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The ingredients of the creative mind: Book Review of Elkhonon Goldberg's *Creativity: The Human Brain in the Age of Innovation* (2018, Oxford University Press)

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Creativity: The Human Brain in the Age of Innovation (2018) is the first book of its kind. Certainly in terms of scope, application and perspective. Where else can one find an open exploration of the neural, behavioral, evolutionary and cultural factors that stand to have an unmistakable impact on our powers of perception, sense-making, and, by extension, creativity. Having tackled some truly complex and fascinating fields of study like executive functions (Goldberg, 2001) and wisdom (Goldberg, 2006) in his previous monographs, Elkhonon Goldberg lends his considerable talents of observation, reasoning and explanation to the domain of creative thinking in his latest book (Goldberg, 2018). The unique insights afforded by his cross-disciplinary and cross-cultural perspectives, from decades of work as a research scientist, educator and practicing neurologist, alongside some of the veritable giants in the fields of medicine and psychology, is palpable throughout this volume.

The book begins with a free fall of sorts, leading (at least this reader) to experience alternating emotions of fascination and wariness, as it lays bare the reality of what awaits us as a species (following the conceptual leanings of Harari, 2015, 2016) – an overwhelmingly fast paced, ever-changing and novelty saturated future. Goldberg goes well beyond the present realm to imagine how the technological advances of the future (that stand to further render the merging of physical and virtual planes of reality) will necessarily impact brain function, and, by extension, how the mind perceives and how the mind creates. The fitting phrase of the “fusion revolution” (p. 4) is evoked right at the outset, the consequence of which is an ever-increasing exposure to novelty in our daily lives. It certainly whet my appetite, not just for the rest of the book, but also for still more reasoned speculations within that context. Are we likely as a species to continue to effectively adapt and thrive in the perennial age of novelty? Or it is more likely that we eventually reach a breaking point that will lead to a steep

“fragmentation of knowledge” and the consequent “balkanization” (p. 3) or disintegration of our own minds? The latter is an unsettling prospect but one that is worth considering as it is unlikely that there is no upper limit to how much novelty can be readily processed at any given time by the human brain. While the author avers that “novelty is inexorably linked to creativity” (p. 10) and that quantitative changes will beget qualitative changes in our minds, I wish he had gone further in his proposal and broached the issue of what type of qualitative changes we can expect to undergo with the unabated and ever-increasing barrage of novelty. Will we become overwhelmed and fall to dull perseverance following the inevitable path of least resistance or else risk becoming mired in a state of confusion? Or would exposure to more novelty instead linearly give rise to higher levels of creativity? If the latter is unlikely, then it would appear that the future of humankind in effect puts the future of human creativity at stake.

There are several useful insights that this book delivers that will give the careful scholar much food for thought. One is the distinction drawn between ‘cognitive skills’ and ‘cognitive habits’. This is mentioned in the context of understanding cultural differences in cognitive styles but the significance of this distinction applies just as well to how we conceive of and assess creative potential. After all, I may have the skills or ability to pen a poem but I may not routinely expend the effort to do so as I have not mastered the “habit of mental effort” (p. 8). If I do not exert requisite levels of effort with discipline and regularity, I am hardly going to be in a position where I can improve my skills to reach any level of notable creative achievement. We typically test for creative potential by examining the ability to generate creative responses using a range of tasks (Barbot & Reiter-Palmon, 2019), but we rarely go further by also examining cognitive habits in the same context. In drawing attention to this

overlooked yet critical facet of mental functioning, Goldberg has provided us an important avenue for further empirical exploration; one which stands to be particularly fruitful given the established link between expending effort and skill improvement (Ericsson, Krampe, & Tesch-Römer, 1993; Macnamara, Hambrick, & Oswald, 2014; Macnamara & Maitra, 2019).

Still more useful observations were made in the lucid delineation of the dopamine and norepinephrine systems and the complementary roles they play in arousal modification during information processing that facilitate how we make sense of the world at large. The combined role of these systems has been advocated by other scholars in mediating a range of functions, such as explorative versus exploitative modes during reinforcement learning (McClure, Gilzenrat, & Cohen, 2006) and motivation-cognition interactions in creativity (Flaherty, 2011). In characterizing the wider role of these systems in information processing as a whole, Goldberg argues that the norepinephrine system is held to be in place for detecting 'stimulus novelty' while the dopamine system is sensitive to 'stimulus salience' or importance. Given the nature of their functional profiles, both these neurochemical systems are proposed to be key in our capacity to create. Such intuitions certainly seem prescient when considering that recent empirical and theoretical work have begun examining the joint role of dopamine and norepinephrine systems on creative ideation (Baas, Boot, van Gaal, de Dreu, & Cools, 2020; Beversdorf, 2019; Gu et al., 2018; Khalil, Godde, & Karim, 2019).

Proponents of the view that the right hemisphere is of especial relevance to creativity will find precious information in this book as they will discover the breadth of evidence that Goldberg draws on to make the argument that the right hemisphere is sensitive to 'cognitive novelty' very handy for their own purposes. However, it would be an error to give the

impression that lazy generalizations were being made about the ‘creative right brain’ versus the ‘uncreative left brain’ in this book. In fact, the subject is handled by the author with considerable nuance as the contribution of the left hemisphere to creative thinking is also given its due given its key role in ‘cognitive routines’ which is also important in the realization of creative ideas. While the importance of both hemispheres in creativity has been emphasized right from the dawn of laterality research on the same (e.g., Bogen & Bogen, 1988; Hoppe, 1988; Miran & Miran, 1984), what this book delivers is an up-to-date, deep and meaningful explanation of anatomical and functional bases of hemispheric differences and why these are relevant to our understanding of the creative mind. In doing so, Goldberg articulates his novelty-routinization theory of hemispheric lateralization, a theory which aligns seamlessly with recent proposals that the two hemispheres serve complementary roles during reasoning. While the left hemisphere is held to be geared towards doggedly pursuing the obvious path, thereby reducing uncertainty during inference generation even in the face of evidence to the contrary, the right brain reduces conflict by accommodating new evidence which results in the updating, refinement or rejection of the generated inferences (Turner, Marinsek, Ryhal, & Miller, 2015). Goldberg’s ideas also correspond with empirical work which shows unique functional activity patterns within the two hemispheres such that the interactions of left hemisphere regions are largely limited to other regions within the same hemisphere, whereas right hemisphere regions demonstrate strong interactions with regions of both hemispheres (Gotts et al., 2013).

What this book does well is to outline these and several other ingredients of the creative mind, such as the role of constrained or directed mental wandering in creative thinking (Chapter 7), the perpetual flux within the mechanisms of neural networks as a function of

learning (p. 101), how the discovery of prefrontal specific dynamic network connectivity (DNC) at the molecular level has implications for creative thinking (p. 61), and the utility in employing Vygotsky's seminal idea of 'the zone of proximal development' as an indicative measure of the capacity for novelty-mastery (p.150). The book also does well to point out general principles that one tends to lose sight of when studying creativity. The fact that there are many paths to creativity (p.212), the trap of frontal lobe idolatry (p. 184), the wonderful reality of non-human forms of creativity (Chapter 8), and that merely practicing the arts is not a guarantee of creativity which is indicative of the need to recognize the "semantic conflation" that routinely occurs when we *prima facie* equate being creative to mere membership in creative professions (p. 171).

In elucidating how and why these factors constitute the essential building blocks to creativity, the author steers us towards a number of different directions of relevance. While this feat in and of itself is undoubtedly of utility to the creativity scholar, what cannot be discounted is that these factors have largely been explored in isolation rather than in an integrated fashion. So much so that the book often comes across as being devoted to exploring functions that are not particularly specific to creativity. It is of course possible that telling the tale in this manner is inevitable given that the neural and cognitive elements that make up creative and non-creative operations of the mind are one and the same (see Finke, Ward, & Smith, 1996; Ward, Finke, & Smith, 1995). Yet this is, in fact, the very reason why an integrated account is necessary. The dynamic relations between creative and non-creative aspects of our mental life need to be explicitly spelt out for any neuroscientific account of the creative mind to be complete. The field is more in need of a landscape depicting the whole gestalt than it is a catalogue of entries. The book does, however, allude to several worthy starting points for

such an exercise. For instance, one promising venture would be to derive how a neural system that is sensitive to stimulus novelty or stimulus salience (at the level of both sensory reception and interoception) interacts with our individual propensity for novelty seeking (at the level of personality traits and motivational drive), and how these in turn impact generativity and exploration (at the level of responses or performance).

One of the challenges faced by the reader when attempting to integrate the disparate strands explored in this book is that the author has not used some of the terminology that is typically adopted in the field when referring to key constructs. The importance of ‘openness to experience’ in creative ideation, for instance, is well documented in the literature (e.g., McCrae, 1987; Silvia, Nusbaum, Berg, Martin, & O’Connor, 2009). But it is unclear whether the author’s conception of ‘novelty seeking’ is the same as or partially overlaps with that of ‘openness to experience’ as there is no explicit mention of the same. A bigger challenge is posed by the many omissions in the cited neuroscientific literature that have a direct bearing on creativity in the book, particularly surprising of which – given the author’s own academic leanings – are those in relation to contemporary neuropsychological studies (e.g., Abraham, Beudt, Ott, & von Cramon, 2012; Shamay-Tsoory, Adler, Aharon-Peretz, Perry, & Mayselless, 2011). Although not stated as such, this could be due to the author putting little stock in the utility of divergent thinking tasks (p. 167) in examining creative thinking, and such tasks are typically employed in the vast majority of neuroscientific studies. However, omissions are also apparent in relation to theoretical proposals within the neuroscience of creativity (e.g., Dietrich, 2015; Jung, Mead, Carrasco, & Flores, 2013; Martindale, 1999), some of which have clear parallels with the author’s own proposals. For instance, Goldberg’s proposal of ‘directed mental wandering’ in idea generation as an alternative to that of Donald Campbell’s ‘blind

variation' in his BVSR (*blind variation and selective retention*) model (Campbell, 1960) bears significant conceptual similarities to Arne Dietrich's (2015) proposal of 'degrees of sightedness' during idea generation.

The crowning achievement of this work is that it takes the defining attribute of creativity – novelty – and puts it front and central in the glare of the spotlight, which is exactly where it belongs. In chasing down its many eager interacting partners in the form of salience, routines, neural networks, neurochemical systems and other hopefuls across the pages of the book, the implicit message that abounds is this – there can be no understanding of creativity without an understanding of how novelty is perceived, how novelty is generated and how novelty is selected. That, in a nutshell, is the challenge we face.

Creativity: The Human Brain in the Age of Innovation is a deeply personal and subjective book. And therein lies its strength. In an era where empirical findings in relation to the creative mind are stockpiled with scarcely a nod in the direction of theory, meaning or relevance to the defining element of novelty, the need for informed conceptual frameworks and perspectives to discern relevant patterns and inform future work is dire. Goldberg's book arrives at this opportune hour to deliver us from this state of affairs with periodic injections of optimism and sage guidance. Creativity neuroscientists would do well to heed this work.

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