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## Creativity and the Social Brain

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The neuroscientific approach to investigating creativity refers to the study of brain basis of the mental operations that underlie creative ideation (Abraham, 2018b; Jung & Vartanian, 2018). The creative brain has been the subject of concerted investigations for a few decades now, and there are several consistencies in the patterns of findings that are reported regardless of whether one adopts a ‘global’ or a ‘local’ approach. Global approaches focus on large-scale brain networks when interpreting the brain correlates of creativity, whereas the spotlight in local approaches is far more circumscribed in that it is limited to local brain regions or brain activity patterns (Abraham, 2018a).

It is clear now that there is no single brain region or brain network that is purely specialized for creative cognition. While the functional roles and dynamics of the array of brain regions and brain networks that are implicated in creative ideation are slowly becoming clearer, most insights from brain research remain at the level of mere description. Few scholars attempt to infer beyond surface activity patterns to consider what these patterns reveal about the fundamental nature of mental operations applied to the context of creativity. If the brain areas involved in creative cognition overlap with those of normative cognition, this requires considering not only the differences but also the similarities between creative and non-creative aspects of cognition.

Let’s take the example of the global brain networks perspective, the currently influential trend in creative neurocognition. Abundant evidence has shown the contribution of regions within the default mode network (DMN)

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and the central executive network (CEN) in orchestrating creative cognition (e.g., Abraham et al., 2012; Beaty, Benedek, Kaufman, & Silvia, 2015; Ellamil, Dobson, Beeman, & Christoff, 2012; Limb & Braun, 2008). In general terms, these brain networks are distinguished in terms of their functional profiles. The DMN is called upon in contexts of internal mentation, whereas the CEN is engaged in contexts that necessitate cognitive control in goal-directed thought and action. These two networks are normally anticorrelated (Fox et al., 2005), which means that when one is highly engaged or more active the other one is relatively inactive. A third network of the brain, the Salience Network (SN), which is primed to detect behaviourally relevant stimuli, largely determines which of these two networks will be engaged at any given time depending on what is necessitated by the currently relevant context. So the SN modulates the switch between the DMN and CEN, such that it triggers the CEN when external goal-directed processing is required and, alternatively, the DMN when a situation calls for internal spontaneous processing. What do we know so far about the functions of these networks?

The CEN is engaged during goal-directed tasks that require executive function and cognitive control, such as working memory, inhibitory control, task switching, controlled semantic retrieval, problem solving and reasoning (Cole & Schneider, 2007; Niendam et al., 2012). The anterior and lateral prefrontal cortices of this network occupy central focus in the context of creativity as they are involved during analogical reasoning, conceptual expansion, lyrical improvisation, metaphor processing, musical improvisation, problem solving and story generation (Abraham et al., 2012; Fink et al., 2009; Green, Kraemer, Fugelsang, Gray, & Dunbar, 2012; Kröger et al., 2012; Limb & Braun, 2008; Liu et al., 2012; Rutter, Kröger, Stark, et al., 2012b; Shah et al., 2011; Vartanian, 2012).

The DMN, in contrast, is strongly engaged during rest, and includes medial regions of the prefrontal cortex (Buckner, Andrews-Hanna, & Schacter, 2008; Raichle, 2015). The functional profile of this network is such that these regions are engaged during different types of social and self-referential imaginative thought processes. These include autobiographical and episodic memory (e.g., remembering my last day as a student at university), episodic future thinking (e.g., imagining what my next house will be like), mental state reasoning or theory of mind (e.g., making inferences about what my date is thinking), self-referential thinking (e.g., reflecting on my own behavior earlier that day), and moral reasoning (e.g., judging the permissibility of my boss's behavior). These operations can be either directly prompted (i.e., within a study using experimental design to assess the same) or spontaneously elicited under at rest and when performing cognitively undemanding tasks during

which mind-wandering inadvertently takes place (Andrews-Hanna, Reidler, Huang, & Buckner, 2010).

The core brain regions within the SN (Goulden et al., 2014) include the dorsal anterior cingulate cortex and the orbital frontoinsula cortices (Uddin, 2015) of which the latter mediates “dynamic interactions between other large-scale brain networks involved in externally oriented attention and internally oriented or self-related cognition” (Menon & Uddin, 2010). The insula is characterized by its sensitivity to bottom-up salience which account for how it determines when to switch between engaging the DMN or the CEN. Recent work using brain functional connectivity analyses has shown that hub regions across all three networks – DMN, CEN and SN – are implicated in relation to high levels of creative ideation (Beaty et al., 2018).

So where does this evidence take us? In a bid to uncover the differences between creative and non-creative cognition, we have fundamentally ignored the need to consider the similarities between them. The rest of this chapter is devoted to showcasing the advantage of following this novel approach by exploring the candidate mechanisms of correspondences between creativity and social behaviour. The three that will be described include the ‘drive to understand’, the ‘intention to communicate or evoke’, and the ‘personal relevance bias’.

## **The Drive to Understand (by Means of Inference and Discovery)**

The human brain is increasingly being understood and portrayed as an engine of predictive and proactive processing (Bar, 2009; Bubic, von Cramon, & Schubotz, 2010; Clark, 2013). Through our sense organs we are constantly statistically sampling the information in our environments and form expectations based on context-specific consistencies. This is a rapid and dynamic process and one that is optimized for efficiency, which is why we experience our perceptual world to be smooth and continuous. Indeed, if we attended to every single stimulus in our environment as though it were an entirely new stimulus with no contextual connection to any previously experienced stimulus, we would be incapable of functioning in the usual rapid and efficient manner as the information processing demands would be perpetually overwhelming. Under such circumstances, accuracy in stimulus processing would be very high but we would necessarily be very slow in moving through our environments.

One of the ideas for the types of algorithms that might be applicable in generating quick and efficient processing, which generates the ability to engage with the environment to a sufficiently high level but not perfect of accuracy, was postulated by Daniel Dennett. He proposed that the brain uses three mental shortcuts to categorise events that we experience (Dennett, 1987). The ‘physical stance’ is applied when an event can be understood by means of the natural forces in the world (e.g., A ball that is thrown up will fall down to the floor). The ‘design stance’ applies when an event can be explained with reference to the manner in which stimuli in that context are designed for a specific function (e.g., A ball that emits flashing lights whenever it is bounced on the floor has been designed to do through an engineered connection between pressure and light). Events that cannot be explained through either the physical stance or the design stance are viewed through the lens of the ‘intentional stance’ where the events are interpreted as intentional or goal-directed (e.g., A ball that is thrown up suddenly stops falling to the ground and instead lingers in the air and moves around erratically).

The DMN has been characterized as priming the intentional stance (Spunt, Meyer, & Lieberman, 2015), as it is often involved in when inferring the mental states of others. Inference generation is a key component of mental state reasoning as one is not privy to the contents of another person’s mind. Mental state reasoning, also commonly referred to as mentalizing or theory of mind, together with other operations that engage the DMN such as episodic memory, episodic future thinking, self referential processing and moral cognition, has been classified as falling into the category of ‘intentionality-based imagination’ as it elicits information processing mechanisms that are “predominantly recollective in nature with a view to establishing the best possible explanation of a situation or event in question. This is brought about by means of spontaneous access to an extensive and diverse repertoire of relevant knowledge when processing such contexts. The best or most plausible explanation is the one that fits best with what is already known in terms of oneself and/or one’s worldview” (Abraham, 2016: 4203).

A key point to note though is that while the DMN regions are strongly engaged in these contexts of social and self-based cognition, they are also involved in contexts that are not explicitly social or self-based, but still call upon or necessitate similar computational demands. The dorsal aspect of the medial prefrontal cortex, for instance, is involved in inference generation across contexts – discourse processing, humour, etc. – regardless of the sociality of the background context (Ferstl & von Cramon, 2001, 2002;

Siebörger, Ferstl, & von Cramon, 2007). So the discovery of coherence within a context that comes about by making an associative or inferential leap (between two statements, for instance) leads to heightened activity in this core DMN region regardless of whether it involved non-mental state reasoning (e.g., The lights have been on since last night. The car doesn't start.) or mental state reasoning (e.g., Mary's exam was about to begin. Her palms were sweaty.).

A further example of where a similar case can be made is that of another core DMN region – the temporal poles. This region, which forms the anterior-most extent of the left and right temporal lobe, is held to be critical in the representation and retrieval of social script knowledge (Olson, McCoy, Klobusicky, & Ross, 2013; Wang et al., 2017). From the context of mental state reasoning, this region is held to be a repository of sorts for social script knowledge that we draw on to generate inferences during social cognition (Frith, 2007; Frith & Frith, 2006; Saxe, Carey, & Kanwisher, 2004). What is fascinating is that abundant literature within the field of semantic cognition show that the temporal poles are the hub zone where conceptual knowledge seems to be stored amodally and/or multimodally (Fairhall & Caramazza, 2013; Jefferies, 2013; Patterson, Nestor, & Rogers, 2007). So the temporal poles house abstract, amodal and multimodal representations of conceptual knowledge, regardless of whether the information is categorized social or non-social. The key attribute to not focus on here is which type of information activates this region 'more', as this essentially reflects some core facet of the information that is being processed to a greater degree. If one introspects on the difference in one's conscious experience of social information (e.g., one's boss, the face of a stranger, an interview with Tilda Swinton) versus non-social information (e.g., a menu card, the sound of the rain, the smell of a department store), it should be fairly obvious that social information encoded in a manner that is more amodal or multimodal and more highly associative per se than non-social information. This could be the reason why social information processing engages the temporal poles more than non-social information processing. However, the fact that all types of conceptual knowledge evoke activity in this region begs us to consider what is the common denominator. And the answer is that this region is not engaged when processing unimodal or modality-specific information, but instead when processing abstract, amodal and multimodal information. So the ability to infer and discover new associative connections within one's conceptual space is necessarily incumbent on being able to draw upon this form of representation.

## The Intention to Communicate and Evoke (by Means of Expression)

Let us think for a moment about why we create. It is clear that human beings are an extraordinarily creative species. Although the term ‘creativity’ is typically associated with prominence and productivity in the arts as well as invention and discoveries in the sciences, it is in fact central to virtually all domains of human life, including industry, policy-making, services and community development, as creativity is the foundation from which innovation and progress emerges (Sawyer, 2012). This is to be expected given that the need to be creative is typically viewed as central to the human self-actualization drive (Maslow, 1943), which refers to the need that each of us have to realize our unique potential in the form of distinctive achievements and personal growth throughout our lives.

This drive to create is not given nearly enough focus in the literature despite the fact that its power is unmistakable. Let us take the example of *de novo* artistic skills. This refers to the sudden emergence of visual artistic and musical abilities in people who did not previously exhibit such tendencies following brain injury or neuronal degeneration (B. L. Miller et al., 1998; Z. A. Miller & Miller, 2013). This unexpected release of artistic behaviors is believed to reflect the drive to communicate and express oneself in the face of the inability to do so effectively due to language impairments that are symptomatic of such conditions (Zaidel, 2014). As the customary route of expression is thwarted in this context, the turning to art is viewed as an alternative means of personal expression for the purpose of communication. Indeed, the healing power of engaging with the arts, given that it allows for unique self-expression and promotes resilience, has been highlighted in relation to several clinical disorders, so much so that positive interventions in relation to the same are advocated in such contexts (Assael & Popovici-Wacks, 1989; Forgeard & Eichner, 2014; Forgeard & Elstein, 2014; McFadden & Basting, 2010).

What is more, creative expression does not occur in a vacuum, but within a social context. It is after all when our creations resonate with others that our ideas gain traction. In fact, the “set of social institutions, or field, that selects from the variations produced by individuals those that are worth preserving” is one of the three main shaping forces that determine the degree of creativity associated with an output (Csikszentmihalyi, 1988).

The response of others, both real and imagined, to the outputs of one’s generativity is central to the process of creative ideation. Neuroscientific evidence does in fact indicate that we are highly tuned to the factors that facilitate

understanding of information being imparted in our social world. For instance, the N400 is a well-studied event-related potential (ERP) which indexes the detection of semantic and world knowledge violations (e.g., The colour of milk is orange) during language comprehension (Kutas & Federmeier, 2011; van Berkum, Hagoort, & Brown, 1999) and is of key relevance to creative cognition (Kröger et al., 2013; Rutter, Kröger, Hill, et al., 2012a). The sensitivity of the N400 also extends to social contexts as it is preferentially engaged when faced with culturally specific social norm violations (Mu, Kitayama, Han, & Gelfand, 2015) and is influenced by the knowledge of other listeners. For instance, participants who had knowledge about a language stimulus but knew that a co-listener could not know the same, showed a N400 response when listening to the stimulus with the co-listener but not when hearing the stimuli alone (Rueschemeyer, Gardner, & Stoner, 2015).

The fact that we are sensitive to the knowledge of others and our brain activity indicates selective responsivity for the same has powerful implications for understanding how a keen awareness of both our knowledge of others and our power to evoke emotional and behavioral responses in others shapes our ability to create products that have a deep resonance with others in our social space.

## **The Personal Relevance Bias (by Means of Alertness to Self-Related Salience)**

The relevance of the DMN in the information processing of social and self-relevant information has been highlighted in a previous section. Several studies using a range of different paradigms have indicated that certain brain regions within this network, particularly ventral aspects of the medial prefrontal cortex, are particularly sensitive to the degree of self-relatedness or personal relevance of the information (Mitchell, Macrae, & Banaji, 2006; Murray, Schaer, & Debbané, 2012; Northoff et al., 2006; van der Meer, Costafreda, Aleman, & David, 2010). This means that the greater the degree of similarity of the information being processed is to oneself, the higher the activity in these specific brain regions. The paradigms in these cases typically entail the evaluation of entities, i.e., people who are similar to oneself in terms of physical attributes, personality characteristics, filial association, political leaning, and so on. However, the bias towards self-similarity applies beyond explicit entity-based contexts (Abraham, 2013). It need not involve explicit evaluations of people, and the contexts need not involve living beings at all. Indeed,

one characterization of the ventral medial prefrontal cortex held that this region mediates the “identification and appraisal of stimulus-induced self relevance” (Schmitz & Johnson, 2006).

An impressive example of a study that showed the activity of this region in contexts that neither involved real entities nor necessitated explicit evaluative judgments was one that involved simple and neutral geometric forms such as a two-dimensional circle (Sui, Rotshtein, & Humphreys, 2013). Participants tagged forms with labels for themselves, their best friend, and an unfamiliar other. Self-tagged responses were associated with greater engagement of the ventral medial prefrontal cortex and faster response speed. This finding of advantageous in information processing even in contexts of arbitrary and transitory self-object associations indicate that personal significance is automatically encoded in the brain and our information processing is modulated by the same (Roye, Jacobsen, & Schröger, 2007). We involuntarily orient and are alerted towards stimuli in the environment that are personally relevant. That the salience associated with personal relevance generalizes to contexts that are not explicitly socially or self-focused is the key point to note here. Topics, themes and ideas that drive our individual fascinations and passions have a deep personal significance for us. We are alert and aware to a heightened degree to anything in our environment that informs the interests of our minds, and in the case of the creative drive, this automatic attuning towards and gathering of this form of personally significant information influences our capacity for inventiveness and generativity.

## Concluding Thoughts

It would be erroneous to regard the three aforementioned drives as mutually exclusive as they are fully interwoven capacities that dynamically influence one another. Delving into the literature on the social brain to seek correspondences between creative and social cognition allows one to derive much that is vital about the dynamics of creativity. The utility of this focus often goes unnoticed as most efforts are directed at outlining the differences between creative and non-creative cognition. Adopting this alternative approach of comprehending the nature of the commonalities between the same seems just as crucial to understanding how creativity emerges across contexts. The importance of considering the impact of one’s social milieu cannot but be central to this process.



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Editors

# The Palgrave Handbook of Social Creativity Research

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*Editors*

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