Title: The Neuropsychology of Creativity

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Abstract:

The neuropsychological approach has been instrumental in delivering key insights that have enabled a clearer understanding of the human mind and its workings. Despite the unique promise of this approach and the perspective it affords, it has only been limited utilized when exploring creative cognition. This papers an overview of three methodologies – single case studies, case series investigations on neurological populations, and case series investigations on psychiatric populations – that have been employed within the neuropsychology of creativity and highlights some of the important revelations that each direction of study has delivered. In doing so, the aim is to make a case for the unique utility of the neuropsychological approach in allowing for a better understanding of the creative mind.

Highlights:

- The neuropsychological approach is limitedly employed in the study of creativity
- An important focus of single case studies is the phenomenon of 'de novo' creativity
- Case series investigations in creativity cover neurological and psychiatric groups

Keywords:

creative neurocognition; creative cognition; de novo abilities; neurology; psychiatry; clinical psychology; subclinical groups; cognitive neuropsychology

The brain basis of creativity, or the capacity to conceive of ideas that are original, unique, unusual or novel as well as relevant, fitting, appropriate or satisfying to a particular end (Runco & Jaeger, 2012), is primarily explored through neuroimaging and EEG based approaches (Jung & Vartanian, 2018). Neuropsychological studies are relatively uncommon (Abraham, 2018). This is extremely unusual given the unmistakable utility of the neuropsychological approach in delivering answers about the mechanisms underlying cognition and behavior as well as the unique insights it affords when comparing competing theories of any aspect of these functions (Caramazza & Coltheart, 2006). Although this would also naturally extend to the context of creative neurocognition, neuropsychological studies are rarely leaned on when making inferences on the mechanisms that underlie the same.

The rationale of the neuropsychological approach is that when brain insufficiencies lead to specific changes in behavioral and cognitive function, we can safely assume that that the implicated brain regions are not only involved in the said functions, they are likely to be vital for the same. Justifiable critiques of the approach notwithstanding (Fischer-Baum & Campana, 2017; Patterson & Plaut, 2009), it is undeniable that this approach has been instrumental in delivering key knowledge on how the workings of the human mind as typically showcased by the iconic case studies of HM (Squire & Wixted, 2011), Phineas Gage (Damasio, Grabowski, Frank, Galaburda, & Damasio, 1994), and Tan (Domanski, 2013) among many others. In fact, these classic cases continue to be influential even in contemporary studies that map brain structure to brain function (Thiebaut de Schotten et al., 2015).

Neuropsychological investigations of cognitive function typically fall into one of two categories: single case studies of individuals with specific neurological damage and case series investigations, which are group-based studies of individuals who have related brain dysfunctions. While the advantages and disadvantages associated with both approaches is a matter of some debate (Lambon Ralph, Patterson, & Plaut, 2011; Medina & Fischer-Baum, 2017; Nickels, Howard, & Best, 2011; Rapp, 2011; Schwartz & Dell, 2010), it can be maintained that following a multipronged approach would afford the best possible outcomes.

Neuropsychological studies on creativity primarily follow three different methodologies (Figure 1): single case studies of neurological patients, case series investigations of neurological samples, and case series studies of psychiatric samples. The last category is also closely associated with a further methodology, namely the personality based approach. This bears mentioning here as it follows a quasi-neuropsychological logic give that the rationale underlying the linking of specific subclinical personality traits and their associated information processing biases in relation to individual differences in creative cognition (Abraham, 2015; Baas, Nijstad, Boot, & De Dreu, 2016).

Of the single case studies that are relevant to creative neurocognition, the most influential have been the investigations in relation to frontotemporal dementia (FTD). Fascinating examinations of people who develop *de novo* artistic capabilities post neurological insult have been reported in a small subset of patients with the temporal lobe variant of FTD where brain damage is seen in temporal regions

whereas frontal regions remain relatively intact (Liu et al., 2009; Miller et al., 1998; Miller & Hou, 2004; Miller & Miller, 2013). The characterization of 'de novo' is warranted in this context as these (predominantly visual and musical) artistic abilities appear suddenly following brain injury or degeneration and they are unexpected given that the person did not exhibit such tendencies prior to the onset of FTD (Schott, 2012; Zaidel, 2010). This tendency to engage in artistic expression is not short-lived, but tends to be compulsive and highly sustained. Indeed, in the first published report to showcase this phenomenon, all three patients went on to become accomplished painters (Miller, Ponton, Benson, Cummings, & Mena, 1996). The emergence of de novo creativity relevant skills has also been associated with semantic variant primary progressive aphasia (PPA) or semantic dementia (SD) in both visual artistic and literary domains (Midorikawa & Kawamura, 2015; Wu et al., 2015) as well as in Parkinson's disease (Schrag & Trimble, 2001)

A few caveats are necessary to ward off errors of generalization. First, de novo capabilities are a rare manifestation that occurs in only a tiny proportion of patients affected with the disorders in question. So higher levels of artistry cannot be regarded as central to the neuropsychological profile associated with these disorders. Second, artistic skills displayed in relation to neurodegenerative disorders are rarely prodigious, unlike the case of savants for instance. Nonetheless, it is highly noteworthy that brain injuries that result in reduced function in some cognitive domains, such as semantic understanding, social awareness and speech production, are accompanied by enhanced artistic abilities that emerge unexpectedly.

One hypothesis that been put forward to explain this phenomenon of what can be seen as evidence of 'paradoxical functional facilitation' (Kapur, 1996) is that the inability to express oneself as one previously did results in the turn towards artistic expression as the drive to communicate is maintained despite the inability to do so (Zaidel, 2014). In fact, longitudinal studies of the creative output of artists who developed FTD (Mell, Howard, & Miller, 2003), PPA (Seeley et al., 2008), left brain injury post-stroke (Takahata et al., 2014) and Parkinson's disease (Chatterjee, Hamilton, & Amorapanth, 2006; Shimura, Tanaka, Urabe, Tanaka, & Hattori, 2012) indicate that their drive for creative expression continued unabated regardless of their altered neurological function. Moreover, fascinating changes in the creative style of these artists, specifically in relation to frontal lobe damage, were documented such that the paintings produced post-injury are characterized by enhanced visual realism and vividness of detail. What this fascinating shift in style following specific forms of brain damage tells us about the workings of the creative brain is as yet unclear as it as received only limited attention thus far. What is clear though is that the damage-resistant capacity of the human brain to engage in artistic expression is attested to by the enormous collection of case discussions of artists who sustained some form of neurological dysfunction yet continued to be productive in a creative capacity (Finger, Zaidel, Boller, & Bogousslavsky, 2013).

The second approach, case series or group-based investigations on neurological populations of interest, has been adopted in a far more limited capacity compared to the first approach, yet at the same time also in a more heterogeneous manner. This makes Disorders of interest include FTD (de Souza et al., 2010; Rankin et al., 2007),

SD (Rankin et al., 2007), Parkinson's disease (Canesi, Rusconi, Isaias, & Pezzoli, 2012; Canesi et al., 2016; Lhommée et al., 2014) and savant syndrome (Mottron, Dawson, & Soulières, 2009; Treffert, 2009, 2014), as well as patients with lesions of the frontal lobe (Abraham, Beudt, Ott, & von Cramon, 2012; Reverberi, Toraldo, D'Agostini, & Skrap, 2005; Shamay-Tsoory, Adler, Aharon-Peretz, Perry, & Mayseless, 2011), the hippocampus (Duff, Kurczek, Rubin, Cohen, & Tranel, 2013; Warren, Kurczek, & Duff, 2016), the parieto-temporal cortex (Abraham et al., 2012; Shamay-Tsoory et al., 2011), and the basal ganglia (Abraham et al., 2012).

As the samples employed within the case series investigations of FTD and SD do not only include participants with documented de novo artistic capacities, the findings from such case series investigations are difficult to align with the findings from the single case studies of these neurological disorders. Case studies also do not typically include standard divergent thinking psychometric tasks as a form of creativity assessment of the person in question. The limited case series evidence on hand suggests that while differences in artistic style could be seen in the drawings that were generated by these groups compared to neurotypical control participants (Rankin et al., 2007), they also demonstrated poor performance on standardized psychometric measures of creativity (de Souza et al., 2010; Rankin et al., 2007). On the other hand, in a comparison of PD patients with and without increased artistic production relative to healthy control subjects on psychometric tests of creativity revealed that PD patients with enhanced artistic abilities performed comparable to healthy control samples, whereas those without exhibited poorer performance (Canesi et al., 2012). One of the key issues of focus in relation to this patient

population is the influence of dopaminergic therapies on creative capacity in PD with some suggesting that improved creative performance could be attributed to the impact of the drugs on reducing latent inhibition which would abet wider associative thinking (Faust-Socher, Kenett, Cohen, Hassin-Baer, & Inzelberg, 2014). Indeed, recent evidence using an option generation task, where participants are instructed to draw as many different paths as they can between two points in space within a fixed time period, showed that the use of dopaminergic drugs in PD patients and in healthy older adults increased the uniqueness of the responses associated with a given level of fluency (number of responses generated) (Ang et al., 2018).

The idea that cognitive disinhibition can confer advantages in creative cognition has also received support from case series studies of patients with lesions of the basal ganglia (BG) (Abraham et al., 2012). BG patients demonstrated better performance compared to healthy matched control subjects on a specific creativity task (overcoming constraints of knowledge) that requires that participants transcend the mental set imposed by recent knowledge, brought about through the imposition of active contextual salience (presenting examples of new toys generated by others), when creating something new (inventing a new toy). Greater distractibility and disinhibition that typify such populations would be beneficial in this context as it allows one to disregard the salience of the presented information more effortlessly. The study also showed the converse pattern of performance on the same in patients with lesions of the parieto-temporal lobe (PTL), a population that is characterized by perseverative response patterns. Another key point to note was the selectivity of the advantage in relation to BG lesions as the same group showed other patterns of

performance relative to the matched healthy control sample (impaired and comparable) on other aspects of creative cognition.

A more complicated picture emerges from the study of patients with lesions of the frontal lobe (FL) as both advantages (e.g., better insight in problem solving associated with dorsolateral prefrontal damage; better overcoming of knowledge constraints associated with frontopolar and orbitofrontal damage) and disadvantages (e.g., reduced originality associated with lateral and medial prefrontal damage; reduced practicality in creative imagery associated with lateral prefrontal damage) have been reported in select aspects of creative cognition as a function of select types of FL insufficiencies (Abraham et al., 2012; Reverberi et al., 2005; Shamay-Tsoory et al., 2011). The ideas of Boot et al. (2017) appear to have a particular relevance when considering the manifestation of both enhanced and impoverished creative performance in relation to the frontal lobe and the basal ganglia as they make a case for frontostriatal brain networks in orchestrating processes relevant to flexibility (neither low nor high but moderate striatal dopamine) and persistence (neither low nor high but moderate prefrontal dopamine) in creativity (Boot, Baas, van Gaal, Cools, & De Dreu, 2017).

The third approach is that of case series studies on psychiatric groups of interest whose information processing deficits are believed to be of especial relevance to creative cognition. Disorders that have received most of the focus so far are bipolar disorder (Andreasen, 2008; Santosa et al., 2007; Soeiro-de-Souza, Dias, Bio, Post, & Moreno, 2011; Taylor, 2017) and schizophrenia (Abraham, Windmann, McKenna, &

Güntürkün, 2007; Acar, Chen, & Cayirdag, 2018), which is to be expected given the population based studies that indicate a higher degree of these disorders of psychosis in relation to creative professions (Kyaga et al., 2013, 2011; MacCabe et al., 2018) as well as a modest genetic propensity for the same (Power et al., 2015) (also see Keller & Visscher, 2015). Other disorders of interest, which have albeit received comparatively little attention, include attention deficit hyperactivity disorder (ADHD) (Abraham, Windmann, Siefen, Daum, & Güntürkün, 2006; Boot, Nevicka, & Baas, 2017; Healey & Rucklidge, 2006), autism (Craig & Baron-Cohen, 1999; Diener, Wright, Smith, & Wright, 2014; Kasirer & Mashal, 2014) and dyslexia (Kasirer & Mashal, 2016; von Károlyi, Winner, Gray, & Sherman, 2003; Wolff & Lundberg, 2002).

Empirical studies on the association between creativity and schizophrenia have resulted in mixed findings, with the grounds for this inconclusive state of affairs tied to methodological factors, such as varied symptom severity associated with the patient population being tested across studies, type of creativity measure being employed, and so on. A recent meta-analysis (Acar et al., 2018) concluded that the evidence indicates a negative association between schizophrenia and creativity. Similar to postulations made by other researchers (Abraham, 2014; Carson, 2011; Eysenck, 1995), they also hypothesize the presence of an inverted-U type function between creativity and psychopathological traits, such that mild levels of schizophrenia symptoms (but not fully manifested schizophrenia) can confer advantages in creative thinking. A series of meta-analyses of the link between creativity and mood disorders, in contrast, largely revealed a positive association,

and particularly so in relation to bipolar disorder (Taylor, 2017). For instance, apart from dysthymic disorder, mood disorders were more prevalent among creative individuals (defined as professionals or students in the domains of music, writing or the fine arts) than controls, and higher levels of creative performance were associated with cyclothymic and unspecified bipolar disorders, whereas the converse was true of dysthymic disorder. A wide range of neuropsychological deficits are associated with bipolar disorder across domains that include executive function, attention, verbal and nonverbal memory, emotional reactivity, and emotion-related impulsivity (Lima, Peckham, & Johnson, 2018). How the information processing biases that confer negative functionality in these domains of psychological function also confer positive functionality within the domain of creativity is still an open question.

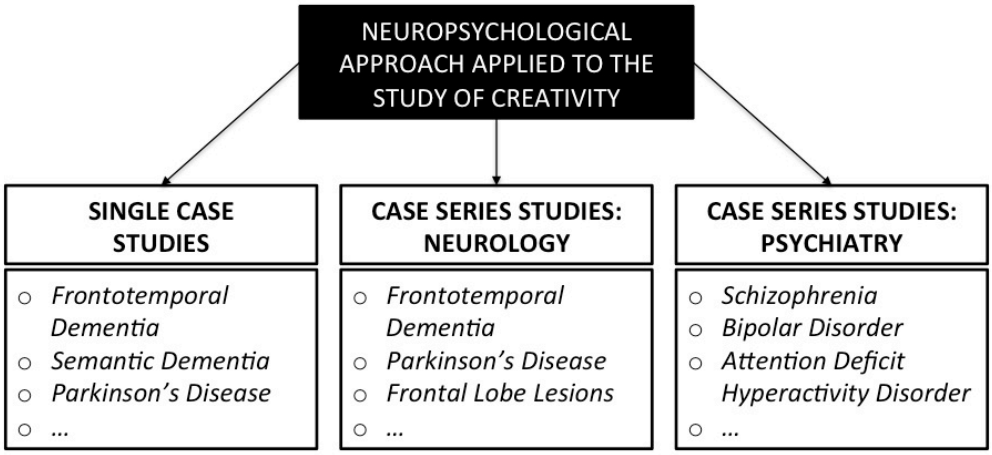
In conclusion, the promise of the neuropsychological approach in delivering many pieces of the puzzle in understanding the workings of the creative mind is not one that has been capitalized on by psychologists, neurologists and neuroscientists nearly enough. The neuropsychological approach enables us to make substantial and unique gains in knowledge that are not afforded by the alternative approaches of neuroimaging and electrophysiology, which are inherently limited by several conceptual and methodological problems (Abraham, 2018). The scientific literature provides us abundant behavioral tasks of creative function that can readily be employed on many different neurological and psychiatric populations of interest. These can be used in combination with chosen behavioral tasks of non-creative function (and even physiological assessments) that are especially relevant in light of

the neuropsychological profile of the population in question to verify whether our theoretical postulations regarding the mechanisms underlying creative cognition (e.g., disinhibition abets creative thinking) actually bears out in empirical investigations of the same. The neuropsychological approach bodes truly fruitful opportunities for the scientific exploration of core ideas in creativity.

Figure Legends

Figure 1: The three approaches employed in the neuropsychology of creativity and examples of populations that have been studied within each approach.

Figure 1


NEUROPSYCHOLOGICAL APPROACH APPLIED TO THE STUDY OF CREATIVITY
SINGLE CASE STUDIES
Frontotemporal Dementia
Semantic Dementia
Parkinson's Disease
...
CASE SERIES STUDIES: NEUROLOGY
Frontotemporal Dementia
Parkinson's Disease
Frontal Lobe Lesions
...
CASE SERIES STUDIES: PSYCHIATRY
Schizophrenia
Bipolar Disorder
Attention Deficit Hyperactivity Disorder
...

References

Abraham, A. (2014). Is there an inverted-U relationship between creativity and psychopathology? *Frontiers in Psychology*, *5*, 750. https://doi.org/10.3389/fpsyg.2014.00750

Abraham, A. (Ed.). (2015). *Frontiers | Madness and Creativity: Yes, No or Maybe?* Lausanne: Frontiers Media SA. Retrieved from http://www.frontiersin.org/books/Madness_and_Creativity_Yes_No_or_Maybe_/721

** Abraham, A. (2018). *The Neuroscience of Creativity*. New York: Cambridge University Press.

[A comprehensive resource on the brain basis of creativity that encompasses its theoretical and empirical foundations with a specific focus on conceptual and methodological issues to keep in mind in relation to the same.]

Abraham, A., Beudt, S., Ott, D. V. M., & von Cramon, D. Y. (2012). Creative cognition and the brain: dissociations between frontal, parietal-temporal and basal ganglia groups. *Brain Research*, *1482*, 55–70. https://doi.org/10.1016/j.brainres.2012.09.007

Abraham, A., Windmann, S., McKenna, P., & Güntürkün, O. (2007). Creative thinking in schizophrenia: the role of executive dysfunction and symptom severity. *Cognitive Neuropsychiatry*, *12*(3), 235–258. https://doi.org/10.1080/13546800601046714

Abraham, A., Windmann, S., Siefen, R., Daum, I., & Güntürkün, O. (2006). Creative thinking in adolescents with attention deficit hyperactivity disorder (ADHD). *Child Neuropsychology: A Journal on Normal and Abnormal Development in Childhood and Adolescence*, *12*(2), 111–123. https://doi.org/10.1080/09297040500320691

** Acar, S., Chen, X., & Cayirdag, N. (2018). Schizophrenia and creativity: A meta-analytic review. *Schizophrenia Research*, *195*, 23–31. https://doi.org/10.1016/j.schres.2017.08.036

[An important meta-analysis that explores the study of the association between creativity and schizophrenia by focusing on the range of factors that may account for the mixed pattern of findings that typify this field.]

Andreasen, N. C. (2008). The relationship between creativity and mood disorders. *Dialogues in Clinical Neuroscience*, *10*(2), 251–255.

* Ang, Y.-S., Manohar, S., Plant, O., Kienast, A., Le Heron, C., Muhammed, K., … Husain, M. (2018). Dopamine Modulates Option Generation for Behavior. *Current Biology: CB*, *28*(10), 1561-1569.e3. https://doi.org/10.1016/j.cub.2018.03.069

[A cleverly designed study that utilizes a purely motoric task to assess how response features that are of relevance to creativity, namely fluency and uniqueness, are altered in direct relation to dopaminergic function.]

Baas, M., Nijstad, B. A., Boot, N. C., & De Dreu, C. K. W. (2016). Mad genius revisited: Vulnerability to psychopathology, biobehavioral approach-

avoidance, and creativity. *Psychological Bulletin*, *142*(6), 668–692. https://doi.org/10.1037/bul0000049

** Boot, N., Baas, M., van Gaal, S., Cools, R., & De Dreu, C. K. W. (2017). Creative cognition and dopaminergic modulation of fronto-striatal networks: Integrative review and research agenda. *Neuroscience and Biobehavioral Reviews*, *78*, 13–23. https://doi.org/10.1016/j.neubiorev.2017.04.007 ***[An informative perspective on the dopaminergic system and its differential impact on flexibility versus persistence during creative ideation via different aspects of the frontostriatal network.]***

Boot, N., Nevicka, B., & Baas, M. (2017). Creativity in ADHD: Goal-Directed Motivation and Domain Specificity. *Journal of Attention Disorders*, 1087054717727352. https://doi.org/10.1177/1087054717727352

Canesi, M., Rusconi, M. L., Isaias, I. U., & Pezzoli, G. (2012). Artistic productivity and creative thinking in Parkinson's disease. *European Journal of Neurology*, *19*(3), 468–472. https://doi.org/10.1111/j.1468-1331.2011.03546.x

* Canesi, M., Rusconi, M. L., Moroni, F., Ranghetti, A., Cereda, E., & Pezzoli, G. (2016). Creative Thinking, Professional Artists, and Parkinson's Disease. *Journal of Parkinson's Disease*, *6*(1), 239–246. https://doi.org/10.3233/JPD-150681 ***[A well-conceived study examines three groups of Parkinson's disease (PD) groups on psychometric measures of divergent creativity. The groups include professional artists with PD as well as individuals with PD with artistic-like skills and without artistic-like skills.]***

Caramazza, A., & Coltheart, M. (2006). Cognitive Neuropsychology twenty years on. *Cognitive Neuropsychology*, *23*(1), 3–12. https://doi.org/10.1080/02643290500443250

Carson, S. H. (2011). Creativity and psychopathology: a shared vulnerability model. *Canadian Journal of Psychiatry. Revue Canadienne De Psychiatrie*, *56*(3), 144–153.

Chatterjee, A., Hamilton, R. H., & Amorapanth, P. X. (2006). Art produced by a patient with Parkinson's disease. *Behavioural Neurology*, *17*(2), 105–108.

Craig, J., & Baron-Cohen, S. (1999). Creativity and imagination in autism and Asperger syndrome. *Journal of Autism and Developmental Disorders*, *29*(4), 319–326.

Damasio, H., Grabowski, T., Frank, R., Galaburda, A. M., & Damasio, A. R. (1994). The return of Phineas Gage: clues about the brain from the skull of a famous patient. *Science (New York, N.Y.)*, *264*(5162), 1102–1105.

de Souza, L. C., Volle, E., Bertoux, M., Czernecki, V., Funkiewiez, A., Allali, G., … Levy, R. (2010). Poor creativity in frontotemporal dementia: a window into the neural bases of the creative mind. *Neuropsychologia*, *48*(13), 3733–3742. https://doi.org/10.1016/j.neuropsychologia.2010.09.010

Diener, M. L., Wright, C. A., Smith, K. N., & Wright, S. D. (2014). Assessing visual-spatial creativity in youth on the autism spectrum. *Creativity Research Journal*, *26*(3), 328–337. https://doi.org/10.1080/10400419.2014.929421

Domanski, C. W. (2013). Mysterious "Monsieur Leborgne": The mystery of the famous patient in the history of neuropsychology is explained. *Journal of*

the History of the Neurosciences, *22*(1), 47–52. https://doi.org/10.1080/0964704X.2012.667528

Duff, M. C., Kurczek, J., Rubin, R., Cohen, N. J., & Tranel, D. (2013). Hippocampal amnesia disrupts creative thinking. *Hippocampus*, *23*(12), 1143–1149. https://doi.org/10.1002/hipo.22208

Eysenck, H. J. (1995). *Genius: The natural history of creativity*. Cambridge Mass.: Cambridge University Press.

Faust-Socher, A., Kenett, Y. N., Cohen, O. S., Hassin-Baer, S., & Inzelberg, R. (2014). Enhanced creative thinking under dopaminergic therapy in Parkinson disease. *Annals of Neurology*, *75*(6), 935–942. https://doi.org/10.1002/ana.24181

Finger, S., Zaidel, D. W., Boller, F., & Bogousslavsky, J. (Eds.). (2013). *The fine arts, neurology, and neuroscience: new discoveries and changing landscapes* (First edition). Amsterdam, The Netherlands: Elsevier.

* Fischer-Baum, S., & Campana, G. E. (2017). Neuroplasticity and the logic of Cognitive Neuropsychology. *Cognitive Neuropsychology*, *34*(7–8), 403–411. https://doi.org/10.1080/02643294.2017.1389707
[An important overview of the issue of brain reorganization following brain injury and the impact that these processes of neuroplasticity have on key assumptions of cognitive neuropsychology.]

Healey, D., & Rucklidge, J. J. (2006). An investigation into the relationship among ADHD symptomatology, creativity, and neuropsychological functioning in children. *Child Neuropsychology: A Journal on Normal and Abnormal*

Development in Childhood and Adolescence, *12*(6), 421–438. https://doi.org/10.1080/09297040600806086

** Jung, R. E., & Vartanian, O. (Eds.). (2018). *The Cambridge handbook of the neuroscience of creativity*. Cambridge: Cambridge University Press. ***[A contemporary collection of theoretically and empirically informed expert views on the neural underpinnings of creative thinking. Among other things, it showcases the many cognitive and behavioral factors that have a direct or indirect impact on creative function.]***

Kapur, N. (1996). Paradoxical functional facilitation in brain-behaviour research. A critical review. *Brain: A Journal of Neurology*, *119 (Pt 5)*, 1775–1790.

Kasirer, A., & Mashal, N. (2014). Verbal creativity in autism: Comprehension and generation of metaphoric language in high-functioning autism spectrum disorder and typical development. *Frontiers in Human Neuroscience*, *8*.

* Kasirer, A., & Mashal, N. (2016). Comprehension and generation of metaphoric language in children, adolescents, and adults with dyslexia. *Dyslexia: An International Journal of Research and Practice*. https://doi.org/10.1002/dys.1550 ***[A study showing dissociations in metaphor processing such that dyslexic children perform worse than typically developing children in processing conventional metaphors but adults with dyslexia perform better than controls during novel metaphoric generation.]***

Keller, M. C., & Visscher, P. M. (2015). Genetic variation links creativity to psychiatric disorders. *Nature Neuroscience*, *18*(7), 928–929. https://doi.org/10.1038/nn.4047

Kyaga, S., Landén, M., Boman, M., Hultman, C. M., Långström, N., & Lichtenstein, P. (2013). Mental illness, suicide and creativity: 40-year prospective total population study. *Journal of Psychiatric Research*, *47*(1), 83–90. https://doi.org/10.1016/j.jpsychires.2012.09.010

Kyaga, S., Lichtenstein, P., Boman, M., Hultman, C., Långström, N., & Landén, M. (2011). Creativity and mental disorder: family study of 300,000 people with severe mental disorder. *The British Journal of Psychiatry: The Journal of Mental Science*, *199*(5), 373–379. https://doi.org/10.1192/bjp.bp.110.085316

Lambon Ralph, M. A., Patterson, K., & Plaut, D. C. (2011). Finite case series or infinite single-case studies? Comments on "Case series investigations in cognitive neuropsychology" by Schwartz and Dell (2010). *Cognitive Neuropsychology*, *28*(7), 466–474; discussion 515-520. https://doi.org/10.1080/02643294.2012.671765

Lhommée, E., Batir, A., Quesada, J.-L., Ardouin, C., Fraix, V., Seigneuret, E., … Krack, P. (2014). Dopamine and the biology of creativity: lessons from Parkinson's disease. *Frontiers in Neurology*, *5*, 55. https://doi.org/10.3389/fneur.2014.00055

* Lima, I. M. M., Peckham, A. D., & Johnson, S. L. (2018). Cognitive deficits in bipolar disorders: Implications for emotion. *Clinical Psychology Review*, *59*, 126–136. https://doi.org/10.1016/j.cpr.2017.11.006

[A highly useful overview detailing the neuropsychological profile associated with bipolar disorder with an especial focus on the cognition-emotion link.]

Liu, A., Werner, K., Roy, S., Trojanowski, J. Q., Morgan-Kane, U., Miller, B. L., & Rankin, K. P. (2009). A case study of an emerging visual artist with frontotemporal lobar degeneration and amyotrophic lateral sclerosis. *Neurocase*, *15*(3), 235–247. https://doi.org/10.1080/13554790802633213

* MacCabe, J. H., Sariaslan, A., Almqvist, C., Lichtenstein, P., Larsson, H., & Kyaga, S. (2018). Artistic creativity and risk for schizophrenia, bipolar disorder and unipolar depression: a Swedish population-based case-control study and sib-pair analysis. *The British Journal of Psychiatry: The Journal of Mental Science*, *212*(6), 370–376. https://doi.org/10.1192/bjp.2018.23 ***[A case-control examination of population-based registries that shows an increased risk of developing serious psychiatric conditions, such as schizophrenia, bipolar disorder and unipolar depression, following a tertiary education in an artistic domain.]***

* Medina, J., & Fischer-Baum, S. (2017). Single-case cognitive neuropsychology in the age of big data. *Cognitive Neuropsychology*, *34*(7–8), 440–448. https://doi.org/10.1080/02643294.2017.1321537 ***[A perspective article that argues for the usefulness of the single case study alongside large scale informatics approaches specifically to the end of developing models of cognitive function.]***

Mell, J. C., Howard, S. M., & Miller, B. L. (2003). Art and the brain: the influence of frontotemporal dementia on an accomplished artist. *Neurology*, *60*(10), 1707–1710.

Midorikawa, A., & Kawamura, M. (2015). The emergence of artistic ability following traumatic brain injury. *Neurocase*, *21*(1), 90–94. https://doi.org/10.1080/13554794.2013.873058

Miller, B L, Cummings, J., Mishkin, F., Boone, K., Prince, F., Ponton, M., & Cotman, C. (1998). Emergence of artistic talent in frontotemporal dementia. *Neurology*, *51*(4), 978–982.

Miller, B L, Ponton, M., Benson, D. F., Cummings, J. L., & Mena, I. (1996). Enhanced artistic creativity with temporal lobe degeneration. *Lancet*, *348*(9043), 1744–1745.

Miller, Bruce L, & Hou, C. E. (2004). Portraits of artists: emergence of visual creativity in dementia. *Archives of Neurology*, *61*(6), 842–844. https://doi.org/10.1001/archneur.61.6.842

Miller, Z. A., & Miller, B. L. (2013). Artistic creativity and dementia. *Progress in Brain Research*, *204*, 99–112. https://doi.org/10.1016/B978-0-444-63287-6.00005-1

Mottron, L., Dawson, M., & Soulières, I. (2009). Enhanced perception in savant syndrome: patterns, structure and creativity. *Philosophical Transactions of the Royal Society of London. Series B, Biological Sciences*, *364*(1522), 1385–1391. https://doi.org/10.1098/rstb.2008.0333

Nickels, L., Howard, D., & Best, W. (2011). On the use of different methodologies in cognitive neuropsychology: drink deep and from several sources. *Cognitive Neuropsychology*, *28*(7), 475–485; discussion 515-520. https://doi.org/10.1080/02643294.2012.672406

Patterson, K., & Plaut, D. C. (2009). "Shallow draughts intoxicate the brain": lessons from cognitive science for cognitive neuropsychology. *Topics in*

Cognitive Science, *1*(1), 39–58. https://doi.org/10.1111/j.1756-8765.2008.01012.x

Power, R. A., Steinberg, S., Bjornsdottir, G., Rietveld, C. A., Abdellaoui, A., Nivard, M. M., … Stefansson, K. (2015). Polygenic risk scores for schizophrenia and bipolar disorder predict creativity. *Nature Neuroscience*, *advance online publication*. https://doi.org/10.1038/nn.4040

Rankin, K. P., Liu, A. A., Howard, S., Slama, H., Hou, C. E., Shuster, K., & Miller, B. L. (2007). A case-controlled study of altered visual art production in Alzheimer's and FTLD. *Cognitive and Behavioral Neurology: Official Journal of the Society for Behavioral and Cognitive Neurology*, *20*(1), 48–61. https://doi.org/10.1097/WNN.0b013e31803141dd

Rapp, B. (2011). Case series in cognitive neuropsychology: promise, perils, and proper perspective. *Cognitive Neuropsychology*, *28*(7), 435–444. https://doi.org/10.1080/02643294.2012.697453

Reverberi, C., Toraldo, A., D'Agostini, S., & Skrap, M. (2005). Better without (lateral) frontal cortex? Insight problems solved by frontal patients. *Brain: A Journal of Neurology*, *128*(Pt 12), 2882–2890. https://doi.org/10.1093/brain/awh577

Runco, M. A., & Jaeger, G. J. (2012). The Standard Definition of Creativity. *Creativity Research Journal*, *24*(1), 92–96. https://doi.org/10.1080/10400419.2012.650092

Santosa, C. M., Strong, C. M., Nowakowska, C., Wang, P. W., Rennicke, C. M., & Ketter, T. A. (2007). Enhanced creativity in bipolar disorder patients: A controlled study. *Journal of Affective Disorders*, *100*(1–3), 31–39. https://doi.org/10.1016/j.jad.2006.10.013

Schott, G. D. (2012). Pictures as a neurological tool: lessons from enhanced and emergent artistry in brain disease. *Brain: A Journal of Neurology*, *135*(Pt 6), 1947–1963. https://doi.org/10.1093/brain/awr314

Schrag, A., & Trimble, M. (2001). Poetic talent unmasked by treatment of Parkinson's disease. *Movement Disorders: Official Journal of the Movement Disorder Society*, *16*(6), 1175–1176.

Schwartz, M. F., & Dell, G. S. (2010). Case series investigations in cognitive neuropsychology. *Cognitive Neuropsychology*, *27*(6), 477–494. https://doi.org/10.1080/02643294.2011.574111

Seeley, W. W., Matthews, B. R., Crawford, R. K., Gorno-Tempini, M. L., Foti, D., Mackenzie, I. R., & Miller, B. L. (2008). Unravelling Boléro: progressive aphasia, transmodal creativity and the right posterior neocortex. *Brain: A Journal of Neurology*, *131*(Pt 1), 39–49. https://doi.org/10.1093/brain/awm270

Shamay-Tsoory, S. G., Adler, N., Aharon-Peretz, J., Perry, D., & Mayseless, N. (2011). The origins of originality: the neural bases of creative thinking and originality. *Neuropsychologia*, *49*(2), 178–185. https://doi.org/10.1016/j.neuropsychologia.2010.11.020

Shimura, H., Tanaka, R., Urabe, T., Tanaka, S., & Hattori, N. (2012). Art and Parkinson's disease: a dramatic change in an artist's style as an initial symptom. *Journal of Neurology*, *259*(5), 879–881. https://doi.org/10.1007/s00415-011-6271-y

Soeiro-de-Souza, M. G., Dias, V. V., Bio, D. S., Post, R. M., & Moreno, R. A. (2011). Creativity and executive function across manic, mixed and depressive

episodes in bipolar I disorder. *Journal of Affective Disorders*, *135*(1–3), 292–297. https://doi.org/10.1016/j.jad.2011.06.024

Squire, L. R., & Wixted, J. T. (2011). The cognitive neuroscience of human memory since H.M. *Annual Review of Neuroscience*, *34*, 259–288. https://doi.org/10.1146/annurev-neuro-061010-113720

Takahata, K., Saito, F., Muramatsu, T., Yamada, M., Shirahase, J., Tabuchi, H., … Kato, M. (2014). Emergence of realism: Enhanced visual artistry and high accuracy of visual numerosity representation after left prefrontal damage. *Neuropsychologia*, *57*, 38–49. https://doi.org/10.1016/j.neuropsychologia.2014.02.022

** Taylor, C. L. (2017). Creativity and Mood Disorder: A Systematic Review and Meta-Analysis. *Perspectives on Psychological Science*, *12*(6), 1040–1076. https://doi.org/10.1177/1745691617699653

[An insightful review and series of meta-analyses that thoroughly explores the study of the association between creativity and mood disorder. The findings reveal a positive association for the same, which is especially noteworthy in the case of bipolar disorder.]

Thiebaut de Schotten, M., Dell'Acqua, F., Ratiu, P., Leslie, A., Howells, H., Cabanis, E., … Catani, M. (2015). From Phineas Gage and Monsieur Leborgne to H.M.: Revisiting Disconnection Syndromes. *Cerebral Cortex (New York, NY)*, *25*(12), 4812–4827. https://doi.org/10.1093/cercor/bhv173

Treffert, D. A. (2009). The savant syndrome: an extraordinary condition. A synopsis: past, present, future. *Philosophical Transactions of the Royal*

Society of London. Series B, Biological Sciences, *364*(1522), 1351–1357. https://doi.org/10.1098/rstb.2008.0326

Treffert, D. A. (2014). Savant syndrome: realities, myths and misconceptions. *Journal of Autism and Developmental Disorders*, *44*(3), 564–571. https://doi.org/10.1007/s10803-013-1906-8

von Károlyi, C., Winner, E., Gray, W., & Sherman, G. F. (2003). Dyslexia linked to talent: global visual-spatial ability. *Brain and Language*, *85*(3), 427–431.

Warren, D. E., Kurczek, J., & Duff, M. C. (2016). What relates newspaper, definite, and clothing? An article describing deficits in convergent problem solving and creativity following hippocampal damage. *Hippocampus*, *26*(7), 835–840. https://doi.org/10.1002/hipo.22591

Wolff, U., & Lundberg, I. (2002). The prevalence of dyslexia among art students. *Dyslexia (Chichester, England)*, *8*(1), 34–42. https://doi.org/10.1002/dys.211

Wu, T. Q., Miller, Z. A., Adhimoolam, B., Zackey, D. D., Khan, B. K., Ketelle, R., … Miller, B. L. (2015). Verbal creativity in semantic variant primary progressive aphasia. *Neurocase*, *21*(1), 73–78. https://doi.org/10.1080/13554794.2013.860179

Zaidel, D. W. (2010). Art and brain: insights from neuropsychology, biology and evolution. *Journal of Anatomy*, *216*(2), 177–183. https://doi.org/10.1111/j.1469-7580.2009.01099.x

Zaidel, D. W. (2014). Creativity, brain, and art: biological and neurological considerations. *Frontiers in Human Neuroscience*, *8*. https://doi.org/10.3389/fnhum.2014.00389