RESEARCH ARTICLE

The cognitive basis of psychosocial impact in COVID-19 pandemic. Does it encircle the default mode network of the brain? A pragmatic proposal.

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Abstract:
Epigenetics, hypothalamic-pituitary axes, environmental and metabolic influences, and transgenerational plasticity govern social behavior. Cognitive research considers the brain's default mode network (DMN) as a central hub that integrates various cognitive and social processing domains responsible for emotion perception, empathy, theory of mind, and morality. Hence, DMN is regarded as the "social brain." Upsurge in social turmoil, social anxiety, panic, depression, post-traumatic stress, hoarding, herd behavior, substance and behavioral addictions, sexual abuse, and violence in the time of the COVID-19 pandemic are intricately related to personality traits resulting in disruptive social cognition and social behavior, conceptualized as the result of unsettling and disruption of the functional nexus of the DMN. Considering overt and conspicuous display of neuroticism during the current pandemic, its impact upon modulation of the DMN functional nexus and the DMN itself, and the potential to presage cognitive impairment in the future, the authors caution that an increase in the global burden of dementia may be one of the long-term ramifications of COVID-19. Social behavior, a functional derivative of the DMN, can strikingly affect the functional nexus of DMN and the DMN itself, in a centripetal way via the phenomenon called "Experience-Dependent Plasticity," with long-term consequences. In this review, we intend to 1) decipher the association between social cognition and social behavior with the DMN, in time of COVID-19; and to 2) discuss the prospective aftermath of disrupted social behavior during the pandemic on modulation/alteration of functional connectomes of DMN or the DMN itself in the time ahead.

Keywords: Social Behavior; Cognition; COVID-19; Default mode network.

Introduction

Social cognition can be conceptualized as a processor of perception, encoding, and application of information regarding different social beings and social situations. It enables one to obtain, retrieve, and process information about life, relationships, and mental states and helps us appropriately respond to them.[1,2] It is quintessential for personal, vocational, educational, or, for that matter, any social interaction .[1,2] Social behavior, the projector of social cognition of humankind, is formed, framed, and steered by epigenetics, hypothalamic-pituitary-end-organ axes, environmental and metabolic influences, and transgenerational plasticity.[3–8] The environment can modulate metabolism across generations with an impact on social interactions.[3–8] Thus, transgenerational plasticity can lead to future populations' changed or altered social behavior.[9–12] Various psychosocial issues like panic, anxiety, obsessive behaviors, hoarding, paranoia, depression, post-traumatic stress disorder, "infodemic," racism, stigmatization, and xenophobia against particular communities, disrupted personality traits, neuroticism, psychopathy, and narcissism, have emerged or re-emerged during the COVID-19 pandemic and can be presumed to have a considerable impact on social cognition and behavior of the current and future population.[13–18]

In this review, we intend to 1) decipher the association between social cognition and social behavior with the "social brain," i.e., the default mode network (DMN) of the brain,[19] in time of COVID-19; and to 2) discuss the prospective aftermath of disrupted

social behavior during the pandemic on modulation/alteration of functional connectomes of DMN or the DMN itself in the time ahead.

The Default Mode Network: Interface of Behavior, Cognition, and Social Interaction

The DMN plays the role of a central hub for integrating various domains of cognitive and social processing, which are responsible for emotion perception, empathy, theory of mind (ToM), and morality.[20–22] When individuals remain defocused and detached from the external milieu, some specific anatomical networks of their brain get preferentially activated and assembled to constitute the DMN.[23] The elemental areas of the DMN include the medial prefrontal cortex (MPFC), medial posterior cortex (especially the posterior cingulate cortex and portions of precuneus), and bilateral inferior parietal lobules extending up to temporoparietal junctions.[20–22] Hippocampal formation, parahippocampal cortex, retrosplenial cortex, and adjacent areas of the medial temporal lobe and lateral temporal cortex are often considered ancillary parts of DMN.[23–25] The MPFC has been considered the critical node, which sets up complex interplay with other nodes, and helps to establish three major subsystems of DMN [i.e., dorsal MPFC subsystem, medial temporal lobe subsystem, and midline (connecting) core subsystem)], which engage in social understanding and interactions.[20–22,25–27] In the lower circuit, the ventral MPFC cross-talks with the medial temporal lobe subsystem and its connections to blend emotions in social interactions.[21,22,24–26,28,29] In the middle, the anterior MPFC, associated with cortical midline structures and its connections with the posterior and anterior cingulate cortex, generates self-other distinctions.[21,22,24–26,28,29] At the top, the dorsal MPFC and its connection with temporoparietal junctions are primarily related to the "Theory of Mind," that is, to make sense and understand the mental states of others.[20–22,24–26,28,29] Extrinsic and intrinsic information integrated over long time scales provide room for shared neural encryption to be encoded, which is essential for establishing shared meaning, communication tools, narratives, and communities, above all, social networks.[21,30–32]

Emotion Perception

Amidst the four pillars of social cognition, emotion plays the most crucial role. Interception and interpretation of other people's emotional status is the quintessential step during social interaction.[21] The DMN makes the sensory social inputs perceivable and meaningful (i.e., situated conceptualizations) for distinct emotions using past experiences.[21,33–36] Over the last few decades, several studies failed to comprehensively explain emotion perception using different models, like the “location approach," psychological “constructionist approach," and the newest “brain functional connectivity” approach.[21,33–36] Obtaining excerpts from several similar studies using the “brain functional connectivity” model, it can be presumed that the ventral-MPFC (including parts of anterior cingulate cortex) and other emotion-related areas, especially amygdala and insula, are indeed associated with successful regulation of human emotion perception and responses.[21,33–36]

The Universe has sunk under peculiar emotional dysregulations and crises, which have emerged alongside the COVID-19 pandemic.[18,37] It can be anticipated that these dysregulated perceptions, in their entirety, stem from alterations in the functional connectivities of DMN, influenced by an unfavorable environment.[2,21,22,38] Whether the modulation of DMN and its functional nexus by environmental influences will have any long-term consequences on social cognition

and behavior remains an earnest and consequential topic of future research.

Empathy

Empathy enables human beings to sense the emotional states of others. It is a process of generating an isomorphic affective state in the self to perceive the emotional condition of another individual, but the realization remains unaffected that it is the other who causes this affective state.[39–42] It can promote affective interactions and contribute to prosocial behaviors towards other conspecifics depending on social relationships and social contexts.[39] Empathy, another bedrock of social cognition, has a deep-rooted evolutionary substratum that emanates from the phylogenetically ancient practice of parental care/filial love, contributing to the transgenerational passage of the genetic legacy.[39,40,43] Facilitation of a positive relationship between two unrelated persons can be ascribed to the positive motivational systems initially developed to care for one's offspring. Hence, empathy acts as a pivotal mode of forming and maintaining strong social bonds between two unrelated individuals.[41] Empathy, essentially, is based on emotion perception. Unsurprisingly, the anterior MPFC (one of the first nodes of the DMN's operative machinery) is the region in the frontal cortex, which separates self from non-self, and it is strongly implicated in both empathy and emotion perception.[44–46] The dorsal MPFC and its connections also contribute to recognizing the emotional status of non-self-individuals.[47,48] Years of ongoing research have postulated three neural systems that embrace empathy: the mirror neuron system, the affective empathy system (consisting of the anterior insula and mid-cingulate cortex), and the cognitive empathy system of ToM that almost overlaps with the DMN network. Cognitive empathy needs higher frontal associations and is representative of ToM, which almost shares the same functional connectivity with the DMN network.[49] Ventral MPFC acts as a bridge between the affective and cognitive empathy system.[49]

Lack of empathy was unexpectedly featured during the COVID-19 pandemic more ways than one.[13–18,37] The elderly, marginalized, and people from lower socio-economic strata suffered the most.[13–18,37] The adverse social responses (especially lack of empathy) observed during this pandemic have possibly also arisen from disruptions of the DMN and its functional links due to unfavorable, hostile environmental situations.[13–18,37] If this state of social tumult prevails, it could cast its long-term impact on several faculties of the DMN in association with its transgenerational spread that will be deleterious for the human race. DMN can be surmised as the central meeting-point of idiosyncratic self and shared social behavior,[29] which, unfortunately, has skewed towards self-obsession,[37] leaving sharing far behind in the pandemic.[18,37]

Theory of Mind

Three primary processes are involved in the genesis of ToM: 1) representation of cognitive and affective mental states; 2) attribution of these mental states to others (non-self); and 3) application (deploying) these mental states to accurately comprehend and forecast behavior.[50–52] ToM enables a person to predict, interpret, and explain another individual's behavior by attributing cognitive and affective mental states (i.e., intentions, beliefs, desires, and emotions) to others.[50–52] Theory of mind has to be considered a relatively higher-level cognitive ability to emotion perception and empathy. ToM involves the process of self-projection and helps separate one's mental perspective from that of non-self/others. Thus, ToM requires critical inputs from the frontal cortex (dorsal MPFC, distinguishing self from non-self) and the posterior DMN (representing

current and mnemonic event materials).[50,53–56] Posterior DMN, associated with temporoparietal junctions and frontal lobe, are the anchors of ToM in the brain.[50,53–56] The left temporoparietal junction coupled with the frontal lobes properly represent mental states.[53] False beliefs also have a neuroanatomical localization, as argued by Saxe *et al*.[57], stating that the right temporoparietal junction is accountable for this. Neuroimaging studies have found a common thread for the brain's functional connectivity pattern underlying ToM, the DMN, and autobiographical memory.[54–56,58]

False beliefs have prevailed throughout the pandemic in every aspect of social life, starting with the origin of the virus, propagation, dynamics, treatment, [13–18] and with myths and controversies regarding vaccination still dominating,[59,60] indicating misalignments of higher complex DMN circuits in individuals resulting in dysregulated social cognition,[59,60] behavior, and responses as a whole.[18]

Morality

The evidence so far shows that the brain networks governing morality closely associate the DMN and its functional networks.[26,61,62] Neuroimaging studies argued for a probable relationship of morality with several brain regions, such as the anterior cingulate cortex,[63] temporoparietal junctions,[64–67] ventral-MPFC,[68,69] and dorsolateral prefrontal cortex.[63,70] In an attempt to decipher the complexity of morality, researchers have found relationships between the DMN and other networks, particularly the amygdala. Marsh *et al*.[71] observed reduced functional connectivity between the amygdala, thalamus, and the medial orbitofrontal cortex when categorizing illegal and legal behaviors in youths with psychopathic traits compared with healthy individuals. Age also impacts the functional connectivity of complex moral circuits, as shown by Decety *et al*.[42]. They pointed out an age-related increase in functional connectivity between the ventral-MPFC and amygdala in response to intentional harm.[42] Craig *et al*.[72] found an association with reduced fractional anisotropy between the uncinate fasciculus and orbitofrontal cortex in psychopaths. It was also observed that coupling between the dorsolateral prefrontal cortex and the DMN positively correlates with impulsivity scores.[73] Moral judgment revolves around multiple complicated socially responsible behaviors and cognitive processes, like distinguishing self from non-self, appreciating social norms, following goal-directed actions, feeling empathetic to the sufferings of others, and inferring the intentions of other persons.[61,69,74]

The surge of illegal behaviors, addictions, psychopathic traits, and intentional harm in the pandemic period,[13–18,37] being assumed as negative moral deflections, derive from faulty/disrupted DMN functional connectivity, hypothesized as a derivative of the environmental impact on DMN or the circumstantial preference of self in crisis over supreme moral codes.[37]

The Triple-Network Model of Brain

The integrated and well-tuned activities of DMN and the central executive network are two ingrained, dynamic, and primarily anticorrelated (with some temporal intervals of correlated activity) functional consortia of the healthy human brain *sine-qua-non* for the unruffled performance of cognitive and executive functions.[26,74,75] The antagonistic pursuits of DMN and central executive network presumably represent competing modes of information processing.[26,74] The posterior cingulate cortex, MPFC hubs of DMN, and the DNM aid in unfocused inner thought, i.e., internal mentation;[27] whereas central executive network succors to targeted stimulus-dependent attention within the dorsolateral prefrontal cortex and posterior parietal cortex

in particular.[30,74,76] The right anterior insula is the surrogate and emblematic part of the third functional brain network; the salience network synchronizes and keeps an eye on these inter-network performances and, thus, accords apt behavioral responses to salient stimuli, facilitating both the reorienting of attention and bottom-up perception.[30] The cognitive bewilderment and pandemonium of internally and externally focused attention that has been stupefying the community hit by the current COVID-19 pandemic can be accredited to the dysfunctional or unsettled synergism of the DMN-central executive network- salience network, i.e., maladaptive dynamics of the triple-network model of the brain.[13–18,37,77–82]

Metacognition: The External Patterned Reflection or Meeting-Point of the Triple-Network?

Metacognition is interpreted as an awareness of one's thought processes, and a basic understanding of the patterns behind these.[83–85] Genetic and cultural influences, intention, and ToM are essential determinants of metacognition.[86] Metacognition depends on the "perception-action" cycle.[85,86] Perception may be at the intrapersonal and supra-personal level and is constantly modified by error checking.[87] Installation and acquisition of metacognition within the human brain occurs through cultural learning and is of paramount importance with three overriding components of discrimination, interpretation, and broadcasting.[85,86] Metacognitive bias and metacognitive sensitivity lead to radical or polarized beliefs.[88] A pandemic of false information (infodemic), racism, conspiracy theories, and the wave of superstitions are a few unfortunate facts of metacognitive bias and sensitivity, leading to disruptive social behavior.[13–18,37,89] Cognitive insight embodies cognitive flexibility that encompasses evaluating and correcting distorted beliefs and misinterpretations.[90–92] Cognitive insight mirrors self and acts as a checker of incorrect beliefs and incorrect self-certainty, which is impaired in several neuropsychiatric disorders.[90–92] It is essential for regulating and monitoring one's behavior.[93–95] Cognitive insight is a dynamic process that depends on the resting-state functional connectivity of DMN.[96–98]

Social Anxiety, Panic, Depression, Post-Traumatic Stress Disorders, Hoarding, Herd Behavior, Behavioral and Substance Addictions, Sexual Abuse, Violence, Disorganized Personality Traits, Disrupted Social Cognition, Behavior and the Default Mode Network

Distortion in cognitive-behavioral and metacognitive processes implicates belief in social anxiety.[99,100] Types of beliefs depending on perspectives.[101,102] Gkika *et al*.[101] showed an association between social and metacognitive beliefs and social anxiety. Metacognitive beliefs through cognitive processes correlate well with social anxiety, both directly and indirectly.[101] Depression roots from a disrupted default mode network.[103–105] Failure to suppress resting-state DMN by the task-positive network, i.e., salience network and central executive network, may result in anxious rumination and depression, though the functional relevance of these subsystems in depression is unclear.[106] Coping strategies are also based on modulation of the DMN and its nexus.[107,108]

Perceived Social Support: Does It Depend on Robust Functional Connectivity of the Default Mode Network? [109]

Contemporaneous activation within the DMN circuitry correlates with perceived social support.[110] Perceived social support emphasizes the subjective feeling of provisions offered by family, friends, and significant others.[111,112] Maladaptive synchronization of the DMN and its connections for perceived social support in

the pandemic is partly explained by personal loss, lockdown, and lack of proper social interactions and communications, leading to non-resolution of psychological issues throughout the pandemic.[113–116]

Functional Connectivity of the Brain and its Correlates of Coping Styles[107]

Coping abilities denote mental and behavioral strategies of individuals for facing and adopting stress or traumatic experiences.[107,117,118] Avoidance in coping style is related to post-traumatic stress disorders, anxiety, and depression. [107,117–119] Well-being and high quality of life depend on a problem-oriented coping style.[119] Coping style adoption again depends on functional connectivity of the DMN and the anterior salience network.[107] A problem-oriented healthy coping style is also associated with increased resilience of the network mentioned above, again poorly practiced during the pandemic due to its unpredictable course and the misinformation-driven unexpected situation, leading to an increased incidence of anxiety, depression, and post-traumatic stress disorders.[13–18,120–122] Rappaport *et al*.[123], in a comprehensive review, discussed the brain's responses to social feedback in internalizing disorders. Social anxiety is interrelated with amygdala hyperactivity in anticipation of social feedback.[124,125] Cingulo-opercular network hyperactivity has been noted in depressive disorders in response to negative social feedback.[126] Studies on personalities, DMN, and negative social feedback are increasing. Deming and Koenigs[125] demonstrated an intricate and intriguing relationship of borderline personality disorder with hyperactivity in a specific region of the DMN coupled with negative social feedback.

Personality Neuroscience, Brain Networks, Environment, and Experience: The Convergence Interface Remains Ill-Defined-Where Lies the Evidence?

Personality is a property exclusive to the human brain.[127] Interactive cross-play at multiple levels involving several substrates, ranging from a single neuron to various overlapping neural networks, directly or indirectly interconnected with various modalities, is the basis of the complex function of the brain.[127,128] Experience-dependent plasticity refers to the environmental impact on brain development and wiring, following Hebbian-like algorithms.[129–132] Experience engrams can influence and modulate the DMN, i.e., the internal representation of the human brain depending on the perception means and keeping the timescale as a variable.[133,134] These internal configurations blocks represent the external world and personality determinants.[135,136] The internal representations are continuously modulated by the changing world, pivoting on adaptability and functional effectivity.[135] Maldevelopment, faulty wiring, biased, fixed, and non-adoptive internal configurations of the brain (i.e., DMN and its connections) lead to the emergence of kindred personality disorders.[136–138] Eventually, disruption of experience-dependent plasticity is likely to be one of the dominant roots of the anticipated long-term psychosocial impact of the COVID 19 pandemic. This overt surplus of anxiety, depression, panic, and post-traumatic stress disorders during the pandemic can be readily explained by faulty adoptions and altered functional integrity of the DMN and its radiations.

Personality Traits, Default Mode Network and Its Relationship/Impact on the Pandemic

A revised version of the NEO Personality Inventory has explained personality traits based on five pivotal factors, i.e., Openness to Experience, Extraversion, Neuroticism, Agreeableness, and Conscientiousness.[139] Openness is related to sensitivity to feel, esthetic experience and values for new ideas, increased cognitive flexibility, creativity, intellectual curiosity, and motivations for seeking novel experiences.[140] Extraversion indicates a positive effect, often describing an outgoing person.[141,142] Neuroticism reflects nervous sensitivity and related reaction(s) to stressful situations and arguably has significant public health importance.[143–146] Agreeableness is associated with compassion, resulting in friendly behavior.[146,147] Conscientiousness adds disciplines and organizations to behavior.[148,149] Resting-state functional magnetic resonance imaging studies have established that the DMN of the human brain is engaged in a plethora of cognitive phenomena, such as self-reference,[78] social behavior,[150] rumination,[151] emotional states,[152] creativity and imagination,[153] and, overall, social cognition.[36] Personality problems can also lead to various cognitive dysfunctions, behavioral problems, and affective disorders encompassing the convergence of the DMN and personality and its relevance in social cognition.[121,154] Thus, it may be assumed that there must have been some intricate relationship between disruptive social behavior/social cognition with DMN and personality during the COVID-19 pandemic.[18,109]

Personality Traits, Default Mode Network, and the Relationship with Disrupted Social Behavior in Time of Pandemic

Functional connectivity of the DMN is arguably responsible for the genesis of several types of personalities, like schizotypal personality disorder,[155] causing much distress in a time of pandemic as regards social behavior,[109] polarized beliefs, magical thinking, which can influence the spread of rumors, as well as superstitions regarding treatment and vaccines.[156–159] Alterations of DMN functional connectivity in obsessive-compulsive personality disorder, previously studied by Coutinho *et al.*,[160] is characterized by excessive self-awareness, perfectionism, and behavioral as well as cognitive rigidity. The impact of obsessive-compulsive personality disorder during the pandemic is marked by hoarding and other compulsive behaviors, like repeated hand washing habits, which were already announced as a preventive measure.[161] Excessive self-awareness, obsessive thinking about an uncertain future, and mental stimulation with other related facts are derivatives of obsessive-compulsive personality disorder and have prevailed throughout the pandemic.

Neural Code of Openness-Psychoticism, Intelligence and Addictions with Obsessive-Compulsive Personality Disorder and Fronto-Parietal Network Connectivity: Does It Fall Beyond the Captivity of Social Disruption in the Pandemic?

The openness-psychoticism dimension in relationship with functional connectivity in the DMN and frontoparietal control networks has been studied by Blain *et al.*[162] and Maglanoc et al.[163]. Excessive openness has been associated with psychopathy and cognitive deficits.[164] Openness also has an association with intelligence via the frontoparietal control network.[162] Research suggests that heightened openness is also associated with addictive behavior.[165,166] Thus, it may be extrapolated that openness-psychopathy, cognitive distortions, and addictive behaviors, which were plaguing during the pandemic, are inherently linked to faulty functional connectivity of the DMN,

grouped under the "personality-psychopathy" conundrum. Psychopathy means disruption of emotional processing and attention. Psychopathic traits are thought to result from abnormalities in functional connectivity of the DMN with salience network.[167] Self-reported anxiety stems from spontaneous brain state oscillation.[168] Antisocial personality disorder, characterized by a disregard for social obligations/norms and gross unconcern towards the feelings of others, has again been shown by recent research to be the product of aberrant topographic organizations of the DMN with other networks within the human brain.[169] Heightened corruptions, black marketing, violence, sexual abuse and addictive behaviors are not uncommon in times of pandemic. They are triggered by the unfortunate people harboring antisocial personality disorder, assumed to be the activation of preexisting disruptive/faulty topographic organizations of the DMN during the pandemic crisis.[170] Neuroticism, a personality trait, is known to be an essential risk factor for psychopathology, leading to anxiety disorders and depression.[145,146,171] Neurotic individuals not only add burden to social behaviors but also display a peculiar paradox of high self-criticism and are overly sensitive to criticism by others.[145,146,171]

In short, personality depends on resting-state functional connectivity, chiefly involving the DMN network in allegiance with other brain networks.[127,172] Furthermore, personality determines individual behavior. In turn, individual behavior collectively builds social behavior and social cognition. Therefore, it holds to hypothesize that the DMN (resting-state functional connectivity) ultimately governs social behavior and cognition, based on an individual's personality, acting as building blocks of social behavior.[173]

Neuroticism-Cognition interface: Anticipated Long-Term Consequences [145,146,170,174]

Neuroticism traits and mood disorders of anxiety and depression have an emerging relationship with the development of cognitive impairment.[175–178] A meta-analysis of eight studies found that higher neuroticism is associated with higher amyloid deposition and tau pathology.[179]

Several prospective studies have found that high neuroticism in cognitively normal adults predicts later development of Alzheimer's disease and related dementias. [178-179]. Studies have further added that adjusting for age, sex, education, race, and ethnicity, lower conscientiousness, agreeableness, and higher neuroticism were independently associated with increased risk of dementia, especially of Alzheimer's type.[180,181] Higher neuroticism was proven to accelerate the progression of cognitive impairment, no dementia to overt dementia, thus establishing an intriguing relationship of brain networks, personality, cognitive aging, and dementia.[180–183] The Mental Noise hypothesis in neuroticism is characterized by increased mental noise, attributing disruptive attention, cognitive performance, and deficits, underpinning the role of DMN and the dorsal attention network in the cognitive performance of individuals.[184–186] Due to the higher rates of anxiety, depression, and neuroticism during the pandemic,[187] its influence and modulation of the DMN, and association with possible cognitive impairments, the authors apprehend a likely increase in dementia burden globally as one of the unfortunate long-term consequences of the pandemic.[184–186]

Addictions, Default Mode Network and the Pandemic

A surge of addictions has prevailed throughout the pandemic in substance use disorders and behavioral addictions.[15] Faulty

DMN and central cortical network cross-talk, aberrant functioning of both ventral-MPFC and dorsolateral prefrontal cortex, and regional gray matter volume loss are proposed substrates underlying addictive behavior as evidenced by previous studies.[188–190] An abnormal pattern of brain functional integrity in the DMN lies behind substance use disorder.[188] Growing evidence suggests DMN dopaminergic, glutamatergic, and GABAergic signaling alterations in individuals with acute and chronic drug use. [236,238]

Researchers showed aberrant insular-DMN (resting-state functional connectivity) in behavioral addictions such as gambling disorder.[191,192] Disruption of the canonical triple-network model is observed in internet gaming disorder.[193,194] Problematic internet gaming disorder is often associated with major depressive disorder.[195–197] Depressive symptoms, including impulsivity being controlled by serotonergic neurotransmission in the DMN, are known to have the potential to modulate DMN.[198] The core feature of addictions is characterized by a deficit in cognitive control.[166] Behavioral addictions, a term sometimes interchangeably used for impulse control disorders, are seen to stem from aberrant DMN functional connectivity.[166] Chronic substance use is hypothesized to influence cortico-striatal neuroplasticity, leaving the natural reward circuit insensitive to usual pleasure inputs and inducing anhedonia, resulting in a negative effect.[165,199] Mindfulness-based programs thought to modulate the DMN have shown promising efficacy in treating substance-use disorders.[200] Serotonergic neurotransmission and genetic variants of the serotonin transporter in DMN can alter attention and impulse control implicated in various psychopathologies.[201] Dopaminergic dysregulation in the reward network results in food addictions, often derivative of coping mechanisms in response to anxiety and stress.[202]

Conclusions

The DMN is the thread believed to link, influence, and modulate all components of social behavior and, overall, the entire metacognition and social cognition observed during the pandemic. Substantial evidence from relevant coeval literature and comprehensive analysis of many of the psychosocial facets of the COVID-19 pandemic has highlighted the significance of the DMN and intertwined social behavior and cognition in the time of the pandemic. The practical extrapolation of evidence from basic research indicates that the societal burden of overall adverse effects during the pandemic is chiefly associated with faulty/disrupted resting-state functional connectivity of the DMN (figure).

Figure 1:
The figure depicts how alterations of the default mode network (DMN) of the brain influence the correlates of social behavior in the pandemic and anticipated long-term psychosocial and cognitive impacts of these alterations:
https://s3.amazonaws.com/chd-data/data/mra/tickets/81310/replies/6637867/attaches/DMN%20image%20%281%29.jpg

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