

Creativity Understood: From Neuromythology to Neuroscience

Review of "The Neuroscience of Creativity" by Anna Abraham

Systematic exploration of human creativity is a very recent enterprise, which until barely a few decades ago would have been regarded outside the purview of legitimate science. While astute introspections into the nature of the creative process had been offered by a few individuals themselves gifted with exceptional creativity: Mozart, Einstein, Poincare, - the more "scientific" treatises by psychologists dealt mostly with strictly cognitive constructs with very little serious consideration of the underlying neural mechanisms. As far as the brain behind the creativity magic was concerned, a plethora of popular, one might even say "pop," notions had coalesced into a certain neuromythology of creativity, often resulting in an incoherent soup of the "right hemisphere," "frontal lobes," "dopamine," and even "mirror neurons" for full measure.

It was only very recently that we witnessed a transition from the neuromythology of creativity to the true neuroscience of creativity. *The Neuroscience of Creativity* by Anna Abraham is arguably the best and most balanced account of the neuroscience of creativity to date. A pioneering and creative student of creativity (pun intended), imagination, and intuition, Abraham is uniquely qualified to critically assess the state of the field. The 371-page book is remarkably capacious in its scope and range. It is also remarkable for its balance between scientific rigor and an easy-on-the eye, engaging writing style, erudite vignettes about famously creative individuals, and a large number of attractive black-and-white illustrations dispersed throughout the text. This makes the book equally attractive to a fellow neuroscientist and to an inquisitive lay reader. To cut to the chase, I believe that Abraham's book is the most comprehensive and thoughtful review and discussion of creativity research today; so all my comments below should be taken in that spirit.

In the first chapter, *What Is Creativity?*, Abraham reviews various domains of creative endeavor: artistic, scientific, engineering, and others; as well as the definitions of creativity on the intersect of the Original and Appropriate (which in my own work I refer to as Novel and Salient). She actually draws a Venn diagram highlighting this essential relationship. Since most interesting things in life have more to them than meets the eye at the first encounter, Abraham proceeds with a nuanced discussion of such deceptively self-explanatory constructs, like the difference between P (psychological) and H (historical) creativity; differences between mini-c creativity, Big-C creativity and other c's in between. Attention to fine conceptual nuance, at times leading to unexpected conclusions, comes across throughout the book, making the narrative particularly interesting. How to recognize and "value" a creative idea or product is another non-trivial issue addressed in the book.

The narrative then veers into the relationship between creativity and consciousness, a bit of a treacherous terrain, as long as no consensus exists about the nature of consciousness. Indeed, the understanding of this relationship will be very different depending on which of the extreme views (or anything in between) one holds on consciousness: simply as a product of a sufficiently large, distributed cortical network being active for a sufficient length of time at a sufficient level of intensity (a global but minimalist point of view); or the assumption of a dedicated neural machinery, perhaps even a locus, of consciousness in the brain (a local but highly embellished point of view). Likewise, the creative agent's awareness of the potential ramifications of one's invention or discovery, may be very different in different situations and contexts, ranging from a humble self-deprecation to a self-conscious conviction of one's own greatness. Was George Boole fully aware of the impact his algebra would make on the development of computing a century later? Could he have been? Was even Alan Turing, a century later, in a position to fully anticipate the massive impact his Turing Machine would have on shaping our digital world? Finally, the question of the "purpose of creativity" is discussed. Like with any teleologically phrased question, one is tempted to ask, somewhat mischievously, if our restless species would have been better off with less creativity. After all, it has been said that the cro-magnons lived happier and more plentiful lives before they were thrown out of the Garden of Eden for being too inquisitive (too creative?).

The title of the second chapter is, *How Can Creativity Be Assessed?* While the question is self-explanatory, the answer is not. What exactly should be studied in assessing creativity? Abraham suggests that the answer to this question could be "the Four P's of Creativity:" Process, Product, Person, and Place, each requiring its own metric. With respect to Person, the relationship between creativity and intelligence is often invoked. But what intelligence? If the one numerically expressed in the IQ Quotient, then the answer is that a positive relationship exists up to an IQ of 120, but the relationship breaks down beyond that point. But the nagging question remains, how good the IQ test is at sampling intelligence as it is broadly understood by most people in the sense of "I know it when I see it." The role of Place (context) in fostering or retarding the creative output of society is discussed, with interesting implications for historical serendipity, like the Medici family's patronage of the arts. Would Renaissance have happened had the Medicis been interested in maritime exploits and not in the arts? Would Italian be spoken in Central and South America today, instead of Spanish and Portuguese? Finally, Process. Here the influential theory of a four-stage process (Preparation-Incubation-Illumination-Verification) is discussed, as well as the oversimplification inherent in the assumption of its discrete nature. The issue of the relationship between knowledge and creativity is brought up, which resonates nostalgically with my own youthful musings more than half-a-century ago. I remember how sometime in my late teens I was amused by the "discovery" that most people "know more than they understand," but there are those who "understand more than they know." Without any evidence, I decided that I belonged to the second group.

The discussion then progresses toward a cogent review of the ways creativity can be assessed – both of the process underlying individual creativity, and of the product of that creativity. For process, various tests of divergent and convergent thinking are discussed, comprehensively but perhaps a bit too leniently with respect to the underlying assumptions about their relationship to real-life, consequential creativity. The fate of a novel product is decided by its consumers, by certain segments of society. What happens if a product (an idea, a theory, or technological innovation) which would be judged as exceptionally creative a few generations later, falls on deaf ears in its own time? Then the answer may be, sadly, nothing. If it is too far ahead of the contemporaries' Zeitgeist, then the creative product may be erased from the society's collective memory before the society is ready to embrace it. I would have enjoyed Abraham's thoughts about the "optimal delta," by how far an innovation should be ahead of the society's Zeitgeist in order to be judged as groundbreaking, yet not be lost altogether, and how to formulate such a metric of being ahead of contemporaries. This "delta" will be obviously a range, constrained on both ends. If the delta is too small, then the product may be judged as creative but not with a capital C. On the other hand, too large a delta may spell oblivion due to incomprehension.

The third chapter, titled *Cognitive Explanations of Creativity*, opens with an ancient quote: "All that we are is the result of what we have thought; it is founded on our thoughts, it is made up of our thoughts;" and now we know that before Immanuel Kant there was Gautama Buddha. What follows is a review of various theories of creativity, mostly the vintage ones, formulated in the pre-cognitive neuroscience age in the spirit of the "boxological" tradition, as well as an attempt to map them, post-hoc, on the more contemporary knowledge of the brain.

The fourth chapter, *Brain-Based Global Explanations of Creativity*, starts with an admonition about the lack of simple "correspondences between operations of the mind and operations of the brain." This statement might have benefited from amplification to the effect that both of these types of "operations" are nothing but epistemological fictions, somewhat arbitrary constructs whose value is more heuristic than truly explanatory. It behooves us all to remember that such "false but useful" constructs, while being useful are, for the most part, false. Such elaboration would have been particularly welcome because most members of the general public, and even many professionals, think of the constructs such as "memory," "attention," "perception" literally, as real, categorical, and separated by intrinsically discrete boundaries.

A cogent, and appropriately critical, review of several dual-factor models follows, as well as the comment on psychology and cognitive neuroscience's infatuation with dichotomies. The dichotomies reviewed include right brain vs left brain, mental health vs mental illness, and default mode network vs central executive network. Various other approaches are then reviewed, including the simplistically appealing but mathematically impossible Blind-Variation-Selective-Retention (BVRS) model, as well as the subsequent correction of the model proposed by Arne Dietrich and others. The chapter concludes with a "caveat emptor" note of caution regarding any of these models. I concur.

Fittingly, the fifth chapter is *Brain-Based Local Explanations of Creativity*. Here, the brain mechanisms underlying specific mental operations implicated in creativity are discussed. Prefrontal cortex figures most prominently, including the intriguing issue of hypofrontality and its role in creativity. A very large number of studies, not all of them replicated, is reviewed, some of them resulting in very specific neuroanatomical claims. My many years both as a researcher dealing with highly contrived experimental paradigms asking narrowly phrased questions; and as a clinician dealing with the messy, unpreconceived experiments of nature with broad consequences, have taught me to take overly specific neuroanatomical claims with a huge grain of salt, particularly considering that the heteromodal association cortex, for which most such claims are made, lacks strong functional modularity. One should never assume from the outset that such claims *are* wrong, but one should always keep in mind the possibility that they *may be* wrong. For all these reasons, replications are particularly desirable but by far not always available. Neuroimaging research is expensive, there is relatively little glory in replication studies, and as a result they are too infrequently forthcoming. I suspect that many unreplicated claims would turn out to be unreplicable even if one tried. This concern applies not just to this chapter, but to virtually any review, book chapter, or journal article, where multiple highly specific functional neuroanatomical findings are presented; particularly if the studies employed equally specific, often highly esoteric cognitive activation tasks, but the results are phrased in broad cognitive terms. In any review which includes a large number of such claims, a tentative, rather than definitive nature of the claims should always be acknowledged, but almost never is.

The sixth chapter, *Neuroscientific Methods in the Study of Creativity* is a very well written, succinct and to the point, factual review of research methods: functional neuroimaging, structural neuroimaging, electroencephalography, and neuromodulation, in all their multiple forms and applications. Numerous examples of their use in creativity research are included.

The seventh chapter, *Unique Problems in the Neuroscientific Study of Creativity*, opens with the question: “Problems? What problems?” – The answer is, plenty, and Abrams provides a detailed and incisive review of these problems, and at times also of solutions. The problems tackled pertain to the experimental trials, responses, task (including control task) selection, subject groups, and validity. As Abraham correctly notes, “...the general rule is that the greater the number of trials, the more robust is the average response.” This premise is universally shared in functional neuroimaging research, and it is based on the implicit assumption that all trials are equal and sample activity in fixed neural structures, which are constant throughout the experiment; in other words that all the trials sample the same population of data points. However, this assumption is plausible only for highly overlearned cognitive tasks, which are the antithesis of creativity. In contrast, any “creative” process probably entails learning and gradual decrease of the degree of novelty and ambiguity involved, as well as other possible changes in the course of the experiment. Such task dynamics most likely corresponds to a gradual (or maybe even precipitous) change of the underlying neural substrates. This calls for a different methodology, not based on averaging across the whole experimental sequence. Regrettably,

the consideration of neural dynamics (as opposed to fixed neural substrate) in the course of an experiment is absent from most discussions of functional neuroimaging methodology, as is the case here. On the other hand, Abram's discussion of control tasks is particularly valuable, as these tasks are too often thrown in into the experiment as an afterthought, without rigorous vetting or consideration. When this happens, it may undermine the whole study by rendering the findings uninterpretable, particularly if the critical tasks are very complex and esoteric. The chapter concludes with Arne Dietrich's quote: It is high time that researchers became more creative about creativity." Ditto!

The remaining five chapters deal with specific domains of creative expression: musical, literary, visual artistic, kinesthetic, and scientific. The chapters are full of intriguing facts and astute observations. As in the rest of the book, Abraham continues to impress with her ability to pack prodigious amounts of relevant information into relatively brief chapters. At times, however, this parsimony comes at a cost. I wish Abraham's discussion of "mirror neurons" was more nuanced, considering a range of attitudes toward this construct among neuroscientists. The fact that the same neurons fire when an animal (and presumably a human) executes an action, observes the same action executed by a co-specimen, or imagines that action, is utterly unsurprising if one believes in the adaptive course of evolution (or has due respect for the Creator's engineering acumen). It would have been more surprising (and evolutionarily wasteful) if these three acts were mediated by separate neuronal ensembles. Demonstration of such separateness, had it existed, would have constituted a real discovery – one of evolution's unwisdom.

The Neuroscience of Creativity ends with a quote from Rabindranath Tagore: "everything comes to us that belongs to us if we create the capacity to receive it," originally written in Bengali. Tagore was my mother's favorite poet, and I remember the little book of his poetry translations in our home when I was growing up. Tagore was a polymath, a man of many creativities. He was a poet, novelist, musician, artist, and public intellectual. It is only fitting that a book about creativity culminates with a tribute to the man who was so richly endowed with it. *The Neuroscience of Creativity* is a remarkable book and anyone interested in the science of creativity – or just creativity – should read it.

Elkhonon Goldberg

New York City, NY

Email: eg@elkhonongoldberg.com