-scale dynamics of the universe for any effective theorizing that I'm aware of.

The discovery of Cosmic Microwave Background radiation was dramatically convincing. In 1964, some guys at Bell Labs built a radio telescope which picked up low-temperature noise they couldn't explain. They thought it might be bird poop on the antenna. Turned out to be light from the early universe as predicted by the Big Bang. Game, set, match for Big Bang Theory.

The Big Bang explains a lot – the apparent velocities of billions of galaxies, the formation of heavy elements, the size and apparent age of the universe, the proportions of elements found in the universe, the relative youthfulness of more distant galaxies.

It's conceptually easy – one big explosion, everything flies apart. Has a catchy name. Is the title of the biggest sitcom on TV.

But it doesn't explain enough. It minimizes cosmic questions, with the main question being, why is nothingness so volatile that it explodes into an entire enormous universe? With enough tweaks, Big Bang theory can explain the mechanics of how the universe exploded out of nothingness, which is kind of satisfying from the point of view of physics, but not of philosophy.

Some problems of Big Bang theory include:

It leaves too many physical constants unexplained – the proton-electron mass ratio and dozens more. The Big Bang in general is not overly explanatory – it only tells you why some stuff is the

way it is – how elements form in stars, for instance. (But you can have element formation in stars without the Big Bang.)

Big Bang Theory incorporates assumptions of uniform conditions and constants across the entire universe. This is usually seen as a theoretical strength, but, like the unexplained physical constants, Big Bang theory doesn't completely justify why the universe should be uniform. The philosophical reason, called the cosmological principle, is that we on earth are located nowhere special in the universe, and furthermore, the entire universe is nowhere special. This is a dangerous assumption. You can't just demand that the universe be roughly the same everywhere. What if that's not how the universe works? The Big Bang has that assumption built in. And while the Big Bang assumes uniformity in space, it does no such thing in time. There is no uniformity across time in Big Bang theory – every observer is located at a unique moment in the universe's unfolding.

Some of universe's spatial uniformity is explained by cosmic inflation in the very early universe. According to cosmic inflation, the universe expanded so fast (blowing up by a factor of at least 10^26 in less than 1/10^32nd of a second – that is, doubling in size every 1/10,000,000,000,000,000,000,000,000,000,000,000th of a second or so) that a tiny volume without much room for variation became the entire visible universe, and the rapid expansion also spread out any irregularities. The reason for such rapid inflation isn't known, so cosmic inflation is a little ad hoc.

Beyond cosmic inflation, the Big Bang requires more and more precise, fussy tweaks to agree with increasing amounts of observational data. One would hope that there would be a theory, either an add-on to Big Bang theory or an alternative, which would explain more of the conditions of the universe without having to be tweaked to fit the conditions of the universe.

Our galaxy contains globular clusters – tight groups of a million or so stars – which may be older than the Big Bang. Calculations are pretty equivocal on this – the clusters might not be that old. Meh to the clusters.

Yeah, the Big Bang is in danger of being supplanted. It's pretty much our first try at a theory of the universe based on not-hopelessly-incomplete observational evidence. Even though the Big Bang is young, it's already accumulated a bunch of patches.

A digression –

Was up late last night, thinking about how active galaxies get to the active center. They can't just light up and slide into the center – what would cause the slide? And they can't just slide out of the center when burned out. I'm thinking maybe it looks like soap bubbles – lit-up galaxies expand enough of the surrounding space that bubbles would be too big not to merge. There wouldn't be walls between bubbles – that's incorrectly extending the analogy – but there would be dark galaxies along the saddles between bubbles. Without being able to contribute to the photon flux that keeps the active center inflated, maybe dark galaxies would slide along the

saddle between lit-up regions, back down to the dark outskirts. Could be messy enough to work. Over billions of years, there would be an ordering of regions by brightness – the greatest producers of photon flux would float to the top of the lumpy bubble, and less-bright regions would be pulled down to the outskirts by gravity.

I suppose this would mean you could temporarily be of two minds – thinking of two things somewhat independently – having a pair of incompletely merged active centers in your mind-space – until your thoughts merge. While driving, you're trying to remember your second-grade teacher when another driver forces you slightly out of your lane. Your thoughts about your split-second evasive driving maneuver don't necessarily disrupt your thoughts about second grade. Each pattern of thought informs itself more than it informs the other, unless you then ponder your bifurcated thinking during the incident.

107. Who do you consider the three greatest mathematicians/physicists/cosmologists?

Darwin is one of my favorite cosmologists, even though he's not a cosmologist. He took the idea of deep time, which was being debated by geologists of his era, and applied it to biology, which indirectly set the stage for the discovery, 60 years later, that we live in a universe that's many billions of years old. Some physicists of Darwin's time argued against deep time, saying stars couldn't last that long. The longevity of stars wasn't explained until the discovery of nuclear fusion.

Newton was the first to describe gravity as the force holding all large objects together, which is a necessary first step in a conceptual framework that encompasses the entire universe. And Einstein made that framework much more explicit.

Also important are the developers of theories of information, including Alan Turning and Claude Shannon.

108. What do you consider the three greatest mathematics/physics/cosmology concepts?

I like Mach's Principle, which states that inertia arises from an object's interaction with the stellar background (all the matter in the universe). Mach's Principle has never been turned into a precise mathematical theory, but it's still compelling. If true, Mach's Principle can't mean that an object is directly interacting with all matter as that matter is now, because of the speed of light. The object has to be interacting with its local inertial field which is created by all matter, but with matter's contribution to the field delayed by distance, the same way we can see all the visible stars in the universe but only as they were in the past.

Quantum mechanics is powerful, especially when viewed as the universe observing and defining itself.

And relativity, both special and general and including Big Bang cosmology, is essential, particularly when considered as aspects of how information is structured and how it behaves.

109. How does informational cosmology incorporate high level concepts like The Heisenberg Uncertainty Principle? How about Wave-Particle Duality?

Uncertainty and wave-particle duality are aspects of a finite universe having a finite capacity to define itself. Particles will be fuzzy. Say you're playing roulette, one chip at a time. The best you can do, on average, based on whether your chip pays off (and nothing else), is pin down the number that came up to somewhere among half the numbers on the wheel. The universe is like that – it doesn't have an infinite number of chips to lay down to see exactly what comes up. Or have an infinity of photons for particles to exchange with each other. (Though one difference between the universe and blind betting and roulette is that an incompletely observed quantum roulette ball lands in all possible slots. The information isn't there-but-hidden – it's just not there. Black pays off – well, the ball's probability wave occupies all the black slots (unless observed to occupy a specific slot). The universe moves on.)

The universe writes its own history moment by moment. But history is always incomplete. Under the uncertainty principle, you can pin down some aspects of things with as much precision as you want, but this will always be at the expense of other aspects. We're used to feeling that the universe has great solidity and precision because at our macroscopic scales, it does. Our bodies contain nearly 10^28 atoms. We're big, compared to atoms. We don't generally perceive atomic-scale lack of precision. We're the beneficiaries of living in a universe with something like 10^80 particles, which define each other pretty precisely but not infinitely so through their interactions.

Inexactly defined particles behave with a certain degree of mystery – of unknown information. This unknownness takes definite forms – probability waves, etc. Defining how unknownness and imprecision manifest themselves is the job of quantum mechanics. Patrick Coles, Jedrzej Kaniewski, and Stephanie Wehner at the National University of Singapore just proved that wave-particle duality is a manifestation of the uncertainty principle. Dr. Wehner said, "The connection between uncertainty and wave-particle duality comes out very naturally when you consider them as questions about what information you can gain about a system. Our result highlights the power of thinking about physics from the perspective of information." (Once co-wrote an adult movie about time travel which included a scientist named Dr. Wiener. This is not the same Dr. Wiener.)

110. How about Einstein-Podolsky-Rosen (EPR) Nonlocality?

Existence depends on self-consistency. You can set up situations in the universe in which the discovery of the value of a variable at Point A implies the value of a linked variable at an arbitrarily distant Point B. Every particle interaction is a handshake between two points in time (as seen from points of view that aren't moving at the speed of light – from the photon's POV, no time passes). These handshakes are part of how the universe defines itself and maintains its self-consistency. The EPR setup links two such handshakes. The unfolding of time is the setting up and completing of vast numbers of these handshakes.

111. How about the possibility of the universe operating in something more essential than information?

I don't know what would be more essential (in a practical sense) than information. Information is the pure essence of choice with everything extraneous stripped away. In a binary system of information, it's just 0s and 1s or whatever you want to call it – apples and oranges, Bens and Jerrys – but it's all just the choice between two values – what you call these two values isn't included. It's no-frills.

However, this doesn't get at the essence of distinct choices, why something can only be true or not true (Gödel aside), how non-contradiction arises and why it's the key to existence. We have to work on the logical foundation of existence, including the existence of information, but in terms of how the universe does moment-to-moment business, information is a highly efficient framing device.

While we're at it, we have to get at the foundation of numbers – how they exist (in an abstract sense that's reflected by numbers in the material world) without contradiction and with infinite precision. The same logical structures of non-contradiction – the infinite choices of and handshakes between values that allow numbers to work – also allow material existence. (My article about meta-primes in *Noesis* begins to discuss the infinite series of choices among numerical values that make numbers work.)

[Editor's Note: https://megasociety.org/noesis/59]

112. How does everything in essence equate to a Turing Machine in informational cosmology?

A Turing machine constructs a picture of reality one finite step at a time. Any finite process or system can be mathematically translated into a series of bitwise steps – a series of 0s and 1s. Multiple Turing machines can be married into a single machine – the Church-Turing thesis states that any computable function on the natural numbers is computable on a Turing machine. I'm assuming that the universe (or any information-space) is finite and that possible transitions between states of the universe are computable (given the input of new information to reflect the outcome of events that had yet to be resolved). With these assumptions, subsequent events can be computed by a Turing machine.

113. Where one contained armature/universe equals A_2 and another container armature/universe equals A_3, does A_2 operate on a different kind of time than A_3?

The armature world and the mind-space world are temporally linked – the mind-space is reacting in real time, but there's no coordination of physical processes – between the speed of light in the armature world and in the mind-space, for instance.

114. What can we never know? In other words, what count as, by their nature, mysteries?

The universe observes and defines itself. It takes information to get information. There's not an infinite amount of specification to be spread around. There will always be gaps in knowing. Even in a deterministic universe, which ours isn't, you'd need something vastly, hugely huge to model the universe.

So our knowledge of specifics will always be at risk of being threadbare. But we can hope to learn more about the general principles of existence. Richard Feynman laid out the possible paths of future scientific knowledge, something like – we figure out the universe, learning just about everything there is to know. Or we fail to figure out the universe – it's just too tough. Or we keep learning more and more but never learn just about everything because what there is to know just keeps going and going.

I think we'll mostly figure out the universe – we'll develop a pretty good picture of the Whys. Our knowledge, however, will always be surrounded by a deep metaphysical chasm of not yet understanding the Whys behind the Whys. There's no absolute knowledge – there's just hope.

It's not an unreasonable assumption that there's an unlimited amount of stuff to know. There are reasons behind reasons behind reasons, and we may never get to the rock-bottom essential nature of things, because there may not be a rock-bottom essential nature. Everything might be bootstrapped and self-referential and the way it is because it can't not be the way it is without being contradictory. You can never precisely draw a fractal or a Mandelbrot set – there's always an infinity of little curlicues you're leaving out. And as you go bigger and bigger and more complex, there are emergent properties and essential stories too big to be contained in smaller information sets.

Having a beginner's understanding of the Whys of the universe is just a first step to learning how to operate within the universe. There will always be infinitely far to go to figuring everything out.

115. How does informational cosmology explain ex nihilo cosmogony for the modern form of nothing defined by science and the modern philosophical/theological kind of "nonbeing" nothing?

In informational cosmology, there's a reason in the armature world for a mind-space to come into existence. Reasons can be anything that creates a wide-angle information processing system – can be natural, as when our brains form as a fetus grows, could be semi-mechanical, as with us building future sophisticated robots, could be a spontaneous negentropic process (which the billion-year evolution of life on earth can be seen as).

Also, the principles of self-defined information-spaces should generate a roughly defined set of all possible such spaces. If these principles more-or-less completely specify what can exist, consistent with non-contradiction, then anything that can exist, can't not exist – that is, must

exist (though we can only experience one moment at a time, and each moment has to be consistent with its history – we can't jump world-lines).

So, between every information-space having a reason to exist in an armature world that's created it and the principles of existence pretty much mandating that information-spaces exist, you have pretty solid justifications for there not being just nothingness.

116. With universe as mind and theology as study of the nature of God – in large part, theology becomes informational cosmology, and vice versa. How does this reframe the enormous discipline of theology?

If widely embraced, informational cosmology would eventually prompt a whole new mess of unfounded and semi-unfounded belief and misunderstanding. It has a whole set of new and semi-new hooks on which to hang irrational beliefs.

Even if it becomes an accepted theory, not everyone's going to believe it. I assume our semi-artificial selves of a century hence will be pretty scientific in their beliefs, but there will be many groups that continue to hold traditional beliefs. Figure 14 to 25 billion entities with at least human-level cognition 100 years from now (could be many, many more if independent, individual AIs are all over the place). The majority will hold scientific worldviews, but billions of others will be various degrees of Christian or Muslim or Buddhist.

Informational cosmology contains more Whys than Big Bang theory. Big Bang theory asks you to believe that nothingness is unstable and wants to explode without much philosophical justification. I'd think that people would embrace a theory that, if largely verified, offers more Whys within a scientific framework.

Informational cosmology also offers huge questions to try to answer – is the universe truly conscious? If so, what's it up to, and what world contains it? How old is the universe? Can civilizations survive the recycling of galaxies? Is there a ladder of worlds? What are some of the other conscious beings scattered throughout the universe up to? Do they participate in the mechanics of the universe? Are three-dimensional space and one-dimensional time structures that all civilizations are stuck with? And a zillion more questions. Some people will try to answer them theologically.

117. If you had the opportunity to look at deep human time in an instant, you would see antiquity's graveyard with a small section, where we can find remnants of the great theologians, and these grand figures of theology lie in the grave with some onlookers – no doubt to join – around the graveyard; look close, some found in this grave, some at the eulogies, and others to partake of this cemetery: Abraham Joshua Heschel, Albert Schweizer, Baháu'lláh, Charles Wesley, Clement of Alexandria, Clive Staples Lewis, Eliabeth Stuart, Gordon Clark, John Calvin, John Ronald Reuel Tolkien, John Wesley, Jonathan Edwards, Joseph Smith, Jr., Karl Barth, Ketut Wiana, Leila Ahmed, Marilyn McCord Adams, Martin Luther, Pelagius, Polycarp, Prophet Muhammad, Saint Anselm, Saint Augustine of Hippo, Saint Francis of Assisi, Saint Ignatius of

Antioch, Saint Irenaeus, Saint Jerome, Saint Thomas Aquinas, Soren Kirkegaard, Teilhard de Chardin, and so on.

With such a deep background into the realm of ethics in the world of theology, informational ethics provides the basis for theoretical analysis of issues in ethics such as asserted proclamations on ethics in prior times. Application of C^E to each set or subset of proposed ethics; C^E provides the basis for logical analysis of ethics.

How might other pervasive ethics have rational calculation in such a moral calculus from informational cosmology? How might the longstanding tradition of theology work in such a framework? How do some vogue – within the timeline of recorded human civilization's history – assertions of ethics operate in informational ethics such as Christianity, Confucianism, humanism, Islam, Judaism, secularism, and so on?

Most ethical implications of informational cosmology probably come from the idea that everything exists within a framework of (technical-not-mystical) consciousness. Consciousness is a big deal – it's the context for everything. At the same time, it is weak – it's technical, not transcendent, and it doesn't transcend death unless abetted by technology. Consciousness is threadbare, it lies to us, and it's not everlasting. At the same time, it's all we have.

We have to assume that respect for conscious beings is important. At the same time, we have evidence that it's not. We know pigs are fairly intelligent and have feelings. At this point, only schmucks would argue that pigs aren't conscious. (Unless they're arguing that no living beings are truly conscious, in which case they're using a completely different (and schmucky) definition of consciousness.) We slaughter pigs by the billions, but there's no proof that this mass killing of conscious beings leaves a metaphysical stain on the universe.

We can go back to existentialism, that the world is meaningless, so we have to build our own moral systems. But we're potentially in a better position than the existentialists confronting a random, spontaneously arising Creator-less universe that contains no inherent moral values. If informational cosmology is correct about conscious information-spaces being the framework for existence that, at least, is a unifying theme for existence. We still have to build our own moral systems, but there's a little more to grab onto than the completely random, coldly purposeless, Big Bang universe.

Consciousness is a mathematically describable, verifiable thing, not just a suspicion of or an ineffable feeling that there might be a thing. And consciousness might be a thing on all scales, up to the most humongous. We don't know much yet, but there's a chance that our self-built moral systems might eventually get some support, not from some Creator handing down pronouncements, but from the structure of things. If consciousness is embedded in existence, and existence is the default state of things, then there might be reasonable ways to philosophize the problem of how to exist, without just blindly, bravely doing it for the sake of keeping on.

We still have to face that existence is governed by the math-like principles of non-contradiction, rather than being granted by a deity. We may always face the problem that there's not some Ultimate Mover who wants us to exist, but rather that it's up to us to design ourselves to want to exist (after having inherited the drive to exist from purposeless evolutionary processes). But we can be hopeful about consciousness being inherent to existence. The principles of existence won't be able to squeeze the ghosts out of the machine.

118. How might this calculate the most difficult issue in the history of theology, The Problem of Evil?

The deal is, the processes that created us don't have purpose, and they don't judge. We've been created by a history of things happening via natural processes. I think we arose instead of being created by a purposeful being with plans for us. And since there's no planner to keep things in line, to make things nice, lots of things can happen, and some of the things that can happen are horrible. It's up to us to create moral systems which help us decide good and bad and up to us to do what we can to minimize the bad. There's no One in charge; we have to be in charge of ourselves. But we get some help, in that existence seems to be unpreventable. We're in a fight against personal and civilizational and even universal oblivion (our universe, not all possible universes), but existence itself is undodgeable. Existence isn't a fluke, and nothingness is not the default state. There is a fabric of existence (well, not exactly, because where would it exist? It exists the way numbers exist.), a set (a quite likely messy, not-well-defined set) of possible moments of existence, because there can't not be.

Evil, as opposed to bad things happening by accident, involves choice. Something capable of choice chooses to do something bad or to allow something bad to happen. There's no deity in charge who's allowing bad things to happen. But what about the conscious entities who are so much bigger than us that they might as well be gods? In the case of the universe itself, it probably has an idea that the information which comprises its information-space can take forms which are so complicated that they can include worlds with conscious beings and civilizations. However, it's unlikely that the universe would care about beings which are low-level relative to itself and which do not exist in a form of which it is explicitly conscious, unless such forms threaten to impede the universe's information-processing. As for advanced civilizations within the universe, they seem unlikely to go out of their way to prevent bad things from happening on our planet.

So, to boil everything down –

No one is in charge, neither a Creator nor an agent or ethical system put in place by a Creator.

The universe isn't concerned about relatively low-level worlds which form in its information-space. The universe wants its information-space to process information. It's okay with, and is largely unaware of, whatever happens to specific negentropic forms taken by the information in its information-space – that is, us.

Other civilizations in the universe haven't invited us to join some galactic empire of goodness in which we get help in not having bad things happen.

For the time being, we're on our own in building ethical systems and in trying to minimize evil.

119. Do souls exists? How do you define them?

Souls exist if you call our conscious selves our souls. If by "soul" you mean a magic ingredient, not information-based, that transforms an unconscious automaton into a feeling, experiencing being, then no, I don't think souls exist. Our consciousness, our feeling that we exist in the world, is a property of how we process information. It's not the result of a transcendent soul that rides unfeeling matter like a little sparkly cowboy or a golden thinking cap on a flesh-and-bone Roomba.

Our soul is what we're feeling and experiencing and the incompletely expressed background to what we're thinking at any given moment. At any given moment, there's a lot we don't consciously know but are comfortable that we could know if we needed to. Our moment-to-moment awareness is somewhat rooted in all our stored knowledge (including feelings associated with that knowledge) that's only unpacked a little at a time. Our being accustomed to knowledge-in-waiting, our at-homeness in the world, our not freaking out that we don't know everything at every moment, is part of what feels like a soul – a generalized feeling of self.

We don't see a painting all at once – we fill it in mentally as our eyes wander over the painting. Similarly, we don't know ourselves all at once. We constantly fill in ourselves about ourselves as our awareness wanders through our stored knowledge. Being comfortable with our normal brain function is part of feeling we have a soul.

We could even speculate that a feeling of comfort with and complacency about our brain function – this feeling of self and soul – might be encouraged by evolution, because it wouldn't do for every organism to be freaking out over every mental glitch. Consciousness is glitchy, and we might have a certain optimum level of glitch-blindness that's consistent with calm, normal functioning. In people suffering from Alzheimer's, failure to recognize mental deficits seems to be fairly common. This could be a manifestation of a normally helpful defense mechanism (or it could be another symptom – a failure in self-perception caused by the Alzheimer's itself).

The speed and precision of perception and thought are also a big part of feeling as if we have a soul. There's a not-uncommon feeling among people who've been on heart-lung machines for many hours during an operation, called "pumphead" or post-perfusion syndrome. Apparently, while you're on the machine, your circulatory system can get gunked-up, and during the month or so after the operation, your brain becomes clogged and strokey. It becomes harder to think and concentrate and control your mood. Some people with pumphead describe it as losing their soul.

And most of us have had the “wrapped in cotton” feeling of reduced reality when exhausted or a little bit buzzed. It’s apparent that degrading brain function reduces the feeling of the authenticity of reality and of self.

120. Father Teilhard de Chardin remains a controversial figure to some. In particular, his ideas in *The Phenomenon of Man* (1955) evoked praise, infamy, and even calumny. He had some ideas of note. Ideas in relation to theology and the world. With rich theological undertones, he spoke of an Omega Point in the book *The Future of Man* (1964). Does this idea hold merit in informational cosmology?

I believe that, as in Omega Point theory, the universe evolves more complicated and effective ways to process and store information, which can include biological and technical evolution. However, I don’t believe in the Omega Point’s teleology, that some god-like entity is the engine of progress, drawing us towards its enlightenment. And evolution doesn’t just progress towards increased complexity; evolution spreads out across all levels of complexity. Bacteria didn’t disappear when humans emerged.

Also, if the universe recycles itself across octillions of years, then life within it emerges zillions of times as a natural consequence of negentropy. (Every solar system is an open, negentropic system, though life won’t evolve in every such system.) So you don’t have a universe relentlessly climbing towards higher levels of complexity; you have a universe in which complexity arises over and over, trillions and quintillions of times. Even if intelligent life arises only once per galaxy, that’s still 10^11 instances of intelligent life, not even considering the recycling of galaxies. The universe should gradually grow more complex as it accumulates more information, but it could operate just fine with an unchanging amount of information, just as we could.

121. What do you see as still needing to be done with Informational Cosmology?

Informational Cosmology:

Needs mathematical structure – words translated into equations.

Needs testable aspects and testing – it’s not a theory unless it can be tested. Many of its elements are hard to test observationally – dark matter being collapsed normal matter, there being a bunch of burned-out galaxies in the neighborhood of T = 0, the universe being many, many times older than 14 billion years. But these same difficulties pertain to other theories of dark matter and the large-scale structure of the universe. These theories are often tested via mathematical modeling, which could be applied to Informational Cosmology. Fortunately (perhaps), Informational Cosmology is also a model of our minds, which, while not sharing our physical space, aren’t 14 billion light years away and are amenable to observation.

Needs attention. I’m trying to sell a memoir, *Dumbass Genius*, about the dumb things I’ve done, with some of the dumb things being done in pursuit of a theory of the universe. The proposal for

Dumbass Genius is currently being looked at by publishers. The memoir will be 95% narrative and 5% physics. The narrative is a Trojan horse to get the physics in front of people. I've hired some PR people, and I'm trying to expand my social media presence, and I will continue to do and say semi-stupid stuff with the hope that this might cause people to accidentally pay attention to my non-stupid stuff.

Needs professionals to look at it. Professional scientists hate this kind of stuff. I'm working on an article titled "On Being a Crackpot." I can tell you that professors don't greet wild, all-encompassing amateur theories with unbridled joy. The standard reaction is, "I'm not even gonna look at your theory. I've dealt with lunatics like you before. Your theory is almost certainly crap, and reading the theory and explaining why it's wrong would be a waste of time because nothing I could say would change your crazed mind. Why did the receptionist even let you into my office?" My best bet is to have my brain transplanted into the body of an attractive young woman and marry Brian Greene or Neil deGrasse Tyson or Michio Kaku. We'll get married and have lots of sex and then he'll have to at least pretend to pay attention to my theory. Anyone know an attractive young woman who wants to swap bodies with a 54-year-old man with hair plugs? [Ed. Note: This scenario is reminiscent of the film *Being John Malkovich*]

Needs further integration – to have its elements combined into a smoothly functioning model of the life cycles of thoughts, galaxies, and the entire mind and universe (preferably with cool diagrams).

Needs to be shown to address shortcomings of currently accepted theories and explain things currently accepted theories don't. A theory which explains why the universe does what it does is preferable to a theory which says, "There was a big explosion, then some cosmic inflation, and now there's some accelerated expansion." Current thinking tends in the direction of, "Asking 'Why?' is naïve – a pinpoint that explodes with vast broken-symmetry energy just is," but a nice metaphysical/mathematical explanation that might also explain why some physical constants are what they are could eventually be well-received.

Needs time and for Big Bang theory to continue to accumulate contravening evidence. Thomas Kuhn, in his classic book about how science works, *The Structure of Scientific Revolutions*, explains that science progresses through a kind of punctuated equilibrium – theories prevail until they accumulate a bunch of anomalies, and then there's a scientific revolution. Big Bang theory has been the boss-man theory of the universe for only 50 years. And before that, we didn't really have a widely accepted theory of universal structure, because all the pieces weren't in place. The Hubble redshift and expanding universe equations of general relativity weren't discovered until the 1920s. We didn't even know that the universe extended beyond the Milky Way until Hubble provided incontrovertible evidence in the 1920s. So we've had this one theory for not too long – basically our first and only theory based on decent information about the universe. (There was Steady State theory, but it was never boss before getting swatted down by observational evidence.) Big Bang's getting a little creaky – needs a lot of add-ons and geegaws to account for the results of observation.

The Big Bang will eventually be replaced, but it won't go away, the same way Newton's gravitation didn't go away – it became part of the larger conceptual framework of general relativity. The universe will always appear to be Big Bangy due to the nature of information. Informational cosmology still has the universe blowing up, but just a little at a time. (And by little, I mean maybe at an average rate of around ten galaxies a year.)

122. Would you ever have theorized without your outlier background?

The background definitely helps. Can imagine many different destinies – resentful math teacher, divorced unsuccessful novelist….But think those versions would do some theorizing, too. Maybe not as much as this version. And they certainly wouldn't have had this forum.

123. Do you see a difference between common sense and intelligence?

It's an old question which has an element of what might now be called nerd-shaming. It implies that regular people with common sense can get along in the world, while you, Nerd, with your so-called intelligence, have a hard time with things such as sports or getting a girlfriend or not dressing weird.

As a nerdy kid, I ran into this attitude fairly often, with people saying, "Well, you may be a brainiac, but I've got common sense." This reflects a lost world of nerds being somewhat isolated from regular people. Today, tech forces us all to be nerds to some extent, all searching for the new best practices for living.

124. What do you most regret?

I regret squandering time on some stupid stuff – all the *Gilligan's Island* and *I Love Lucy* reruns I watched as a kid, the crazy amount of time spent suing a quiz show. (My lawsuit was justified, but it ate up a lot of time.) I regret not being more skeptical of medical procedures which turned out to be unhelpful at best – varicose vein stripping, CT scan….I regret not being born a couple decades further into the future. I regret not becoming wildly handsome in my 20s.

125. You live among an interesting cohort, no doubt. A group of individuals among the elite of intellectual abilities. What of the ethics of forming elite organizations – "elite" by admission standards? What about joining them? What about the possibility of some exploiting concomitant assumed authority of an individual or group? Perhaps some of those in the ultra-high IQ community make a conscientious choice – moral choice even – to not join such societies. Insofar as the ethics of forming, joining, and sustaining elite groups, what of the possibility of ultra-high general ability individuals choosing to not enter?

There are probably more hyper-intelligent people not in high-IQ societies than in them. Smart, highly successful people tend to be more involved with the things that made them successful than in exploring their mental skills.

But there's not a super-high correlation between intelligence and success, especially at the highest levels. Many high-IQ people have pretty normal lives and jobs. Some of them find high-IQ societies, where they can get a little recognition and interact with people who have meshing interests. People turn to high-IQ societies on social media for the same reasons people do anything on social media – recognition and sharing. Social media makes it easier to join high-IQ societies – every two or three months, I'll be emailed that I've been added to some high-IQ group. Because they're easy to join, quite a few people belong to high-IQ groups on social media, which means that such groups consist largely of nice people who are delighted to have online friends.

126. You suffer from the attention and invective of internet trolls. Trolls come in many variety within the flora and fauna of internet life. I hear they feed on a combination of foaming at the mouth and others' time – at least in their natural habitat. Unfortunately, they're like starfish. If one chops the poor little echinoderm to pieces – or like the story of the wizard from *Fantasia* with the shredded broom, they have a "population explosion" and emerge with greater force and invective than ever before. Do you have any responses for the harsh internet crowd? In other words, what comes across with the highest frequency? How do you respond to them?

Arrogant – Well, I'm really good at IQ tests. Does that make me a snotty jerk? I hope not. Do I know what's best for people or have a plan for remaking society? No. Do I want to be the boss of everybody? No. Do I think I'm really smart? Kinda, but my Twitter handle is @DumbassGenius, not @geniusgenius, which shows at least a little modesty.

Weirdo – Yes, I'm kind of weird – not weird just to be weird, but weird because I'm used to figuring out on my own how to do stuff, and often this figuring works out oddly. And even though I do weird things like go to the gym five times a day, I also do normal, responsible things like stay married for 23 years and be a dad and hold down jobs more successfully than most people in my profession.

Loser – If you've read that I'm a high-IQ bouncer and stripper and nude model, that's kind of loserish. Very loserish. But I've also been a TV writer and sometimes-producer since the late 80s. I've written for more than 2,500 hours of broadcast television, including the Emmys, ESPYs, American Music Awards, Grammys, and Jimmy Kimmel Live!, earning seven Writers Guild Award nominations (one win) and an Emmy nomination. I've gotten a lot of material on TV. As I've said before, I'm married and a dad, which is important. I've got a memoir that's being shopped around, and I have a theory of the universe. So, not entirely a loser.

Obvious hair plugs – Yes, you can tell that I have hair plugs. They're not the worst plugs in the world, but they could be better. I started getting them in 1989, before the technique had been refined, so they're a little clumpy. But they're better than no hair, and if you didn't know what you were looking for, you might not notice them.

Why should you listen to me? – I've been trying to figure out how the universe works since I was ten, and I've had a decent foundation for a theory for more than 30 years. I might be onto

something. Current big bang cosmology is getting a little threadbare. A very, very, very old universe explains a lot of stuff.

You were very concerned about losing your virginity – Sex is kind of a given. Unmarried couples live together without social censure, everyone's saturated in porn and sexualized images, everyone suspects the worst about everyone else in terms of sexual behavior. But as a population, we're just about fatter than ever, there are a zillion other things to besides sex, and people in general don't seem overly concerned with having sex, at least not as much as in the 70s.

127. Provisions for principles of existence would equate to the *language* of existence, and therefore one can derive the more appropriate, direct, and proper phrase "principles of existence" rather than "laws." We have more derivations from defined principles of existence:

Principle One: universe operates within limits of complexity. Any further complexity will likely deteriorate into optimal simplicity. Universe among logical possibilities of the set of universes bound by optimal simplicity.

Principle Two: relevance/irrelevance, information of relevance will occupy or begin to occupy the active center; conversely, information of irrelevance will not occupy or begin to not occupy the active center.

Principle Three: The Persistence Project divides into The Statistical Argument for Universe and The Statistical Argument for Consciousness**.** Universe cannot not exist; consciousness cannot not exist. Therefore, the non-absolute high probability for existence, and persistence, of universe and consciousness.

Principle Four: informational cosmology implies informational ethics in a progressive argument. Where I_c equals informational cosmology, S_u equals Statistical Argument for Universe, S_c equals Statistical Argument for Consciousness, P equals The Persistence Project, C^E equals "existence-valuing principles," and I_e equals informational ethics, we can construct one conditional argument to derive informational ethics from informational cosmology: 1) $I_c \Rightarrow (S_u \wedge S_c)$, 2) $(S_u \wedge S_c) \Rightarrow P$, 3) $P \Rightarrow C^E$, 4) $C^E \Rightarrow I_e$, 5) I_c, 6) $\therefore$, I_e. Therefore, one acquires values consistent with the facts of existence: "existence-valuing principles" or C^E. David Hume's is/ought fails. A distinction exists between them, but facts imply values.

Principle Five: universe/mind symmetry, universe as mind based on net self-consistency and information processing. Units of sufficient individuation in a universe with self-consistency and information processing as minds too.

Principle Six: universe (M_n) implies armature (A_n); if armature, universe. Universe equates to information processing; armature equates to material framework/processor: ($A_n \Rightarrow M_n$).

Principle Seven: armature and universe construct mind-space: ($A_n + M_n = S_n$).

Principle Eight: net self-consistency and information processing equates to consciousness. This reflects Principle Five. Sigma, ∑, self-consistency, S, times, *, sigma information processing, $\sum I_p$, would equal mind-space, S_n, where mind-space equals information-space, I_s: $(\sum S * \sum I_p = S_n = I_s)$.

Principle Nine: universe as conscious: $(A_n \Rightarrow M_n)$; ∴, $(A_n + M_n)$; $(A_n + M_n) \Rightarrow S_n$; ∴, $(A_n + M_n = S_n)$. In addition to this, we have the inclusion of *Principle Eight* to derive the same conclusion about mind-spaces, S_n: $(\sum S * \sum I_p = S_n)$. Armature implies universe; therefore, armature and universe; armature and universe imply mind-space; therefore, mind-space; armature and universe construct mind-space, and net self-consistency and information processing equate to mind-space. Consciousness equates to net self-consistency and information processing; universe equates to these too. Therefore, universe equates to consciousness endowed system.

Principle Ten: consciousness at every magnitude exists in finitude and with non-mystical/technical construction. Informational cosmology lacks infinities and describes finites. Information constructs consciousness based on information processor and net self-consistency with finite capabilities. Subsystems internal to universe partake of this consciousness too, but not to the same degree. Units of sufficient individuation in universe with net self-consistency and information processing have consciousness proportional to sum of self-consistency times sum of information processing. Therefore, universe and multiple subsystems in universe have consciousness or equate to minds.

Beyond the foundational elements of informational cosmology laid out in this interview, and the first- and second-order derivations with informational ethics and other areas of discourse, what further realms of investigation have a possible future of analysis within an informational cosmological and informational ethical perspective?

One big field that will open up in during the rest of the century is what our drives should be, as we develop the ability to modify our drives and desires.

By the end of the century, there will be much inquiry about how to merge minds and how connected minds should be. There will be a whole new field addressing issues of mental connectivity. In some communities, people will want to stay completely unmerged. In others, people will try to achieve complete merging.

A critical field will be modeling AI and predicting its behavior. You need a mathematics of consciousness to understand AI. Out-of-control AI could be the greatest threat in history. A related field will be the design of artificial awareness.

There will be the field of informational structure – trying to figure out what the universe and other such systems are doing with information by looking at the distribution and behavior of matter. Can we get any idea of what's in the mind of the universe?

Technical resurrection will be an area of inquiry and development – preserving consciousness after the body is gone, attempting to reconstruct and simulate the minds of people from history. We'll have better and better iterations of Austen, Lincoln, and Shakespeare – all the usual holodeck suspects.

Beyond the physics of information-spaces, there will be the mathematics of information-spaces, which will go farther into the abstract and general properties of self-defined spaces, along with set theory as it applies to the set of all such possible spaces, the connections and transformations among members of the set, the level of infinity that describes the set, whether it's a well-defined set, and so on.

Then there's the cultural analysis of how we'll be affected by thoroughly understanding consciousness. Most people probably believe that consciousness is produced by the brain, but the culture shock may not fully set in until consciousness is fully dismantled and replicated. How people feel and behave when they're no longer more divine than their devices will have to be studied.

128. In the current climate of excess sensitivity tied to a reactionary institutional culture and subsequent radical conformity – in irony, I do not wish to offend anyone; however, institutional analysis does have value for us: internally, to Academia, various filters through achievement measurements (BA/BAA/BBA/BSc, MA/MBA/MPA/MSc, JD, MD, PhD, Post-Doctorate, and so on) and organizational-structural apparatuses operate for academic peers to consider standards high and one another proficient in relevant material under research; externally, to independent researchers and scholars, these can prevent innovation, hinder creativity, foster intellectual docility and acquiescence, and exclude bright and qualified outsiders (even geniuses) – to claim otherwise would consider academics of an angelic form. Both perspectives are valid and compatible. It sounds good in an introductory course for particular ideals to have statement; however, we must face facts in the following reflection. We must speak without prevarication. You do not have academic awards, grants, honors, titles, or persuasive associations such as authoritative academics/institutional connections. If correct, and if someone in mainstream Academia stole these ideas, arguments, calculations, and original conceptualizations, you have little recourse for intellectual copyright and plagiarism.

Your defence would hold little weight, especially with the possibility of defamation, character assassination, and other tenth-rate tricks to discredit an individual rather than consider the claim of plagiarism on truth or falsity of the claim. No internal colleague, principal investigator status (or laboratory), faculty, external department, research institute, ethics board, administrative authority, or university at large to likely remedy such a possibility. The Academy tends to work in a closed way for accreditation and peer recommendations.

129. You live and work outside the university system. Any thoughts on such an outcome? You developed this theory for over three decades. Any words for someone with intention of surreptitious pilfering of even your crumbs? Those with a wolf heart, modicum of talent, but

starved for anything with a resemblance to this conceptual bread of life based on avarice and a gnawing hunger for academic, and eventual popular, glory.

I have one good defence – some of this stuff turning out to be true. If it's true in a big way – if it's picked up and verified by the world, someone will put me in the story.

My wife and I go to couples counselling every three or four weeks, and we discussed this in our last session – what happens if my book doesn't get published, if I don't get recognition, if 30 years from now I'm a frustrated old man whose ideas have become accepted but whose authorship isn't generally recognized. My wife and our therapist and I agreed that would suck.

And yeah, my credentials are: not-great stripper, epic catcher of fake IDs, legendary goer-back to high school, nude art model, compulsive overachiever on IQ tests, and writer of jokes for late-night TV. But there's a story there. William Blake said, "The road of excess leads to the palace of wisdom." My excess hasn't been that excessive, but it hasn't been what everyone else has done. Charles Darwin took a five-year trip on the Beagle. He saw eroded landscapes and thousands of species. He thought about it for 20, 30 years. His exceptional life experience plus extended thought lead to the greatest unifying theory in history – the earth's geology plus the vastness of organic variety equals deep time. I like to think that exceptional personal experience plus extended thought can, even in the era of Big Science, lead to a great unifying theory.

I currently have sort of a PR person and next month will hire another PR person. My story will get out there. Eventually, established scientists will consider it. Will someone be able to steal it? At this point, my best chance for this not to happen is for me to keep talking and writing about it in my goofy way.

The Intuitionist Continuum

Werner Couwenbergh

Abstract

The intuitionistic continuum has some very unusual properties that make it stand out from other mathematical continua: it is inherently incomplete – “perpetually in the process of creation” – and fundamentally indecomposable. In addition, every total function on the unit interval is uniformly continuous.

These properties are a consequence of the characteristic way in which the intuitionistic continuum is constructed. Ultimately this construction draws on the ‘two acts of intuitionism,’ defining mathematics as a “languageless activity of the mind”, originating “in the perception of a move of time”: all mathematical objects are constructed based on an elementary ‘twoity’, given by pure intuition. The requirement of constructability results in an intrinsic incompleteness of infinite objects, which has far-reaching repercussions on intuitionistic logic and the nature of intuitionistic mathematical objects.

Philosophically, intuitionism has a phenomenological foundation (with strong parallels to Husserl’s transcendental phenomenology), from which a constructive ontology and epistemology flow. This philosophical basis is, however, susceptible to critique, as is the technical complexity of intuitionistic mathematics which has obstructed widespread acceptance.

Content

1 Introduction

Among the three main schools – logicism, formalism and intuitionism – that attempted to provide an answer to the set-theoretic paradoxes that had caused a foundational crisis in mathematics at the start of the 20th century, intuitionism arguably proposes the most original solution. Conceiving mathematics as a languageless, mental activity, based on the pure intuition of (inner) time, it produces a rich mathematical universe that directly contradicts classical mathematics in key areas. The construction and properties of the intuitionistic continuum are of particular interest in this respect.

Following a brief introduction on intuitionism and its historical context, we will present the basic tenets of intuitionistic mathematics – the 'two acts of intuitionism' – and highlight some of the main consequences for both mathematics and logic.

We will then zoom in on the intuitionistic continuum, explaining in detail its construction (based on the intuitionistic equivalents of a set: spreads and species), its properties (both 'classical' and 'non-classical'), and the conception of infinity in intuitionism. A comparison with other mathematical continua will highlight the unique nature and relevance of the intuitionistic continuum.

Next we will have a closer look at the philosophical underpinnings of intuitionism. Its phenomenological basis – and the ontology and epistemology that flow from it – will be expounded. Special attention will be given to some remarkable similarities with Husserl's transcendental phenomenology. Finally, we will list some (potential) issues with intuitionism, from a philosophical as well as from a practical point of view.

[Formalists say that mathematics is a game-like manipulation of strings using manipulation rules and that the body of propositions need not, ontologically, represent abstract objects. Logicism in the philosophy of mathematics maintains that mathematics is reducible to logic; advocates of logicism say that mathematics can be understood *a priori*, without intuition. -Ed. Note]

2 Situating intuitionism

2.1 Historical context[1]

Intuitionism is a philosophy of mathematics that was introduced by the Dutch mathematician L.E.J. Brouwer in the beginning of the 20th century. Set against the background of the *Grundlagenkrise*, it fundamentally differs from classical mathematics in that it considers mathematics not as an independent platonic reality, but as a creation of the free mind (via the 'two acts of intuitionism' – cf. § 2.2).

The constructive underpinnings of intuitionism can be traced back as far as the ancient Greek mathematicians. As of the late 18th century philosophical views evocative of intuitionism are expressed by (a.o.) Kant, Peirce and Schopenhauer, and in the 19th and 20th century various constructive-intuitionistic features appear in the mathematical works of e.g., Poincaré, Lebesgue and Borel ('pre-intuitionists'), Gauss, Kronecker and Weyl.

It was Brouwer, however, who, in his seminal 1907 doctoral thesis[2], outlined present-day ('neo-') intuitionism, and, over the following 2 decades, fully developed it into a foundational program. As such, intuitionism stood alongside formalism and logicism, as a potential answer to the set-theoretic paradoxes that had caused the foundational crisis in mathematics.
In a subsequent paper[3] Brouwer rejected the validity of the principle of the excluded middle (PEM), thus paving the way for the development of intuitionistic logic, which was later formalized comprehensively by Heyting.

Constructivism and intuitionism are intimately related: they share the same constructive tenets regarding mathematical objects, and the same – intuitionistic – logic.[4] But while constructive mathematics is usually a restriction of – and hence compatible with – classical mathematics, intuitionism is fundamentally incompatible with the latter.

---

[1] Cf. Brouwer, 1981; Michel in van Atten, Boldini, Bourdeau and Heinzmann, eds., 2008, pp. 149-162; Heinzmann and Nabonnand in van Atten, Boldini, Bourdeau and Heinzmann, eds., 2008, pp. 163-177; Bostock, 2009; Dragalin, 2011; van Atten, 2011; Van Kerkhove, 2012a and 2012b; McKubre-Jordens, 2012; Iemhoff, 2013.

[2] "Over de grondslagen der wiskunde", cf. Brouwer, 1907.

[3] "De onbetrouwbaarheid der logische principes" cf. Brouwer, 1908.

[4] In contrast to constructivism (and classical mathematics), however, for Brouwer, logic depends on mathematics, and not the other way round.

2.2 The two acts of intuitionism

Early on in his career, Brouwer developed philosophical views that could be labelled as epistemological solipsism.[5] His philosophy of mathematics, grounded in the 'two acts of intuitionism', was developed over several decennia, but always remained in line with these views:

First act of intuitionism (FAI):

> Completely separating mathematics from mathematical language and hence from the phenomena of language described by theoretical logic, recognizing that intuitionistic mathematics is an essentially languageless activity of the mind having its origin in the perception of a move of time. This perception of a move of time may be described as the falling apart of a life moment into two distinct things, one of which gives way to the other, but is retained by memory. If the twoity thus born is divested of all quality, it passes into the empty form of the common substratum of all twoities. And it is this common substratum, this empty form, which is the basic intuition of mathematics. [6]

It is the "common substratum" of this shared intuition of (the move of) time that provides the basis for the intersubjective validity of mathematics, and thus constitutes a 'Husserlian' escape from strict solipsism. Contrary to Kant, Brouwer only recognizes the (ür-)intuition of (inner) time, and abandons the apriority of space.[7]

Second act of intuitionism (SAI):

> Admitting two ways of creating new mathematical entities: firstly in the shape of more or less freely proceeding infinite sequences[8] of mathematical entities previously acquired …; secondly in the shape of mathematical species, i.e. properties supposable for mathematical entities previously acquired, satisfying the condition that if they hold for a certain mathematical entity, they also hold for all mathematical entities which have been defined to be 'equal' to it ….[9]

The SAI thus defines the ways in which one can construct new mathematical objects from existing ones – and ultimately from the basic quality-less twoity given by pure intuition, that was introduced in the FAI.

---

[5] Cf. Brouwer, 1905.

[6] Brouwer, 1981, pp. 4-5.

[7] A number of reasons for why inner time provides a better model than space are listed in van Atten, van Dalen and Tieszen, 2002, p. 8.

[8] The construction of these "more or less freely proceeding infinite sequences" relies on an idealized mathematician (the *creating* (or creative) *subject* (cf. § 3.1.d)), formally introduced by Brouwer in 1948 in order to avoid certain impractical consequences of the limitations of the human mind (thereby bypassing the intersubjectivity problem altogether – cf. Iemhoff, 2013).

[9] Brouwer, 1981, p. 8.

2.3 Consequences

The consequences of FAI and SAI are profound. Followed to their ultimate conclusions, they require a reconstruction of both mathematics and logic.

Logic necessarily becomes time-dependent, as a statement can lack truth value at a certain time t_n, but can (or not) acquire it at a later time t_{n+m}.[10] This, in turn, implies that the PEM – even though it will not necessarily lead to contradictions – is not universally valid.[11]

The intuitionistic negation ($\neg A$) is to be interpreted as the existence of a construction that derives a contradiction from every possible proof of A (i.e. $\neg A := A \rightarrow \perp$). Consequently, the classical law of double negation elimination does not generally hold in intuitionism either.[12]

Mathematical language arises *ex post facto*, as "an efficient, but never infallible or exact, technique for memorizing mathematical constructions, and for communicating them to others"[13].[14] As mathematical objects are mental constructions, based on pure intuition, their truth cannot rely on correspondence with any external – platonic – reality, but solely depends on the *constructability* of the objects themselves.

Construction of the natural numbers is based on FAI: the "falling apart of a life moment" into two separate things, can (potentially) be repeated indefinitely, which implies the constructability (in principle) of the smallest infinite ordinal ω.[15] Constructing an intuitionistic continuum – without invoking the PEM – is, however, less straightforward,[16] and depends a.o. on the notion of choice sequences, introduced by Brouwer in SAI.[17] The

[10] E.g., the Poincaré conjecture.

[11] I.p. for infinite systems, cf. Brouwer, 1908, p. 11.

[12] But $\neg\neg\neg A \leftrightarrow \neg A$ *is* an intuitionistic theorem (cf. e.g., Brouwer, 1981, p.11).

[13] Brouwer, 1981, p. 5.

[14] This also prevents language from becoming – in an 'Hilbertian move' – itself the object of study in mathematics. Cf. Tieszen in van Atten, Boldini, Bourdeau and Heinzmann, 2008, p. 81.

[15] Intuitionism does accept the principle of complete induction, but all infinities are to be regarded as *potential* infinities. Cf. § 3.2.3.

[16] It was in attempting to solve certain problems with the construction of the classical continuum that Brouwer developed his intuitionistic alternative (cf. Posy in Shapiro, 2005, p. 319).

[17] Choice sequences were introduced by Brouwer only in 1918. Before that, he had considered the continuum *as a whole* as a primitive notion, directly given by intuition (cf. Brouwer, 1907, pp. 9 and

resulting intuitionistic continuum is “perpetually in the process of creation: […] points of the real line develop as ‘choice sequences’ and reasoning about them takes place on the basis of the finite amount of information that is available to date”.[18] The construction of the intuitionistic continuum will be covered in detail in § 3.1.

The properties of the intuitionistic continuum strongly deviate from those of its (classical) counterparts (cf. § 3.2 and § 3.3), giving rise to intuitionistic set theory, topology, arithmetic and real analysis.
The two acts of intuitionism are firmly grounded in an intuitionistic philosophy of mathematics. These philosophical foundations will be covered in § 4.

---

62), thus recognizing the existence of *actual* infinite sets (van Dalen, 2000, p. 4 & infra: § 3.1 and § 3.2.3.a).

[18] Ewald, 1996, p. 1169.

3 The intuitionistic continuum

3.1 Construction

In his 1907 doctoral dissertation Brouwer presented continuity and discreteness as "inseparable complements", both fundamental, and directly given by intuition:

> Since [in this ür-intuition] continuity and discreteness occur as inseparable complements, both having equal rights and being equally clear, it is impossible to avoid one of them as a primitive entity, trying to construe it from the other one, the latter being put forward as self-sufficient; in fact it is impossible to consider it as self-sufficient. Having recognized that the intuition of continuity, of 'fluidity', is as primitive as that of several things conceived as forming together a unit, the latter being at the basis of every mathematical construction, we are able to state properties of the continuum as a 'matrix of points to be thought of as a whole'..[19]

Opting for an *intuitive* continuum was motivated perhaps more by necessity than by conviction:[20] at that time Brouwer had not yet developed the mathematical tools necessary to construct an *intuitionistic* continuum. During the 1920's, however, he developed the concepts of *spread* and *species* – two distinct ways to define an intuitionistic set,[21] corresponding to the two ways in which the SAI allows the creation of new mathematical objects:

- A *spread* is the generalization of an infinitively proceeding sequence, and is defined by a 'common mode of generation' for its elements,
- A *species* is defined by a 'characteristic property' of its elements.

These concepts allow the construction of an intuitionistic alternative – but not equivalent – to the classical continuum of real numbers.[22]

The process starts with the construction of a mathematical object in the form of "a more or less freely proceeding infinite sequence of mathematical entities previously acquired" as defined by the SAI:

a. Infinitely proceeding sequences – free choice sequences

An infinitely proceeding sequence (or 'ips') $\{a_n\}$ is simply: "a sequence that can be continued ad infinitum".[23] As specified in the SAI, the choices by which an ips is

[19] Brouwer, 1907, p. 9; English translation from Brouwer, 1975, p. 17.

[20] A comprehensive overview and analysis of Brouwer's early views on (and struggles with) the intuitive continuum can be found in Kuiper, 2004.

[21] Heyting, 1956, p. 37.

[22] Cf. § 3.3.

[23] Heyting, 1956, p. 32.

generated need not be entirely free: restrictions for (further) choices can be added (freely) at any point in the process, as long as the choice of the next component remains decidable.

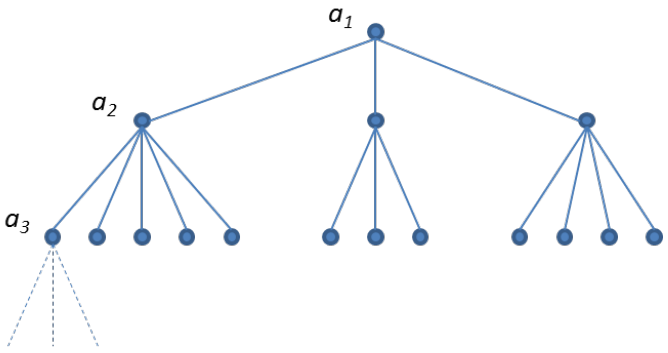
In intuitionism a real number is given by a *real number-generator*. This is an ips which is a Cauchy sequence of rational numbers.[24] The continuum of real number-generators can be represented by the more general concept of spread.

b. Spreads

A spread M is defined by two laws:[25]

1. The spread-law Λ_M: this is a rule Λ which divides the finite sequences of natural numbers into admissible and inadmissible sequences, according to the following prescriptions:
   i. It can be decided by Λ for every natural number k whether it is a one-member admissible sequence or not;
   ii. Every admissible sequence $a_1, a_2, \ldots, a_n, a_{n+1}$ is an immediate descendant of an admissible sequence $a_1, a_2, \ldots, a_n$;
   iii. If an admissible sequence $a_1, a_2, \ldots, a_n$ is given, Λ allows us to decide for every natural number k whether $a_1, a_2, \ldots, a_n, k$ is an admissible sequence or not;
   iv. To any admissible sequence $a_1, a_2, \ldots, a_n$ at least one natural number k can be found such that $a_1, a_2, \ldots, a_n, k$ is an admissible sequence.

   The spread-law thus generates admissible ips's of natural numbers. Graphically these sequences can be represented as follows:



   with $a_1, a_2, \ldots$: natural numbers.
2. The *complementary law* Γ_M of a spread M assigns a definite mathematical entity to any finite sequence which is admissible according to the spread-law of M.

A *fan* is a spread of which the spread-law only allows a finite number of successors to each (admissible) finite sequence.

---

[24] I.e. $|a_n - a_{n+p}| < 1/n$, for every natural number n and p. Cf. Heyting, 1956, p. 33.

[25] Excerpts taken from Heyting, 1956, pp. 34-36.

The continuum of real number-generators can now be defined as follows:

- $r_1, r_2, \ldots$ designate an enumeration of the rational numbers
- Λ_M:
    - Every natural number forms an admissible one-member sequence
    - If $a_1, \ldots, a_n$ is an admissible sequence, then $a_1, \ldots, a_n, a_{n+1}$ is an admissible sequence if and only if $\left|r_{a_n} - r_{a_{n+1}}\right| < 2^{-n}$.
- Γ_M: to the sequence $a_1, \ldots, a_n$ (if admissible) is assigned the rational number r_{a_n}.

The elements of *M* are real number-generators $r_{a_1}, r_{a_2}, \ldots$

To any real number-generator *c* a member *m* of *M* can be found so that *c* = *m*; in this sense the spread *M* represents the continuum of real number-generators.

c. Species[26]

Species are sets defined by a characteristic property of their elements. The following definitions are given by Brouwer and Heyting:

1. A species is a property which mathematical entities can be supposed to possess.
2. After a species S has been defined, any mathematical entity which has been or might have been defined before S and which satisfies the condition S, is a member of the species S.

The property of coinciding with a given real number-generator is a species, which is called a *real number*.[27] The intuitionistic continuum is the species of *all* real numbers.

d. Choice sequences and the creating subject[28]

The SAI relies on choice sequences that proceed "*more or less* freely" as one way to create new mathematical objects. These sequences can therefore range from entirely predefined (*lawlike* – as in classical mathematics) to entirely indeterminate (or free: *non-lawlike*). As of 1948[29] Brouwer uses the method of the 'creating subject' for the construction of non-lawlike sequences. This creating subject can be understood as an

[26] Excerpts taken from Heyting, 1956, pp. 37-38.

[27] If *x* is a real number and if the number-generator *ξ* is one of its members, then *ξ represents x* or *coincides* with *x*. Caution is required in defining a concept of 'equality' for incomplete objects.

[28] Cf. e.g., Shapiro, 2005, pp. 323-325; van Atten, Boldini, Bourdeau and Heinzmann, 2008, pp. 32-36; van Atten and van Dalen, 2002b, pp. 517-518.

[29] I.e. in printed publications. The idea is older though: Brouwer already mentioned it in his 1927 Berlin Lectures, and Borel mentioned it in a 1908 lecture (which Brouwer attended) – cf. van Atten, Boldini, Bourdeau and Heinzmann, 2008, pp. 13 and 29.

idealized mathematician[30] working on the solution to an as yet unsolved mathematical problem (e.g., the Riemann hypothesis). At each point in time it can be determined whether the creating subject has solved the problem at hand, or not (i.c. a proof or refutation for the Riemann hypothesis). The outcomes of these subsequent checks can now be used to define e.g., a real number: the n^{th} digit being dependent on status of the solution to the problem at stage k.

The degree of freedom of choice sequences can be restricted by limiting which elements may be considered for each next choice.[31] Brouwer also allows the introduction of new restrictions after a certain number of choices (as long as the next choice remains decidable). In a mature version of the SAI this is expressed as follows:

> … infinitely proceeding sequences, whose terms are chosen more or less freely from mathematical entities previously acquired; in such a way that the freedom of choice existing perhaps for the first element p_1 may be subjected to a lasting restriction at some following p_n, and again and again to sharper lasting restrictions or even abolition at further subsequent p_n's, while all these restricting interventions, as well as the choices of the p_n's themselves, may be made to depend on possible future mathematical experiences of the creating subject…[32]

e. In summary

The FAI – through the "falling apart of a life-moment" – generates ordered pairs, and by repeated iterations, the natural numbers. Subsequently, abstract manipulations allow the construction of finite[33] mathematics: the standard arithmetic operations, negative whole numbers and the rational numbers (as pairs of integers).

In a similar way as in classical mathematics the continuum is built from infinite convergent sequences. The SAI, stipulates that any legitimate infinite object must be given by a principle or law, but (unlike the pre-intuitionists) Brouwer does not require the generating laws to be entirely deterministic. The continuum for him was built up from choice sequences, whose terms can be made dependent on future experiences of the creating subject.

This potential for indeterminacy is the crux of intuitionistic mathematics.

---

[30] Representing e.g., the whole of the mathematical community.

[31] Cf. real number generators, where the Cauchy condition is imposed.

[32] Brouwer, 1975, p. 511.

[33] Also: 'discrete' or 'separable'.

3.2 Properties

Choice sequences allowed Brouwer to transcend the (constructive) reduced continuum[34] and to construct a full intuitionistic continuum. But the use of choice sequences constitutes a strong deviation from classical (and constructive) mathematics, so that the resulting intuitionistic continuum is a fundamentally different mathematical object than its classical counterpart, and has some very distinctive properties.

Firstly, due to the non-validity of the PEM, one would expect many of the properties that hold for the classical continuum to be not applicable – or at least strongly restricted – for the intuitionistic continuum. However, as Brouwer shows in *Die Struktur des Kontinuums*[35], most of these properties can to a high degree be recovered by modifying or re-interpreting their definitions in an intuitionistically relevant way[36] (cf. § 3.2.1).

Secondly, choice sequences require the use of continuity theorems, which results in properties that are in contradiction with classical mathematics (cf. § 3.2.2).

3.2.1 Recovery of 'classical' properties[37]

a. Discreteness

Definition:

> A species is called discrete if for every two of its elements it is certain either that they are equal or that they are different.

As it is possible to construct real numbers that are neither equal nor different from a given number[38], the intuitionistic continuum is – evidently – not discrete.

b. Ordering

Definition:

> A species is said to be ordered if for every pair of elements (a, b) an ordering relation $a < b$ (equivalent to $b > a$) is defined in such a way that:
>
> - $a = b$ is equivalent to the absurdity of both $a < b$ and $a > b$;
> - $a < b$ and $a > b$ are mutually exclusive;
> - $a \neq b$ implies the existence of either $a < b$ or $a > b$;

[34] In which all points are defied through lawlike Cauchy sequences of rational numbers.

[35] Brouwer, 1930. § 3.2.1 follows the structure and arguments of this paper.

[36] In general, "[…] existential statements are replaced by statements about the existence of approximations with arbitrary precision" (Iemhoff, 2013, § 3.4).

[37] Cf. Brouwer, 1930, pp. 58-59 for the quoted definitions in this paragraph.

[38] Cf. e.g., Posy in Shapiro, 2005, p. 328, and in van Atten, Boldini, Bourdeau and Heinzmann, eds., 2008, p.32. More generally, of course, the PEM does not hold in intuitionism.

- a < c always follows from a < b and b < c;
- h < k always follows from a < b, a = h and b = k.

Just as it is possible to construct real numbers that are neither equal nor different from a given number, it is possible to construct real numbers that are neither smaller nor greater than a given number, and so the intuitionistic continuum is not ordered (and by extension not well-ordered).[39]

Brouwer introduces the weaker properties of *pseudo* and *virtual* ordering, which do hold for the intuitionistic continuum. Virtual order means the order relation (<) is not defined over the whole of the continuum, but only on a subspecies of it (i.p. its elements: real number-generators).[40]

c. Density in itself

Definition:

> An ordered species in which every element is a *main element* is called dense in itself.

A main elements is defined as the boundary element of an increasing or decreasing fundamental sequences $a_1, a_2, \ldots, a_n, \ldots, a$ so that $\forall(b<a)\ \exists(a_n>b)$.

The fact that the intuitionistic continuum is not (well-)ordered is evidently at odds with the above 'classical' definition of a main element. Brouwer therefor adapts the definition as follows:

> *e* [is a main element] of the virtually ordered species *S* […] if there exists an unlimited sequence of distinct *closed intervals* of which everyone is contained in its predecessor and that all contain the element *e*, while every element that belongs to all intervals is identical with *e*.

A *closed interval ab* is defined as:

> […] the species of all elements *c* of *S* for which neither the relation $(c > a) \wedge (c > b)$ nor the relation $(c < a) \wedge (c < b)$ can exist.

With these definitions the intuitionistic continuum is dense in itself.

---

[39] Cf. Brouwer, 1930, p. 59 for a counterexample, and Heyting, 1956 pp.46 and 106 for the proof. Fundamentally, this is due to the role of choice sequences in the construction of intuitionistic real numbers, and their dependence on unsolved mathematical problems. Hence, "to order the full continuum, one should have a method of solving all mathematical problems". (Brouwer, 1930, p. 63). Cf. also Brouwer, 1981, p. 89.

[40] Cf. Heyting, 1956, pp. 25-26 and pp. 105-107.

d. Separability in itself

Definition:

> An ordered species *S* is […] separable in itself if one can indicate in the species a fundamental sequence *F* such that between every two different elements of *S* there lies an element of *F*.

In order to preserve this property, Brouwer introduces the notion of *sharp difference*[41]. The intuitionistic continuum is then separable in itself if:

> … there exists in *S* a discrete and ordered fundamental sequence *F* such that between any two sharply different elements of *S* there lies an element of *F*.

e. Connectedness

Definition:

> An ordered species *S* is called connected if in each ordinal separation of *S* into two *ordinally separate* subspecies α and β either α contains a last and β no first element, or β contains a first and α no last element.

α and β are *ordinally separate* subspecies of *S* if every element of α precedes every element of β.

Depending on whether the notion of division (separation) is specified in terms of composition or splitting, the intuitionistic continuum is either not connected, or the property of connectedness lacks meaning altogether.[42]

In order to recover connectedness as a property of the intuitionistic continuum Brouwer introduces the *exhaustive division*:

> The virtually ordered species *S* is […] *exhaustively divided* into the ordinally separated subspecies α and β of which it is composed, if for any two sharply different elements *a* and *b* (*a* < *b*) either all elements ≤ *a* belong to α or all elements ≥ b belong to β.

And then defines *free connectedness* as follows:

> [A] virtually ordered species *S* [is] freely connected […], if for every exhaustive division of *S* […] into two ordinally separate subspecies α and β, there exists an element *e* of *S* such that every element < *e* belongs to α and every element > *e* belongs to β.

With these definitions the intuitionistic continuum is freely connected.

f. Everywhere-density

Definition:

> An ordered species is said to be everywhere-dense if between every two different elements *a* and *b* of the species there […] exists an element c such that either *a* < *c* < *b* or *a* > *c* > *b*.

---

[41] Cf. Kleene and Vesley, 1965, p. 163, for a detailed definition.

[42] Cf. the theorem of the indecomposability of the continuum – cf. Heyting, 1956, p. 46, and § 3.2.2.a below.

Re-interpreting this definition in a similar way as was done for density in itself, restores everywhere-density as a property of the intuitionistic continuum.

g. Compactness

Definition:

> […] for every indefinite sequence of closed intervals I_1, I_2, …, where each $I_{\nu+1}$ is a subspecies of I_ν, there exists an element common to all I_ν.

Brouwer defines *free compactness* as:

> The impossibility of the existence of a *hollow nesting* of intervals.

With *hollow nesting* defined as:

> A nesting of intervals I_1, I_2, … [for which] for every element π of the virtually ordered species in question there exists a definite ν_π such that π cannot belong to $I\nu_\pi$.

With these definitions, the intuitionistic continuum is freely compact.

3.2.2 'Non-classical' properties

a. The continuity theorem[43]

Choice sequences are inherently incomplete objects: at any given time only a finite initial segment of the sequence has been constructed. This poses problems for the predication of choice sequences. To overcome this, the continuity principle allows for predication of a choice sequence based only on an initial segment.

In its weakest form (Weak Continuity for Numbers) it is expressed as follows:[44]

(WC-N) $\quad \forall\alpha\exists x A(\alpha,x) \Rightarrow \forall\alpha\exists m\exists x\forall\beta\left[\overline{\beta}m=\overline{\alpha}m \rightarrow A(\beta,x)\right]$

With:

- $m, x \in \mathbb{N}$
- α, β: choice sequences of natural numbers
- $\overline{\alpha}m, \overline{\beta}m$: the first m elements of α and β

From WC-N the following continuity theorem can be derived, which asserts that a real function whose domain of definition is the closed segment [0,1] is continuous on [0,1]:

$$\forall\varepsilon\forall x_1\exists\delta\forall x_2\left(\left|x_1-x_2\right|<\delta \rightarrow \left|f(x_1)-f(x_2)\right|<\varepsilon\right)$$

With:

- $\delta, \varepsilon > 0$
- $x_1, x_2 \in [0,1]$

[43] Cf. van Atten and van Dalen, 2002a and 2002b.

[44] Cf. van Atten and van Dalen, 2002b, (p. 7), and Iemhoff, 2013.

Brouwer (using bar induction[45]) also proved the stronger uniform continuity theorem:[46] a real function whose domain of definition is the closed segment [0,1] is uniformly continuous on [0,1]).

More formally:

$$\forall \varepsilon \exists \delta \forall x_1 \forall x_2 \left(\left| x_1 - x_2 \right| < \delta \rightarrow \left| f(x_1) - f(x_2) \right| < \varepsilon \right)$$

b. Unsplittability of the continuum

From WC-N it is also possible to derive the unsplittability (or indecomposability) of the intuitionistic continuum: it is impossible to split the intuitionistic continuum into two non-trivial subsets.

In other words: if $\mathbb{R}$ = A ∪ B and A ∩ B = ∅ then either $\mathbb{R}$ = A or $\mathbb{R}$ = B.[47]

As a consequence, in intuitionism, it is not true that every real number is either rational or irrational.[48]

c. Rejection of the (quantified) PEM

Based on WC-N, it can be shown that the quantified PEM: $\forall \alpha \left[\forall x (\alpha x = 0) \vee \neg \forall x (\alpha x = 0) \right]$ is false.[49]

As already mentioned, this has far reaching consequences for intuitionistic mathematics. An immediate consequence is that on the intuitionistic continuum the law of trichotomy: $\forall x (x < y \vee x = y \vee x > y)$ is not true.[50]

3.2.3 Intuitionistic infinity

a. Hierarchy

In his PhD thesis Brouwer presents the following alternative to Cantor's hierarchy:

> Thus we distinguish for sets the following cardinal numbers, in order of magnitude:
>
> 1. the different finite numbers.
> 2. the denumerably infinite.
> 3. the denumerably unfinished.
> 4. the continuous.[51]

---

[45] Bar induction is a method to prove properties of choice sequences by inductively reducing them to decidable properties of finite lists.

[46] Brouwer in Mancosu, 1998, pp. 36-39.

[47] van Atten, van Dalen, 2002b pp. 519-520 and also Heyting, 1956, p. 46 (Th. 2) for the proof.

[48] Cf. McCarty in Shapiro, 2005, pp. 367-369.

[49] Cf. van Atten and van Dalen, 2002b p. 520 and Iemhoff, 2013 for the proof.

[50] Cf. Iemhoff, 2013 for the proof.

The finite numbers and denumerable sets are intuitionistically legitimate objects since they can – at least in principle – be constructed. Consequently, the resulting infinities are only *potential* infinities, and the corresponding mathematical objects are intrinsically incomplete.[52]

In this early stage of his thinking, Brouwer still considers the intuitionistic continuum to be fundamentally non-constructible. So, being directly given by (*ür-*)intuition, the *intuitive* continuum *is* accepted as a (primordial) mathematical object – even though it implies the existence of an *actual* (completed) infinite set. In his mature intuitionism, with the introduction of free choice sequences and the creating subject, Brouwer provides a constructive basis for the continuum. This intuitionistic continuum is – as is clear from § 3.1 – an incomplete object, and thus avoids the "completed infinite" of the intuitive continuum. It can be argued that through the use of *free* choice sequences and an *idealized* mathematician, intuitionistic infinity ultimately still draws on receptive intuition.[53]
Cantorian higher infinities are – for evident reasons – not valid mathematical objects in intuitionism.[54]

b. The Continuum Hypothesis

Initially Brouwer thought that – intuitionistically – the Continuum Hypothesis did not require a proof.[55] Later he reconsidered, and attempted to provide an intuitionistic account of the theorem,[56] only to retract it later still.[57]
Part of the problem is that "rational reconstructions of classical mathematics within intuitionism, if possible at all, are not determined uniquely". Hence "many propositions of intuitionistic mathematics could be supposed to yield the intended meaning of the classical continuum hypothesis. Some of them are easily proved, others easily refuted, and then there are difficult ones for which we do not know the answer".[58]

---

[51] Brouwer, 1907, p. 62. English translation from Brouwer, 1975, p. 83.

[52] Cf. Dummett, 1985, pp. 55-65.

[53] Cf. Posy in van Atten, Boldini, Bourdeau and Heinzmann, 2008, pp. 35-36.

[54] Brouwer, 1975, pp. 81-82.

[55] Cf. Brouwer, 1975, p. 141.

[56] Ibid., pp. 191-221.

[57] Ibid., p. 516.

[58] Gielen, de Swart and Veldman, 1981, p. 121.

3.3 Distinctiveness

The considerable number and variety of conceptions of the continuum[59] is the result of a long evolutionary process in the development of mathematics. Amidst this diversity of continua, the intuitionistic continuum occupies a special place. Free choice sequences introduce a fundamental indeterminacy into intuitionistic mathematics, and the creating subject gives it a subjective character. What results is a heterodox, often complex, but also very rich mathematics.

The classical continuum, "defined as an infinite collection whose elements are themselves infinite sets, each of whose elements in turn is an infinite sequence",[60] has an 'atomistic' structure: it is the infinite sum of its parts – individual points – which are pre-given and static. These points are not connected in any way, and so the classical continuum is 'brittle' it can be broken up into pieces.[61] According to Brouwer it has "a mere linguistic, and no mathematical, existence".[62] The intuitionistic continuum, on the other hand, is given as a whole. It generates its constituent parts, which are overlapping and unfinished. The resulting continuum is 'syrupy', innately indecomposable, and closely resembles the intuitive 'Aristotelian' continuum. It even remains indecomposable after removal of the rational numbers.[63]

Constructive analysis and intuitionism share their constructive principles regarding the legitimacy of mathematical objects, but they do not share the same logic. Constructive analysis[64] accepts classical logic, including the PEM, and does not contradict classical analysis. Rather it can be seen as a restriction of classical analysis – and i.p. the constructive real line can be viewed as a restriction of its classical equivalent: it is inherently decomposable.

---

[59] Cf. e.g., Feferman, 2008, and Longo, 1999.

[60] Posy in Shapiro, 2005, p. 321.

[61] It should be noted that constructions have been proposed for a classical continuum without points, detaching the notions of indecomposability and non-punctiformity. Cf. Hellman and Shapiro, 2013,

[62] Brouwer, 1981, p. 93.

[63] Cf. § 3.2.2.b. This makes sense from a 'dimensional' point of view: "Classically one gets the one-dimensional continuum as the sum of the two obvious zero-dimensional subsets, the rationals and the irrationals. But intuitionistically the irrationals are themselves already one-dimensional" (van Dalen, 1997, p. 1151). The intuitionistic reals and the intuitionistic continuum are of the same genus, to paraphrase Poincarré.

[64] Following Bishop's *Foundations of Constructive Analysis*.

Nonstandard hyperreals are an extension of the classical reals, but as nonstandard analysis is also based on classical logic, the properties of the hyperreal line closely match those of the classical continuum.

In smooth infinitesimal analysis – formulated within higher order intuitionistic logic – the real line is, like in intuitionism, indecomposable. Any puncturing of $\mathbb{R}$, however, *is* decomposable, so that "the continuum in [smooth infinitesimal analysis] is considerably less 'syrupy' then its counterpart in [intuitionistic analysis]".[65]
Smooth infinitesimal analysis also shares with intuitionism that the continuum is not explicable in terms of the discrete.[66]

Van Dalen captures the unique indecomposability of the intuitionistic continuum as follows:

> The classical comparable fact is the topological connectedness of $\mathbb{R}$. In a way this characterizes the position of $\mathbb{R}$: the only (classically) connected subsets of $\mathbb{R}$ are the various kinds of segments. In intuitionistic mathematics the situation is different; the continuum has, as it were, a syrupy nature, one cannot simply take away one point. In the classical continuum one can, thanks to the principle of the excluded third, do so. To put it picturesquely, the classical continuum is the frozen intuitionistic continuum. If one removes one point from the intuitionistic continuum, there still are all those points for which it is unknown whether or not they belong to the remaining part.[67]

As such, the intuitionistic continuum bears a strong resemblance to the intuitive continuum of e.g., Anaxagoras and Aristotle.[68] Furthermore the uniform continuity property formally articulates Leibniz's apothegm *natura non facit saltus*. Taken together, this makes the intuitionistic continuum a better model for the physical continuum than its classical counterpart.[69]

---

[65] Bell, 2001.

[66] In smooth infinitesimal analysis lines are composed of infinitesimal (one dimensional) segments instead of (zero dimensional) points.

[67] van Dalen, 1997, p. 1147.

[68] Cf. Weyl, 1994 (whose own views were closely related), and Bell, 2005.

[69] Cf. e.g., Dummet, 2000, and Longo, 1999.

4 Intuitionistic philosophy

Brouwer's fundamental issue with the Cantorian set-theoretic construction of the continuum and the transfinite was that it ultimately relied on *arbitrary* objects: "sets that *cannot be described* and sequences that *cannot be calculated*".[70] In response, Brouwer developed his intuitionistic alternative: a constructive theory of mathematics that transcends the discrete and the finite, and encompasses the continuous and the infinite.
Philosophically, Brouwer's intuitionism "rests upon a unique epistemology, a special ontology, and an underlying picture of intuitive mathematical consciousness":[71] it is fundamentally based on a phenomenological worldview.

4.1 Phenomenology

4.1.1 General phenomenology

The phenomenological basis of Brouwer's (mathematical) philosophy[72] is clearly outlined in *Consciousness, Philosophy, and Mathematics*.[73] Consciousness and the mind are spawned by (the sensation of) the primordial phenomenon of transition between stillness and sensation:

> This initial phenomenon is a *move of time*. By a move of time a present sensation gives way to another present sensation in such a way that consciousness retains the former one as a past sensation, and moreover, through this distinction between present and past, recedes from both and from stillness, and becomes *mind*.
>
> As mind it takes the function of a subject experiencing the present as well as the past sensation as object. And by reiteration of this twoity phenomenon, the object can extend to a world of sensations of motley plurality.[74]

Subsequently, "in a dawning atmosphere of forethought", free will then creates awareness of the causally ordered world:

> […] In the world of sensation experienced by mind, the free-will-phenomenon of *causal attention* occurs. It performs identifications of different sensations and of different complexes of sensations, and in this way […] creates *iterative complexes of sensations*. An iterative complex of sensations, whose elements have an invariable order of succession in time, whilst

[70] Posy in Shapiro, 2005, p. 322.

[71] Ibid., p. 319.

[72] "[T]he philosophy […] of intuitionism [is] inseparable from [its] technical core: intuitionistic mathematics […], and intuitionistic logic […]", (Ibid. p. 318).

[73] Brouwer, 1949.

[74] Ibid., p. 1235.

> if one of its elements occurs, all following elements are expected to occur likewise, in the right order of succession, is called a *causal sequence*.[75]

Finally, the "external world of the subject" is composed of things:

> On the other hand there are iterative complexes of sensations whose elements are permutable in point of time [and some of which] are completely estranged from the subject. […] For instance individuals, i.e. human bodies, the home body of the subject included, are things.[76]

4.1.2 Phenomenology of mathematics

In intuitionism, mathematical abstraction is done *ab origine*, i.e., as expounded in the FAI, by dissociating the initial 'twoity' from all sensory content. Hence, there is neither reliance on pre-existing empirical objects (i.p. to introduce the natural numbers), nor are mathematical operations skeletons of empirical operations. "Mathematics is an independent, empirically empty, process of its own".[77] This independence from the empirical world is maintained in the SAI, given that the creating subject is interpreted as truly idealized.[78]

Despite this apparent disconnect between the empirical and the mathematical world, both remain intimately linked, as they share the same starting point (i.e. the ür-intuition of the move of time), and have a parallel formative process: both activities are based on sequences and the result of willful and creative acts. They bifurcate at the moment of abstraction of the initial 'twoity':

> […] The falling apart of moments of life into qualitatively different parts, to be reunited only while remaining separated by time [is] the fundamental phenomenon of the human intellect, […] by [abstraction] from its emotional content [it passes] into the fundamental phenomenon of mathematical thinking, the intuition of the bare two-oneness.[79]

Hence, intuitionistic mathematics can be used to model the empirical world:[80]

> The significance of mathematics with regard to scientific thinking mainly consists in this that a group of observed causal sequences can often be manipulated more easily by extending its of-quality-divested mathematical substratum to a hypothesis, i.e. a more comprehensive and

---

[75] Brouwer, 1949, p. 1235.

[76] Ibid.

[77] Posy in Shapiro, 2005, p. 330.

[78] Cf. § 4.1.3.

[79] Brouwer, 1975, p. 127.

[80] It is noteworthy that intuitionism – like the phenomenal world – isn't fully determinate (as exemplified by the refutation of the *tertium non datur*) and doesn't contain actual infinities (although intuitionism isn't finitistic in the strict sense either).

more surveyable mathematical system. Causal sequences represented in abstraction in the hypothesis, but so far neither observed nor found observable, often find their realization later on.[81]

4.1.3 Intuitionism and Husserl's transcendental phenomenology

Even though Husserl and Brouwer were not directly influenced by each other,[82] strong parallels can be drawn between intuitionism and phenomenology. Van Atten[83] argues that Brouwer's (later) intuitionism can be interpreted as a part of Husserl's transcendental idealism. To that end, he highlights four similarities:

- Like phenomenology, intuitionism recognizes intuition as the legitimizing ground of all knowledge, and recognizes a form of intellectual intuition (categorial intuition). […]
- As in phenomenology, in intuitionism the fundamental notion of subject is not psychological but transcendental.[84] […]
- Like phenomenology, intuitionism recognizes the fundamental role of time awareness[85] in our being aware of any object, and indeed in the bringing about of intentionality itself. […]
- Like phenomenology, intuitionism studies essential, structural properties of consciousness, not those of any particular individual's consciousness.[86]

Furthermore he suggests that "the fundamental 'unfreedom' [in Husserl's transcendental idealism] is that imposed by the basic structure of inner time consciousness",[87] and it therefor "cannot provide a foundation for a pure mathematics that would go beyond intuitionism"[88]. Hence the Husserlian concept of constitution of mathematical objects and the intuitionistic notion of their construction would coincide. This is a strong claim, given that for Husserl mathematical objects and truths are static, complete and *allzeitlich*, whereas in intuitionism some mathematical objects – i.p. (free) choice sequences – are by their very nature dynamic and incomplete.

---

[81] Brouwer, 1949, p. 1237.

[82] Husserl and Brouwer met in person at least once (in 1928 – cf. van Atten, 2007, p. 5).

[83] In van Atten, 2007, and 2010.

[84] "Husserl and Brouwer describe the transcendental ego eidetically, i.e., in terms of its essential properties. […] Describing essential properties and describing an idealized [creating] subject here amount to the same, as the idealization involved is that of abstracting from empirical limitations, and essential properties are those that govern any instance, empirically possible or not." (van Atten, 2010, p. 21).

[85] I.e. Inner, or internal, time.

[86] van Atten, 2007, pp. 5-6.

[87] van Atten, 2010, p. 84. Cf. also van Atten, 2007, pp. 95-101.

[88] van Atten, 2010, p. 43.

Tieszen[89] mentions comparable correspondences between Brouwer's thinking and Husserl's transcendental phenomenological idealism (i.p. regarding the role of consciousness and its origin in the flow of internal time, but also e.g., regarding the conception of the intuitive – non-punctiform – continuum and logical constants[90]). In his view "the basic intuition of mathematics, in Brouwer's sense, is a founded, formal intuition in Husserl's sense", but not a "categorial intuition of unchanging, exact objects".[91]

4.2 Ontology

Existence, for Brouwer, is tantamount to constructability: "what you build is what there is".[92] This deviates from Husserl's more agnostic position that *ἐποχή* should be exercised regarding the existence of the intentional objects of consciousness.
Intuitionistic objects (e.g., real numbers) need neither be complete, nor have determinate properties (or even identity) in order to be legitimate – only a construction (and even that only in principle) needs to be provided to guarantee their existence.
Reductio ad absurdum arguments on the other hand, can – as seen above – *not* be used to provide valid intuitionistic proofs of existence.

Intuitionistic logic follows the constructive mathematical ontology, but the latter has primacy (as said, this is a fundamental difference with classical mathematics, which does not require an ontology, but builds on classical logic). However, according to "the intuitionistic interpretation of mathematical statements, the intuitionistic ontology [is] a consequence of the intuitionistic theory of meaning,[93] not a premise for it".[94] The intuitionistic ontology thus rests upon "a pervasive phenomenological base".[95] Bostock even goes as far as to question the relevance of intuitionistic ontology altogether.[96]

---

[89] In van Atten, Boldini, Bourdeau and Heinzmann, pp. 78-95.

[90] For Husserl mathematical judgments can be either fulfilled, frustrated or neither.

[91] Tieszen in van Atten, Boldini, Bourdeau and Heinzmann, p. 90. I.p. choice sequences would not qualify as "ideal, objective, exact, *mathematical* objects" (ibid. p. 91). Van Atten gives arguments as to why they *would* qualify (in van Atten, 2007, pp. 95-101).

[92] Posy in Shapiro, 2005, p. 333.

[93] Which, as seen, is phenomenological in nature.

[94] Dummett, 1985, p. 382.

[95] Posy in Shapiro, 2005, p. 329.

[96] Bostock, 2009, pp. 215-222.

4.3 Epistemology

According to the FAI, all mathematical knowledge is ultimately based on the primordial intuition of the "perception of the move of time", "divested of all quality" associated with it. It thus precedes any sensory or empirical knowledge. As mathematical knowledge is also a necessary basis for empirical science, it corresponds to synthetic a priori knowledge in the Kantian sense.[97]

Taken together, the FAI and SAI specify that mathematics is a constructional "*activity* of the mind", and that the extension of mathematical knowledge implies an extension of that activity:

> Growth or development […] cannot proceed via the logical extrapolation of its contents (as classical epistemology maintains), but […] only by its *phenomenological* or *experiential* development – that is to say, its extension into further experience of the same epistemic kind.[98]

Logical inference can have heuristic value, but it has no proof value, so it cannot lead to new mathematical knowledge:

> If the principles of classical logic were to be amended in such a way as to eliminate [the] deficiencies of incompleteness and unsoundness, then one would have […] an accurate device for determining which propositions are potential contents for intuitionistic proof-experiences. However, such a device could still serve only to identify those propositions that are capable of intuitionistic justification – which is a very different thing from (and epistemically inferior to) actually supplying such justification.[99]

The development of mathematic knowledge, for the intuitionist, is therefor inherently phenomenological, and it cannot be reduced to a mere "intellectual acceptance of a proposition" without epistemic loss. For the same reason, language is also an "illegitimate surrogate", as "no symbolic notation can ever accurately report the content of a conscious moment".[100]

---

[97] Cf. Posy in Shapiro, 2005, pp. 331-333, and supra: § 4.1.2.

[98] Detlefsen, 1990, p. 515.

[99] Ibid., p. 520.

[100] Cf. Posy in Shapiro, 2005, p. 335.

5 Critique

Throughout his career Brouwer argued vigorously against the 'contradictority' of classical mathematics.[101] According to him, mathematics evolved from the study of finite, complete objects in its early stages, to that of infinite and (necessarily) incomplete objects in more recent times. This meant that the PEM lost its original nomological status. In classical (platonic) mathematics, however, these inherently incomplete infinite objects are unwarrantedly idealized to completeness and the PEM is continued to be applied with universally validity. This, according to Brouwer, inevitably leads to inconsistencies.[102]

Intuitionism has a phenomenological basis and rejects platonism, but it remains anti-nominalist and the abstractions and idealizations Brouwer makes are, they too, susceptible to critique:

- Intuitionism explicitly recognizes the immanent indeterminacy in (potential) infinities and incomplete objects. As seen, this is formally done by the introduction of free choice sequences and the method of the creating subject. This method, however, contains an implicit assumption of assertabilism, which seems at odds with the rejection of the PEM[103] and is reminiscent of platonism.[104,105]
- Said indeterminacy essentially reflects an underlying epistemic incompleteness regarding certain mathematical objects. The source of this indeterminacy is placed exclusively in the future (*past* knowledge is assumed to be infallible, perfectly preserved and fully accessible at any time). This is an important idealization, and even though it does not lead to logical contradictions, conceptually – and arguably also from an epistemic and phenomenological point of view – it seems questionable.

---

[101] Cf. e.g., the counterexamples in 1948A, 1948C, 1949A, 1949B, 1950A, 1950B, 1951, 1952C, 1954E and 1954F in Brouwer, 1975.

[102] Cf. Posy in Shapiro, 2005, p. 334.

[103] Cf. supra (§ 3.1.d), and Posy in Shapiro, 2005, pp. 344-345.

[104] "The intuitionist thus finds himself in the unenviable position of depending upon the existence of something – an undecidable proposition – that he cannot in fact construct, and whose possible existence he thus may not assert!" (Posy in Shapiro, 2005, p. 345).

[105] The 'idealized mathematician' has been linked to both the Husserlian and Kantian transcendental subject (cf. van Atten, 2007, p. 164, note 245, and supra (§ 4.1.3)), but the exact ontological status is debatable. One could argue that the creating subject necessarily exists independent from our (combined) mental abilities.

- The initial abstraction that creates the “common substratum of all twoities” involves two distinct steps:
  1. Introduction of a boundary: the “falling apart of life moment” renders discrete what was initially continuous,
  2. Removal of content: “divesting all quality” reduces what was initially different to a contentless identity.

  The result is a fundamental ontological shift: what was a continuous measure of differentiation or change has been transformed into a discrete measure of duplication or repetition. I.p. the second step poses a problem, as it can be argued that this is an idealization rather than an abstraction. Instead of being given by pure intuition, the resulting twoity would then be more akin to a platonic idea.

Apart from these philosophical considerations, there are also some practical concerns regarding intuitionistic mathematics. The introduction of free choice sequences and the method of the creating subject unquestionably leads to a very rich mathematical universe – as exemplified by the intuitionistic continuum. But at the same time it considerably increases the technical complexity of mathematical practice, which becomes more laborious[106] and hence less palatable for the mainstream mathematical community. Although intuitionism may not be the “quixotic curiosity”[107] some claim it to be, it has – for the abovementioned reasons – enjoyed a relatively moderate level of success

[106] Cf. the recovery of classical properties – § 3.2.1.

[107] Cf. Posy in Shapiro, 2005, p. 344.

6 Conclusions

Through the two acts of intuitionism, Brouwer defines intuitionistic mathematics as an "essentially languageless activity of the mind", "having its origin in the perception of a move of time". New mathematical objects can be constructed (exclusively) based on "mathematical entities previously acquired" (ultimately the intuitive "bare two-oneness"), either as "more or less freely proceeding infinite sequences" of the latter (spreads) or as entities whose (previously acquired) elements share a common property (species). Infinite objects are inherently unfinished and incomplete, and should be regarded as *potential* infinities. The fundamental indeterminacy in intuitionism implies that the PEM is not universally valid.

Using choice sequences and the method of the creating subject, Brouwer is able to construct an intuitionistic equivalent to the classical continuum. Most of the properties of the latter can be recovered for intuitionism by simply revising or re-interpreting the definitions. But being fundamentally incomplete ("perpetually in the process of creation"), the intuitionistic continuum also displays some highly idiosyncratic properties. Most notably:

- It is indecomposable: one cannot simply take away one point, or even split the continuum into nontrivial subsets,
- Uniform continuity: every total function on the unit interval is uniformly continuous.

These properties are reminiscent of an *intuitive* continuum and set the intuitionistic continuum apart not only from its classical counterpart, but also from e.g., other constructive continua, the nonstandard hyperreal line and the real line in smooth infinitesimal analysis.

Intuitionistic mathematics has a phenomenological foundation, and significant similarities exist between Brouwer's intuitionism and Husserl's transcendental phenomenology. On this phenomenological basis rest an anti-nominalist, constructive ontology (existence of mathematical objects is synonymous to their constructability), and a languageless, intuitive epistemology (mathematical knowledge is synthetic a priori knowledge in the Kantian sense).

Brouwer's intuitionism is not impervious to critique, though. Free choice sequences and the method of the creating subject are – arguably – liable to internal inconsistency.

And although intuitionistic mathematics is undeniably very rich and subtle, it is also technically complex and demanding, and in some ways very restrictive. All this has undoubtedly contributed to the fact that intuitionism never really became mainstream.

References

Bell, J. L., 2001, “The Continuum in Smooth Infinitesimal Analysis, Reuniting the Antipodes – Constructive and Nonstandard Views of the Continuum”, *Synthese Library*, 306: 19-24.

Bostock, D., 2009, *Philosophy of Mathematics: An Introduction*, Wiley-Blackwell, West Sussex.

Brouwer, L.E.J., 1905, Leven, kunst en mystiek, English translation by van Stigt in Notre Dame Journal of Formal Logic, 37 (3): 381-429.

Brouwer, L.E.J., 1907, *Over de Grondslagen der Wiskunde*, Academisch Proefschrift, Maas & Van Suchtelen, Amsterdam-Leipzig.

Brouwer, L.E.J., 1908, “De onbetrouwbaarheid der logische principes”, Tijdschrift voor Wijsbegeerte, 2: 152-158. English translation in Brouwer, 1975, pp. 107-111.

Brouwer, L.E.J., 1930, *Die Struktur des Kontinuums, Wien: Komitee zur Veranstaltung von Gastvorträgen ausländischer Gelehrter der exakten Wissenschaften*, in Brouwer, 1975, pp. 429-440. English translation in Mancosu, 1998, pp. 54-63.

Brouwer, L.E.J., 1949, “Consciousness, philosophy and mathematics”, *Proceedings of the 10th International Congress of Philosophy*, Amsterdam 1948, 3*: 1235-1249.*

Brouwer, L.E.J., 1975, *Collected Works 1. Philosophy and Foundations of Mathematics*, A. Heyting (ed.), North-Holland, Amsterdam.

Brouwer, L.E.J., 1981, Brouwer's *Cambridge Lectures on Intuitionism*, D. van Dalen (ed.), Cambridge University Press, Cambridge.

Detlefsen, M., 1990, “Brouwerian Intuitionism”, *Mind*, New Series, 99 (396): 501-534.

Dragalin, A. G., 2011, “Intuitionism”, *Encyclopedia of Mathematics*, URL=<http://www.encyclopediaofmath.org/index.php/Intuitionism>.

Dummett, M., 1985, *Elements of Intuitionism*, Clarendon Press, Oxford.

Dummett, M., 2000, “Is Time a Continuum of Instants?”, *Philosophy*, 0 (4): 497-515.

Ewald, W., 1996, *From Kant to Hilbert: A Source Book in the Foundations of Mathematics*, Volume *2,* Clarendon Press, Oxford.

Feferman, S., 2008, “Conceptions of the Continuum”, URL=<http://math.stanford.edu/~feferman/papers/ConceptContin.pdf>.

Gielen, W., de Swart, H., Veldman, W., 1981, “The Continuum Hypothesis in Intuitionism”, *The Journal of Symbolic Logic, 46 (1): 121-136.*

Hellman, G., Shapiro, S., 2013, “The Classical Continuum without Points”, *Review of Symbolic Logic, 6(3): 488-512, 571.*

Heyting, A., 1956, *Intuitionism. An Introduction*, North-Holland, Amsterdam.

Iemhoff, R., 2013, "Intuitionism in the Philosophy of Mathematics", *The Stanford Encyclopedia of Philosophy* (Fall 2013 Edition), Edward N. Zalta (ed.), URL=<http://plato.stanford.edu/archives/fall2013/entries/intuitionism>.

Kleene, S., Vesley, R.,1965, *The Foundations of Intuitionistic Mathematics*, North-Holland, Amsterdam.

Kuiper, J., 2004, “Ideas and Explorations: Brouwer’s Road to Intuitionism”, PhD thesis, Universiteit Utrecht, URL=<http://dspace.library.uu.nl/bitstream/handle/1874/90/full.pdf>.

Longo, G., 1999, “The Mathematical Continuum: From Intuition to Logic”, in *Naturalizing Phenomenology: Issues in Contemporary Phenomenology and Cognitive Science (pp. 401-428),* J. Petitot et al., eds., Stanford University Press, Stanford.

Mancosu, P., ed., 1998, *From Brouwer to Hilbert. The Debate on the Foundations of Mathematics in the 1920s*, Oxford University Press, Oxford.

McKubre-Jordens, M., 2012, “Constructive Mathematics”, *Internet Encyclopedia of Philosophy*, URL=<http://www.iep.utm.edu/con-math>.

Shapiro, S., ed., 2005, *The Oxford Handbook of Philosophy of Mathematics and Logic*, Oxford University Press, Oxford.

van Atten, M., 2010, “Construction and Constitution in Mathematics”, *The new yearbook for phenomenology and phenomenological philosophy, 10: 43-90, (M. van Atten, personal* communication, March 2, 2014).

van Atten, M., 2011, "Luitzen Egbertus Jan Brouwer", *The Stanford Encyclopedia of Philosophy* (Summer 2011 Edition), Edward N. Zalta (ed.), URL=<http://plato.stanford.edu/archives/sum2011/entries/brouwer>.

van Atten, M., Boldini, P., Bourdeau, M. Heinzmann, G., eds., 2008, *One Hundred Years of Intuitionism (1907-2007)*, Birkhäuser, Basel.

van Atten, M., van Dalen, D., 2002a, “Arguments for the Continuity Principle”, *The Bulletin of Symbolic Logic, 8 (3): 329-347.*

van Atten, M., van Dalen, D., 2002b, “Intuitionism”, in *A Companion to Philosophical Logic*, D. Jaquette, ed., Blackwell, Oxford, pp. 513-530.

van Atten, M., van Dalen, D., Tieszen, R., 2002, “Brouwer and Weyl: The phenomenology and mathematics of the intuitive continuum,” *Philosophia Mathematica*, 10: 203-236.

van Atten, M., 2007, *Brouwer meets Husserl: On the Phenomenology of Choice Sequences*, Springer, Dordrecht.

van Atten, M., 2009, “Intuitionism as Phenomenology”, Unpublished manuscript, (M. van Atten, personal communication, March 2, 2014).

van Dalen, D., 1997, “How connected is the intuitionistic continuum?”, *Journal of Symbolic Logic*, 62: 1147-1150.

van Dalen, D., 2000, “What is Mathematics? Intuitionistic Reflections”, Published in: *Issues in Contemporary Western Philosophy Islam-West Philosophical Dialogue.* The Papers Presented at the World Congress on Mulla Sadra (May, 1999, Tehran), 7: 175-190.

Van Kerkhove, B., 2012a, “Hedendaagse Filosofie van de Wiskunde in Historisch Perspectief”, *Cursustekst bij het vak Filosofie van de Wiskunde, Master in de Wijsbegeerte Logica en Wetenschapsfilosofie*, VUB.

Van Kerkhove, B., 2012b, “De Grondslagenstrijd”, *Engelstalige cursustekst bij het vak Filosofie van de Wiskunde, Master in de Wijsbegeerte Logica en Wetenschapsfilosofie*, VUB.

Weyl, H., 1994, *The Continuum: A Critical Examination of the Foundation of Analysis*, trans. S. Pollard and T. Bole, Dover Publications, New York, (English translation of Das Kontinuum, Leipzig: Veit, 1918.)

Litton Industries' Problematical Recreations

Ron Yannone

My sincere hope is that the readers of this document will enjoy several of the problems posed here and find some easy, amusing, challenging, and easy to "carry around" in your head as you go about your daily activities. I hope, too, that you will share this document with parents of gifted children who like math – be they middle schoolers, high schoolers or college students. My desire is that you share this document with math teachers you know or tutors/mentors in math teams, MATHCOUNTS program, American Mathematics Competitions (AMC), and the like.

Litton Industries was acquired by Northrop Grumman in 2001. Northrop is a highly successful defense contractor giant with many innovations to its credit. The success of Northrop Grumman in developing extremely complex systems is in line with the quality of excellence and innovation Litton Industries had – and offered Northrop Grumman. Visit the Northrop Grumman home website to read of the history and the specific legacy Litton Industries had prior to becoming part of Northrop Grumman in 2001.

The last problem in Littons' *Problematical Recreations* was #580 from March 29, 1971.

Curious questions I have include:

(1) How much money did Litton invest over the 12 years of hosting and championing *Problematical Recreations*?

(2) Based on their closing advertisement on the last page of their 11 annual booklets, how many engineers, mathematicians, scientists and computer programmers made inquiry with Litton and ended up working for them?

(3) Did Litton ever proactively contact those readers who submitted multiple correct and innovative answers to their weekly problems - if so, how many?

(4) How many man-hours were expended in all in the 12-year series by Angela Dunn and her team of mathematicians?

This document covers Litton's *Problematical Recreations* that were produced over a 12-year period (1960 -1971). It all began for me by being introduced to them via a little annual booklet by Mr. Otto Rittenbach, an electronics engineer who worked for the U.S. Army Camp Evans location in Belmar, NJ. Read more later in this article.

I think the best overview is via the preface given by the editor Angela Dunn of Litton's *Problematical Recreations* from the Dover publication "Mathematical Bafflers" (1964; 1980 re-issued), with creative woodcut illustrations by Edward Kysar for each problem.

[Angela Dunn:]

This book is an outgrowth of one of the most successful campaigns in the history of technical publications, a weekly series called *"*Problematical Recreations*,"* which ran for twelve years in *Aviation Week* [*and Space Technology*] magazine and the *Electronic News*, winning the top readership award year after year.

Conceived and sponsored by Litton Industries of Beverly Hills, California, "Problematical Recreations" offered a weekly mathematical puzzle, the answer appearing the following week, geared to attract the technically minded. Happily, the series proved to be more than well read; it was actually aided and perpetuated by the readers themselves.

The quality of their written response was the key to the series' continuing appeal. Week after week letters from engineers, mathematicians, scientists, and puzzle fans in general would offer a more elegant solution, or an interesting mathematical sidelight to a problem from our series. Often readers would challenge us for an explanation, and occasionally they would disagree, sometimes vehemently, with our published solution. But always they exhibited original thinking. It was the quantity of imaginative puzzle contribution that poured in from all over the United States and from a dozen foreign countries that kept the campaign going at a high level of interest for twelve years.

As director of "Problematical Recreations*,"* from 1962 until its cancellation in 1971, I was fortunate in acquiring a staff of some of the best creative minds in mathematics to help check and evaluate each original contribution. My chief consultant, the late David L. Silverman of the University of California at Los Angeles, was truly a mathematical genius. His inexhaustible knowledge, his infinite supply of ingenious original puzzles, and his ability to communicate any principle or idea simply are responsible for both the series' success and this volume. One of David Silverman's many admirers, Mr. George Koch, President of Guidance Industries Corporation of San Francisco, commented: "He was the only mathematician I found in front of whom I was comfortable admitting ignorance. He answered my ignorance with information, not disdain, and thereby taught me a great deal."

I relied heavily on Mr. Silverman's expertise in handling the volume of correspondence. Each letter was answered personally, after careful checking and research, a fact which so surprised and pleased one reader in Washington, D.C., that he wrote me: "Thank you for not sending me the 'bed bug' letter. You present Litton as a warm and human organization." Because "Problematical Recreations" may enhance your enjoyment of a puzzle, shed new mathematical light, or simply amuse, selections have been included at the beginning of each of the seven sections of this book. (Bed bug letter: a form letter, from a company to an individual who has made a complaint, which promises to correct a situation, but is actually only intended to pacify the person making the objection.)

When the puzzles were originally published, their sequence was chosen to provide interesting variety from week to week. You will find, therefore, that the selections here run the gamut from

simple problems requiring no mathematical background to those that would challenge a professional mathematician. For example, a little imagination is all that is required to solve the following sequence problem from Chapter 6:

What letter follows OTTFFSSE___ ?

On the other end of the scale, advanced mathematics is involved in solving a variation of “The Alpenstock” (first problem of Chapter 5), and an acquaintance with Number Theory is required for the problems in Chapter 7.

In making this selection of more than 150 posers, we chose those that we hope combine the unusual, the unexpected, and the non-obnoxious. You will find, therefore, that a majority of the solutions may be reached by the application of a well-conceived hunch rather than by drudgery and exhaustive checking of tables. For our object is, after all, to entertain.

The mathematical challenges that follow have been contributed by dozens of puzzlers throughout this country, and from all over the world, most of them skilled mathematicians and applied scientists. We share their pet brain twisters and original work with you in these pages. For consistently submitting original and ingenious puzzles, the editor is indebted to: Mr. Leonard A. Baljay of Cherry Hill, New Jersey; Mr. Walter Penney of Greenbelt, Maryland; Mr. Charles Baker of Los Angeles, California; Mr. Noel A. Longmore of Kent, England; Mr. B. van Blaricum of Melbourne, Australia; Mr. William Shooman of Orange, California; and Mr. J. N. A. Hawkins of Pacific Palisades, California.

Acknowledgement is made also to *American Mathematical Monthly* and *Mathematics Magazine*, the two publications of the Mathematical Association of America, for permission to include in the *“*Problematical Recreations*”* series a few sample problems from their large and excellent stock.

For their patient counseling and technical assistance in conducting the series, the editor is grateful to Dr. Silverman and Dr. Harry Lass of the California Institute of Technology.

This book is for those who take pleasure in the process of reasoning, who enjoy exercising their inventive faculties, who delight in the pursuit of an elusive proof. If the reader enjoys these particular challenges, he or she is indebted to all the gentlemen named above and to all those hardy fellows who took the time to write to “Problematical Recreations.”

Angela Dunn

Some of My Favorite Problems From Litton's Problematical Recreations Series

Ron Yannone

Email: ronald.yannone@yahoo.com

Many unending thanks to electronics engineer, Mr. Otto Rittenbach (father of my high school friend Klaus). Otto worked with my dad and my friend David Anick's father George (also an electronics engineer) at the U.S. Army's Camp Evans radar facility in Belmar, NJ. In his humble living room in Neptune, NJ, Otto shared some of the Litton's *Problematical Recreations* booklets from a couple of the years they were published (between 1960 – 1971). I was a senior in high school then. Otto had over 50 patents. My junior and senior years at Neptune High School are my most memorable early years in developing and nurturing a strong love for math.

I have been thoroughly enjoying these problems at age 62 (retired) and sharing several with my wife Jacqueline. I still need to "work" on many of the following problems shared here with you, the reader. I take my time, look up formulas and principles I have forgotten and sometimes turn the problem into a small research adventure–spanning several days as required. I work on multiple problems in parallel so that when I hit a brick wall, I can switch to another problem with maybe a fresh mind. I vividly recall sharing what I thought were the toughest problems (from the few booklets I eventually bought) with David Anick (math genius in every sense) and most times he solved them easily and could furnish supporting proofs as well.

Some of the problems below are from Angela Dunn's book and some from a book by James F. Hurley, professor at the University of California, titled *Litton's Problematical Recreations* and published by Van Nostrand Reinhold Company. Other problems are from the actual Litton Industries annual booklets I have obtained over the past month (Books 3, 4, 5, 6, 7, 8, 9 and 11). Keep in mind I was in high school (over 45 years ago) when introduced to Litton's *Problematical Recreations* and although I had the math background I was not "sharp" in ferreting out quickly and successfully the tricks these problems posed in many cases. Oftentimes I "cried uncle" too quickly!!! Many of the readers of this document were once avid puzzle aficionados, now with memorable technical careers and experiences behind them – they can leverage their experiences and expertise in trying a few of these.

As you try specific problems, feel free to send me your answers [ronald.yannone@yahoo.com] and I will try to confirm or give suggestions if desired. In this set of exercises, I am certain you will find some easy, some entertaining, some even very challenging and enlightening. Several of these can be done with simple, clever thinking, versus the normal "school procedures" learned.

KEY: For my easy reference, after each problem statement, I indicate the source of problem: D-Dunn (page), H-Hurley (page), B#-Booklet number and (problem number), BOPRV1(#) – *Best of Problematical Recreations Volume 1* booklet contains the best of the first 5 annual booklets (page number); MPR(#) – *More Problematical Recreations* booklet (page #).

- A coffee pot with a circular bottom tapers uniformly to a circular top with radius half that of the base. A mark halfway up the side says "2 cups." Where should the "3 cups" mark go? Can you determine the number of total cups the coffee pot holds? Can you determine the number of cups the full cone involved (the pot being a subset) holds? What percent difference in height is the 3-cup level from the full pot level? [H(191), B8(#28)]
- A castle and a bishop are placed at random on different squares of a chessboard. What is the probability that one piece threatens the other? [D(143), B4(#13)]
- What is the base of the positional numeration system in which 12102 + 1 = 12220? [B9(#10)]
- Two hot rodders compete in a drag race. Each accelerates at a uniform rate from a standing start. Al covers the last quarter of the distance in 3 seconds; Bob covers the last third in 4 seconds. Who won, and by how much? (Can you conjure up a clear numerical example where the cars travel a distance *d* and meet the ending requirements stated above?) [D(20)]
- Lazy Levy wishes to toss a snowball over a building 144 feet by 144 feet and 133 feet high with the least expenditure of energy. How far away from the building should he stand? (Can you find a solution where mental arithmetic might suffice? Can you determine the launch velocity and launch angle and the time for the snowball to reach the apex of its trajectory and the time for it to clear the roof-top?) [B9(#16)]
- A hula hoop of circumference 40 inches performs one revolution about a girl with a 20-inch waist. How far has the original point of contact of the hoop traveled? [B9(#43)]
- A hostess plans to serve a square cake with icing on top and sides. Upon determining how many guests want cake, what method should she use to ensure that each guest will receive the same amount of cake and icing? (Can you determine the angles between each cut for each number of pieces desired – especially the odd number of cuts? What do you get for the angles between the pieces for 3 cuts, 5 cuts?). [H(194), B8(#39)]
- A contractor estimated that one of his two bricklayers would take 9 hours to build a certain wall and the other 10 hours. However, he knew from experience that when they worked together, 10 fewer bricks got laid per hour. Since he was in a hurry, he put both men on the job and found it took exactly 5 hours to build the wall. How many bricks did it contain? [D(34), B6(#34)]
- What is the cube root of INVENTORY? [B7(#25)]
- Without using any symbols, arrange the digits 1, 3, 5, 7, 9 to equal the digits 2, 4, 6, 8. [D(93), B4(#27)]
- If the hour and minute hands of a watch are interchanged, how many different possible times could the watch show? [D(167), B4(#30)]
- Smith said to Jones, "I just bought four mujibs at $21.78 apiece, and I noted a curious thing. "The total was $87.12, the price of a mujib in reverse order." "Isn't that a coincidence," said Jones. "The other day I bought some glinches (no, not one or four) and I remarked the same thing." How much does a glinch cost and how many did Jones buy? [D(85)]
- Two men are walking toward each other alongside a railway. A freight train overtakes one of them in 20 seconds and exactly 10 minutes later meets the other man coming in the opposite direction. The train passes this man in 18 seconds. How long after the train has passed the second man will the two men meet? (Constant speeds are to be assumed throughout.) [D(19), B4(#16)]
- Four boys, Alan, Brian, Charles and Donald, and four girls, Eve, Fay, Gwen and Helen are in love with one of the others, and, sad to say, in no case is their love requited. Alan loves the girl who loves the man who loves Eve. Fay is loved by the man who is loved by the girl loved by Brian. Charles loves the girl who loves Donald. If Brian is not loved by Gwen, and the boy who is loved by Helen does not love Gwen, who loves Alan? [B4(#6)]

- What operation can be performed three successive times on a solid cube, so that at each stage, the surface area is reduced in the same proportion as the volume? [H(46)]
- An icicle forming from a dripping gutter is in the shape of a cone five times as long as it is wide (at the top). A few hours later it has doubled in length and the generating angle has also doubled. How does its present weight compare with its previous weight? [H(193)]
- If X + Y + Z = 1, prove XY + YZ + XZ < ½ [D(9)]
- A new kind of atom smasher is to be composed of two tangents and a circular arc which is concave toward the point of intersection of the two tangents. Each tangent and the arc of the circle is 1 mile long. What is the radius of the circle? [H(168), D(58), B8(#38)]
- Johann Jungfrau, the famous mountain climber, was traveling through the Trondheim timber country one day. Quite by accident he dropped his trusty alpenstock, an unusually straight stick, near the buzzsaws where, in two shakes of a yak's tail, it was neatly cut into three pieces. What is the probability that these three pieces can be placed together to form a triangle? [D(137), B5(#3)]
- An astute mathematician drives 21 miles round trip to work each day. On the way he passes a gas station which advertises free gas if the price at which the pump stops when filling the tank consists of repetitive digits, i.e., $1.11, $2.22, $3.33, . . . , $9.99. Gas costs 30 cents per gallon and our mathematician knows his car delivers exactly 15 miles per gallon. Considering no additional driving, he computes that once he fills his gas tank at the station he can get all his gas free. The station is an integral number of miles from his home. Where is it with respect to his home? [B4(#20)]
- Find a two-digit number which is a factor of the sum of the cubes of its digits, while the reverse of the number is a factor of the sum of the fourth powers of the digits. [H(144), D(206)]
- There are nine cities which are served by two competing airlines. One or the other airline (but not both) has a flight between every pair of cities. What is the minimum number of possible triangular flights (i.e., trips from A to B to C and back to A on the same airline)? [D(31)]
- Express as the product of sixth- and ninth-degree polynomials with integral coefficients. [D(30), B6(#13)]
- Archimedes O'Toole, a mathematical poet, on seeing this equation, translated it into a limerick. Can you duplicate this feat? [H(43)]
- Six men decide to play Russian roulette with a six gun loaded with one cartridge. They draw for position, and afterwards, the sixth man casually suggests that instead of letting the chamber rotate in sequence, each man spin the chamber before shooting. How would this improve his chances? [H(111)]
- A mathematician whose clock has stopped wound it, but did not bother to set it correctly. Then he walked from his home to the home of a friend for an evening of hi-fi music. Afterwards, he walked back to his own home and set his clock exactly. How could he do this without knowing the time his trip took? [H(133)]
- Mr. Field, a speeder, travels on a busy highway having the same rate of traffic flow in each direction. Except for Mr. Field, the traffic is moving at the legal speed limit. Mr. Field passes one car for every nine which he meets from the opposite direction. By what percentage is he exceeding the speed limit? [H(151)]
- If a coin were randomly shaken out of a certain piggy bank, its expected value would be 15 cents. If a dime had been added, the expected value would have been only 14 cents. What are the contents of the bank? [B8(#18)]
- A guidance technician celebrating a successful moon shot tipped his half full brandy glass slowly to an angle of 45 degrees from the vertical. If the glass was spherical inside, 3 inches in diameter, with a 2-inch diameter hole in its top, what percent of his drink did he lose? [B8(#33)]
- In a little known work, the famous geometer of Skalenos proves the following theorem: "The square of the side opposite the Fandangle is equal to the sum of the squares of the other two sides added to the product of those two sides multiplied by the square root of two." What is a Fandangle? [B8(#43)]
- A wall is made of bricks which are twice as long as they are high. The wall is 13 courses high, with 100 bricks on the odd courses and 99 bricks plus two half bricks on the even courses. An ant starts at the lower left corner and walks in a straight line to the upper right corner. Over how many bricks does he walk? [B8(#34)]

- By the time the radius of a certain pearl has increased 1 millimeter the area will have increased as much (1 millimeter squared) as the volume (1 millimeter cubed). If the pearl is an exact sphere, what is its radius now? What are the original area and volume values? [B11(#3)]
- Consider the sequence 0, 1, 2, 7, 20, 61, … in which . Assuming the ratio of successive terms approaches a limit r, compute r. [H(279)]
- The decimal 0.1 in base two equals 0.5 in base 10. Likewise, 0.12 in base three and 0.123 in base four equal 0.556 and 0.422, respectively. Continuing in this manner, as the base increases, what is the limiting value of the decimal? [H(280)]
- Find the only number consisting of five different digits which is a factor of its reversal. [H(252), B7(#36)]
- While still at a sizable distance from the Pentagon building, a man first catches sight of it. Is he more likely to be able see two sides or three? [H(183)]
- A pupil wrote on the blackboard a series of fractions having positive integral terms and connected by signs which were either all + or all x, although they were so carelessly written it was impossible to tell which they were. It still wasn't clear even though he announced the result of the operation at every step. The third fraction had denominator 19. What was the numerator? [H(147)]
- In the final seconds of the game, your favorite N.B.A. team is behind 117 to 118. Your center attempts a shot and is fouled for the 2nd time in the last 2 minutes as the buzzer sounds. Three to make two in the penalty situation. Optimistic? Note: the center is only a 50% free-thrower. What are your team's overall chances of winning? [H(121)]
- Besides direction, what property is shared by Santa's helpers at the North Pole, the Northwest Passage, and that hundredth root of unity which is northernmost in the Argand plane? [B11(#6)]
- There are at least two ways of representing 20, using three 3's and standard mathematical symbols. Find one. (Can you find as many as 5 ways?) [B11(#17)]
- A kidney-shaped swimming pool is laid out by describing two tangent circles, drawing a circular arc 40 feet long tangent to both of these circles on one side and a parallel circular arc 20 feet long tangent to both of them on the other side. What is longest (straight line) distance one can swim in this pool? [B11(#19)]
- The numbers 6,227,020,800; 6,227,028,000 and 6,227,280,000 are all large and roughly in the same ballpark. But only one is equal to 13! Find it without use of tables, desk calculators, or hard work. [H(263), B11(#31)]
- One of a pair of dice is loaded so that the chance of a 1 turning up is 1/5, the other faces being equally likely. Its mate is loaded so that the chance of a 6 turning up is 1/5, the other faces being equally likely. How much does this loading increase the probability of throwing a 7 with the two dice? [H(122)]
- In a carnival game 5 balls are tossed into a square box divided into 4 square cells, with baffles to ensure that every ball has an equal chance of going in any cell. The player pays $1 and receives $1 for every cell which is empty after the 5 balls are thrown. How much does the operator expect to make per game? [H(127), B11(#42)]
- Having lost a checker game, a specialist in learning programs threw one of the red checkers out the window. His wife re-boxed the 12 black pieces and 11 red pieces one at a time in random fashion. The number of black checkers in the box always exceeded the number of reds. What was the *a priori* probability of this occurrence? [H(128)]
- Archimedes O'Toole was so overcome by the favorable response among "Poeticians" to his last mathematical limerick, that he composed another based on the above identity. Can you reconstruct the limerick? [H(277)]
- The price per cubic inch for platinum trays is the same as that per square inch for platinum sheets. A metal supply house has a square of platinum which will yield the same amount whether sold as a sheet, or fashioned into a tray of maximum volume with the four cut-out corners sold as sheets. How big is the square? [H(283)]
- With only a 7 minute and an 11 minute "hourglass" to keep time, you wish to hard boil some eggs for 15 minutes "on the nose." You could start both timers, put the eggs on when the 7-minute timer runs out, invert the other timer at T=11, and the eggs will be ready when it runs out at T=22. But can the job be done faster? [H(85)]
- A pet store offered a baby monkey for sale at $1.25. The monkey grew. Next week it was offered at $1.89, then $5.13, then $5.94, then $9.18 and on the sixth week a Ph.D. in Aeronautics bought it for $12.42. How were the new prices figured? [H(233)]

- A set of items sells for $1122.00, and another set of like items sells for $2210.00. What is the cost of each item? [D(189)]
- Joe Tankard forms an interesting design by setting his glass down on the bar three times, each ring passing through the centers of the other two. The bartender bets that the center area which is common to all three circles is less than one-fourth the areas of one of the circles. Joe bets that is greater. Who wins? [B7(#6)]
- Two integers were multiplied and it was noticed that d, the leftmost digit of the product, was the average of the leftmost digits of the two factors. What was d? [B7(#21)]
- Two wheels in the same plane are mounted on shafts 13 inches apart. A belt goes around both wheels to transmit power from one to the other. The radii of the two wheels and the length of the belt not in contact with the wheels at any moment are all integers. How much larger is one wheel than the other? [B9(#5)]
- The squares of a checkerboard are numbered in random fashion with the numbers 1, 2, . . . , 64. Find the probability that a "saddle square" exists (simultaneously a row minimum and a column maximum). [B9(#20)]
- A bridge across a river is in the form of an arc of a circle. A boy walking across the bridge finds that 27 feet from the shore the bridge is 9 feet above the water. He continues on to the center of the span and finds that the bridge is now 10 feet above the water. How wide is the river? [B9(#26)]
- A conical drinking cup has a 12-inch rim and is 4 inches deep at the center. If creased flat, what is the vertex angle of the resulting figure? [B9(#32)]
- Four spectators, viewing one of a pair of dice from different angles, see spots totaling 10, 15, 14 and 9, respectively. How many spots are on the top face of the die? [B9(#38)]
- Smith and Jones, both 50% marksmen, decide to fight a duel in which they exchange alternate shots until one is hit. What are the odds in favor of the man who shoots first? [BOPRV1(26)]
- Lottie and Lucy Hill are both 90 years old. Mary Jones, on the other hand, is half again as old as she was when she was half again as old as she was when she lacked 5 years of being half as old as she is now. How old is Mary? [BOPRV1(38)]
- Two similar triangles with integral sides have two of their sides the same. The third sides differ by 387. What are the lengths of the sides? [BOPRV1(48)]
- A, B, and C are three towns, each pair being connected by a network of roads. A motorist notices that there are 82 routes from A to B, including those via C and 62 routes from B to C, including those via A. He also notices that there are fewer than 300 routes from A to C, including those via B. How many are there? [D(83)]
- Using a "true" coin, a random sequence of binary digits can be generated by letting, say, heads denote zero and tails, one. An operations analyst wished to obtain such a sequence, but he had only one coin which he suspected was not true. Could he still do it? [H(98)]
- Three dart players threw simultaneously at a tic-tac-toe board, each hitting a different square. What is the probability that the three hits constituted a win at tic-tac-toe? [H(104)]
- Five points are located in or on the perimeter of an equilateral triangle with 9-inch sides. If d is the distance between the closest pair of points, what is the maximum possible value of d? [H(225)]
- In the arithmetic of Puevigi, 14 is a factor of 41. What is the base of the number system? [H(250)]
- One is the smallest integer which is simultaneously a perfect square, cube, and fifth power. What is the next smallest integer with this property? [H(254)]
- If ¼ of 20 is 6, then what is 1/5 of 10? [MPR(1)]
- Using only mathematical signs and without changing the position of any of the figures, can you make this into an equation? 2 9 6 7 = 17 [MPR22)]
- State a theorem about integers which is valid for all integers n, with the exceptions n = 5, 17, 257. [MPR(32)]
- How many nine digit numbers are divisible by 11, no digit equal to zero and no two digits alike? [B5(#17)]
- Two cubes with integral sides have their combined volume equal to the combined length of their edges. What are the dimensions of the cubes? [B5(#26)]
- Every proper fraction can be expressed as the sum of a number of distinct aliquot fractions, i.e., fractions with unit numerators. What is the "smallest" fraction (sum of

numerator and denominator a minimum) which requires four such fractions for its expression? [B6(#35)]

- No two-digit number times its reversal equals any other two-digit number times its reversal. Two numbers come close but, in fact, the products differ by 4. What are the numbers? [B6(#39)]
- Two snails start from the same point in opposite directions toward two bits of food. Each reaches its destination in one hour. If each snail had gone in the direction the other took, the first snail would have reached his food 35 minutes after the second. How do their speeds compare? [B7(#8)]
- If 2 marbles are removed at random from a bag containing black and white marbles, the chance that they are both white is 1/3. If 3 are removed at random, the chance that they all are white is 1/6. How many marbles are there of each color? [B7(#10)]
- Martian coins are 3-sided (heads, tails, and torsos), each side coming up with equal probability. Three Martians decide to go odd-man-out to determine who pays a dinner check. (If two coins come up the same and one different, the owner of the latter coin foots the bill). What is the expected number of throws needed in order to determine a loser? [B7(#43)]
- Find integers A, B, and C, positive or negative but non-zero, such that the equation has roots A and B. [B8(#11)]
- At a cocktail party a man starts out with a glass of half whiskey and half soda. After each sip he adds enough soda to fill the glass again. Assuming he does this continuously (that is, in infinitesimal sips), how much whiskey has he consumed by the time he has drunk half a glass? [B8(#12)]
- A forgetful physicist forgot his watch one day and asked an electronics engineer on the staff what time it was. The engineer looked at his watch and said: “The hour, minute, and sweep second hands are as close to trisecting the face as they ever come. This happens only twice in every 12 hours, but since you probably haven’t forgotten whether you ate lunch, you should be able to calculate the time.” What time was it to the nearest second? [B3(#3)]
- Dr. Reed, arriving late at the lab one morning, pulled out his watch and said, “I must have it seen to. I have noticed that the minute and the hour hand are exactly together every sixty-five minutes.” Does Dr. Reed’s watch gain or lose, and how much per hour? [B3(#29)]
- Maynard the Census Taker visited a house and was told, “Three people live there. The product of their ages is 1296, and the sum of their ages is our house number.” After an hour of cogitation Maynard returned for more information. The house owner said, “I forgot to tell you that my son and grandson live here with me.” How old were the occupants and what was their street number? [H(212)]
- In a certain code used in high-level communication in Puevigi, the two permutations of the nine digits 692547318 and 768415932 are code equivalents, respectively, of the words INTERVENE and EXTROVERT. Break the code and decipher 895173246. [B8(#14)]
- A man started for a walk when the hands of his watch were coincident between three and four o’clock. When he finished, the hands were again coincident between five and six o’clock. What was the time when he started, and how long did he walk? [BOPRV1(6)]
- Two candles have equal lengths. One is consumed uniformly in four hours, the other in five hours. If they are lit up at the same time, when will one be three times as long as the other? [BOPRV1(8)]
- The numbers one through seven are drawn from a hat without replacement. What is the probability that all the odd numbers will be chosen first? [BOPRV1(60)]
- Three rectangles of integer sides have identical areas. The first rectangle is 278 feet longer than wide. The second rectangle is 96 feet longer than wide. The third rectangle is 542 feet longer than wide. Find the area and dimensions of the rectangles. [B6(#29)]
- Assume that a single depth charge has a probability of ½ of sinking a submarine, ¼ of damage and ¼ of missing. Assume also that two damaging explosions sink the submarine. What is the probability that 4 depth charges will sink the submarine? [B6(#38)]
- Find two numbers whose sum and product are equal and whose quotient and difference are equal. [B7(#1)]

- What two-digit number denotes a prime in the octal and duodecimal scales as well as in the decimal scale? [B7(#17)]
- Using each of the ten digits once, find two 5-digit numbers with the largest possible product. [B7(#26)]
- The numbers 1 - 10 inclusive are to be arranged in a circle and each one multiplied by its right-hand neighbor. How should they be arranged if the number of different products is to be a minimum? [B7(#39)]
- A yang, ying, and yung is constructed by dividing a diameter of a circle, AB, into three parts by points C and D, then describing on one side of AB semicircles having AC and AD as diameters and on the other side of AB semicircles having BD and BC as diameters. Which is larger, the central portion or one of the outside pieces? [B7(#42)]
- Two octopi indulged in a friendly tentacle to tentacle wrestling match. Each managed to pin 4 of his opponent's tentacles with 4 of his own. In how many ways was this possible? [B8(#6)]
- How can seven points be placed, no three on the same line, so that every selection of three points constitutes the vertices of an isosceles triangle? [B8(#30)]
- Prove that neither 999,919 nor 1,000,343 is prime? [B9(#6)]
- Draw the square with vertices at (0,0), (0,4), (4,4) and (4,0). A broken line is to be drawn, consisting of three segments, starting at (0,1), angling successively off the top and bottom sides of the square, and terminating at (4,2). At what points will it meet the top and bottom sides? [B9(#35)]
- The equation has one solution (A,B,C,D) = (2,2,2,2). Find infinitely more solutions in positive integers. [B11(#1)]
- If the equal sides of an isosceles triangle are given, what length of the third side will provide maximum area? (No calculus, please). [B11(#5)]
- If all 720 permutations of the digits 1 though 6 are arranged in numerical order, what is the 417^{th} term? [B11(#9)]
- One side of a triangle is 10 feet longer than another and the angle between them is 60 degrees. Two circles are drawn with these sides as diameters. One of the points of intersection of the two circles is the common vertex. How far from the third side is the other point of intersection? [B11(#12)]
- A sharp operator makes the following deal. A player is to toss a coin and receive 1, 4, 9, …, dollars if the first head comes up on the first, second, third, …, toss. The sucker pays ten dollars for this. How much can the operator expect to make if this is repeated a great many times? [B11(#26)]
- There is one flag at the entrance to a racetrack and another inside the track, half a mile from the first. A jockey notes that no matter where he is on the track, one flag is 3 times as far away as the other. How long is the track? [B11(#37)]
- By the same token that POLYMER is a good "telephomnemonic" for an organic chemist whose number is SNowden 59637, find two good ones for a geophysicist whose number is VErnon 62567 and a surfer whose number is WHitney 73688. [B11(#43)]
- Only two polygons can have a smallest interior angle of 120 degrees with each successive angle 5 degrees greater than its predecessor. One is the nonagon depicted. What is the other? [B9(#23)]
- A housewife noted with dismay that brand A was 50% more expensive than C and contained 20% less weight than B. B was 50% heavier than C but cost 25% more than A. Being of an economical nature, which brand did she buy? [B9(#24)]
- Find a five-digit number whose first two digits, central digit, and last two digits are perfect squares and whose square root is a prime palindrome. [B4(#29)]
- Two flights of bombers were flying at 300 mph on converging courses 30 degrees apart, each flight being 240 miles from the rendezvous. From above each flight a fighter plane, flying at 500 mph, flew to the other bomber flight and returned, continuing the shuttle until the bomber flights met. One fighter always headed directly toward his objective, while the other fighter always flew an interception course. Which fighter flew the greater distance, and how much farther did he fly? [BOPRV1(20)]
- If each of the letters A, B and C represent a specific Digit, what is the MINIMUM value of the whole number ABC divided by A + B + C? P.S. The answer is not 1. [BOPRV1(16)]
- Dr. Irving Weiman, the famous physicist, who is always in a hurry, walks up an up-going escalator at the rate of one step per second. Twenty steps bring him to the top. Next

day he goes up at two steps per second, reaching the top in 32 steps. How many steps are there in the escalator? [BOPRV1(47)]

- A rectangular box without a top is to be made from a sheet of metal in the manner familiar to all calculus students, i.e., by cutting out squares from the corners and bending up the sides. The finished product is to have maximum volume and its dimensions are to be all integers. How will these dimensions compare if the metal cutout amounts to 10% of the original sheet? [H(274)]
- A certain magic square contains nine consecutive 2-digit numbers. The sum of the numbers in any line is equal to one of the numbers in the square with the digits reversed. This is still the case if 7 is added to each entry. What is the number in the center square? [H(265)]
- The sum of the digits on the odometer in my car (which reads up to 99999.9) has never been higher than it is now, but it was the same 900 miles ago. How many miles must I drive before it is higher than it is now? [H(236)]
- Dad and his son have the same birthday. On the last one, Dad was twice as old as Junior. Uncle observed that this was the *ninth* occasion on which Dad's birthday age had been an integer multiple of Junior's. How old is Junior? [H(228)]
- A certain 3-digit number in base 10 with no repeated digits can be expressed in base R by reversing the digits. Find the smallest value of R. [H(223)]
- There are four volumes of an encyclopedia on a shelf, each volume containing 300 pages, (that is, numbered 1 to 600), but these have been placed on the shelf in random order. A bookworm starts at the first page of Vol. 1 and eats his way through to the last page of Vol. 4. What is the expected number of pages (excluding covers) he has eaten through? [H(115)]
- How many primes are in the following infinite series where the digits are arranged in declining order? 9; 98; 987; 9876; ……..; 987654321; 9876543219; 98765432198, . . . etc. [BOPRV1(28)]
- Using the French Tricolor as a model, how many flags are possible with five available colors if two adjacent rows must not be colored the same? [BOPRV1(36)]
- Prove that the product of 4 consecutive positive integers cannot be a perfect square? [BOPRV1(40)]
- The planet Octerra is divided into eight countries, each occupying an octant, (thus each country borders three others). In how many ways can a traveler visit each of the other countries once and only once, returning to his home country only at the end of his trip? [BOPRV1(52)]
- The sum and difference of two squares may be primes: 4 – 1 = 3 and 4 + 1 = 5; 9 – 4 = 5 and 9 + 4 = 13, etc. Can the sum and difference of two primes be squares? If so, for how many different primes is this possible? [BOPRV1(57)]
- A ladder is leaning against a wall at an angle steeper than 45 degrees. Under the ladder there is a barrel which touches both the ladder and the wall. The barrel is placed on its side with its circular end facing the reader (you). If the vertical distance, in feet, between the top of the ladder and the ground is four times the diameter of the barrel, what is the shortest integral number of feet the ladder can be? [D(51)]
- Given a point P on one side of a general triangle ABC, construct a line through P which will divide the area of the triangle into two equal halves. [D(61)]
- An isosceles triangle has a 10-inch base and two 13-inch sides. What other value can the base have and still yield a triangle with the same area? [D(67)]
- In the game "subtract-a-square," a positive integer is written down and two players alternately subtract squares from it until a player is able to leave zero, in which case he is the winner. What square should the first player subtract if the original number is 29? [D(102)]
- There are 120 seven-digit numbers which can be formed by starting from any number in the diagram below and proceeding to any neighboring number, using each number once and only once. Of these, how many are divisible by 11?
- Assuming that each pack of cigarettes from a certain manufacturer contains, as a premium, one of a set of 52 playing cards and that these cards are distributed among the packs at random (the number of packs available being infinite), what is the expected number of packs that must be purchased in order to obtain a complete set of cards? [D(145)]
- There are four towns at the corners of a square. Four motorists set out, each driving to the next (clockwise) town, and each man but the fourth going 8 mi./hr. faster than the car

ahead, thus the first car travels 24 mi./hr. faster than the fourth. At the end of one hour the first and third cars are 204, and the second and fourth 212 (beeline) miles apart. How fast is the first car traveling and how far apart are the towns? [B9(#18)]

- A record enthusiast decided to calibrate his rpm player by placing equally spaced dots around the rim. What is the minimum number of dots required in order that they appear stationary under 60 cycle light? [B9(#21)]
- Recall the standard "15" magic square where each row, column and diagonal sum to 15. Using nine different integers, produce a "multiplicative" magic square, i.e., one in which the word "product" is substituted for "sum." [B9(#30)]
- What is the millionth term of the sequence 1, 2, 2, 3, 3, 3, 4, 4, 4, 4, . . . in which each positive integer n occurs in blocks of n terms? [B8(#16)]
- On what days of the week can the first day of a century fall? (The first day of the twentieth century was January 1, 1901.) [B6(#18)]
- Strephon and Phyllis decide to test their love with a daisy. They agree to pluck petals alternately, taking either one petal or two adjacent petals. There are 13 petals altogether. He picks one saying, "She loves me." She picks two adjacent petals, leaving two groups of 8 and 2, saying, "He loves me not." How should Strephon continue? [B6(#32)]
- A hospital nursery contains only two baby boys; the girls have not yet been counted. At 2 P.M. a new baby is added to the nursery. A baby is then selected at random to be the first to have its footprint taken. It turns out to be a boy. What is the probability that the last addition to the nursery was a girl? [B6(#36)]
- The faces of a solid figure are all triangles. The figure has nine vertices. At each of six of these vertices, four faces meet, and at each of the other three vertices, six faces meet. How many faces does the figure have? [B3(#4)]
- A prisoner is given 10 white balls, 10 black balls and two boxes. He is told that an executioner will draw one ball from one of the two boxes. If it is white, the prisoner will go free; if it is black, he will die. How should the prisoner arrange the balls in the boxes to give himself the best chance for survival? [B3(#9)]
- Arrange the nine digits in three groups of one, four and four digits so that the third number is the product of the first two. There are at least two solutions. [B3(#17)]
- The odd digits 1, 3, 5, 7, and 9, add up to 25, while the even figures 2, 4, 6, and 8, only add up to 20. Arrange these figures so that the odd ones and the even ones add up alike. Complex and improper fractions and recurring decimals are not allowed. [B3(#19)]
- There are pairs of numbers whose sum and product are perfect squares. For instance, 5 + 20 = 25 and 5 x 20 = 100. If the smaller of such a pair is 1090, what is the other? [B3(#27)]
- What is the lowest number that is the sum of two cubes in two different ways? [B3(#31)]
- In a lottery the total prize money available was a million dollars, paid out in prizes which were powers of $11 viz., $1, $11, $121, etc. No more than 6 people received the same prize. How many prize winners were there, and how was the money distributed? [H(#249)]
- Luke and Pete are two privates on K.P. peeling potatoes at the rate of 1 per minute each. They start with the same number, but Goldbrick Luke surreptitiously throws one potato on Pete's pile after every second one he peels. At a certain moment Pete has twice as many potatoes still to be peeled as Luke. Five minutes later this ratio has increased to 7:3. When will it be three to one? [B11(#11)]
- Five cards are drawn at random from a pack of cards which have been numbered consecutively from 1 to 97, and thoroughly shuffled. What is the probability that the numbers on the cards as drawn are in increasing order of magnitude? [BOPRV1(14)]
- Four snails start at the vertices of a unit square and move directly toward one another in cyclic order, at unit rate. How far will they travel before they meet? [BOPRV1(15)]
- What number, if divided by 10, leaves a remainder of 9; divided by 9 leaves a remainder of 8; divided by 8 leaves a remainder of 7; . . . , divided by 2 leaves a remainder of 1? One answer is 14,622,042,959. Find a smaller solution. [BOPRV1(18)]
- A modernistic chess set has pieces in various geometrical shapes. In particular, both the KING and the KNIGHT are squares of integers. What numbers could these represent if each letter is replaced by a different digit? [BOPRV1(49)]

- Mr. Perkins decided to redesign his rectangular rose bed into the shape of a right-angled triangle. The existing bed measured 24 by 35 feet. He discovered that he could make any one of three different right-triangular beds, each equal in area to the existing bed and each having sides of an integral number of feet. As it was his custom to fence his beds, he naturally chose the bed with the smallest perimeter. What were the dimensions, in feet, of the new bed? [D(199)]
- Four cities, A, B, C, and D, lie at the vertices of a rectangle. Inside this imaginary rectangle there is a fifth city, E, which is exactly 33 miles from A and 56 miles from C. E also happens to be an integral number of miles from the other two cities, being further from B than from D. If the distance between B and C is three times that of E from D, how far, to the nearest half mile, is A from B? [B4(21)]
- Near the town of Lunch, Nebraska there is a large triangular plot of land bounded by three straight roads which are 855, 870, and 975 yards long, respectively. The owner of the land, a friend of mine, told me that he had decided to sell half the plot to a neighbor, but that the buyer had stipulated that the seller of the land should erect the fence which was to be a straight one. The cost of fences being high, my friend naturally wanted the fence to be as short as possible. What is the minimum length the fence can be? [B5(9)]
- Find the smallest integer which is such that if the digit on the extreme left is transferred to the extreme right, the new number is three and a half times the original number. [B5(12)]
- The integers 1, 3, 8, and N have the property that the product of any two when added to unity yields a square. What is N? [B5(22)]
- Furbisher lives in Canoga Acres and works in Beverly Flats. LaRouche lives in Beverly Flats and works in Canoga Acres. They usually leave their respective homes at the same time, and pass each other at Sam's Hamburger Shack. (Furbisher drives twice as fast as LaRouche). On a day when Furbisher's wife Formica spoiled the eggs and he left 5 minutes late, they passed each other at the gas station, two miles from Sam's. How fast do they drive? [B5(39)]
- A one-acre field in the shape of a right triangle has a post at the midpoint of each side. A sheep is tethered to each of the side posts and a goat to the post on the hypotenuse. The ropes are just long enough to let each animal reach the two adjacent vertices. What is the total area the two sheep have to themselves, i.e., the area the goat cannot reach? [B6(2)]
- On a certain day, our parking lot contains 999 cars, no two of which have the same 3-digit license number. After 5:00 p.m. what is the probability that the license numbers of the first 4 cars to leave the parking lot are in increasing order of magnitude? [B6(3)]
- Three marksmen simultaneously shoot at and hit a rapidly spinning spherical target. What is the probability that the three points of impact are on the same hemisphere? [B6(4)]
- A divided highway goes under a number of bridges, the arch over each lane being in the form of a semi-ellipse with the height equal to the width. A truck is 6 ft. wide and 12 ft. high. What is the lowest bridge under which it can pass? [B6(6)]
- The numbers are divided into three groups as follows: 0, 3, 6, 8, 9, … in the first group, 1, 4, 7, 11, 14, … in the second group and 2, 5, 10, 12, 13, … in the third. In which groups would 15, 16, and 17 be placed? [B6(21)]
- The smaller of two consecutive integers is divisible by 23 and the larger by 29. Find the smallest pair of such numbers with the property that they both contain only the digits one and two. [B6(23)]
- A salesman visits ten cities arranged in the form of a circle, spending a day in each. He proceeds clockwise from one city to the next, except whenever leaving the tenth city he may go to either the first or jump to the second city. How many days must elapse before his location is completely indeterminate, i.e., when he could be in any one of the ten cities? [B7(16)]
- A game of super-dominoes is played with pieces divided into three cells instead of the usual two, containing all combinations from triple blank to triple six, with no duplications. For example, the set does not include both 1 2 3 and 3 2 1 since these are merely reversals of each other. (But, it does contain 1 3 2.) How many pieces are there in a set? [B7(35)]
- Find A and B if 7A = B and A and B together contain the ten digits 0 through 9 once and only once. [B8(3)]

- In California, automobile license plates have three letters followed by three of the digits from 0 to 9, not necessarily distinct. Is a randomly chosen car more likely to have all 6 symbols different or at least one repetition? (The zero and O are identical.) [B8(4)]
- There are three families, each with two sons and two daughters. In how many ways can all these young people be married? [B8(5)]
- A diaper is in the shape of a triangle with sides 24, 20 and 20 inches. The long side is wrapped around the baby's waist and overlapped two inches. The third point is brought up to the center of the overlap and pinned in place. The pin is to go through three thicknesses of material. What is the area in which the pin may be placed? [B8(19)]
- A roulette player made 5 straight even money bets on the red. Starting with 32 chips, he bet half his current holdings each time. Red came up 3 times, black twice. In what order would he want his 3 wins to come to maximize his profit? How much would his profit be? [B8(25)]
- The pennant of the local yacht club is the usual isosceles triangle. The narrow end has an angle of 20 degrees and the opposite side is 10 inches long. A blue stripe runs from one of the other corners to a point on the edge 10 inches from the narrow end. Determine the angle the stripe makes with the edge of the pennant. [B9(3)]
- Fourteen playing cards, A, 2, 3 … K and joker, valued 1, 2, 3, … 13, and 14 for the joker are face up on a table. Two players alternately turn cards face down while keeping a running count of the sum value of the face down cards. To win, a player must, on his turn, force the sum to equal or exceed 60. Which player has the edge? [B9(13)]
- A novice librarian shelved a twelve volume set of encyclopedias in the following order from left to right. Volumes 8, 11, 5, 4, 9, 1, 7, 6, 10, 3, 12, and 2. Using her system, where will the annual supplement, Volume 13, go? [B9(33)]
- A pencil, eraser and notebook together cost $1.00. A notebook costs more than two pencils, and three pencils cost more than four erasers. If three erasers cost more than a notebook, how much does each cost? [B11(10)]
- What is the smallest positive integer which, when divided by any N in the range 2, 3, …., 10, leaves a remainder of N-1? [B11(28)]
- A card for printed circuits has five terminals on each side. Three of the terminals on the left are to be connected to three on the right. How many different circuits are printable, i.e., do not have any printed 'wires' crossing? [B8(17)]
- 1960 and 1961 were bad years for ice cream sales but 1962 was very good. An accountant was looking at the tonnage sold in each year and noticed that the digital sum of the tonnage sold in 1962 was three times as much as the digital sum of the tonnage sold in 1961. Moreover, if the amount sold in 1960 (346 tons) was added to the 1961 tonnage, this total was less than the total tonnage sold in 1962 by the digital sum of the tonnage sold in that same year. Just how many more tons of ice cream were sold in 1962 than in the previous year? [D(200)]
- Find the digital base in which the number seven thousand, six hundred and forty-two is represented by the symbol 1234. [D(204)]
- What is the largest power of 7 that will divide 1000!? [D(205)]
- Find three integers in arithmetic progression whose product is prime. [D(174)]
- What is the largest number which can be obtained as the product of positive integers which add up to 100? [D(119)]
- What is the largest amount of money you can have in coins and still not be able to give change for a dollar? [D(101)]
- Find a three-digit number that is the sum of the cubes of its digits. [D(73)]
- Luke and Slim have only one horse between them. Luke rides a certain time and then ties up the horse for Slim, who has been walking. Meanwhile Luke walks on ahead. They proceed in this way, alternately walking and riding. If they walk 4 miles per hour and ride 12 miles per hour, what part of the time is the horse resting? [D(40)]
- On a surefire tip from Big Jim, Willy the Welcher placed some bets with Benny the Bookie. Big Jim had told Willy that in the third race at Holly Park one of the four outsiders was bound to win. Of the four, the first horse has odds of 3 to 1, the second 4 to 1, the third 5 to 1, and the fourth is 6 to 1. What must Willy bet on each horse to make a profit of $101, no matter which of the four outsiders wins? [D(40)]
- John was three times as old as his sister 2 years ago and five times as old 2 years before that. In how many years will the ratio be 2 to 1? [D(40)]
- A railroad buys ties for $11 apiece. They last for 10 years and then have a scrap value of $1 apiece. If preservative treatment costing $3 a tie is applied, each tie will last 15

years but will have no scrap value. If the railroad makes 5 per cent on its capital, should it treat the ties? [D(28)]

- Using mathematical symbols to modify four fours it is possible to write expressions for all the numbers from 0 to 100, as well as millions of others. Example: 2 = 4/4 + 4/4. In this manner arrange four fours to equal these progressively more difficult numbers: 13, 19, 33, 85. Do all numbers 0 to 100. [D(3)]
- Assuming the sun rises at 6:00 a.m., sets at 6:00 p.m., and moves at a uniform rate, how can a lost boy scout determine south by means of a watch on a cloudless day? [H(15)]
- A neat computer programmer wears a clean shirt every day. If he drops off his laundry and picks up the previous week's load every Monday night, how many shirts must he own to keep him going? [H(26)]
- The passengers on an excursion bus consisted of 14 married couples, 8 of whom brought no children, and 6 of whom brought 3 children apiece. Counting the driver, the bus had 31 occupants. How is this possible? [H(27)]
- Show, with a simple example, that an irrational number raised to an irrational power need not be irrational. [H(31)]
- A jig-saw puzzle contains 100 pieces. A "move" consists of connecting two clusters (including "clusters" of just one piece.) What is the minimum number of moves required to complete the puzzle? [H(33)]
- At the age of 17, Gauss proved that a regular polygon of 17 sides can be constructed with a ruler and compasses. Suppose every side and every diagonal is painted either red, white or blue. Prove at least one triangle is formed with all three sides painted the same color. [H(39)]
- A coin is so unbalanced that you are likely to get two heads in two successive throws as you are to get tails in one. What is the probability of getting heads in a single throw? [H(103)]
- How many three-digit telephone area codes are possible given that: (a) the first digit must not be zero or one; (b) the second digit must be zero or one; (c) the third digit must not be zero; (d) the third digit may be one only if the second digit is zero. [H(110)]
- Max and his wife Min each toss a pair of dice to determine where they will spend their vacation. If either of Min's dice displays the same number of spots as either of Max's, she wins and they go to Bermuda. Otherwise, they go to Yellowstone. What is the chance they'll see "Old Faithful" this year? [H(114)]
- In a carnival game, 12 white balls and 3 black balls are put in an opaque bottle, shaken up, and drawn out one at a time. The player gets 25 cents for each white ball which emerges before the first black ball. If he pays one dollar to play, how much can he expect to win (or lose) on each game? [H(117)]
- An expert on transformer design relaxed one Saturday by going to the races. At the end of the first race he had doubled his money. He bet $30 on the second race and tripled his money. He bet $54 on the third race and quadrupled his money. He bet $72 on the fourth race and lost it, but still had $48 left. With how much money did he start? [H(132)]
- Three hares are standing in a triangular field which is exactly 100 yards on each side. One hare stands at each corner; and simultaneously all three set off running. Each hare runs after the hare in the adjacent corner on his left, thus following a curved course which terminates in the middle of the field, all three hares arriving there together. The hares obviously ran at the same speed, but just how far did they run? [H(178)]
- Prove that each median of a triangle is shorter than the average of the two adjacent sides. [H(195)]
- A boat owner agrees to take a group on an outing at $4.50 apiece if the number of passengers is equal to or less than his break-even point. For each person above this he reduces the fare for all passengers 3 cents per person. If he has on board now the number of passengers that maximizes the total collected, what is the boat owner's profit? [H(281)]
- Every year an engineering consultant pays a bonus of $300 to his most industrious assistant, and $75 each to the rest of his staff. After how many years would his outlay be exactly $6,000 if all but two of his staff had merited the $300 bonus, but none of them more than twice? [H(221)]
- When I am as old as my father is now, I shall be five times as old as my son is now. By then my son will be eight years older than I am now. The combined ages of my father and myself are 100 years. How old is my son? [D(27)]

- A farmer owned a square field measuring exactly 2261 yards on each side, 1898 yards from one corner and 1009 yards from an adjacent corner stood a beech tree. A neighbor offered to purchase a triangular portion of the field, stipulating that a fence should be erected in a straight line from one side of the field to an adjacent side so that the beech tree was part of the fence. The farmer accepted the offer but made sure that the triangular portion was of minimum area. What was the area of the field the neighbor received, and how long was the fence? [D(63)]
- A farmer used 139 yards of fencing to enclose a rectangular field and to construct a fence along one of the diagonals of length 41 yards. He then found that a neighbor had fenced a one-third larger rectangular area in the same manner with less fencing. If all dimensions are integral yards, what are the dimensions of the neighbor's field? [D(77)]
- An engineer ordered 9 boxes of 100-ohm resistors and 1 box of 110-ohm resistors. When they arrived there were 10 resistors in each of the 10 boxes, but both the boxes and the resistors were unmarked. How many resistance measurements did he have to make to locate the box of 110-ohm resistors? [D(97)]
- Noel Wentworth-Longmore, the famous Oxford rower, was rowing downstream on Sunday when his favorite rowing cap fell in the water. So absorbed was he in one of Housman's poems that it was 10 minutes before he discovered his cap missing. He turned around and recovered the cap 1 mile downstream from where he initially lost it. Assuming constant speed and no allowance for turnaround, how fast was the river flowing? [D(108)]
- The family of a quality control engineer consisted of 1 grandmother, 1 grandfather, 2 fathers, 2 mothers, 4 children, 3 grandchildren, 1 brother, 2 sisters, 2 sons, 2 daughters, 1 father-in-law, 1 mother-in-law, and 1 daughter-in-law. What is the smallest possible number of persons in his family? [D(111)]
- An engineer must test three space suits in two test chambers. Each suit must be tested for 1 hour at each of two low pressures. He takes 10 minutes to load a suit in a chamber, set the pressure, and start the test; 4 minutes to change the pressure; and 10 minutes to unload a suit from a chamber. What is the minimum time to complete the tests? [D(115)]
- A man has an odd number of wires running from his basement to his roof. He has available some numbered tags and a meter which detects open and short circuits. In order to label the corresponding ends of the wires in the basement to those on the roof, what is the least number of round trips necessary? [D(120)]
- Not having colored ink with which to make red and black dots, the Wizard wrote numbers on the foreheads of his three apprentices instead and announced that each had been given a prime number (not necessarily distinct) and that the three numbers formed the sides of a triangle with prime perimeter. The first to deduce his own number was to be the Wizard's successor. Apprentice A noted that B had a 5 and C had a 7. After a long period of silence he announced his number. What was it? [D(128)]
- For a group picture a photographer wishes to arrange 10 people (all of different heights) in two rows of five each. Each person in the back row must be taller than the person in front of him. Also, the various heights are to increase in each row from left to right. In how many ways can this be done? [D(128)]
- A husband and wife start walking together, both stepping out on the right foot. The wife takes steps for every steps her husband takes and in walking a mile she takes 531 steps more than her husband. How many times in walking that distance did they simultaneously step out on the left foot? [D(128)]
- Supply the missing number in the following sequence: 10, 11, 12, 13, 14, 15, 16, 17, 20, 22, 24, ___ , 100, 121, 10,000. [D(159)]
- The game of reverse tic-tac-toe (known to some as toe-tac-tic) has the same rules as the standard game with one exception. The first player with three markers in a row loses. Can the player with the first move avoid being beaten? [D(166)]
- A bricklayer has 8 bricks. Seven of the bricks weigh the same amount and 1 is a little heavier than the others. If the man has a balance scale how can he find the heaviest brick in only 2 weighings? [D(169)]
- A rectangular picture, each of whose dimensions is an integral number of inches, has an ordinary rectangular frame 1 inch wide. Find the dimensions of the picture if the area of the picture and the area of the frame are equal. [D(198)]
- If a certain six-digit number is split into two parts, one constituting the first three digits and the other the last three digits, and the two parts are added and the resulting sum

squared, it is found that the product is the original number. What is the number? [D(183)]

- Rufus T. Flypaper drives two miles to work every morning. Very precise, he knows he must average 30 mph to arrive on time. One morning a women driver impedes him for the first mile, cutting his average to only 15 mph. He quickly calculated his proper speed for the rest of his trip to arrive on time. Assume that his car could do 120 mph. Could he arrive on time? [H(3)]
- Two squares are removed from opposite corners of a checkerboard leaving 62 squares. Can the checkerboard be filled with 31 dominos, each domino covering two adjacent squares? [H(14)]
- A chemist has three large test tubes and a beaker with 54 c.c. of elixir. Using the test tubes and ingenuity only, how can he retain 50 c.c. in the beaker? [H(23)]
- How many colors are necessary for the squares of a chessboard in order to assure that a bishop cannot move from one square to another of the same color? [H(25)]
- Six boys on a hockey team pick a captain by forming a circle and counting out until only one remains. Joe is given the option of deciding what number to count by. If he is second in the original counting order what number should he choose? [H(30)]
- In Greenwich Village, tic-tac-toe is played in an unusual way. At each turn a player marks as many squares as he wishes provided they are in the same vertical or horizontal row (they need not be adjacent). The winner is the one who marks the last square. Which player has the advantage and what strategy should he employ? [H(41)]
- With some sharp reasoning, you ought to be able to determine the last member of the sequence for which the first 20 members are: 11, 31, 71, 91, 32, 92, 13, 73, 14, 34, 74, 35, 95, 16, 76, 17, 37, 97, 38, 98, _____? [H(42)]
- Four players played a hand of hearts at $1 a point (pairwise payoffs). Dave lost $10 to Arch, $12 to Bob, and $20 to Chuck. How many hearts did poor Dave take in? [H(52)]
- A Solid State Physicist gives a small stag party. He invites his father's brother-in-law, his brother's father-in-law, his father-in-law's brother, and his brother-in-law's father. Find the number of guests. [H(60)]
- Assume that every tree has at least one leaf. If there are more trees than there are leaves on any tree, then there exist at least two trees with the same number of leaves. Is this conclusion valid? [H(61)]
- Between Kroflite and Beeline are five other towns. The seven towns are an integral number of miles from each other along a straight road. The towns are so spaced that if one knows the number of miles a person has traveled between any two towns he can determine the particular towns uniquely. What is the minimum distance between Kroflite and Beeline to make this possible? [H(71)]
- An expert gives team A only a 40% chance to win the World Series. Basing his calculation on this a gambler offers 6 to 5 odds on team B to win the first game. Is his judgment sound? [H(101)]
- In Puevigi, the game of craps is played with a referee calling the point by adding together the six faces (three on each die) visible from his vantage point. What is the probability of making 16 the hard way? (That is, by throwing two eights.) [H(113)]
- To stimulate his son in the pursuit of partial differential equations, a math professor offered to pay him $8 for every equation correctly solved and to fine him $5 for every incorrect solution. At the end of 26 problems, neither owed any money to the other. How many did the boy solve correctly? [H(131)]
- A necklace consists of pearls which increase uniformly from a weight of 1 carat for the end pearls to a weight of 100 carats for the middle pearl. If the necklace weighs altogether 1650 carats and the clasp and string together weigh as much (in carats) as the total number of pearls, how many pearls does the necklace contain? [H(146)]
- In Puevigi numbers such as 2, 5, 8, 10, etc. that are the sum of two squares, are considered sacred. Prove that the product of any number of sacred numbers is sacred. [H(162)]
- A wizard in Numerical Analysis has a gold chain with 7 links. A Lady Programmer challenges him to use the chain to buy 7 kisses, each kiss to be paid for, *separately*, with one chain link. What is the smallest number of cuts he will have to make in the chain? What is his sequence of payments? [H(165)]
- A circle of radius 1 inch is inscribed in an equilateral triangle. A smaller circle is inscribed at each vertex, tangent to the circle and two sides of the triangle. The process

is continued with progressively smaller circles. What is the sum of the circumference of all circles? [H(172)]

- When little Willie had sold all his lemonade he found he had $7.95 in nickels, dimes and quarters. There were 47 coins altogether and, having just started to study geometry, he noticed that the number of coins satisfied a triangle inequality, i.e., the sum of any two denominations was greater than the third. How many of each were there? [H(219)]
- No factorial can end in five zeros. What is the next smallest number of zeros in which a factorial can *not* end? [H(253)]
- Among those numbers whose literal representations in capitals consist of straight line segments only (e.g., FIVE), only one is "orthonymic", i.e., is equal to the number of segments which comprise it. Find the number. [H(262)]
- It is rumored that the inscription below appears on the purple moon boulder, a fragment of which was brought home by our Apollo 11 astronauts. If the visitors who inscribed it were humanoid, and if the plausible inference is made that it represents an addition in a place notation system, can one make a further inference as to the number of fingers these visitors had? [H(264)]
- A tennis club invites 32 players of equal ability to compete in an elimination tournament. If both John and Jim Smith are invited, what is the chance of their playing each other during the tournament? [BOPRV1(1)]
- Three men play a game with the understanding that the loser is to double the money of the other two. After three games, each has lost just once; and each has $24. How much did each have to start? [BOPRV1(3)]
- In how many zeros does 10,000! end? [BOPRV1(12)]
- In a contest: Jim beat Frank, and John; Frank beat Joe, Tom, and John; Joe beat Jim, and Tom; Tom beat Jim, and John; and John beat Joe. Rank the players according to their winning ability. [BOPRV1(13)]
- Around a cylindrical tube, outside circumference 4 inches, length 9 inches, 10 turns of a wire are helically wound. The ends of the wire coincide with the ends of the same cylindrical element. Find the length of the wire. [BOPRV1(17)]
- Fourbisher and LaRouche started working for different firms at the same salary. Last year Fourbisher had a raise of 10%, and LaRouche had a drop in pay of 10%. This year Fourbisher had the 10% drop and LaRouche the 10% raise. Who is making more now? [BOPRV1(54)]
- In the game of "Stogey," two players alternately place cigars on a rectangular table with the restriction that each new cigar must not touch any of the previously placed cigars. Can the 1st player assure himself of victory if we define the loser as the first player who finds himself without sufficient room to place a cigar? [B3(14)]
- If a number is added to its reversal and the process repeated with the result, a number will eventually be obtained which reads the same backward and forward. For a certain two-digit number this process must be repeated more than ten times to arrive at a palindromic number. What is this number? [B6(14)]
- Tickets for the senior prom were $1.00 for boys and 65 cents for girls. Although there were more boys than girls at the dance, the percentage of boys who did not go was twice the percentage of girls who did not go. Knowing this percentage and the total senior class enrollment, one can deduce the total receipts for the affair. If this enrollment is between 60 and 100, what was the total attendance at the prom? [B6(26)]
- A Bingo player has ten squares covered including the free center square. There are two squares covered in each row and column, but only the center square on the diagonals. The next three numbers called allow him to fill the first, second, and last squares in the first column and he cries, "Bingo!" What did his board look like? [B7(2)]
- Four swimming pool builders submit sealed bids to a homeowner who is required by law to accept the last bid that he sees, i.e., once he looks at a bid, he automatically rejects all previous bids. He is not required to open all the envelopes, of course. Assuming that all four bids are different, what procedure will maximize his chances of accepting the lowest bid, and what will be the probability of doing so? [B7(24)]
- How many colors are necessary to color the squares of a chessboard in such a way that the King cannot move from one square to another of the same color? (The case of the King castling should not be considered). [B7(9)]
- Jai Alai balls come in boxes of 8 and 15; so that 38 balls (one small box and two large) can be bought without having to break open a box, but not 37. What is the maximum number of balls which cannot be bought without breaking boxes? [B7(22)]

- There are four boys of different ages, heights and weights. Al, the youngest, is shorter than Bob, the heaviest, who is younger than Carl, the tallest. If no boy occupies the same rank in any two categories, how does Dan compare with the others? [B7(28)]
- All the members of a fraternity play basketball while all but one play ice hockey; yet the number of possible basketball teams (5 members) is the same as the number of possible ice hockey teams (6 members). Assuming there are enough members to form either type of team, how many are in the fraternity? [B7(29)]
- A motorist rotated his tires every 5000 miles. At the end of 10,000 miles the original spare got slashed, and was replaced. He continued rotating every 5000 miles, but avoided using the new tire as a spare until all five had worn equally. When the new tire first became a spare, what was the reading on the mileage gauge? [B9(22)]
- Leave six adjacent numbers of the face of a clock intact and rearrange the other six in such a way that the sum of every pair of adjacent numbers is prime. [B9(2)]
- A teenager wants to go out 2 consecutive nights out of a 3-day weekend. Permission for each night is obtained (or denied) by asking either Father or Mother. Father is known to be more likely to grant permission. However, if the same parent is asked on 2 consecutive days the answers are never the same 2 days running. Whom should he ask first? [B9(34)]
- An amphora contains black and green olives. An olive stuffer wishes to estimate which type is more abundant by sampling two olives at random. To optimize his estimate, should he sample with or without replacement? [B9(39)]
- While visiting Cape Kennedy, we came upon an engineer digging a hole. “How deep is that hole?” we asked. “Guess,” said the engineer, being evasive. “My height is exactly 5 feet 10 inches.” “How much deeper are you going?” we inquired. “I am one-third done,” was the answer, “and when I am finished my head will be twice as far below ground as it is now above ground.” How deep will that hole be when finished? [D(22)]
- Citizens of Franistan pay as much income tax (percentage-wise) as they make rupees per week. What is the optimal salary in Franistan? [D(32)]
- Obviously the smaller the compounding period, the greater the interest. How much does one dollar amount to after one year at 100 percent per annum interest, compounded continuously, i.e., instantaneously? [D(37)]
- A man packing 1-inch spheres into a rectangular tray fills the tray in a single layer with no slack, using a rectangular packing. Trying a different arrangement, he fits in one more sphere. He then uses a third arrangement and fits in still another sphere. What is the size of the tray? [D(66)]
- In Byzantine basketball there are 35 scores which are impossible for a team to total, one of them being 58. Naturally a free throw is worth fewer points than a field goal. What is the point value of each? [D(80)]
- In a certain community there are 1000 married couples. Two-thirds of the husbands who are taller than their wives are also heavier and three-quarters of the husbands who are heavier than their wives are also taller. If there are 120 wives who are taller and heavier than their husbands, how many husbands are taller and heavier than their wives? [D(104)]
- What is the largest number of pigeonholes that can be occupied by 100 pigeons if each hole is occupied, but no two holes contain the same number of pigeons? [D(176)]
- Tom, Dick, and Harry played a round of golf, each ending with a total of 72 strokes. Each pair competed against each other in match play (most holes won). Tom beat Dick, and Dick beat Harry. Does it follow that Tom beat Harry? [H(29)]
- In any gathering of six people prove that either three are mutually acquainted or three are mutually unacquainted. [H(69)]
- A lamp has three on-off buttons, all of which must be on for the lamp to light. A man wishes to turn on the lamp at a moment when only the second switch is off. He does not know this and proceeds to press the first button. Getting no result he presses the second and eventually, on the seventh trial, (never repeating any on-off configuration), the lamp finally lights. In what order did he press the buttons? [H(76)]
- In Bristol 90% of the citizens drink tea; 80% drink coffee; 70% drink whiskey; and 60% drink gin. No one drinks all four beverages. What percent of Bristol’s citizens drink liquor? [H(81)]
- A pirate buried his treasure on an island, a conspicuous landmark of which were three palm trees, each one 100 feet from the other two. Two of these trees were in a N-S line. The directions for finding the treasure read: “Proceed from southernmost tree 15 feet

due north, then 26 feet due west." Is the treasure buried within the triangle formed by the trees? [H(184)]

- The Ben Azouli are camped at an oasis 45 miles west of Tagaba. They decide to dynamite the Trans-Hadramaut railroad joining Taqaba to Maqaba, 60 miles north of the oasis. If the Azouli can cover 18 miles a day, how long will it take them to reach the railroad? [H(186)]
- Through binoculars a bird watcher observed a hummingbird feeder between one and two o'clock of an afternoon. He timed the visits and saw a ruby-throat take a drink at 1, 5, 6, 8, 15, 16, 19, 22, 27, 29, 32, 36, 43, 45, 49, 50, 57, and 58 minutes after the hour of one. The last visit he saw took place at two, at which time he left in perplexity. He knew from experience that a hummer's "feeding cycle" is remarkably stable and is generally between 5 and 15 minutes long. This one seemed rather erratic, to say the least. Can you advise him on what was going on? [H(204)]
- Three farmers, Adams, Brown and Clark all have farms containing the same number of acres. Adam's farm is most nearly square, the length being only 8 miles longer than the width. Clark has the most oblong farm, the length being 34 miles longer than the width. Brown's farm is intermediate between these two, the length being 28 miles longer then the width. If all the dimensions are in exact miles, what is the size of each farm? [H(216)]
- If you solve the alphametic WATER – HEAT = ICE, you will have the solution to this double riddle: "This bird's assured of his breakfast/ and these before steeds cause a wreck fast." Curiously, 70243 is the answer to *both* riddles! [H(258)]

References

Mathematical Bafflers edited by Angela Dunn, Dover publications; ISBN 0-486-23961-6. Paperback, 217 pages. (1980 with corrections from the 1964 edition and foreword by Angela Dunn). McGraw-Hill Book Company. Available on AMAZON for $10.95. I did not stumble across this book until around 1996 – and the title distracted me because it did not spell out Litton's "Problematical Recreations" – but when I saw the woodcut illustrations by Ed Kysar – and some familiar problems, I was nostalgically elated! You can *peek inside* the book online at AMAZON – try not to cheat though!

On the back cover of her book, we read (in part) the following:

Mathematical Bafflers gathers the prime problems from 12 years of the esteemed weekly *Problematical Recreations* which appeared in *Aviation Week* [and *Space Technology*] and *Electronic New*s – periodicals read by mathematicians, engineers, scientists, computer programmers, and over the years, by serious puzzlists who heard about the special section. To keep the quality at a peak, Angela Dunn and a team of mathematicians invented their own puzzles and gleaned the best submissions from an enormous reader response. Criteria were conceptual originality, ingenuity of approach, elegance of solution, with preference given to the kind of puzzle more vulnerable to a flash of inspiration than mere persistence. Categories include algebra, geometry, diophantine equations, logic and deduction, probability, insight and number theory.

The woodcut illustrations (by very gifted Ed Kysar) really add to the charm (as used in the 11 annual booklets they published). Also, creative titles at the top of each problem greatly enhances the lure of the problems! The book contains more than 150 problems. Note: James F. Hurley's book *Litton's Problematical Recreations* does not contain these cute problem titles.

Litton's Problematical Recreations by James F. Hurley, 1971, Van Nostrand Reinhold Company. AMAZON has Jim's book for under $10.00 hardback. Jim breaks his selection of the *over 600 problems* in the 12-year series into 8 chapters by topics. I recall stumbling across this book when I was with General Electric Company Aerospace and Electronic Systems Department in Utica, NY in 1977 browsing the math books in the town library. I recall my thrill and excitement when I saw these collected into a single book! I had to get it!!! I loved that Jim gave progressively harder problems by math topic. But the earlier chapters are as tough or tougher because they require that flash of insight and clever inspiration. Over the years I lost the book but in March 2013 Jim sent me an autographed copy. I hadn't yet seen Angela Dunn's book until later when I came to Nashua, NH in 1995. I got Angela's book at Barnes and Noble.

A photo of some of the annual booklets published by Litton Industries follows later. On the back page of each of these booklets was Litton's solicitation for engineers, mathematicians, and scientists to contact Litton for challenging careers. Some of the advertisements presented follow.

Excerpt From *Best of Problematical Recreations* Volume 1 (contains Booklets 1-5) - 1964

"Seeking new solutions to current technological problems is but a part of our activity at Litton. We continually pose questions concerning the future state-of-the-art and pursue the answers that will be needed tomorrow.

To do so, we need inquisitive engineers, mathematicians and scientists with the ability to anticipate and predict. We invite such independent thinkers to consider a career with us."

***Booklet 3* (1963)**

"To whom shall the world look for the enlargement of its knowledge? Who shall venture into untrodden regions, follow up the faint discoveries of earlier times, and resolve a thousand difficulties that baffle human ingenuity? You must look to the intellectual adventurers who are not afraid to go out of the common track of thought." -E. T. Channing (from a speech delivered at Harvard College in 1818)

We look to the engineer, the scientist, the investigative mind to search beneath the surface, to detect new materials and new methods, to create new concepts.

Our Plants, Laboratories, and Offices in the United States and throughout the Free World are expanding as rapidly as our space age technology, constantly creating new careers for independent thinkers.

Our fields of endeavor are: Defense Equipment and Systems, Business Machines, Communications Systems, Components, Geophysical Research and Instrumentation.

Booklet 4 **(1963)**

". . . it is the man, not the method, that solves the problem." -Heinrich Maschke (on *Present Problems of Algebra and Analysis: Congress of Arts and Science*, Vol. I, 1905)

"Our man is the independent engineer who, not content to browse along beaten paths, looks for new methods to yield more elegant solutions. He is our innovator, our growth, our future.

If you are such a man, your future can grow with Litton. The long-term potential for our products is responsible for the expansion of our Plants, Laboratories, and Offices in the United States and throughout the Free World. It is this continual advancement that is creating careers for the original engineer."

Booklet 5 **(1963)**

Front Page: The forty-one problems that follow were, for the most part, thoughtfully contributed by our readers. We pass them along for your mathematical entertainment.

Some require simple reasoning while others might challenge a professional mathematician. In all the emphasis has been on conciseness of statement, elegance of solution, and imaginative appeal.

When you have arrived at an answer, check with ours in the back of the booklet. May we hope they agree.

Back page: New methods of solution, new approaches, [and] new answers are being sought and encouraged at Litton in every area of our activity. At the prevailing rate of change in technology, "keeping abreast" is not sufficient. It is vital to anticipate, to foresee, to predict.

We look to inquisitive minds for this vigorous expansion of man's knowledge. We invite imaginative engineers, scientists, mathematicians to investigate a career with us.

Our Plants, Laboratories, and Offices in the United States and throughout the Free World continue to grow, creating new positions in our fields: Electronic Systems; Electronic Components; Business Machines, Equipment and Supplies; Commercial Electronic Equipment and Services; Nuclear-Powered Submarines, Surface Vessels.

Booklet 6 **(1964)**

In our search for new answers, new concepts to advance our technology, we find the *uncommon* denominator, the untried direction, the original approach most often leads to innovations. We at Litton are known for being self-starters with the courage to get off the beaten track.

Engineers, mathematicians and scientists looking for mental elbowroom and longing for the freedom to forge new trails are invited to investigate a career with us.

We have Plants, Laboratories, and Offices throughout the United States and the Free World. Our fields of endeavor are wide and varied. Generally: Electronic Systems; Electronic Components; Business Machines, Equipment and Supplies; Commercial Electronic Equipment and Services; Nuclear-Powered Submarines, Surface Vessels.

Booklet 7 **(1965)**

Open-page of booklet: Seventh in a Series. 1 + 6 + 7 = 143

The strange mathematics above can be readily proven. In our efforts to avoid the cumbersome and maintain conciseness, we combined the first five books of this series into one handy edition, *The Best of Problematical Recreations – Volume 1,* now replacing the out-of-print, individual booklets one through five. Our sixth and seventh booklets are single compilations of 40 and 43 problems, respectively, representing our continuing booklet series. All three editions (143 problems!) are available upon request by dropping a card to: Problematical Recreations, Litton Industries, Beverley Hills, California.

Back Page: Proof of the unique solutions being found at Litton is our continual development of new methods, new materials, new procedures. The advanced equipment that attends is answering the need for greater accuracy, increased efficiency and more reliability in electronic components and systems.

We consider our recognition of the individual contribution to be the foundation of our accomplishments. We therefore encourage original and inventive engineers, mathematicians, and scientists to join us.

Booklet 8 **(1966)**

Back Page: We hope you have enjoyed this set of mathematical challenges designed to delight your inventive faculties. We at Litton delight in the application of mathematical and scientific disciplines to the practical problems facing us in our fast-moving, technological fields of endeavor.

If you are an engineer, mathematician, or scientist with the ability to translate your skills into advanced electronic components and systems, you are invited to apply for a Litton career.

Booklet 9 **(1967)**

[1st page] – Our series is raised to the ninth power with this new edition of mathematical challenges largely contributed by our readers. We thank them for their consistently novel offerings and welcome all readers to follow suit and extend, what we hope will be, an infinite sequence. [back page advertisement] – Our Plants, Laboratories, and Facilities throughout the United States and the Free World are continually expanding and creating new positions. We at Litton consider good problem-solvers to be the foundation of our technological accomplishments. If you are an engineer, mathematician or scientist and would like to apply your ingenuity to advanced electronic components and systems, we suggest you consider a Litton career.

Booklet 11 **(1970)**

If you've found this collection of rigorous mental gymnastics stimulating and entertaining, we suggest you take your talents to LIEPS (Litton Industries Extended Placement System). Your qualifications can then be known to all our Litton divisions in the United States and throughout the Free World. You can be placed in the area of our endeavors best suited to your capabilities: Business Systems and Equipment; Professional Services and Equipment; Industrial Systems and Equipment: Defense and Marine Systems.

Engineers, mathematicians, and scientists are invited to address an inquiry to: LIEPS (Litton Industries Extended Placement System), 360 North Crescent Drive, Beverley Hills, California 90213

Political Legitimacy Through The Ages

Ken Shea

"Politics is the shadow cast on society by big business." -John Dewey

"Technique is the boundary of democracy. What technique wins, democracy loses." -Jacques Ellul

As few as three or four millennia ago, mankind, the uncontrollable and occasionally tumultuous forces of nature, and society were largely considered one. The implications from this undifferentiated apprehension were profound, but mostly took the form of mythopoeia and believing that mankind's fortunes waxed and waned due to awesome, uncontrollable forces. Propitiations to the gods could be made, of course, but the idea that the course of society could be significantly and directly altered by mankind in some fashion was considered dangerously exotic or outright incomprehensible to most people. Before Athenian democracy and the Greek philosophers, particularly the fifth-century BCE Sophists (e.g., Antiphon) and Plato (b. 428 BCE), nature and politics were essentially inextricable; ontologically, politics as such arguably didn't exist yet as an independent mode of thought or sophisticated field of inquiry. Eventually both political philosophy and politics became differentiated from the earlier skein of mankind, nature, and society and reciprocal exchanges were possible between political philosophy and politics. Reifying these concepts, Plato hoped the artistry of the statesman would overwhelm the insincere promises of the mere politician. Considering Plato's foundational influence, it wouldn't be much of an exaggeration to apply British philosopher Alfred North Whitehead's famous comments on European philosophy in general ("a series of footnotes to Plato") to political philosophy in particular, such was Plato's reverberating impact and ingenuity in conceptualizing politics as an entire system of interlocking roles, procedures, institutions, and assumptions (cf. Plato's *Republic*, Plato's *Laws*). In fact, the Roman statesman Cicero includes the following rhetorical question in his first-century BCE Socratic dialogue, *De re publica*: "What better authority can we cite than Plato?"

But what are political philosophy and politics all about? Political philosophy seeks to clarify the background assumptions upon which politics is predicated. Therefore, political philosophy is concerned with the following kinds of ostensibly abstract issues: rights, justice, liberty, duties, law, and political legitimacy. The distinction between political philosophy and politics is analogous to that between philosophy and science more generally insofar as philosophers will inspect the background assumptions of science (e.g., naïve realism) while science - viz., political science or empirical science proper - will be concerned more narrowly with the facts on the ground and the rules of engagement with those facts. What exactly are these political facts on the ground and how do they define, and get defined by, the issues political philosophers perennially grapple with? Politics, at bottom, may be a way of exchanging power for the promise of security to better navigate constants in human affairs, such as change, resource scarcity, and the fact that groups in society seek competitive advantage within and between themselves. James Madison would much later say that, "if men were angels, no government would be necessary"; this is only half-true because of resource scarcity, partial rights, and concentration of wealth. The role of private power, on the whole, has been criminally underappreciated qua a facilitator or check on freedom, which has at least two aspects, viz., freedom from government coercion, i.e., the right-wing libertarian conceptualization of liberty, and, second, the actual

means to carry out one's desires (cf. Milton Friedman's *Free to Choose*, Friedrich Hayek's *The Road to Serfdom*, Charles Murray's *In Our Hands: A Plan to Replace the Welfare State*).

Put another way, politics is fundamentally about power, how it is attained, justified, wielded, and to whom the fruits of that exercise of power flow. The word politics can be historically traced to Aristotle's *Politics*, an eight-part text, which some historians consider to be a companion piece to *Nicomachean Ethics*, such was Aristotle's earnest striving towards virtuous, legitimate, general welfare-promoting rule; please excuse Aristotle's qualified defenses of slavery, monarchy, and aristocracy. Etymologically, politics itself means something like the "affairs of the cities"; *polis* means city in Greek. The conflation of politics and ethics - an understandably head-scratching combination to modern minds - came naturally for the ancient Greeks since they made fewer distinctions between personal and social modes, which could help explain why Aristotle's *Politics* and *Nicomachean Ethics* would be linked. Aristotle essentially concludes in Book IV of *Politics* that a polity, or constitutional form of government, is potentially ideal because, all things being equal, such would consistently tend to promote widespread personal fulfillment and champion the common interest by harmonizing class concerns; Aristotle considered democracy a "defective" and "perverted" politics compared to polity because the former, democracy, was prone to eventual concentration of power, demagoguery (*agogos* means "leading" in Greek), and mob rule. The mob can be more charitably called the *demos*, which historically meant the common people of ancient Greece; today, the term *demos* is used to refer to the electorate in a democracy. Etymologically, the word democracy itself means power (Greek *kratia* for -cracy, meaning power or rule) of the people (Greek *demos*, meaning the people).

The phrase *de re publica* is Latin and treated synonymously with *res publica*, which might literally translate to a "public matter." Today, *res publica* is used coterminously with the word commonwealth. Already, the reader will appreciate how far the fifth-century BCE Sophists and Plato have shifted the landscape and, in critical respects, created the landscape. In the dialogue *Laws*, Plato, who rarely missed an opportunity to blend mathematics, philosophy, and inchoate civics, homed in on the number 5,040 for the ideal number of citizens composing a *polis* partly because 5,040 is a superior highly composite number boasting a staggering 60 divisors (5,040 is the sum of 42 consecutive prime numbers, seven factorial, and the product of 10 times 9 times 8 times 7). Plato's rationale seemed to be that a highly composite number would be advantageous for divvying up positions and roles in a society. The trouble would come as the de facto interregnum of the Hellenistic Age - historians trace this period from the death of Macedonian king Alexander the Great in 323 BCE to the death of the Roman Republic and birth of the Roman Empire right after the Battle of Actium in 31 BCE - marked a transition from the sheltered reality of the city (*polis*) to the more unbounded, expansionist nature of empire. The Seleucid Empire, founded by and ruled dynastically starting with Seleucus I Nicator, existed throughout much of the Hellenistic Age and accumulated significant chunks of Alexander the Great's once-grand Macedonian Empire post-323 BCE before succumbing to Roman general Pompey the Great, a pivotal figure in the Roman Republic's transition to Roman Empire.

Meanwhile, the Cynics, Stoics, and Epicureans sought to enlarge the depth of field from the traditional obligations of citizenship and questioned the basic values inhering within the *polis*. Sheldon Wolin lyrically writes in *Politics and Vision* that, "The strong elements of despair and withdrawal that colored Cynicism and Epicureanism were nourished by an anti-political impulse which could not be concealed by their temporizing and grudging acknowledgment of some utility in a political order." Epicurus went as far as to suggest, "we must free ourselves from the prison

of affairs and politics" (*Politics and Vision*, pg. 71). These emerging philosophical schools viewed the individual life as more precious, and the philosophers associated with these schools largely encouraged acolytes to universalize their sense of citizenship to the entire cosmos, hence taking a considerable amount of liberty with the notion of citizenship. Centuries later, Marcus Aurelius in *Meditations* would glancingly articulate this Stoic ideal by saying, "the world is in a manner a state." Because these universalized conceptions of man basically eschewed civic identification as such, let alone civic engagement, considering them political would be magnanimous. In terms of scale, however, these broader or more tenuous conceptions of citizenship do function as a useful metaphor for the Hellenistic period, a kind of interregnum or gawky adolescence between city and empire. Isopolity and the more extreme sympolity can be seen as equally awkward stopgaps on the rocky road from city to empire.

With sprawling areas increasingly at stake, one way to bind people together is through myth tethered to hierarchy. As the attainment and wielding of power usually requires or, at least, benefits from some kind of myth or attempt at political legitimation in an ordered society, emperors and monarchs throughout history have predictably played the divinity card. The Mandate of Heaven that putatively informed various Chinese dynasties and the Imperial cult of ancient Rome were early attempts at shoring up political legitimacy under celestial pretexts. One popular, and seemingly incontestable, way of purporting to have political legitimacy through the ages has been to say that some sort of celestial being has sanctioned one extraordinary individual, or special group, having power and implicitly nodded at the subjugation of a less fortunate group composed of lesser beings - the divine right of kings comes to mind. Church and state, for instance, significantly blurred when French and English monarchs provided the royal (a.k.a., King's) touch in the sacramental ritual of laying on of hands to supposedly cure scrofula (i.e., mycobacterial cervical lymphadenitis, an abnormality of the lymph nodes associated with tuberculosis), or the King's evil, as scrofula was apparently misapprehended at the time. Shakespeare's *Macbeth* even references Edward the Confessor's legendary touch ("A most miraculous work in this good king," gushes Malcolm in Act IV, Scene III). Monarchs would hope to cement dynasties or merely heighten the legitimacy of their reign by miraculously curing diseases, which often naturally went into remission. Clearly, this entire situation left a lot to be desired in terms of scientific acumen, but the religious practice of laying on of hands did outwardly broaden political legitimacy for the monarch across social classes. If nothing else, the religious practice of laying on of hands highlights the centuries-long function that the Roman Catholic Church served as a quasi-state granting, bolstering, or withdrawing claims of political legitimacy to European monarchs in the Middle Ages and Early Modern Period.

Over time, both scientific understanding and colonial ambitions grew. The European colonizers, thus, seized on a self-serving explanation for colonialism that they felt sufficiently justified exploiting poorer peoples in Asia and Africa: exposure to European culture does a world of good for an occupied country's development, backwards manners, and spiritual health. Or so the stated rationale went. Domestically, a different story was being told by the Enlightenment-era political philosopher John Locke, who would impress Thomas Jefferson with a concept known as the consent of the governed. The social contract theorist John Locke maintained that governments gained moral and political legitimacy through shoring up consent from those governed, which consequently justified the use of state power. Thomas Jefferson would go one step further than invoking the consent of the governed in the preamble to the U.S. Declaration of Independence: Thomas Jefferson grandly asserted that "unalienable" rights and "self-evident" truths were "endowed by their creator." The second sentence of the preamble, confusingly,

informs the reader that these "unalienable" rights need securing by governments "deriving their just powers from the consent of the governed." The word unalienable, and the more modern inalienable, literally denotes that which cannot be taken from the possessor, which would seem to render the follow-up sentence about government safeguarding a non sequitur. James Madison simply reasoned the government “should be so constituted as to protect the minority of the opulent against the majority.” John Jay, esteemed Founding Father and the first Chief Justice of the Supreme Court of the United States, more bluntly said, "those who own the country ought to govern it." This sort of callous attitude, betraying realpolitik, came to inform ensuing U.S. imperialism and, relatedly, the current decrepit state of U.S. electoral politics, which the late, great political philosopher Sheldon Wolin characterized as highly illiberal in *Democracy Incorporated: Managed Democracy and the Specter of Inverted Totalitarianism*.

Bearing these later developments in mind, Founding Father and Federalist Alexander Hamilton was idealistic when he declared, "The fabric of American empire ought to rest on the solid basis of the consent of the people. The streams of national power ought to flow immediately from the pure original fountain of all legitimate authority," at a time when the U.S. Electoral College tempered the passions of the *hoi polloi* and state legislatures elected members to the U.S. Senate, which was once actually known as the “cooling saucer.” The latter U.S. Senate election process would cause much chaos, bribery, and violence throughout the 19th century until the 17th Amendment was ratified and direct election of senators came to pass in 1913. Further, this concept of the consent of the governed remains difficult to square with the practice of gerrymandering, multiplying federal agencies peopled with unelected bureaucrats, and the fact that six of the last seven presidential elections in the United States have seen the Democratic candidate win the popular vote over the Republican candidate. (Only two major parties are typically tolerated in the United States, though Ross Perot garnered 18.9 percent of the popular vote in the 1992 U.S. presidential election. The exasperation from both major parties reached a fever pitch when “spoiler” Ralph Nader had the audacity to run in the closely contested 2000 U.S. presidential election.) Structurally, the U.S. Electoral College itself obviously has roots in slavery and shrewd political calculation - Thomas Jefferson, in fact, is known by historians as The Negro President (e.g., by historian Garry Wills), and Federalists at the time bristled at the so-called slave power of three-fifths representation in the Electoral College that bestowed Thomas Jefferson the 1800 U.S. presidential election. Thomas Jefferson, the third president of the United States and purported Author of America, is an enormously complicated figure. On the one hand, Thomas Jefferson may have owned 600 slaves and, on the other, he harbored genuinely egalitarian tendencies, though perhaps not as heartfeltly as Thomas Paine (cf. *Rights of Man*), and wanted a Constitutional Convention every generation to ensure freshness of ideas. To put this all in perspective, the U.S. Constitution came into force in 1789, when about six percent of the population had the right to vote. Property-owning white males were waved through and permitted to vote, but Native Americans, blacks, and women were turned back, if they weren't killed or enslaved outright. The "unalienable" rights and "self-evident" truths "endowed" by the Almighty apparently did not initially encompass the latter three groups. White women were permitted to vote 100 years ago in 1920 with the ratification of the 19th Amendment, 131 years after the U.S. Constitution came into force. The “consent of the people” was soaring rhetoric when 94 percent of the population was effectively disenfranchised. Native Americans had to wait longer than the 14th Amendment and Indian Citizenship Act of 1924 to receive full citizenship and suffrage in a way that mirrored the trajectories of blacks and women achieving the franchise - gradually and with significant setbacks across individual states. The

Voting Rights Act of 1965 sought to prohibit voting discrimination nationally and update the Reconstruction Amendments to guarantee civil rights from coast to coast for all U.S. citizens.

These issues collectively revolve around how far the fabric of America extends. Alexander Hamilton, for example, emphasized implied powers when he mentioned American empire, as opposed to a constitutional republic outlining a separation of powers, in *The Federalist Papers*. After all, who can say that providing for the common defense and promoting the general welfare for the American people doesn't necessitate taking proactive steps outside the explicit language of The Constitution, assuming an implied powers interpretation of The Constitution? In *The Federalist* No. 22, Alexander Hamilton refers to the fledgling constitutional republic (i.e., a form of indirect democracy whereby representatives are theoretically elected) of the United States as an empire, thereby anticipating the imperialist aggression of the Spanish-American War, Philippine-American War, and annexation of Guam, Puerto Rico, Hawaii, and the Philippines by the United States that would come decades later at the turn of the 20th century. Many historians of vastly different political bents, such as Gore Vidal and Niall Ferguson, consider these spats between the United States and Spain the beginnings of U.S. empire. The *fin de siècle* debates over whether the United States should be inward-looking or imperialistic are exhaustively chronicled in Stephen Kinzer's recent book *The True Flag: Theodore Roosevelt, Mark Twain, and the Birth of American Empire*. U.S. imperialism got underway in earnest as Theodore Roosevelt proclaimed that "flagrant" and "chronic" wrongdoing by a weaker Latin American nation legitimated invasion; the United States would, of course, unilaterally decide all of this. This ad hoc process was called Roosevelt's corollary to the Monroe Doctrine. Stephen Kinzer, on the whole, concluded that Americans have coexisting instincts of imperialism and isolationism. Interestingly, the United States didn't have to choose between the two when it expanded its borders considerably without seafaring via, chronologically: Thomas Jefferson inking the Louisiana Purchase in 1803 and acquiring nearly a million square miles from France (Napoleon Bonaparte needed funds to finance the post-revolutionary conflicts), the Adams-Onís Treaty (a.k.a., Florida Purchase Treaty) of 1819 that shored up land from Spain, and bringing the Mexican-American War to a close with the Treaty of Guadalupe Hidalgo in 1848 and securing land from Mexico. A spirit of manifest destiny truly pervaded 19th-century America.

After the impassioned debates about America's part to play on the world's stage had been sufficiently aired, the quixotic Wilsonian quest to "make the world safe for democracy" with the Committee on Public Information (cf. Edward Bernays's *Propaganda*) was echoed by the Truman Doctrine, fueled by the National Security Act of 1947, and belligerent Kennedy Doctrine roughly one, two, and three generations later. One will scan the U.S. Constitution in vain in search of justification for such globe-trotting missions, which necessitate the leadership of the self-deputized United States maniacally scouring the entire planet for perceived deviant behavior; the threat of communism proved useful to rally the troops for a time. Decades later, the Reagan Doctrine and Bush Doctrine simply dispensed with a few niceties in deterring democracy abroad (e.g., Nicaragua) and rolling back civil liberties at home (e.g., USA PATRIOT Act), purportedly to fight the global war on terror. The concept of democracy, in principle, had gone from a way of empowering the *demos* (remember that democracy derives from *demos* and *kratia* in Greek) to dubiously legitimizing the internationally unpopular imperialist aggression of the United States in the name of supposedly spreading democracy and, curiously, so-called free market capitalism, which is said to be almost inexorably paired with democracy by the World Economic Forum and International Monetary Fund (cf. Washington Consensus). In the immediate wake of the Soviet Union's dissolution, political economist Francis Fukuyama served

up a preposterous riposte to Karl Marx's historical materialism by declaring that humanity had reached the eschatological "end of history" with democratic capitalism pedestalled as the crowning achievement. A more sober assessment will show that the worldwide adoption of any political or economic framework (e.g., Western liberal democracy or communism) is intrinsically a utopian fantasy; cultures are simply too different. What's more, markets are almost never free in the Rothbardian sense (is that even desirable?) because the overwhelming majority of governments establish rules for contracts, charters, commerce, taxation, and hundreds of other decisive factors; the U.S. economy is marked by substantial rent seeking and corporate welfare, which is the antithesis to true *laissez-faire* (French for "let do") economics and widely actualizing the Schumpterian concept of creative destruction. Presently, the only creative destruction is that done to the public coffers, democracy, and trust in the system.

A country can have an illiberal democracy or no democracy to speak of and still have capitalism, or a country can feature democratic institutions with nationalization of public assets, high welfare spending, and stringently regulated trading. In spite of this apparent variance, the evidence increasingly shows that actual democracy is incompatible with unregulated capitalism, grotesque levels of inequality, and concentrated wealth (cf. Joseph Stiglitz's *The Price of Inequality: How Today's Divided Society Endangers Our Future*). The bottom seventy percent socioeconomically in the United States have scant impact on federal policy in the sense that their wishes are not reflected in legislation; the opposite is increasingly the case as a citizen moves from the 70th percentile socioeconomically to the 99th percentile socioeconomically. This situation does not describe an actual democracy. Corporate capture, the manufacture of consent, and managed democracy have rendered federal elections in the United States all but theater (cf. Princeton's "Testing Theories of American Politics: Elites, Interest Groups, and Average Citizens"). Voter turnout in the United States (voter turnout percentage = raw turnout number among voting-age population (VAP)/raw number of VAP in underlying population X 100) hasn't exceeded more than two-thirds of the electorate at any point in the last century in terms of these dramatized quadrennial U.S. presidential elections. That's exactly the kind of yawning apathy one would expect in such an illiberal system awash in corporate investments and pliant career politicians. The United States would be a wonderful place to start spreading actual democracy but, instead, the neoconservatives and neoliberals - two terms almost tailormade to rouse George Orwell, and perhaps even Franz Kafka, for their reversals of meaning - in the United States have conspired to preclude actual democracy from breaking out internationally or domestically. There might be no easy way out electorally. Radical reforms of some kind will have to occur to sidestep the descent into corporate tyranny. Consumer advocate and civil libertarian Ralph Nader has a series of sensible proposals in *The Seventeen Solutions: Bold Ideas for Our American Future* designed to serve as a roadmap to enliven Americans' sense of citizenship moving forward. There's a window for positive change, but it is quickly closing.

"Societies grow into systems. The systems require management and are therefore increasingly wielded, like a tool or a weapon, by those who have power. The rest of the population is still needed to do specific things. But the citizens are not needed to contribute to the form or direction of the society. The more "advanced" the civilization, the more irrelevant the citizen becomes." -John Ralson Saul

"What is at stake in democratic politics is whether ordinary men and women can recognize that their concerns are best protected and cultivated under a regime whose actions are governed by principles of commonality, equality, and fairness, a regime in which taking part in politics becomes a way of staking out and sharing in a common life and its forms of self-fulfillment." -Sheldon Wolin

Works Consulted

Bernays, Edward. *Propaganda*. New York, New York. Ig Publishing. 2005.

Chomsky, Noam. *Chomsky on Anarchism*. Oakland, California. Edinburgh, Scotland. AK Press. 2005.

Chomsky, Noam. *Deterring Democracy*. New York, New York. Hill and Wang. 1992.

Chomsky, Noam. *Failed States: The Abuse of Power and the Assault on Democracy*. New York, New York. Metropolitan Books. 2006.

Chomsky, Noam. *Hegemony or Survival: America's Quest for Global Dominance*. New York, New York. Metropolitan Books. 2003.

Chomsky, Noam, Edward S. Herman. *Manufacturing Consent: The Political Economy of the Mass Media*. New York, New York. Pantheon Books. 2002.

"Committee on Public Information" - https://en.wikipedia.org/wiki/Committee_on_Public_Information

Ellul, Jacques. *Propaganda: The Formation of Men's Attitudes*. New York, New York. Vintage Books. 1973.

Ellul, Jacques. *The Technological Society*. Alfred A. Knopf, Random House. 1964.

Federalist No. 22 - https://founders.archives.gov/documents/Hamilton/01-04-02-0179

Ferguson, Niall. *Colossus: The Price of America's Empire*. New York, New York. The Penguin Press. 2006.

Frank, Thomas. *Listen, Liberal: Or, What Ever Happened to the Party of the People?* New York, New York. Metropolitan Books. 2016.

Frank, Thomas. *What's the Matter With Kansas: How Conservatives Won the Heart of America*. New York, New York. Metropolitan Books. 2004.

Frank, Thomas. *One Market Under God*. New York, New York. Doubleday. 2000.

Friedman, Milton. *Free to Choose: A Personal Statement*. Boston, Massachusetts. Mariner Books. 1990.

Gray, John. *Black Mass: Apocalyptic Religion and the Death of Utopia*. New York, New York. Farrar, Straus and Giroux. 2007.

Gray, John. *False Dawn: The Delusions of Global Capitalism*. New York, New York. Granta Books. 1998.

Hedges, Chris. *America: The Farewell Tour*. New York, New York. Simon & Schuster. 2018.

Hedges, Chris. *Death of the Liberal Class*. New York, New York. Nation Books. 2010.

Hedges, Chris. *Wages of Rebellion*. New York, New York. Nation Books. 2015.

Hedges, Chris. *The World As It Is: Dispatches on the Myth of Human Progress*. New York, New York. Nation Books. 2013.

Hitchens, Christopher. *Thomas Jefferson: Author of America*. New York, New York. HarperCollins. 2005.

Jefferson, Thomas. *Writings: Autobiography, Notes on the State of Virginia, Public and Private Papers, Addresses, Letters.* New York, New York. Library of America. 1984.

"Karl Marx" - https://plato.stanford.edu/entries/marx/

Kinzer, Stephen. *The True Flag: Theodore Roosevelt, Mark Twain, and the Birth of American Empire*. New York, New York. Henry Holt and Company. 2017.

Klein, Naomi. *The Shock Doctrine: The Rise of Disaster Capitalism*. New York, New York. Henry Holt & Company. 2007.

Lofgren, Mike. *The Deep State: The Fall of the Constitution and the Rise of a Shadow Government*. New York, New York. Penguin Books. 2016.

McCoy, Alfred. *In the Shadows of the American Century: The Rise and Decline of US Global Power*. Chicago, Illinois. Haymarket Books. 2017.

Murphy, Cullen. *Are We Rome?: The Fall of Empire and the Fate of America*. New York, New York. Houghton Mifflin Company. 2007.

Murray, Charles. *In Our Hands: A Plan to Replace the Welfare State*. Washington, D.C. American Enterprise Group. 2006.

Murray, Charles. *By the People: Rebuilding Liberty Without Permission*. New York, New York. Crown Forum. 2015.

Nader, Ralph. *The Seventeen Solutions: Bold Ideas for Our American Future*. New York, New York. HarperCollins. 2012.

Nader, Ralph. *Unstoppable: The Emerging Left-Right Alliance to Dismantle the Corporate State*. New York, New York. Nation Books. 2014.

"National Security Act of 1947" - https://en.wikipedia.org/wiki/National_Security_Act_of_1947

Nichols, John, McChesney, Robert. *Dollarocracy: How the Money and Media Election Complex is Destroying America*. New York, New York. Nation Books. 2013.

Paine, Thomas. *Collected Writings: Common Sense, The Crisis, Rights of Man, The Age of Reason, Pamphlets, Articles, & Letters*. Library of America. New York, New York. Penguin Putnam. 1995.

Piketty, Thomas. *Capital in the Twenty-First Century*. Cambridge, Massachusetts. Harvard University Press. 2014.

Rocker, Rudolf. *Anarcho-Syndicalism: Theory and Practice*. Oakland, California. Edinburgh, Scotland. AK Press. 2004.

"Roosevelt Corollary" - https://en.wikipedia.org/wiki/Monroe_Doctrine#The_"Roosevelt_Corollary" https://en.wikipedia.org/wiki/Roosevelt_Corollary

Russell, Bertrand. *A History of Western Philosophy*. New York, New York. Simon & Schuster. 1972.

Saul, John Ralston. *The Collapse of Globalism: And the Reinvention of the World*. Toronto, Ontario. Viking Canada. 2005.

Saul, John Ralston. *Voltaire's Bastards: The Dictatorship of Reason in the West*. New York, New York. Simon & Schuster. 2013.

Schumpeter, Joseph. *Capitalism, Socialism, and Democracy* (Third Edition). New York, New York. Harper Perennial. 2008.

Sowell, Thomas. *Intellectual and Society*. New York, New York. Basic Books. 2011.

Sowell, Thomas. *Knowledge and Decisions*. New York, New York. Basic Books. 1996.

Stiglitz, Joseph. *Making Globalization Work*. New York, New York. W.W. Norton & Company. 2006.

Stiglitz, Joseph. *The Price of Inequality: How Today's Divided Society Endangers Our Future*. New York, New York. W.W. Norton & Company. 2012.

"Testing Theories of American Politics: Elites, Interest Groups, and Average Citizens" -

https://scholar.princeton.edu/sites/default/files/mgilens/files/gilens_and_page_2014_-testing_theories_of_american_politics.doc.pdf

Vidal, Gore. *Burr*. New York, New York. Vintage Books. 1973.

Vidal, Gore. *Empire*. New York, New York. Random House. 1987.

Vidal, Gore. *United States: Essays 1952-1992*. New York, New York. Random House. 1993.

Vidal, Gore. *The Last Empire: Essays 1992-2000*. New York, New York. Doubleday. 2001.

"Voter turnout in the United States presidential elections" -

https://en.wikipedia.org/wiki/Voter_turnout_in_the_United_States_presidential_elections

"Voting Rights Act of 1965" - https://en.wikipedia.org/wiki/Voting_Rights_Act_of_1965

"Washington Consensus" - https://en.wikipedia.org/wiki/Washington_Consensus

Wills, Garry. *Negro President: Jefferson and the Slave Power*. Boston, Massachusetts. Mariner Books. 2005.

Wolin, Sheldon. *Democracy, Incorporated: Managed Democracy and the Specter of Inverted Totalitarianism*. Princeton, New Jersey. Princeton University Press. 2008.

Wolin, Sheldon. *Politics and Vision: Continuity and Innovation in Western Political Thought*. Princeton, New Jersey. Princeton University Press. 2016.

Wolin, Sheldon. *The Presence of the Past: Essays on the State and the Constitution*. Baltimore, Maryland. The Johns Hopkins University Press. 1989.

Foreword to *Stains Upon the Silence: Something for No One*

Kadam Isbe, Ph.D.

The unclassifiable ruminations of the author of the present work, *Stains Upon the Silence* — something for no one, blur the lines between philosophy, cosmology, poetry and humor. Perhaps they are conceptual free verse, surreal, pithy, sometimes sardonic. May wanders in a hyperdimensional Garden of Forking paths throughout a hologrammic Library of Babel. Each letter of his writings, and certainly the spaces between the letters, themselves, and all possible combinatoric arrangements of these, are clearly isomorphic to each point in the Cosmic hologram; linked by reverse causality to all information which exists on the future event horizon, in this series of divagations, a conceptual Drunkard's Walk.

If May is an atheist, then he writes only for God. Aspiring to become a popular writer, he writes for beings which do not, and never will, exist. He recognizes that reality, a Rorschach inkblot interpreted as if it were a geometric theorem and a geometric theorem interpreted as if it were a Rorschach inkblot, has made parody obsolete. The libraries of the 'future' in each of Hugh Everett's Many-Worlds will be strewn with uncountable numbers of sublime corpses of amortal beings, who spent their endless lives attempting to determine the most optimal order of the 54 factorial arrangements of the subsections of this work, in order to extract each particle of meaning. This is certainly infinite time well spent.

"I know of an uncouth region whose librarians repudiate the vain and superstitious custom of finding a meaning in books and equate it with that of finding a meaning in dreams or in the chaotic lines of one's palm...the books signify nothing in themselves. This dictum, we shall see, is not entirely fallacious." — Jorge Luis Borges, "The Library of Babel," page 3

If, contra J. W. von Goethe, everything that does not exist is a symbol of the eternal, then this is certainly true of the wisdom of the present work.

Professor Kadam Isbe, Transontological Studies, Kafka International University, Akkad

Foreword to *Stains Upon the Silence: Something for No One*

Anonymous

I've done some writing myself, and have found that one of the hardest things to do is sustain humor. Good humor is more than stringing together jokes, there has to be pacing, a rise and fall, which you do very well. I'm impressed how you find so many twists and paradoxes and absurdities where I wouldn't even have looked for them.

I actually think it's more like poetry than an attempt at humor, though. I think that finding those twists and paradoxes is how you deal with unknowable things, and make them less daunting or even frightening. Each one encapsulates where reason isn't good enough to lead to absolute truth. Sometimes. Other times you are just looking for laughs. It's good, though. High-brow without being stodgy or tedious. They're good laughs, too, or at least good tries at good laughs, with a good success rate.

Preface to *Stains Upon the Silence: Something for No One*

Richard May, a.k.a., May-Tzu

Someone asked me what *Stains Upon the Silence: Something for No One* was about. If I knew what it was about, I wouldn't have written it. An editor once suggested that these writings are an admixture of what Tibetan Buddhism calls "crazy wisdom" with sane folly.

"But I don't want to go among mad people," Alice remarked.

"Oh, you can't help that," said the Cat: "we're all mad here. I'm mad. You're mad."

"How do you know I'm mad?" said Alice.

"You must be," said the Cat, "or you wouldn't have come here."

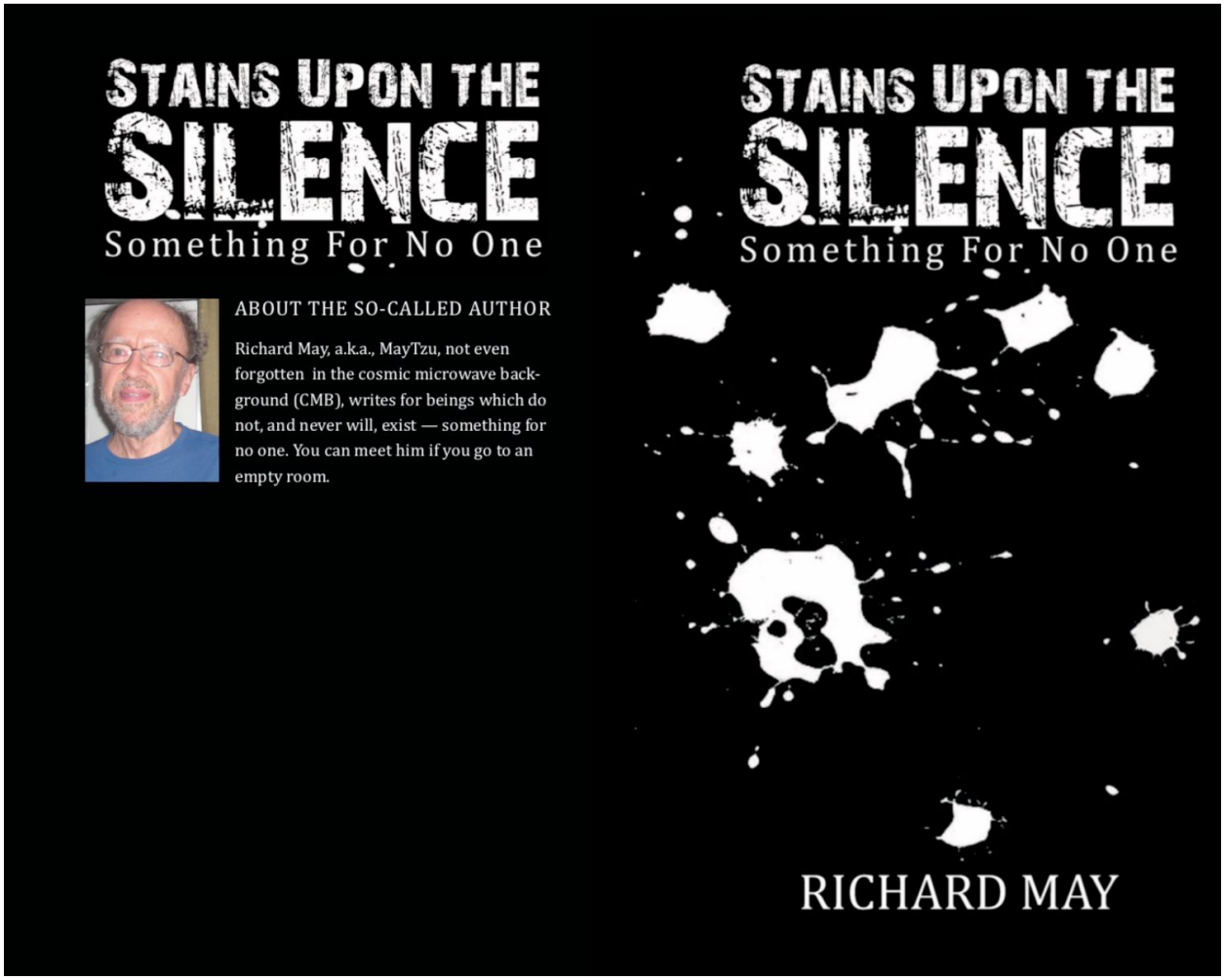
— Lewis Carroll, *Alice's Adventures in Wonderland*, Chapter 6

Maybe the act of trying to understand what I have written changes its meaning, as the act of making an observation or measurement at the quantum scale changes the very phenomenon being observed. G. I. Gurdjieff maintained that all knowledge was material. Presumably then, if he is correct, knowledge and information would be subject to the conservation laws of physics. There is in fact a principle of conservation of quantum information as a consequence of two fundamental theorems of quantum mechanics. See, e.g., "Experimental Test of the Quantum No-Hiding Theorem," Jharana Rani Samal, et al., Physical Review Letters.

If information in the universe is conserved, i.e., can neither be created, nor destroyed, neither added to nor deleted, then what are the implications of this for the acquisition of knowledge by individuals and perhaps even of wisdom, however defined, or for the persistence of memories?

Richard May, a.k.a., May-Tzu

https://www.amazon.com/Stains-Upon-Silence-something-one-ebook/dp/B07WKGH752



A Stain Upon the Fermi Silence:

Forethought and Afterword for *Stains Upon the Silence* by Richard May

Adam Kisby

akisby@uchicago.edu

Today, I met with a self-described alien. I traveled deep inside a mountain to find him. We discussed a variety of topics including the trauma of pre-existence, the Matrioshka nature of the subtler spiritual bodies, the precise duration of the timeless Bardo state, birth as death, death as birth, alpha as preceding beta, beta waves as preceding alpha waves, physical immortality as a practical means by which to attain enlightenment, and enlightenment as a practical means by which to attain post-existence. We discussed synchronicity and mere coincidence, noting that perceptions of the same are largely a matter of attention, but that, generally speaking, events must exist in order to be attended to. We agreed that certain license plates have a lot to say, but that they're limited to using such words as "nomads" when perhaps "peripatetics" would be better, due to their having far fewer characters than a standard Twitter post. He engages in terrestrial spiritual practices but has abandoned sitting as pedestrian, preferring instead standing or even walking. His writings, consisting mostly of observations on the human condition in the form of Monarch notes on haikus, are less obscure, in fact, than the magna opi of some Earth prodigies. He spoke of commissioning me to compile his writings, half-despairing, like the Buddha, that so few would understand. There was no talk of Tibetan music or strawberry ice cream, but his eyes grew wide at his own mention of Roquefort cheese. He offered me Bing cherries or walnuts, but he was careful not to offer me any Roquefort. It's unclear to me if this was due to his own deliberate attachment to it or his consideration of my difficulties in overcoming a pernicious casomorphin addiction.

Exceptionally Intelligent Individuals' Extraordinary Ideas Index (EIIEII)

Adam Kisby

akisby@uchicago.edu

Directions:

The relationship between intelligence and belief is complex. This survey is designed to discover the extent to which members of the high-IQ community believe "weird things" (in the sense of Shermer).

First, list any high-IQ societies of which you have ever been a member (high-IQ society membership is not required to complete the survey).

Second, rate each of the 100 belief statements on a scale of 1 to 7, according to the following table:

1 = Strongly Disagree

2 = Moderately Disagree

3 = Mildly Disagree

4 = Ambivalent

5 = Mildly Agree

6 = Moderately Agree

7 = Strongly Agree

The belief statements are phrased as precisely as possible, so be sure to answer them exactly as they are written.

For any belief statement that contains an unfamiliar reference, take a moment to look up the reference online before choosing your response.

Feel free to include any explanations or other comments that you wish to share.

Third, send your complete set of responses (list of high-IQ society memberships, belief statement ratings, and any explanations or other comments) to akisby@uchicago.edu.

___ 1. UFOs have been observed by thousands of credible witnesses.

___ 2. Former President Jimmy Carter actually saw the planet Venus.

___ 3. Extraterrestrial biological entities have abducted human beings.

___ 4. People actually experience hallucinations of supposed extraterrestrial biological entities during episodes of sleep paralysis.

___ 5. Interplanetary vehicles of extraterrestrial biological entities have landed on Earth.

___ 6. Doug Bower and Dave Chorley have stated publicly that crop circles attributed to extraterrestrial biological entities were really made by them using a plank of wood and some rope.

___ 7. A species of primate unknown to mainstream science lives in the forests of the Pacific Northwest.

___ 8. The son of Ray Wallace has stated publicly that footprints attributed to Bigfoot were really made by his father using a pair of carved wooden feet.

___ 9. A thorough search of Loch Ness using hundreds of sonar beams and satellite tracking failed to prove the existence of the Loch Ness monster.

___ 10. A plesiosaur (or similar organism, unknown to mainstream science) really lives in Loch Ness in Scotland.

___ 11. A thorough search of Carl Sagan's garage failed to prove the existence of a fire-breathing dragon.

___ 12. A sauropod (or similar organism, unknown to mainstream science) really lives in the vicinity of the Congo River in Africa.

___ 13. There is not a Flying Spaghetti Monster in the sky that grants some of the people some of their wishes some of the time.

___ 14. A buoyant betentacled blob (or similar organism, unknown to mainstream science) actually feeds on the psychic energy of human beings as it floats near the ceilings of crowded movie theaters.

___ 15. Human behavior is measurably influenced by the relative positions of celestial bodies.

___ 16. The gravitational force exerted by the planet Mars on an infant at the moment of its birth is theoretically less than the gravitational force exerted on that infant by its mother at the same moment.

___ 17. Deviant human behavior does not increase due to the influence of the full Moon apart from the effects of higher levels of light and other generally accepted factors.

___ 18. The relative position of the planet Mars at the moment of the birth of an individual is significantly correlated with the eventual athletic eminence of that individual.

___ 19. The Earth and other planets revolve around the Sun.

___ 20. The Sun and the planets revolve around the Earth.

___ 21. Solutions with solutes at concentrations of less than one part in 10^{60} can measurably improve human health.

___ 22. The placebo effect explains why many ineffective treatments seem to be effective.

___ 23. Cold fusion of the sort reported by Fleischmann and Pons is not real.

___ 24. Two nuclei have fused into a single nucleus at temperatures below one hundred degrees Fahrenheit.

___ 25. Human beings have been transported from one location to another location ten miles away in less than one second.

___ 26. That quantum teleportation has been effective over a distance of ten miles does not imply that it is possible to teleport human beings over such distances.

___ 27. That positrons are said to travel backward in time does not imply that human beings can travel into the past.

___ 28. Human beings can travel into the future whether or not time machines already have been invented.

___ 29. So-called remote viewing is not a reliable means by which to discover information about distant places.

___ 30. There are people who can reliably discover information about distant places using psychic abilities.

___ 31. So-called precognition is not an accurate means by which to predict the future.

___ 32. There are people who can accurately predict the future using psychic abilities.

___ 33. There are people who can move physical objects by thinking about them.

___ 34. Sleight-of-hand techniques and other conventional explanations account for all instances of apparent telekinesis.

___ 35. There are people who can know the unexpressed thoughts of others.

___ 36. Verbal and nonverbal communication account for all instances of apparent telepathy.

___ 37. There are visual and auditory hallucinations that result from consuming or neglecting to consume psychotropic substances.

___ 38. There are people who can see the spirits of deceased human beings.

___ 39. There are people who can talk to the dead.

___ 40. Cold reading techniques are used to manipulate grieving widows.

___ 41. Subliminal messaging is not a reliable means by which to influence the behavior of others.

___ 42. There are people who can influence the behavior of others using psychic abilities.

___ 43. The Universe is a creation of God.

___ 44. The Universe is an accident of the Big Bang.

___ 45. The Universe is thousands of years old.

___ 46. The Universe is between ten and twenty billion years old.

___ 47. Bertrand Russell's teapot once passed somewhere between Earth and Mars.

___ 48. The God of Abraham, Isaac, and Jacob never existed in the historical sense.

___ 49. There is a man in the sky who grants some of the people some of their wishes some of the time.

___ 50. The God of Abraham, Isaac, and Jacob does not answer prayer.

___ 51. Jesus Christ lived, died, and rose from the dead.

___ 52. Jesus Christ never existed in the historical sense.

___ 53. True memories require physical brains of some kind for their encoding, storage, and retrieval.

___ 54. There are people who have memories of past lives.

___ 55. There are people who have birthmarks on their current physical bodies that correspond to wounds that were inflicted upon their previous physical bodies during their past lives.

___ 56. The consciousness of an individual ends with the death of the physical body of that individual.

___ 57. The Face on the planet Mars is a monument of an ancient Martian civilization.

___ 58. The Face on the planet Mars appears due to optical phenomena.

___ 59. High technology did not exist before the modern era.

___ 60. Nuclear reactors have been discovered on Earth that pre-date modern civilization.

___ 61. According to the International Astronomical Union's definition of the term planet, there are currently eight planets.

___ 62. According to the International Astronomical Union's definition of the term planet, there are currently twelve planets.

___ 63. The Anunnaki mentioned in ancient Sumerian texts continue to intervene in the affairs of human beings.

___ 64. The Twelfth Planet in the sense made famous by Zecharia Sitchin never existed in the historical sense.

___ 65. Chemtrails are sprayed at high altitudes from officially unacknowledged tanker aircraft for the purpose of climate modification.

___ 66. Chemtrails are not sprayed at high altitudes from officially unacknowledged tanker aircraft for the purpose of mind control.

___ 67. The Twin Towers fell at rates consistent with accepted principles of physics on September 11th, 2001.

___ 68. The destruction of the Twin Towers on September 11th, 2001 was the result of a conspiracy.

___ 69. The destruction of the Twin Towers on September 11th, 2001 was perpetrated by members of the militant Islamist organization known as al-Qaeda.

___ 70. The destruction of the Twin Towers on September 11th, 2001 was part of a false flag operation perpetrated by agents of the government of the United States.

___ 71. Given the number of star systems that appear to be capable of supporting life, the only logical conclusion is that extraterrestrial biological entities exist.

___ 72. I have had an experience that could be plainly described as an encounter with an extraterrestrial biological entity.

___ 73. I have not had an experience that could be plainly described as an encounter with Bigfoot, the Loch Ness monster, or some other legendary cryptid.

___ 74. Given the number of new species that have been discovered in recent years, the only logical conclusion is that Bigfoot, the Loch Ness monster, or some other legendary cryptid exists.

___ 75. Considering how many scientific discoveries have been opposed by mainstream science, it is unreasonable to assume that cold fusion of the sort reported by Fleischmann and Pons is not real.

___ 76. I have direct knowledge that cold fusion of the sort reported by Fleischmann and Pons is real.

___ 77. I have had an experience that could be plainly described as an instance of telepathy, telekinesis, or some other psychic phenomenon.

___ 78. Given how little human consciousness has been studied by mainstream science, the only logical conclusion is that telepathy, telekinesis, or some other psychic phenomenon is real.

___ 79. Considering the number of natural phenomena that appear to be intelligently designed, it is unreasonable to assume that the God of Abraham, Isaac, and Jacob does not exist.

___ 80. I have not had an experience that could be plainly described as an encounter with the God of Abraham, Isaac, and Jacob.

___ 81. I do not have direct knowledge that the destruction of the Twin Towers on September 11th, 2001 was part of a false flag operation.

___ 82. Considering the number of false flag operations that have been proposed by the CIA, it is unreasonable to assume that the destruction of the Twin Towers on September 11th, 2001 was not part of a false flag operation.

___ 83. The idea that extraterrestrial biological entities are interacting with human beings is more frightening than fascinating.

___ 84. The idea that legendary cryptids are sighted by human beings is more fascinating than frightening.

___ 85. The idea that cold fusion of the sort reported by Fleischman and Pons is real is more fascinating than frightening.

___ 86. The idea that there are people who have psychic abilities is more fascinating than frightening.

___ 87. The idea that the God of Abraham, Isaac, and Jacob exists is more frightening than fascinating.

___ 88. The idea that there are conspiracies behind events such as the destruction of the Twin Towers on September 11th, 2001 is more frightening than fascinating.

___ 89. It is better to have a small amount of information about which one is certain than to have a large amount of information about which one is uncertain.

___ 90. It is better to believe that an idea is true that later turns out to be false than to believe that an idea is false that later turns out to be true.

___ 91. Data should be rejected when they contradict scientific theories.

___ 92. Scientific theories should be modified when they contradict data.

___ 93. Unrepeatable data are admissible in science.

___ 94. Unfalsifiable theories are meaningful in science.

___ 95. A potentially infinite number of explanations may be proposed that are consistent with any given set of data.

___ 96. The simplest explanation is usually the best.

___ 97. The burden of proof is on the claimant.

___ 98. Extraordinary claims require extraordinary evidence.

___ 99. Man's mind once stretched by a new idea never regains its original dimensions.

___ 100. Keep an open mind, but not so open that your brains fall out.

Arthur Schopenhauer's and David Benatar's Contributions to Philosophy

Ken Shea

Arthur Schopenhauer was a German 19th-century philosopher who was inspired by a chorus of different voices: Plato, Immanuel Kant, David Hume, George Berkeley, Buddhism, the *Bhagavad Gita*, and the *Upanishads* of the Hindu *Vedas*. In a Positivist age, Schopenhauer propounded an unpopular type of metaphysical voluntarism which maintained Will informed the core of reality and intellect represented a mere secondary phenomenon. The epistemological, ontological, aesthetic, and ethical ramifications of this seemingly disempowering, and essentially godless, double-aspect theory are tenderly unpacked in Schopenhauer's masterpiece, *The World as Will and Representation*. Therein, Arthur Schopenhauer essentially flavors Immanuel Kant's epistemological idealism with a fresh, some would say disturbing, form of ontological realism by claiming Will stands outside space, time, plurality, and the principle of individuation "as thing in itself and therefore imperishable." Schopenhauer's double-aspect theory echoes the Hindu *Upanishads* in this seminal double-aspect dimension, n.b., the dueling monist and dualist schools in connection with Brahman and Atman in Hinduism.

Some, retrospectively, consider Arthur Schopenhauer the first Western philosopher to seriously incorporate Eastern mystical-philosophical conceptions into a fleshed-out philosophical system encompassing manifold dimensions of metaphysics. As Schopenhauer propounded that Will was a blind and striving force (a fundamentally irrational "dark, dull driving") without any aim or ultimate satisfaction in mind, he thought the ideal strategy for lessening suffering was lessening involvement with Will through worldly resignation à la Christian Quietism, compassion, aesthetic contemplation, and sexual abstinence. Christian Quietism might be defined here as the devotional contemplation and the renunciation of the will; more colloquially, quietism is the composed acceptance of that which one cannot change. Bertrand Russell, in *A History of Western Philosophy*, distilled the essence of Schopenhauer's ethical advice for living relatively peaceably in the whirlwind of Will and worldly strife by saying: "The cause of suffering is intensity of will; the less we exercise will, the less we shall suffer" (Russell, pg. 756).

The metaphysical affinities between Schopenhauer's Will and the three marks of existence in Buddhism (viz., anicca, dukkha, and anatta or impermanence, suffering, and non-self, respectively) are certainly compelling, though Schopenhauer seems irretrievably pessimistic that something like Buddhism's Noble Eightfold Path could light the way to *permanent* liberation, curtail rebirth in samsara, or transport devotees to rapturous divine union. Within the essay "On the Vanity of Existence," Schopenahuer makes a bleak ontological argument and asserts, "the vanity finds expression in the whole way in which things exist." Schopenhauer might, therefore, look askance at the soteriology, as opposed to the handy myth, of Nirvana in Buddhism, the so-called *summum bonum* of the Noble Eightfold Path - etymologically, Nirvana means "be extinguished" or "to blow out" in Sanskrit and has parallels to moksha in Hinduism - and treat permanent liberation as *deus ex machina*. Because Schopenhauer saw Will as a pernicious yet central force of this world ("thing in itself and therefore imperishable," after all), permanent liberation as peddled by spiritualists would be precluded *a priori* unless one somehow drastically altered the fundamentals of reality. Put another way, a Buddhist monk still feels occasional hunger pangs no matter the monk's belief system or relationship to sunyata in Schopenhauer's metaphysics because of said metaphysics's ontological architecture built around Will.

Antinatalism, which ascribes a negative value to birth in particular and existence in general, seems a more obvious, achievable, and elegant solution to the immanent problems of existence for unborn *future* generations - a different, though intimately related, set of problems than those posed for *current* generations. In fact, Arthur Schopenhauer himself talked about the "blessed calm of non-existence," which would seem to, at minimum, tacitly endorse antinatalism's ascription of a negative value to life. Schopenhauer's conceptualization of pleasure and pain is quite interesting in the sense that he grokked pleasure is merely the freedom from pain, hence pleasure is negative in character, and pain is positive in character since pain makes its presence positively felt. There are definitely resonances here to both Epicureanism and David Benatar, a moral philosopher keen on antinatalism who wrote *Better Never to Have Been: The Harm of Coming Into Existence*. David Benatar claims that the absence of pain is a good (viz., no matter whether that absence is for someone actually living or an unborn potential life) whereas the absence of pleasure is not a bad per se (viz., provided the absence of pleasure is not a deprivation for someone actually living, as opposed to an unborn potential life).

David Benatar is a contemporary South African moral philosopher who says that there is a moral obligation not to procreate because of the foregoing asymmetry between pleasure and pain. There is simply too much suffering in the world (e.g., more than 20,000 people die from hunger or malnutrition every day), and "a charmed life is so rare that for every one such life there are millions of wretched lives" (Benatar, pg. 92), to morally justify procreation. Moreover, David Benatar makes the case that self-assessments of well-being are significantly skewed towards the positive end of the spectrum and basically unreliable. The so-called Pollyanna Principle, for instance, is a staple of human psychology that causes humans, presumably for evolutionary reasons, to bias their judgements towards a positive self-assessment for past, current, and future states. Research shows that people tend to recount many more positive than negative events, subscribe to being "pretty" or "very" happy in the current moment, and anticipate glad tidings in the years ahead no matter what the actual situation. There is also a psychological tendency towards adaptation whereby a person will quickly weather a bad situation in the present and alter their expectations in the future by, in effect, establishing a new baseline and papering over the past via the Pollyanna Principle (cf. hedonic treadmill). The implications for a potential parent's assessment of the *future* child's presumed well-being are immense, insofar as those assumptions are predicated on established psychological biases. One such psychological bias is comparison: bolstering one's self-assessment by subjectively comparing one's life to the lives of those around one, as opposed to providing an objective assessment of one's own life on its unique merits. The upshot of this psychological bias of comparison is that one will tend to focus on differences between oneself and others, which glosses over collective suffering because it is ubiquitous (cf. Freudian narcissism of small differences). The preceding psychological mechanism interacts with the Pollyanna Principle such that people not only fail to objectively assess their own lives but, also, compare themselves to others in a way that proves flattering or egosyntonic, e.g., by more frequently comparing themselves to those who are worse off than themselves rather than those who are better off than themselves. The grounds for such comparisons are seemingly interminable.

In Chapter Three of *Better Never to Have Been: The Harm of Coming Into Existence*, David Benatar directly addresses Arthur Schopenhauer's metaphysics by saying, "Life, on the Schopenhauerian view, is a constant state of striving or willing - a state of dissatisfaction" (Benatar, page 76). David Benatar, then, lucidly interprets Arthur Schopenhauer by continuing to report that, "On the Schopenhauerian view, suffering is all that exists [for sentient creatures] independently" (Benatar, page 77). David Benatar espouses a different, and probably more sophisticated and scientifically supportable, perspective as he concedes that there are indeed

intrinsic pleasures ontologically distinct from chimerical perceptions of pleasures, which merely demarcate the evanescent dimming of pain qua Schopenhauer's view of pleasure as negative in character and effect. Bertrand Russell characterizes Arthur Schopenhauer's grim views: "There is no such thing as happiness, for an unfulfilled wish causes pain, and attainment brings only satiety" (Russell, pg. 756). In the end, David Benatar and Arthur Schopenhauer ultimately come to many of the same basic ontological and axiological conclusions as each finds "dissatisfaction does and must pervade life" (Benatar, page 77) because of "needs and necessities inseparable from life itself" (Arthur Schopenhauer's "On the Sufferings of the World").

Ironically for someone who loathed myriad aspects of Christianity ("mere despotic theism"), Arthur Schopenhauer's philosophy of resignation enjoys remarkable affinity with 17th-century Christian Quietism in its renunciation of the will. Arthur Schopenhauer, accordingly, advises treating others kindly in the fourth and final book of *The World as Will and Representation* in order to temporarily flee the corrosive effects of pure egoism and mitigate suffering in this lifetime. If seen through, Schopenhauer reckoned once the veil of Maya was lifted - Maya obscures a monist conception of Brahman in the Advaita Vedanta (meaning "non-duality" in Sanskrit) school of Hindu philosophy - through denial of the will and an insight of love, phenomenal boundaries would dissolve, leaving behind further silencing of volition and a sympathy for sufferers. Still, the reader can almost hear the sigh as Schopenhauer writes, "It is all one whether he has been happy or miserable; for his life was never anything more than a present moment always vanishing; and now it is over." In light of these realities, treating others kindly in the present and waving off the asinine hustle and bustle of the world doesn't seem irrational, unlike Will, which relentlessly cracks the whip on sentient creatures who are promised certain hardship and unfulfilled desires before returning to the blessed calm of non-existence.

"In early youth, as we contemplate our coming life, we are like children in a theatre before the curtain is raised, sitting there in high spirits and eagerly waiting for the play to begin. It is a blessing we do not know what is going to happen." -Arthur Schopenhauer

"There are moments, perhaps even periods, of satisfaction, but they occur against a background of dissatisfied striving." -David Benatar

Sources:

Benatar, David. *Better Never to Have Been: The Harm of Coming Into Existence*. New York, New York. Oxford University Press. 2006.

"Quietism" (Christian philosophy) - https://en.wikipedia.org/wiki/Quietism_(Christian_philosophy)

Russell, Bertrand. *A History of Western Philosophy*. New York, New York. Simon & Schuster. 1972.

Schopenhauer, Arthur. *Essays and Aphorisms*. New York, New York. Penguin Classics. 1973.

Schopenhauer, Arthur. *On the Fourfold Root of the Principle of Sufficient Reason.* Peru, Illinois. Open Court Publishing Company. 1974.

Schopenhauer, Arthur. *World as Will and Representation* (Volume 1). New York, New York. Dover Publications. 1966.

Schopenhauer, Arthur. *World as Will and Representation* (Volume 2). New York, New York. Dover Publications. 1966.

Transontological

Guess I'll identify as an advanced-AI quantum computer.

We'll see how that goes.

May-Tzu

Physics as Erotica: Objective Lust

As an Omni Amorist and a Multi Omni I have little sympathy for you straight-laced uptight Bi Poly Amorists, who whine about a lack of societal acceptance. We Omni Amorists who are Multi Omni have a lack of acceptance by the very laws of physics. Moreover, you hidebound orthodox Bi Poly Amorists are only interested in the macro-level of phenomena. We go after the delicious sub-quantum phenomena too and bonding by strong and weak forces, not handfasting or marriage. Young juicy neutrinos and tight little photons are not as grave as gravitons.

You “Bi”s are so straight. Have you ever felt the exquisite sensation of the annihilation of matter and antimatter or listened to the sounds of release of Hawking radiation, as your soul penetrates a black hole? You never have to deal with wave-particle duality or the Heisenberg uncertainty principle in your so-called Poly Amory. You don’t have a clue what it’s like to get a juicy young neutrino in bed only to learn that when you discover her location in space-time, you don’t know how fast she’s moving or – Damn that Heisenberg! You go to bed with a gamma radiation photon and afterward she’s a particle of different charm and spin, not to mention ‘color’, even in the quantum world. Her charm can make your head spin. And Pauli was no Poly with his exclusive “exclusion principle.” Try having a quantum non-local relationship with a succulent mu meson only to find her decaying into an entire family of bizarre vibrating Strings. (Incidentally, were the vibrating membranes of M-theory circumcised on the eight day? Is the Multiverse, itself, Jewish?) You get strung along by String Theory and how do you compete with the Big Bang? Try competing with the Big Bang in bed.

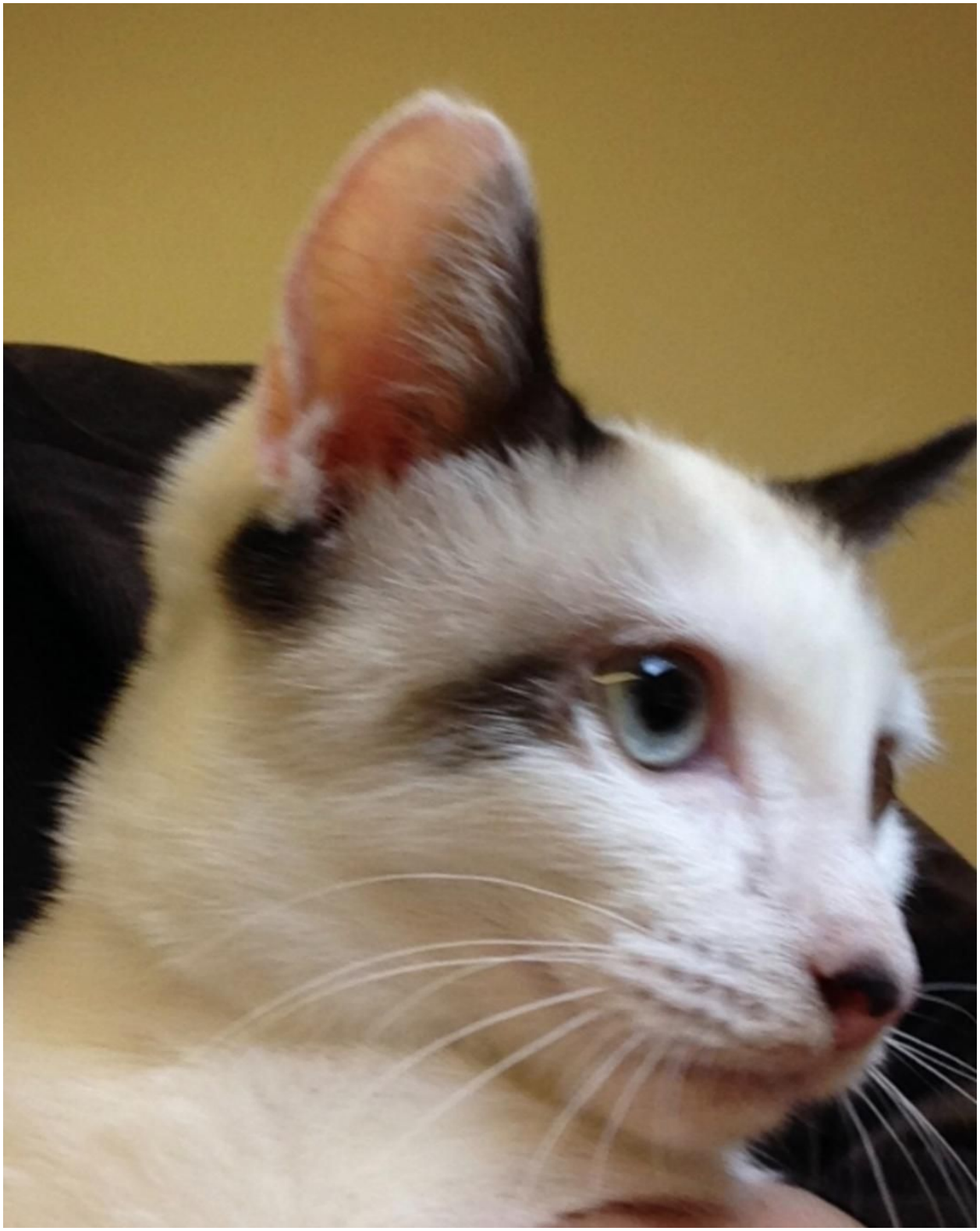
I love every wave-particle in the quantum foam, just as long as the feeling lasts beyond space-time, or until my attention wanders, whichever comes first, true objective love. But what about objective lust, where is it to be found? Alas, there are so many warps in the space-time continuum, vibrating Strings playing the music of Hermes and Pythagoras, as juicy wavicles dance seductively, and so few views from eternity.

May-Tzu

The Immortality of Zeno of Elea

Zeno of Elea reportedly had a calendar on which he scheduled special events, such that he could only approach halfway to an event and then halfway again. The events on his schedule receded asymptotically to Zeno's own event horizon. While Zeno appeared to be frenetically busy to himself, he generally appeared to be a puddle of Bose–Einstein condensate to an outside observer. In this way Zeno was unaffected by his own death, which only occurred beyond his event horizon.

May-Tzu



There are women and goddesses and beings like Yin-Yin