CME

Brains Seek Patterns in Coincidences

CME EDUCATIONAL OBJECTIVES

1. Evaluate evidence that the brain seeks order.
2. Express how basic attractor patterns and bias influence the meaning of coincidences.
3. Identify how hemispheric lateralization influences coincidence detection and interpretation.

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The neurobiological study of coincidence rests upon the brain's need for order and predictability. Coincidences alert the brain to possible causal relationships between events. Through the apprehension of such relationships, the world appears as more orderly and more predictable. Even though the scientific method has created a systematic way of determining the validity of possible causal connections between events, the human brain persists in its often non-scientific interpretations of coincidences. The same

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brain processes that manage coincidence interpretation can yield the strangest superstitions as well as new ideas about the nature of reality. This article addresses the following concepts:

1. The brain seeks patterns;
2. The brain is predisposed to use coincidences to create or discover patterns;
3. The philosophical basis for interpreting coincidences is provided by fundamental association cortex schemas;
4. Personally relevant coincidence interpretation is influenced by a person's biases;
5. Hemispheric lateralization influences coincidence detection and interpretation — the right brain associates while the left brain inhibits; and
6. Coincidences suggest the possibility that we can look where we cannot see.

THE BRAIN SEEKS PATTERNS

Our brains seek coherence, structure, and order. Words and numbers order perceptions. Words and sentences package complex experiences, commonly omitting experiential fragments. Who can say what being in love is? Numbers allow us to count, put things in place, and imprint our places on earth with streets and squares and buildings. We have maps to order space and various chronometers to order time. We develop daily routines and then, when possible, organize additional time for vacations. Our 10-digit counting system forms much of the basis for how we structure reality. Numbers provide measures of worth in athletics, academics, friendships, and business. The language of math allows us to predict things such as, for example, where two cars will meet given their speed and starting location, if other variables are constant.

The brain wants to complete patterns, like finally finishing a tax return or finally remembering someone's name and where you met. We can feel its pleasure in making a correct connection. We can guess that not only do amygdalas become calmer but that the nuclei accumbens fill with dopamine:

"Pattern pleases us, rewards a mind seduced and yet exhausted by complexity. We crave pattern, and find it all around us, in petals, sand dunes, pine cones, contrails. Our buildings, our symphonies, our clothing, our societies — all declare patterns. Even our actions: habits, rules, codes of honor, sports, traditions — we have many names for patterns of conduct. They reassure us that life is orderly.[1]

Finding patterns helps with survival. When confronted with certain ambiguities, our hypersensitive "agency-detecting device" can be activated. For our early human ancestors, survival was probably enhanced by concluding that a strange formation off in the distance was a potential predator rather than a fallen log that only resembled it. Better to be safe and wrong than to be sorry and attacked.[2]

Finding patterns helps with survival.

We also seem to be predisposed to interpret ambiguous observations and events as evidence of beneficent agents.[3] Religions, existential philosophies, and science provide maps for interpreting these ambiguities, thereby satisfying the deeply felt yearning to comprehend our place in the world and to fend off the usually disturbing idea that we live in a random universe.

Human minds also abhor chaos. Observe the effects of sensory deprivation. Subjects may be blindfolded, have their ears plugged. They may be placed in water at body temperature or have their arms and hands encased in cardboard. After a while, as they seek stimuli from which to create order; their minds begin to disintegrate.[4,5] Patterns are perceived where none, in fact, exist. Without external sensation, the brain either attempts to make sense out of its own activity or amplifies minute sensation into unreal but stabilizing patterns. A CIA training manual describes the following observations in people who have been deprived of social input:

"The symptoms most commonly produced by solitary confinement are superstition, intense love of any other living thing, perceiving inanimate objects as alive, hallucinations and delusions."[4,5]

Consider a 20-year-old beginning to descend into schizophrenia: the world becomes increasing perplexing. Events seem disconnected; thoughts skip from subject to subject. Both inner and outer worlds become increasingly more disordered. Paranoia provides a map by which to order the confusing territory. Positioning the self as the perceived center of plots orients the confused mind to an apparently clear, well-defined role in relationship to others and the world.

Loneliness and the loss of control represent different forms of uncertainty, each of which tends to generate the drive to find patterns. In the first of three studies, Epley et al correlated self-reported loneliness (on a survey) with the tendency to imbue inanimate objects with anthropomorphic human intention.[6] People who reported feeling lonely were more likely to attribute human-like intention to four technological gadgets including "Pillow Mate" (a torso-shaped pillow that can be programmed to give a hug). In a related study in the same article, another pool of subjects took a personality inventory that ostensibly predicted midlife loneliness or social connection. The subjects were then asked if they believed in ghosts, the Devil, miracles, and curses. Those in the more disconnected group reported stronger belief in supernatural agents.

In a series of studies in which subjects were induced to feel that they had lost control, Whitson and Galinsky

demonstrated a strong correlation between loss of control and the tendency to find patterns in randomness.[7] Loss of control increases anxiety that is associated with increased amygdala activation.[8] This activation drives the search for patterns — the identification of a coherent relationship among a set of stimuli. Acquiring a name, a predictor, or a pattern in the midst of ambiguity appears to reduce amygdala firing by providing the brain with its sometimes desperately sought organizing principle (see Figure 1). Patterns literally organize a distraught brain.

The patterns identified in the face of ambiguity under emotionally charged conditions may not be always false but instead could be suggestive of unrecognized facts. At the very least, pattern and structure identification helps people regain a sense of control. Psychotherapists, for example, find themselves in ambiguous situations for which theories and personally favored patterns provide relief from the anxiety of conceptual chaos. In such cases, these theories and patterns often help patients to create coherent patterns, the accuracy of which is less relevant than their amygdala-soothing properties and associated changes in interpersonal functioning.

When the brain cannot easily locate or project a pattern upon a situation, it stalls. In the uncertainty, anxiety may be generated, spurring the association machinery to find some way of "making sense" of the confusion. The brain wants to reduce the negative emotion by finding a pattern. It seeks homeostasis, equilibrium, and calm through perceived order. Its simplest alternative is to call up the "not important" pattern. "No meaning there. Forget about it." However, if the emotional drive to find meaning, to find a pattern, is too strong to accept this easy conclusion, then the brain whirrs on to find something that fits, like trying on various pairs of shoes. The following example illustrates the drive to find a pattern in ambiguity.

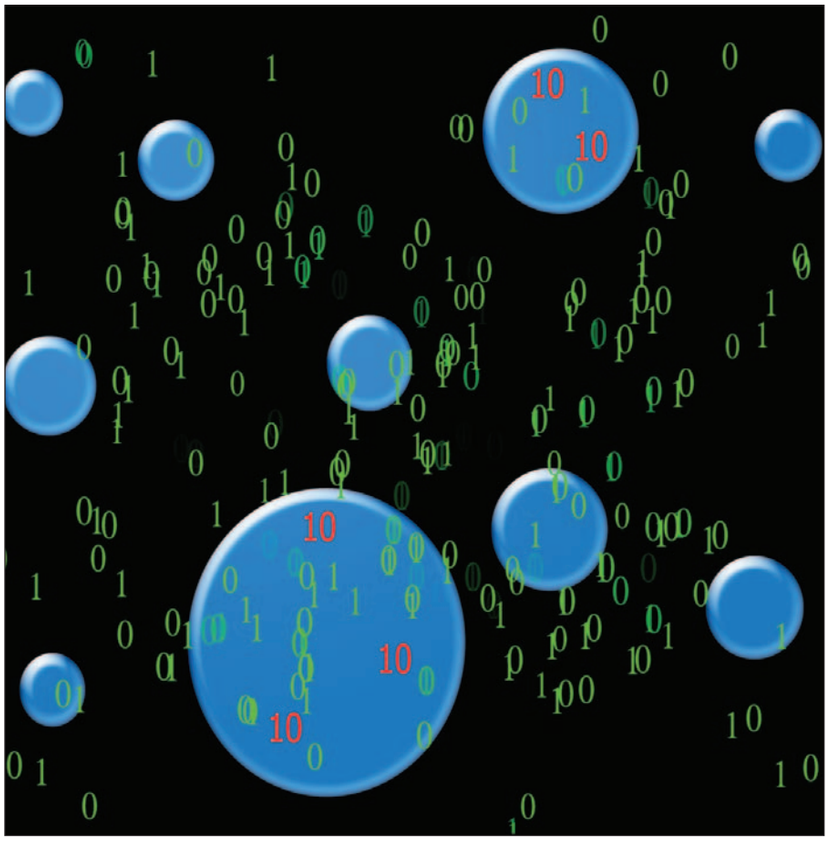


Figure 1. The broader an organizing principle, the higher probability that it will encompass coincidental events. Copyright George I. Viamontes, MD, PhD, 2009. Used with permission.

Jack and Jill were lounging on the deck looking over the lake while talking about the lack of response from Ms. X. Jill had met her in Springfield several months ago about a job teaching English as a Second Language. Ms. X had responded very positively to Jill's suggestion of a new curriculum and had welcomed her return for a formal interview and formal job application. However, as the couple prepared to return to Springfield, Ms. X did not return Jill's emails and phone calls. Jill mused: why? At first, they guessed that perhaps Ms. X was sick or out of town, or caught up in too much work. Yet she seemed so straightforward, so interested in Jill and her ideas. What happened? Jill's best guess was a "paranoid" one: Ms. X had taken Jill's ideas and recruited someone else to carry them out.

Why did Jill seek an explanation? Ms. X's failure to respond generated a negative feeling in her. Not anxiety, exactly, but "perturbation." The explanation settled that perturbation. She pulled this explanation from a store of general patterns available in the "causal concept file system" of her brain. She, like most of us, has a whole list of them: "I'm ugly, I said the wrong thing, Ms X is a liar, they have no money, life is unfair." The "paranoid" one had the effect of reducing her negative feeling by boosting her self-esteem: they may have used her idea after all.

THE BRAIN IS PREDISPOSED TO USE COINCIDENCES TO CREATE OR DISCOVER PATTERNS

Causal principles help to predict and control our environment. The co-oc-

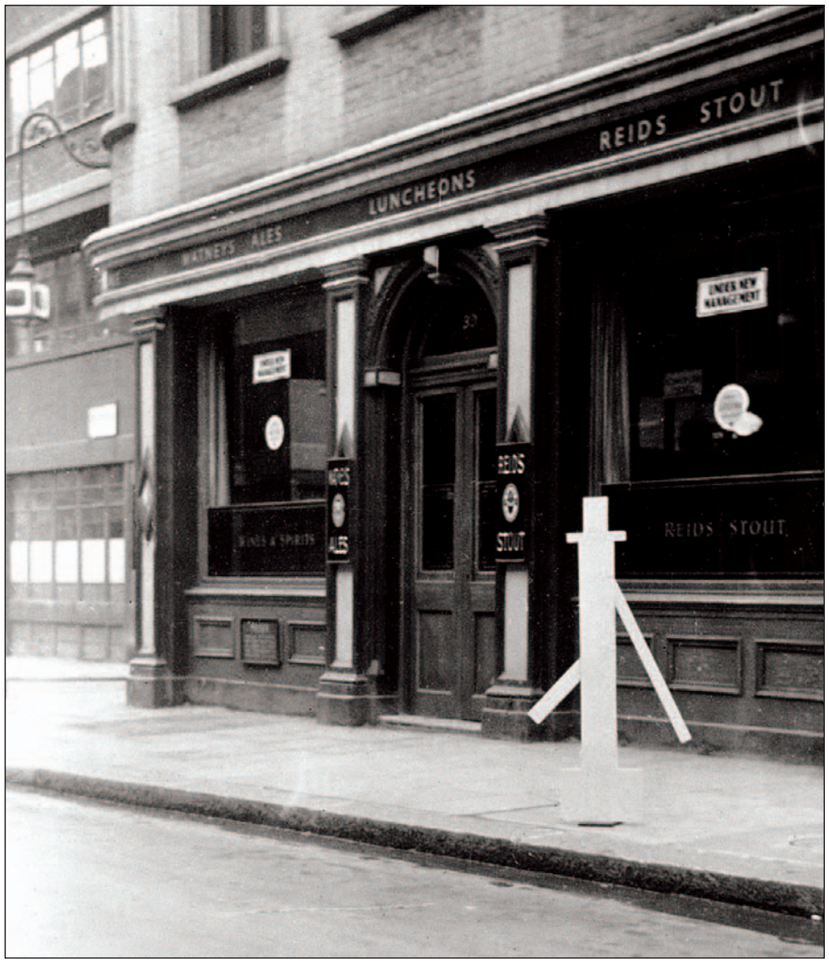


Figure 2. Broad Street pump. Copyright Wellcome Library, London. Used with permission.

currence of two events within a short period of time suggests that the two events may be related to each other. If one happens, then the other is likely to also happen. The detection of coincidences offers the possibility of identifying causal relationships:

A baby hears footsteps, and mother appears. The baby can predict from hearing the sound again that mother will appear. And the baby cries and mother appears. Soon the baby seems to discover that crying predicts when mother will appear. Warmth, food, or comfort are likely to follow. As we grow up, we learn connections between events. These connections can become causes. If one thing happens, then a second thing happens.

Especially interpersonally, we continue to try to create causal connections between co-occurring events. The mother of a teenage girl dies suddenly of a stroke. The teenager had been thinking angry thoughts about her mother including imaging her dead. The child believes her thoughts contributed to her mother's death. "I killed my mother."

Scientific discovery often proceeds through coincidence detection that then leads to the discovery of causal connections. The first comprehensive epidemiological study was undertaken by Dr. John Snow, who analyzed fatalities in the London cholera outbreak of 1854. He noted that the majority of deaths correlated with proximity to one water pump on Broad Street in Soho, London, and that death rarely occurred in those living nearer other pumps (see Figure 2). The meaning of the coincidence between the pump and death rates was determined to be causal when the pump was removed and the cholera outbreak quickly receded.[9]

Low-probability intersections of events may be produced randomly, but they also can provide clues to causation. Snow was alerted to the possibility of water-borne disease through the low-probability clustering of deaths near the Broad Street water pump. The coincidence became a clue to the underlying factors causing the deaths. To determine possible causation, Snow altered one variable (removed the pump), keeping all else constant.

PHILOSOPHICAL BASIS FOR INTERPRETING COINCIDENCES

Coincidence interpretation takes place on two broad levels:

1. The philosophical: hints about the nature of reality; and
2. The personal: possible assistance.

This section looks at the broad philosophical/neurobiological grounds for coincidence interpretation. The following section examines brain-processing biases inherent in personal interpretations.

In response to most stimuli, association cortices instantaneously work on connecting the incoming signal with related information. The associations and their conclusions are not random. They follow brain tracks created by previous personal experiences as well as by cultural and phyletic memories.[10] The stimulus ends up activating a favored conclusion, opinion, belief, or pattern fashioned by learning. Experience has etched many different roads to them; these learned thoughts attract associations. Once an attractor-pattern is activated, it provides an explanation (name,

reason, idea) and a plan for action. For example, you see someone familiar. As that person approaches, your brain searches for a name, a history and then the behavioral program fitting the situation. "Hi, Karen, haven't seen you for a long time. How are you?"

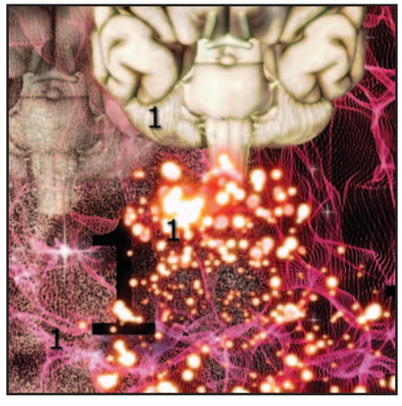
The ways in which people respond to coincidences depends upon inborn, cultural, and personal experiences. We come to this world needing to find patterns in the chaos around us. As with the child and the mother's footsteps, our brains seek causal explanations between the two temporally related events. Coincidences provide clues about how things work. But when we sense that there is no apparent cause between something we feel and something similar that happens outside of us, a problem arises.

I am uncontrollably coughing at 11 PM one night. I can't stop. The coughing goes on for 15 minutes, then subsides. Next day, my birthday, I find out that my father was choking on blood streaming into his throat and died around the same time I was choking.

How do I make sense of this strange, unexplainable coincidence? Our brains automatically search for meaning through their ability to move associations toward their existing schemas. As our surveys show, people with high religious and spiritual tendencies are more likely to analyze coincidences than those who are not. They see God winking at them,[11] they find evidence for more connectedness among and between people and our surroundings. The belief in God[12] and the belief in human connectedness already exist in their brains. Weird coincidences confirm those beliefs.

Potential basic attractor-patterns for weird coincidences include:

- God speaks to us through meaningful coincidences.
- Coincidences can be explained by the laws of probability or chance.
- Meaningful coincidences help me grow spiritually.
- Meaningful coincidences point to a connection between my internal and external worlds.
- Fate works through meaningful coincidences.
- Human minds are interconnected.
- Coincidences mean that I am very special.



Biases help to shape personal meanings.

Each of these schemas appears to lie latent in all brains. Genes and environment then interact to increase or decrease the likelihood that a coincidence will activate it.

PERSONALLY RELEVANT COINCIDENCE INTERPRETATION

Biases help to shape personal meanings. In themselves, biases are neither good nor bad. In the pragmatics of survival, usefulness remains the key measure of value. Biases help to determine which of several possible personal schemas will be selected as the relevant pattern that will inform interpretation and response. Key biases relating to the interpretation of coincidences include:

- Confirmation bias
- Egocentric bias
- Hindsight bias
- Availability bias

Confirmation Bias

The confirmation bias refers to the tendency to seek or interpret evidence in ways that confirm existing beliefs, expectations, or hypotheses.[13] Information that is consistent with our expectations is readily assimilated to strengthen beliefs. Information that does not fit with our expectations may be distorted so that it does fit, is selectively ignored, or forgotten.[14] Advertisers, for example, not only run ads to encourage people to buy their products but also to confirm belief in the product by those who have already purchased it.

Westen and colleagues[15] studied brain activity involved with the confirmation bias or, as they called it, "motivated reasoning." They studied the neural responses of 30 politically committed people during the U.S. presidential election of 2004. Both Republican and Democratic test subjects were shown self-contradictory quotes. For the Republicans, it was George W. Bush, and for the Democrats, it was John Kerry. Both groups explained the apparent contradictions in a manner biased toward their candidate. The prefrontal cortex did not respond during this activity while amygdalas and the cingulate showed increased activity. Subjects were then presented with information that exonerated their candidate. This supportive information was associated with activation of areas of the brain involved in reward processing (the orbitofrontal cortex and nucleus accumbens).

Westen concluded:

"None of the circuits involved in conscious reasoning was particularly engaged … Essentially, it appears as if partisans twirl the cognitive kaleidoscope until they get the conclusions they want … Everyone... may reason to emotionally biased judgments when they have a vested interest in how to interpret 'the facts.' "[15]

Similarly, coincidences can be used to confirm existing beliefs and intentions:

A husband and wife were in the process of selecting a new home. He wanted to buy one that she hated. Happily for her, someone else had already put some money down to purchase the house. However, while the husband was talking with the couple that was in the process of buying the house, a friend of his called him to say that the friend was putting his own house on the market, and did the husband know of any potential buyers. Thinking this might be a sign to him that his dream house will be available, the husband told the couple about his friend's house. The couple became very excited, saw the friend's house, and dropped the contract on the first house making it available to the husband. He decided to purchase it against his wife's wishes. He pointed to the coincidence as encouragement to do so. (This decision signaled a disintegrating marital relationship, which ended in divorce several years later.)

Egocentric Bias

Brains are also biased by a desire for personal relevance — the egocentric bias. If a coincidence happens to me, it is likely to be strange and amazing. If it happens to someone else, it can be explained by probability and/or is just not very surprising. Falk and MacGregor[16] tested the hypothesis that coincidences concerning the self are more surprising than similar coincidences happening to others. The experimental subjects were given a standard coincidence story to read and rate for surprisingness. This coincidence became the coincidence happening to someone else — the other-coincidence. The subjects also wrote and rated a coincidence that happened to them, the self-coincidence. The control group wrote no personal coincidences but instead rated for surprisingness the standard coincidence stories as well as the personal ones written by the subjects. The control group provided the means by which to test whether or not coincidences written by the experimental subjects were less or more surprising than standard coincidence stories. The results showed that the experimental group rated their own stories as more surprising than the standard coincidence stories. The control group rated the standard stories as more surprising than the stories written by the experimental group. In addition, the control group rated the experimental group's stories substantially less surprising than did the experimental group. In other words: 1) my story is more surprising than your story, and 2) my story is more surprising to me than it is to you.

The ease with which a belief is called into consciousness influences interpretation and response to events.

The egocentric bias tends to exaggerate the personal importance of a coincidence relative to its potential meaning for others.

Hindsight Bias

The hindsight bias changes the importance of events when viewed in time's rear view mirror. For example, when a prediction turns out to be true, subjects tend to believe that their predictions were much stronger than they actually were. New information changes the way we look at past events.

The hindsight bias may have several different components.[17] These components include: memory distortions (did it really happen the way I remembered it), impressions of foreseeability (it was predictable), and impressions of inevitability (it had to happen). These components play out in the way in which coincidences are viewed after they have occurred. In retrospect, chance meetings may seem much more significant than they had seemed at the time of their occurrence. This point is illustrated by reports from the Weird Coincidence Survey (University of Missouri):

"Running into one of my best friends from high school whom I hadn't seen in 2 years … we chatted and caught up on everything. Then 2 days later she passed away, and I felt our meeting was meant to make sure we remembered each other before she left." (WCSa-105)

"Whenever I delete someone's phone number out of my cell phone, I randomly run into the person, receive an e-mail about him or her, or they call me. It is like that person is meant to be in my life for a reason I do not yet know. I also once dated a guy that ended up being wrong for me. Months after that ended, I ran into his best friend, started talking to him, and we have been dating for 7 months. We plan to get engaged soon. Now I understand why I had to meet and date the guy that was wrong for me." (WCSb-133)

"Last weekend I was waiting at a red light, and as it turned green, my cell phone rang. I looked down to answer the phone, thereby delaying my acceleration into the intersection. When I looked back up a truck ran the red light through the intersection just where I would be if I had started at the change of the light. This was meaningful because it was a call from my older brother with whom I haven't spoken in months and I've always felt like he was a protector of mine." (WCSa-174

Each of these people looked back and found a personally meaningful coincidence.

Availability Bias

The ease with which a belief is called into consciousness (ie, the degree to which it is available) influences

interpretation and response to events.[18] The most recent emotionally charged events, for instance, are the most available, and therefore more likely to influence interpretation of other events.

The availability bias influences investors to over-react to the high emotions caused by the current market conditions. For example, in 2001, investors got caught up in high-tech mania, ignoring the economic bubbles of the past. The bursting bubble led to the negative emotion that accompanies great economic declines, and thereby influenced investors to overfocus on current negative results.[19]

In clinical practice, a physician's recent success with a certain treatment influences their potential prescribing practices when treating the next patient with a similar problem. Because the human brain easily generalizes from one highly charged experience to other similar situations, single case reports have the potential of generating unjustified credibility. From this bias emerges the need for case series and controlled trials.

Similarly, recently reading probability theory or a synchronicity book will influence the likelihood that a coincidence will be interpreted as meaningful. Or as suggested from the following story from the Weird Coincidence Survey, taking a survey on the subject increased the speaker's recognition of coincidences:

"I believe that taking this survey is my most recent meaningful experience. The example above is about a woman going through Alcoholics Anonymous, and I just happened to go to my second Narcotics Anonymous meeting of this attempt to be clean. That shows to me that I am definitely doing the right thing by going to NA and by taking the survey." (WCSb-48)

Other Biases

Several other variables influence the frequency by which coincidences are reported:[20]

1. Everyday life provides numerous opportunities to find connections between events.

Pretty frequently (at least twice a week) when I am driving, street lights will either turn on or turn off, just as I drive underneath them." (WCSb-66)

2. People allow themselves excessive flexibility in identifying meaningful relationships between events that have a relatively high chance of co-occurring:

"Today I saw a specific ambulance company's ambulance in one city and the same company's ambulance in another city. When I got to my township, there was a township emergency vehicle in front of a restaurant. I think it's being on the same course." (WCSa-35)

3. People are willing to include near misses:

"Yesterday, I had an interview for a job that I really wanted. It went well, and I have a chance of getting the job. After the interview, I had Chinese food for lunch. Before opening my fortune cookie, I jokingly said that I hoped it would say that I would get a job. When I opened it, it read "You are next in line for promotion in your firm." While I'm not so much getting promoted as just getting a job, I took this to be a good sign. I don't know yet if I will get the job, but I do take this to be a meaningful coincidence." (WCSa-98)

USEFULNESS OF BIAS

Bias is neither bad nor good. The brain needs principles or pathways in the association cortices by which to guide important inputs. Without bias the brain could spin in multiple directions, and fail to find meaning or make a plan. Each bias has its usefulness.

1. Confirmation bias encourages us to stick by important beliefs in the face of pressures to change them. Many coincidences provide confirmation for already made decisions.

2. Egocentric bias encourages us to interpret events around us as having importance to ourselves, to recognize that we exist in a particular time and place, and that events around us can influence us. This bias can lead to an overemphasis on the personal meaning of coincidences. Yet they may be telling us something. Perhaps they are like dreams which we can ignore as meaningless symbols of the night or messages about our current lives and future.

3. Hindsight bias uses new perspective to put old experiences in a different light. Without the potential for retrospective viewing, psychotherapy would be without its ubiquitous past-present connections, and history would appear to be a random set of events with no discernible patterns and lessons. Similarly, coincidences may develop richer meanings than they appeared to have at the moment of their occurrence.

4. Availability bias uses emotionally charged memories to act as guides. The memory of a recent failure can influence how a similar situation is handled the next time. Highly charged, recently useful coincidences can serve as reminders about the potential usefulness of a related coincidence.

Worries about the importance of bias can lead to recursive paralysis — the "bias-correcting bias." For example, the author of a paper on confirmation bias had to admit that he might have a bias toward confirming the importance of the confirmation bias.[12] Recognizing the role of bias may help clarify the rules of coincidence interpretation.

Coincidence analysis yields a discrete set of potentially useful processes[21] that includes: summaries, interpretations, affirmation, confirmation, suggestions, advice, predictions, criticisms. Like responses from a friend, relative, or therapist, coincidence interpretation can aid decision making and psychological change. Some may be life-changing while others may be simply interesting and funny. Not all are helpful, and some may be harmful.

Guidelines for coincidence interpretation are in their early developmental stages. Systematic study must move from current case reports to more extensive surveys with attempts at controlled trials. Questions to be asked include: how are coincidences to be noticed? Which characteristics should signal their scrutiny? How can interpretive rules be developed and validated?

HEMISPHERIC LATERALIZATION

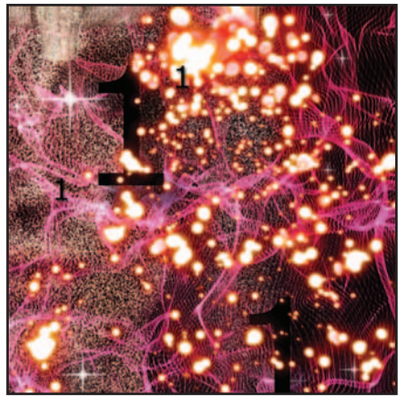
As the social and technical tasks facing the evolving human brain accelerated in complexity, the cerebral cortex divided its responsibility into two interrelated brains connected by and coordinated through the strong, thick fibers of the corpus collosum as well as the anterior and posterior commissures. The left brain took on a word-based, logical, accountant-like tendency while the right brain took on visual, intuitive, artistic-like tendencies.

In regard to creating meaning to inputs, the left brain tends to minimize the spread of associations while the right brain fosters them. In studying word associations Brugger noted:

"As a general rule, the left hemisphere tends to keep the spread of semantic activation within a narrow range while the right hemisphere pursues an opposite but complementary strategy of defocusing semantic activation. Unfocused, coarse semantic processing may give rise to new, uncommon and creative ideas. A focusing mechanism is needed, however, to protect associations from spreading "too far" and to allow integration of new concepts into established knowledge."[22]

From this perspective, an overactive right hemisphere and/or underactive left hemisphere may allow for an excessive attribution of meaning to events. The excessive attribution of meaning to coincidences has been termed apophenia. Conrad offered this definition: "unmotivated seeing of connections accompanied by a specific experience of heightened meaningfulness."[23] The "loose associations" of schizophrenia may be caused by this hemispheric imbalance. People with schizophrenia respond to stimulus words with more "uncommon" associations (with semantically more unrelated words) than persons without acute psychosis.[22]

On the other hand, the disinhibition of associations may be the source of much creativity, which can be understood as finding new meanings in old observations. Artists have long relied upon the looseness of the brain's association machinery for viewers and readers to find their own meanings in ambiguous patterns.[22] In regard to coincidences, creative associations restrained by left brain principles may find meanings that the probability- and statistics-oriented left hemisphere might ignore. The right hemisphere may act like an anomaly detector: Specialization of the left hemisphere for the suppression of anomalies and the preservation of the status quo and a complementary function of the right hemisphere as an "anomaly detector" whose main task is to shift a currently accepted paradigm.[22]



Science progresses by looking beyond chance as an explanation for underlying causal mechanisms.

Science progresses by looking beyond chance as an explanation for underlying causal mechanisms. A subset of coincidences that are not easily explained by chance because of their very low probability may be anomalies offering clues to new paradigms including neuroscientific approaches to belief formation.[24] The history of science is studded with examples of theories built upon possible patterns that turned out to be meaningless, random, and without cause. Yet the history of science also shows instances when the left brain-like scientific establishment initially denied the possibility of a causal explanation supplied by a right brain-like anomaly-detecting scientist and then later had to admit that this explanation actually did point to a likely cause.

For example, in 1790, the idea that meteors actually fell from the sky to become meteorites was regarded as superstitious and delusional. By 1805, it was accepted by the scientific community as an indisputable fact. The painstaking work of numerous observers made heresy into modern science. Numerous people had to notice a meteor passing, see it falling to the ground, locate its hot embers, and collect the fragments or call others to confirm the sighting. These data then needed to be collected and organized to confirm the connection between meteor and meteorite. This rapid transition from folk myth to science demonstrated the recalcitrance of the scientific community in accepting new explanations as well as its willingness to change paradigms when sufficient evidence and a satisfactory theory exists.[25]

A similar tension exists between the observations of the lay, non-scientific community and the guild of science. We have come to believe that scientific advancement comes only through the careful, sometimes inspired work

of scientists. The history of science shows a different reality.[26] Lay people do, indeed, participate in the development of new paradigms as illustrated by the meteorite example. The many reports of meaningful coincidences by non-scientists may lead to a possibly testable theory that will expand our concepts of reality.

WE CAN LOOK WHERE WE CANNOT SEE

Coincidence detection seems to have been naturally selected through evolution because it leads to the possibility of understanding cause and effect relationships. The scientific behavior of adults may represent an extension of the capacity for causal discovery that is essential for children's mapping of reality. Children are surrounded by events that, for them, involve novel causal relationships. For example, a parent might point to an object and say a word enough times for the coincidence to become an association — this word connects to that thing.

Small children are justified in being conspiracy theorists because their world is run by an inscrutable and all powerful organization possessing secrete communications and mysterious powers — a world of adults that acts by a system of rules that children gradually master as they grow up.[27]

Coincidences show the way. I think something. I say it. Something happens related to what I thought. Thoughts connect to events. Words can be intermediaries but not always.

The attribution of causes to coincidences is often misapplied. There appear to be no novel theories to be uncovered, no person meaning necessarily embedded in the co-occurrence. How then are we to understand coincidence detection?

One step may be to separate the elements of a coincidence that create surprise. In a series of experiments, Griffiths and Tennenbaum found that people seem to be able to correctly judge the probability of a coincidence happening. The surprise seems to emerge from how a low probability event challenges currently held theories of how the world works. This challenge then elicits several possible responses:

1. Probability — a mere coincidence.
2. Dysfunction of normal brain processing — a distortion.
3. Evidence for a faith-held rather than scientifically supportable theory.
4. Evidence for a new paradigm.

Probability provides the current scientific explanation for coincidences. Coincidences are low probability events; in large populations low probability events are highly likely. Someone will win the lottery. Someone's teenager will die in a car accident. Probability and randomness provide necessary checks and balances to easy speculation about the sources of surprising coincidences. Nevertheless, winning the lottery or experiencing the death of a child, weird coincidences will generate strong emotional responses because they challenge the individual's theory of reality. The association cortices will be activated. Emotion drives the need to seek an explanation. Amygdalas must be soothed by a familiar pattern.

As also discussed, hyperfunction of the normal brain offers a possible cause for the weirdness of a coincidence. Just because a great many people experience coincidences as meaningful does not necessarily mean that such coincidences are "real" but are more a creation of an association cortex put into hyperdrive[22] or a brain twisted by experience and genetics to detect and overly create meaning in them. The cause of the weird coincidence can lie with the abnormal brain processing of events rather than the events themselves.

And then there is possibility that some coincidences suggest new theories

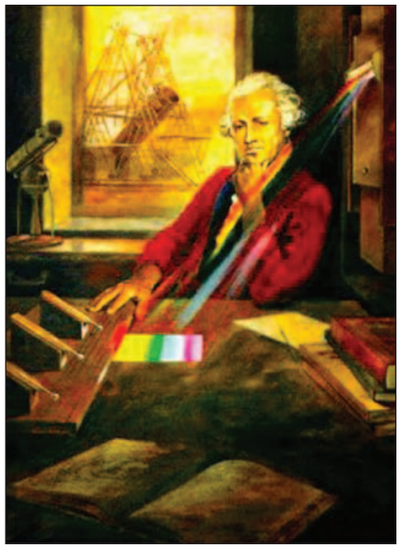


Figure 3. Sir Frederick William Herschel. Photo courtesy NASA, Jet Propulsion Laboratory, Pasadena, CA.

of reality. We cannot see light waves outside of the ultraviolet and infrared. But we have developed methods to detect light waves outside these spectral limits. As suggested by our inability to see light waves outside of the ultraviolet and infrared, coincidences may be pointing toward realms of order outside our current scientific visual spectrum.

Sir Frederick William Herschel (1738-1822; see Figure 3) directed sunlight through a glass prism to create a spectrum and then measured the temperature of each color. Herschel used three thermometers with blackened bulbs (to better absorb heat) and, for each color of the spectrum, placed one bulb in a visible color while the other two were placed beyond the spectrum as control samples. As he measured the individual temperatures of the violet, blue, green, yellow, orange, and red light, he found that the temperatures of the colors increased from the violet to the red end of the spectrum. Herschel also measured the temperature just beyond the red portion of the spectrum in a region where no sunlight was visible as a control. To his surprise, this region had the highest temperature of all.[28]

The higher temperature below the red end of the spectrum provided a surprising co-occurrence (heat plus position) that suggested a causal connection — infrared caused the thermometer to register a higher temperature.

What made Herschel place a thermometer outside the visible spectrum? Was it an accident, (a happy coincidence, serendipity)? Was he being a good scientist and using the other thermometer as a control? The stories vary. Yet by proceeding systematically and also by good fortune, Herschel found heat where he could not see it. Some coincidences may be like thermometers placed in the darkness, showing us a form of light we cannot see. We need to develop a science to test them.

REFERENCES

1. Ackerman D. *I Sing the Body's Pattern Recognition Machine.* New York, NY: Time Magazine. June 15, 2004.
2. Valtin J: Isolation, sensory deprivation, and sensory overload: An historical overview. Presented at American Psychological Association. San Francisco, August 19, 2007, From http://progressivehistorians.wordpress.com/2007/10/06/my-apa-paper-on-isolation-sensory-deprivation-sensory-overload/. Accessed April 21, 2009.
3. Guthrie S. *Faces in the Clouds. A New Theory of Religion.* Oxford, UK: Oxford University Press; 1993.
4. Lilly J. *The Deep Self: Consciousness Exploration in the Isolation Tank.* 4th ed. Santa Cruz, CA: Gateways Books; 2006.
5. Central Intennigence Agency. Human Resource Exploitation Training Manual; 1983. From http://www.gwu.edu/~nsarchiv/NSAEBB/NSAEBB27/02-01.htm. Accessed April 21, 2009.
6. Epley N, Akalis S, Waytz A, Cacioppo AT. Creating social connection through inferential reproduction. *Psychol Sci.* 2008;19(2):114-120.
7. Whitson JA, Galinsky AD. Lacking control increases illusory pattern perception. *Science.* 2008;322(5898):115-117.
8. Whalen PJ. Fear, vigilance, and ambiguity: Initial neuroimaging studies of the human amygdala. *Current Directions in Psychological Science.* 2008;7:177-188.
9. Snow J. From http://www.makingthemodernworld.org.uk/learning_modules/geography/05.TU.01/?section=2. Accessed April 21, 2009.
10. Viamontes GI, Beitman BD. Mapping the unconscious in the brain. *Psychiatr Ann.* 2007;37(4):243-256.
11. Rushnell S. *When God Winks.* New York, NY: Simon and Schuster; 2002.
12. Hamer D. *The God Gene: How Faith is Hardwired Into Our Genes.* New York, NY: Doubleday; 2004.
13. Nickerson RS. Confirmation bias: A ubiquitous phenomenon in many guises. *Review of General Psychology.* 1998;2:175-220.
14. Watt C. Psychology and coincidences. In: Anderson K, ed. *The Coincidence File.* London, UK: Blanford; 1999:229-237.
15. Westen, D, Blagov PS, Harenski K, Kilts C, Hamann S. Neural bases of motivated reasoning: An fMRI study of emotional constraints on partisan political judgment in the 2004 U.S. presidential election. *Journal of Cognitive Neuroscience.* 2006;18:1947-1958.
16. Falk, McGregor. The surprisingness of coincidences. In: Humphreys P, Svenson O, Vari A, eds. *Analyzing and Aiding Decision Processes I.* Budapest: Adademiai Kiado; 1983:489-502.
17. Blank H. Nestler S, *von Collani G, Fischer V. How many hindsight biases are there? Cognition. 2008;106(3):1408-1440.*
18. Nisbett R. Ross D. *Human Inference: Strategies and Shortcomings of Social Judgment.* Englewood Cliffs, NJ: Prentice-Hall; 1980.
19. Ciccone JP. Achieving Investment Goals; 2002. From http://www.thebullandbear.com/articles/2002/0502-goals.html. Accessed April 21, 2009.
20. Diaconis P, Mosteller F. Methods for studying coincidences. *Journal of the American Statistical Association.* 1989;84:853-861.
21. Perry R. Personal communication, email, 1/23/2009.
22. Brugger P. From haunted brain to haunted science: A cognitive neuroscience view of paranormal and pseudoscientific thought. In: Houran J, Lange R, eds. *Hauntings and Poltergeists: Multidisciplinary Perspectives.* Jefferson, NC: McFarland; 2001;195-213.
23. Conrad K. Die beginnende Schizophrenie. *Versuch einer Gestaltanalyse des Wahns.* Stuttgart, Germany: Thieme; 1958.
24. Brugger P. Mohr C. The paranormal mind: How the study of anomalous experiences and beliefs may inform cognitive neuroscience. *Cortex.* 2008;44(10):1291-1298.
25. Westrum R. Science and social intelligence about anomalies: The case of meteorites. *Social Studies of Science.* 1978;8:461-493.
26. Jacobs S, Mooney B. Sociology as a source of anomaly in Thomas Kuhn's system of science. *Philosophy of the Social Sciences.* 1997;27(4):466-485.
27. Griffiths TL, Tenenbaum JB. From mere coincidences to meaningful discoveries. *Cognition.* 2007;103(2)180-226.
28. Cool Cosmos. *Herschel and the Discovery of Infrared.* From http://www.brynmawr.edu/Acads/Chem/mnerzsto/Marshall-Infrared.html. Accessed April 21, 2009.