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Positive Neuroscience: Comparing the Neural Correlates of Meditation and Creative Flow

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ABSTRACT

Positive neuroscience focuses on the flourishing and optimized human brain. Despite this optimization being a result of higher conscious states, often caused by meditation or creative flow, the neuroscience field lacks research comparing these two unique brain states. Therefore, through an exploratory content analysis, this research will reveal what neural mechanisms can potentially characterize the flourishing human brain by comparing 21st century, neuroscientific literature on meditation and creative flow. This paper's findings have indicated compelling alignment for increased activity in the VLPFC, DLPFC, and parietal regions, which altogether enhance emotional and attentional regulation. Aligned deactivations of the AMY and DMN (including the mPFC and PCC), increased activity in theta and alpha oscillations, and the inverse relationship between the DMN and CEN also corroborate the potential trend of increased emotional and attentional processing. Despite some limitations, by extracting the neuroscientific results from empirical work on both conscious states and comparing their respective neural correlates, these potential trends implicate the significance of emotional and attentional regulation regarding mental wellbeing, and a more-informed direction for future investigations exploring positive neuroscience.

Introduction

Various clinical interventions have been proven to buffer depression and anxiety due to decades of neuroscientific research on disease and dysfunction. However, according to Dr. Martin E.P. Seligman, Director of the University of Pennsylvania's Penn Positive Psychology Center, very little is known about the opposite: the neuroscience of human flourishing and optimization and its interventions that can enhance wellbeing (Allen, 2019). This emerging field is known as positive neuroscience. The application of positive neuroscience through clinical interventions has been crucial in increasing emotional wellbeing and resilience, and attenuating ongoing decades of suicide rates, chronic depression, loneliness, substance use, and overall mental health disorders (Allen, 2019; Sliwa, 2019). Two specific interventions, known as meditation and creative flow, both promote optimal brain functioning and maximize human flourishing through positive mental health outcomes (Alexander et al., 2020; Sheldon et al., 2014).

Higher States of Consciousness

Meditation and creative flow are both considered higher states of consciousness (Laughlin et al., 1990). Consciousness, or an individual's awareness, can be classified as either waking consciousness or altered states of consciousness (ASC). ASC includes higher conscious states, such as meditative and creative flow states, and lower conscious states, such as dreaming and psychedelic states (Gulick, 2014). Since meditation and creative flow are both higher conscious states, comparing them through a neuroscientific perspective could reveal potential trends that characterize the neural mechanisms of an optimized, flourishing human brain.

Meditative States

Meditation can be an umbrella term for any and all mental training practices, often requiring one to focus their attention on something, and relax the body and mind (NCI Dictionary of Cancer Terms, 2011). Extensive empirical work on meditation and mindfulness interventions have proven the brain's optimization through decreased psychological stress, anxiety, and depression, and increased performance, focus, and overall wellbeing. However, these outcomes can vary depending on the individual and the type of meditation practice (González-Valero et al., 2019; Goyal et al., 2014).

Creative Flow States

In 1975, Csikszentmihalyi founded 'creative flow,' 'flow,' or 'flow state' as: an optimal experience of total engagement in an activity, characterized by high skill and high difficulty **(see Figure 1)**. Colloquially known as "being in the zone," this experience can intensify consciousness and yield involvement, passion, and focus to the extent one loses a sense of their environment and time (Moneta & Csikszentmihalyi, 1996). Empirical work has studied flow state in dancers, painters, singers, writers, and musicians, as well as in science, sports, religious, therapeutic, educational, and workplace settings (Biasutti, 2011; Sonnenburg & Primus, 2020). Since it can be experienced by any population and caused by a variety of activities at different intensities, the criteria for creative flow is distinguished by nine specific characteristics **(see Appendix A)**.

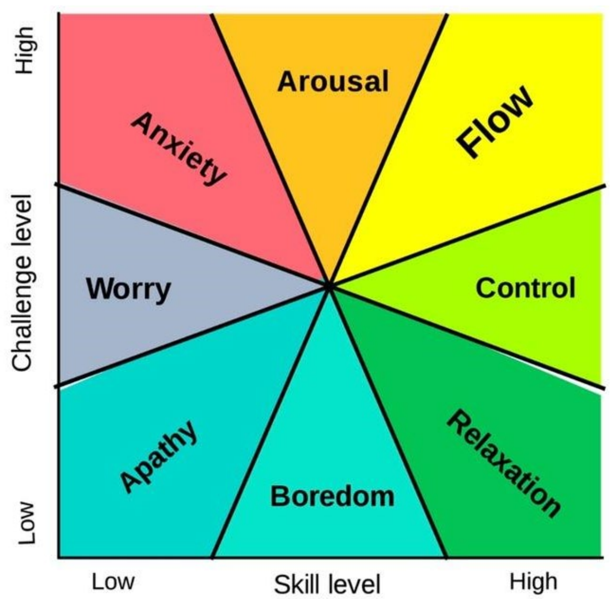

Figure 1. Csikszentmihalyi's flow model of psychological states (Gold & Ciorciari, 2020).

The following literature review will examine the existing and limited neural correlates of meditation and creative flow respectively, and will conclude with a 2014 article directly comparing these two brain states (Sheldon et al., 2014). This 2014 article will represent how exiguous comparisons are across meditation and creative flow, and how comparisons especially lack a neuroscientific perspective. In order to address this gap in the body of knowledge, this research paper will investigate the following inquiry: What can comparing 21st century neuroscientific literature on meditation and creative flow suggest about the neural correlates of the optimized human brain?

Literature Review

Meditation: Conceptualizing a Neural Basis

Compared to creative flow, there is an abundant amount of neuroscientific research on meditation, which has resulted in many reviews and meta-analyses compiling the existing empirical work. These compilations help conceptualize a neural basis for meditation, which is a model representing the neurocognitive processes characterizing the brain during a meditative state. A 2022 systematic review and meta-analysis of functional magnetic resonance imaging (fMRI) studies on Focused Attention (FA) meditation illustrates the ongoing limitation in the field's attempt to conceptualize a neural basis for meditation (Ganesan et al., 2022). The main limitation evident in this 2022 review, and many other qualitative reviews, is the heterogeneity of the empirical work being consolidated. This means diverse domains of methodology, meditation practice, neuroimaging equipment, control conditions, and results within the empirical studies. This 2022 review only attempts to curb this limitation through its selection of only one type of meditation practice, FA meditation, to review for a neural basis. This narrowing via one meditation type could have been applied to this research paper's design, however, since the research purpose is to compare the holistic neural basis of meditation to the neural basis of creative flow, this methodological choice would not be preferred.

This limitation in the field's attempt to synthesize a unified neural basis for meditation is in direct conversation with a 2021 empirical study (Young et al., 2021). This specific study is relevant in providing deeper skepticism of the existing qualitative reviews on the neuroscience of meditation, as it discusses how literature often consolidates heterogeneous results without distinguishing between what different meditation practices are responsible for which neural correlates. Since recent research began suggesting different meditation practices and their brain states differ on a neurophysiological level, this article recognizes the limitations in producing a singular neurocognitive model for *all* definitions of meditation. Therefore, because of this empirical heterogeneity, there have been major themes and inconsistencies regarding the neural basis for meditation, hence representing no major consensus that can be employed for this paper's research inquiry.

However, despite this inconclusive neural basis for meditation, both the 2022 review and 2021 article provide the same justification for comparing heterogeneous literature. They state these qualitative reviews are necessary in order to produce a broader scope of neuroscientific results, which continue to help identify unifying themes that can characterize this extremely nuanced brain state (Ganesan et al., 2022; Young et al., 2021). This complexity helped direct this research paper's inquiry to also pursue a larger perspective of the literature in order to compare any existing neural correlates of meditation, to any existing neural correlates of creative flow.

Creative Flow: Conceptualizing a Neural Basis

To conceptualize a neural basis for creative flow, a 2020 article summarizes key knowledge and gaps in the existing empirical literature (Sonnenburg & Primus, 2020). The 2020 article's "Gaps In Flow Research" section was especially formative for this paper's research inquiry, as it illustrated two main gaps in the existing literature and also provides two suggestions. The first gap is in the exiguous amount of neuroscientific literature on creative flow, which is especially disproportionate to empirical work on meditation. The neuroscience field has attempted to improve upon this by increasing the amount of experimental controlled designs investigating the neural correlates of creative flow, however, this invoked the second gap: empirical work representing an increasingly too-narrow and analytical perspective. The two suggestions illuminated to address these gaps are, first, further investigations analyzing creative flow through a more holistic and complex perspective. Second, it suggests future research is necessary to differentiate flow states with other positive brain states, such as meditation. This second suggestion primarily informed this research paper's inquiry to compare the neural correlates of meditation and creative flow, especially because the first suggestion has already been addressed by the following 2022 review.

A 2022 review addresses the lack of holistic research mentioned in the 2020 article by reviewing the most recent, existing neuroscientific literature on creative flow (Alameda et al., 2022). In an attempt to consolidate a neural basis for creative flow, it resulted in inconsistent activations of brain regions and brain networks. Overall, it could not conclude a unified neural basis for creative flow, or support any of the three, main theoretical models conceptualizing a neural basis for creative flow **(see Appendix A)**. Unlike the previous 2022 review for the neural basis of meditation, this 2022 review for creative flow did not attempt to minimize the heterogeneity of its sampled literature in any domain. This is acknowledged as a methodological shortcoming due to the diminutive empirical work on creative flow, which additionally contributes towards the inconclusive neural basis for creative flow. This inconclusive neural basis for creative flow contrasts the inconclusive neural basis of meditation, as it was a result of an extensive amount of extremely nuanced, narrow empirical work. However, both this 2022 review and the previously reviewed articles on meditation present the same limitations and justification regarding their empirical heterogeneity, as a larger scope is argued to continue revealing potential trends not originally recognized across the neuroscientific literature.

Comparing Meditation and Creative Flow

What has not been addressed by empirical work, as suggested in the 2020 article, is a neuroscientific comparison between two similar, positive states: meditation and creative flow. To the best of the researcher's knowledge, only one 2014 study, "The Experimental Incompatibility of Mindfulness and Flow Absorption," was found to experimentally compare meditation and creative flow. However, this study lacks any neuroscientific component and lacks the intention of developing a unified neural basis from both brain states (Sheldon et al., 2014).

Conclusion

To conclude, the most recent publications regarding meditation and creative flow represent an inconclusive neural basis due to empirical heterogeneity and the limited amount of empirical work available. While this significant limitation will be apparent in this research paper's design, the neuroscience field acknowledges the contributions of qualitative reviews, since a holistic perspective is vital towards identifying key trends across empirical literature (Sonnenburg & Primus, 2020). Furthermore, the lack of direct comparison between the neural correlates of meditation and creative flow signifies the need for a broader perspective in order to identify potential neural correlates across both higher conscious experiences. This research paper aims to accomplish this by comparing 21st century neuroscientific literature on meditative and creative flow states in order to determine what neural correlates could potentially characterize the optimized human brain.

Methodology

This research paper employed an exploratory content analysis of empirical research in order to compare relevant neuroscientific results between meditation and creative flow. Since a content analysis is a systematic research method used to identify the presence of certain words, themes, or concepts from data, this method was optimal in identifying what potential neuroscientific trends can be observed between each conscious state's neurophysiological processes (Columbia Public Health, 2019).

Literature Search

Neuroscientific data came from studies manually curated from the following scientific databases: EBSCOhost, Google Scholar, JSTOR, PubMed Central, and ScienceDirect. These databases were selected for the prevalence of neuroscientific journals and publications, as well as their free, online accessibility. Through these databases, a targeted search for meditation and creative flow studies was conducted through respective lists of keywords. To curate neuroscientific articles on meditation, these databases were searched for the existence of keywords including “meditation,” “neuroscience,” and “wellbeing.” To curate neuroscientific articles on creative flow, keywords included “creative flow,” “neuroscience,” “flow,” “Csikszentmihalyi,” and “wellbeing.” Each source’s list of references was also considered for the same keywords. The database ScienceDirect recommended free access papers under the pop-up “other users also viewed these articles,” which were also observed for evaluation. Some complete PDF downloads of relevant empirical research required access through an institution, which were downloaded through the researcher’s UCLA student account.

Eligibility Criteria & Study Selection

The abstracts of meditation and creative flow papers were first evaluated for eligibility and topic-relevance. The required criteria included the presence of empirical work containing neuroscientific results of meditation and creative flow respectively, and a goal to identify neural correlates caused by either of these conscious states. Eligible articles were confined to 21st century publication, as the neural basis of creative flow emerged in the late 2000’s, along with an exponential interest in neuroscientific research on meditation (Loizzo, 2013). Experimental designs, reviews, and meta-analyses were all eligible for content analysis due to the numerous compilations of literature demonstrating a neural basis for either meditation or creative flow, which were foundational in comparing these two brain states. To improve the comparison between literature on meditation and creative flow, the most similar sample sizes, populations, neuroimaging equipment, and methods in the empirical work would have been ideal, however, due to limited neuroscientific literature on creative flow, the individual differences in empirical research were chosen to be overlooked in order to solely observe neural correlates. To account for empirical heterogeneity, relevant information was recorded in Tables 1 and 2 (**see Appendix B**). Extracted data from each paper included: author and publication date, methods of meditation or creative flow measures, number of participants, and neuroscientific results.

After analyzing and synthesizing the literature, three neuroscientific reviews were selected since they had already organized prominent neural correlates for each conscious state. One 2022 neuroscientific review was selected for creative flow, which consisted of 25 creative flow papers with 22 papers eligible for content analysis, and a total of two neuroscientific reviews were selected for meditation (Alameda et al., 2022; Lomas et al., 2015; Marchand, 2014). One 2014 review on meditation consisted of 36 papers, ranging from 2007-2014, 30 of which were eligible for content analysis. A 2015 systematic review for meditation was added because the 2014 review had no neuroscientific literature on neural oscillations, an instrumental dimension being coded for in order to be compared to the neural correlates of creative flow. So, the 2015 review was added for its compilation of meditation’s oscillatory results from 1966-2015. The inclusion of a 1966 paper did not change the results of the 2015 review.

Content Analysis

Content analysis was conducted on a total of 31 papers on meditation and 22 papers on creative flow. Case-by-case, the empirical results from meditation and creative flow papers were analyzed along the following four dimensions:

1) Activated Brain Regions
2) Deactivated Brain Regions
3) Brain Networks
4) Neural Oscillations

Each dimension examines neural correlates that could be similar across meditation and creative flow results. These classifications were chosen based on prior knowledge and observation of what neuroscientific data is most prevalent in meditation and creative flow studies. For example, most neuroimaging studies revealed fluctuations in brain activity via specific brain regions, brain networks, or neural oscillations. Additionally, by recognizing the greater amount of neuroscientific literature on the activity in brain regions compared to the activity of brain networks and neural oscillations, the classification of brain regions was separated into two dimensions: activated brain regions and deactivated brain regions. When coding neuroscientific results along the four dimensions, if the paper's findings and categorizations were unclear for the researcher, the empirical work was further reviewed in order to ensure validity and accuracy in coding. Papers that did not fall into the four dimensions were omitted, and all final classifications were recorded into Tables 1 and 2 **(see Appendix B)**.

Once the neuroscientific results for each paper had been classified into the appropriate dimensions, this researcher inductively coded each article for different terms in the neuroscientific results via Google spreadsheet (one sheet per dimension). This was done based on the existence, not frequency, of a specific term. An example for terms coded for the dimension of activated brain regions can include the amygdala, while terms coded for the dimension of neural oscillations could include alpha brainwaves. Multiple papers inductively coding for the same term were all listed alongside the corresponding terms in order to show the number of papers representing the existence of the given term. Terms were organized as neuroscientific results from either meditation or creative flow papers, which were arranged into two columns per dimension in order to identify where terms did and did not align across conscious states. This process was conducted for all four dimensions. According to the inductively coded results, the third dimension required terms to be further separated as activated brain networks and deactivated brain networks, and the fourth dimension required terms to be separated as increased and decreased oscillatory activity.

Rationale

Prior to study selection, the researcher consulted Dr. Kennon M. Sheldon, a current researcher in positive neuroscience and psychology, for insight into the likely available proportion of meditation and creative flow papers in the neuroscience field. Dr. Sheldon predicted 30-50 articles available for meditation and 20 articles available for creative flow. In consideration of the limited amount of studies containing the eligible criteria for this research, 31 papers on meditation and 22 papers on creative flow were found and selected for content analysis. Additionally, Dr. Sheldon and his collaborator Dr. Woogul Lee both recommended a qualitative review to best suit this paper's research inquiry, in addition to accommodating for the time constraints of a high school researcher. For a high school student with no access to neuroimaging equipment and limited experience in working with human subjects, the exploration of the neural basis of meditation and creative flow through secondary research was more reliable. Despite limitations to this method, as recognized throughout the literature review, accepting the heterogeneity of secondary research was necessary in order to address the gap in the body of knowledge. Part of why this gap has not been filled is because of how narrow and fine-grained current empirical literature has become. This narrowing makes comparing research across disciplines more challenging, especially as intense specialization in empirical research proliferates fragmentation in scientific knowledge and researching communities (Beste, 2021). Therefore, the methods used to compare 21st century neuroscientific literature on meditation and creative flow were vital in order to determine potential, large-scale neural correlates for the flourishing human brain.

Findings & Analysis

Activated Brain Regions

Activated brain regions refer to brain regions with increased activity in response to meditation or creative flow. Potential trends for this dimension were determined by either alignment or non-alignment across both meditation and creative flow papers per activated brain region.

Alignment

Represented in **Figure 2**, there was alignment for the following six activated brain regions: the ventrolateral prefrontal cortex (VLPFC) and cerebellum which impact emotional regulation; the dorsolateral prefrontal cortex (DLPFC), parietal regions, temporal regions, and the dorsal anterior insula (dAI) which impact attentional networks; and the putamen which impacts reward systems.

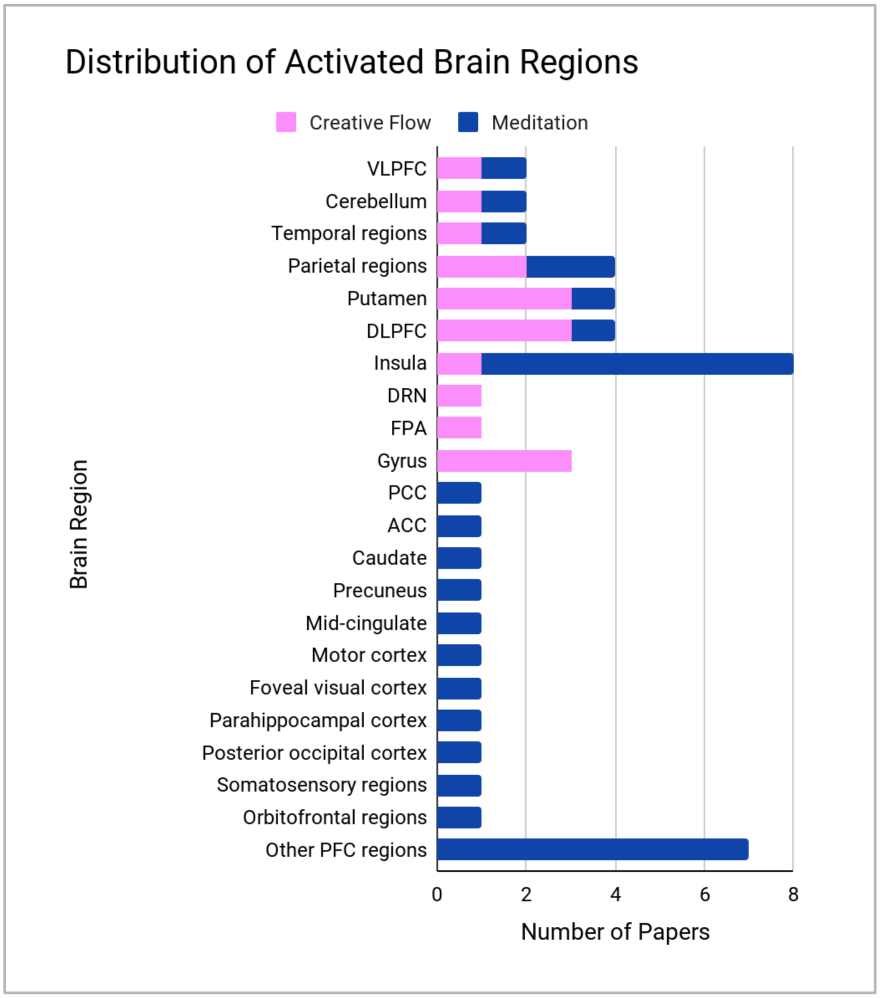

Figure 2. Brain regions activated across empirical work on meditation and creative flow. DRN, dorsal raphe nucleus; FPA, frontal polar area; PCC, posterior cingulate cortex; ACC, anterior cingulate cortex.

First, the aligned activation of the VLPFC during meditation and creative flow can suggest similar neurocognitive enhancements regarding emotional regulation. The VLPFC's function of response inhibition is integral for provoking a more selective, goal-appropriate response that one desires. This is effective during tasks such as meditation and creative flow, where one might need to suppress negative external stimuli that can have a negative emotional impact (Sturm et al., 2016). Therefore, it is possible the aligned activation of VLPFC during either conscious state is responsible for controlling one's responsiveness towards negative external stimuli, and potentially orienting one towards positive emotions. The alignment of the cerebellum can additionally be responsible for enhanced emotional regulation in both states, which can be considered a significant attribute of the optimized human brain (Ackerman, 1992).

Second, the activated DLPFC and parietal regions combined play a key role in the brain's attentional networks (van der Linden et al., 2021). Since the activated DLPFC can limit exterior sensory information and responsiveness towards one's environment, it can help shift one's focus toward the task at hand, whether it be meditative or creative engagement. This promotion of executive functioning, selective attention, and elimination of sensory information contributes towards sustaining one's engagement in both higher conscious states (Sturm et al., 2016). Furthermore, the activation of the DLPFC in conjunction with parietal regions during meditation and creative flow represents the activation of the central executive network (CEN), a main attentional network. An activated CEN is required for enhanced attention and focus, especially during cognitively and emotionally challenging activities (van der Linden et al., 2021). This CEN acts inversely to the default-mode network (DMN), which is activated during mind-wandering and rumination, or when one goes on "auto-pilot." Therefore, this unified activation in brain networks across higher conscious states can suggest the significant role of the DLPFC and parietal regions in optimizing attention and focus. Finally, the activated parietal and temporal regions together are involved in the orienting attentional network, which further emphasize the trend of enhanced attention across both higher conscious states (Alameda et al., 2022).

Third, the recruitment of the dAI suggests a strong coordination in shifting between the antithetical CEN and DMN. This shift between attentional networks is also key in optimizing one's attention and focus towards a task (Uddin et al., 2017). Lastly, the employment of the putamen and its role in reward systems can be a result of the intrinsic and extrinsic benefits of both practices. For example, participating in a positive activity and brain state can be internally and externally rewarding, which can contribute to the numerous positive health outcomes associated with both brain states (Ghandili & Munakomi, 2022).

Non-Alignment

There was a greater number of activated brain regions that did not align across the results of meditation and creative flow, as also represented in **Figure 2**. This incongruence is largely a result of the exiguous amount of neuroscientific results on creative flow compared to meditation, as **Figure 2's** distribution indicates a disproportionate sample of neuroscientific results on creative flow. This limitation is evident within this dimension and the following three dimensions, hence resulting in a consistently greater amount of empirical work representing no trends across meditation and creative flow overall. This was a main expectation and limitation considering the small sample of literature being analyzed to begin with, as there is simply not enough evidence to fully implicate whether or not the trends of alignment and non-alignment across any dimensions are relevant towards optimizing the human brain.

Deactivated Brain Regions

Alignment

Deactivated brain regions refer to brain regions with decreased activity in response to meditation or creative flow. Represented in **Figure 3**, there was a deactivation trend for the following five brain regions: the amygdala (AMY) regarding emotional regulation; the medial prefrontal cortex (mPFC) and posterior cingulate cortex (PCC) regarding attentional implications; and in temporal and PFC regions, which contradicts their activations in the previous dimension. This suggests a need for more research regarding temporal and PFC regions in order to delineate results with more congruent brain activity.

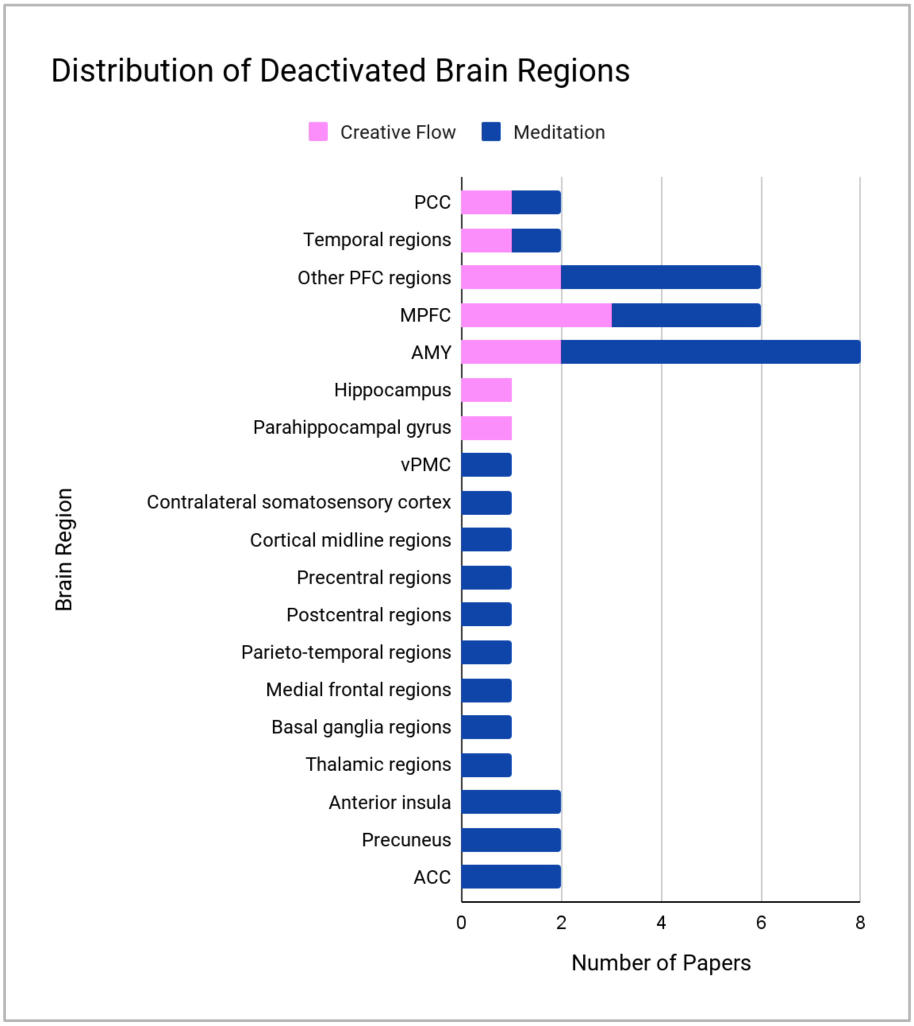

Figure 3. Brain regions deactivated across empirical work on meditation and creative flow. vPMC, ventral pre-motor cortex.

First, the reduction in AMY activity during both conscious states largely contributes to the emotional regulation and reactivity that promote human flourishing (Sturm et al., 2016).

Second, since the mPFC is an integral region in the DMN, the inhibition of the mPFC directly relates to the result of suppressed self-referential thought. This reduction in explicit processing correlates to the Transient Hypofrontality Hypothesis **(see Appendix A)**, where the suppression of frontal activity is associated in reaching optimal creative flow and human flourishing (Alameda et al., 2022). This mPFC reduction also has emotional implications, as the suppression of the DMN can help attenuate emotional processing during an attention-demanding task (Gusnard et al., 2001).

Finally, the unified deactivation of the PCC in both conscious states can also contribute to one's focus on a task. Interestingly, the result of an *activated* PCC indicates an experience of getting "caught up" in something, like in a craving or an attachment to an attribute of oneself. This activation of "getting caught up" in an experience would agree with the definition of creative flow, therefore, making this deactivation of the PCC contradictory. As mentioned throughout this paper, there is still not enough neuroscientific evidence on creative flow to clarify any consistent deactivations, or potential activations, of the PCC (Brewer et al., 2013).

Non-Alignment

Deactivations in the hippocampus and parahippocampal gyrus were evident in creative flow studies, however not in the larger sample of meditation studies. These deactivated regions could be in response to specific creative flow activities that suppress learning, memory, and reward, since only creative flow requires a high-skill level and lacks a state of growth (Moneta & Csikszentmihalyi, 1996). Deactivations represented only in meditation studies, as mentioned before, can be highly individualistic to the neuroscientific results that the one study represents.

Brain Networks

Activation

Brain networks are multiple brain regions functionally connected with one another. Activated brain networks in both meditation and creative flow have only represented a trend for attentional networks **(see Figure 4)**. This result has been previously supported in this paper's earlier dimensions 1 and 2. Therefore, across three dimensions, there has been a trend in enhanced attentional regulation and processing across meditation and creative flow.

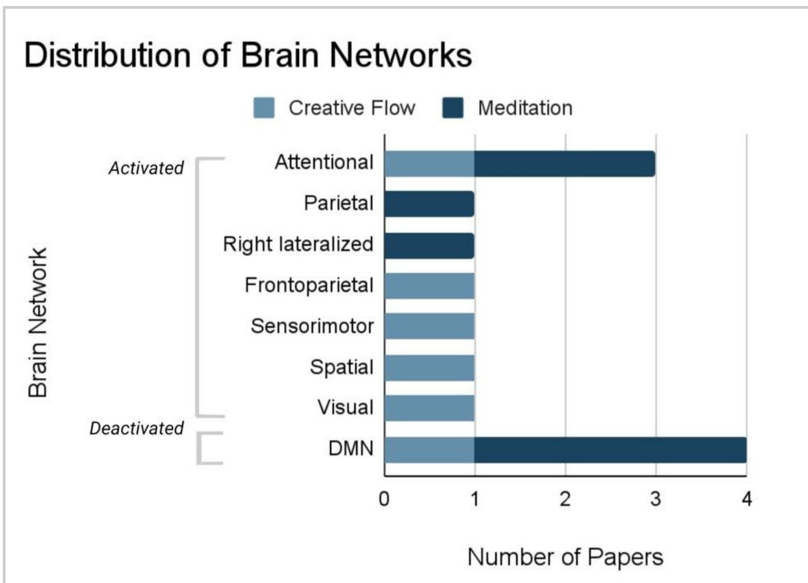

Figure 4. Brain networks activated and deactivated across empirical work on meditation and creative flow.

The employment of full focus on the given task of meditation or creative flow, especially to commence the task, is necessary for full immersion for long durations. These long durations in higher conscious states are evidently what produce the benefits of the optimized human brain, likely indicating the key role of activated attentional networks and their associated brain regions.

Brain networks not aligned between conscious states include the activation of the parietal network and right lateralized network for creative flow, which correlate with the activated parietal regions, prefrontal cortex (PFC), and insular regions that are also present in only creative flow studies, as represented in dimension 1. Activated networks from meditation results also only align with the results specific to meditation papers from dimension 1.

Inhibition

There was only one study per conscious state available representing the inhibition of a brain network, and both aligned for the inhibition of the DMN. This inhibition has been previously supported in the aligned deactivations of mPFC and PCC from dimension 2. As the DMN enhances automatic thoughts, the inhibition of the DMN helps decrease this implicit processing and mind-wandering. This inhibition continues to support the neuroscientific trend of enhanced attentional regulation and helps promote the CEN and orienting networks (Alameda et al., 2022).

Neural Oscillations

Neural oscillations represent the brain's electrical activity. There were trends in increased oscillatory activity for theta and alpha brainwaves, represented in **Figure 5**.

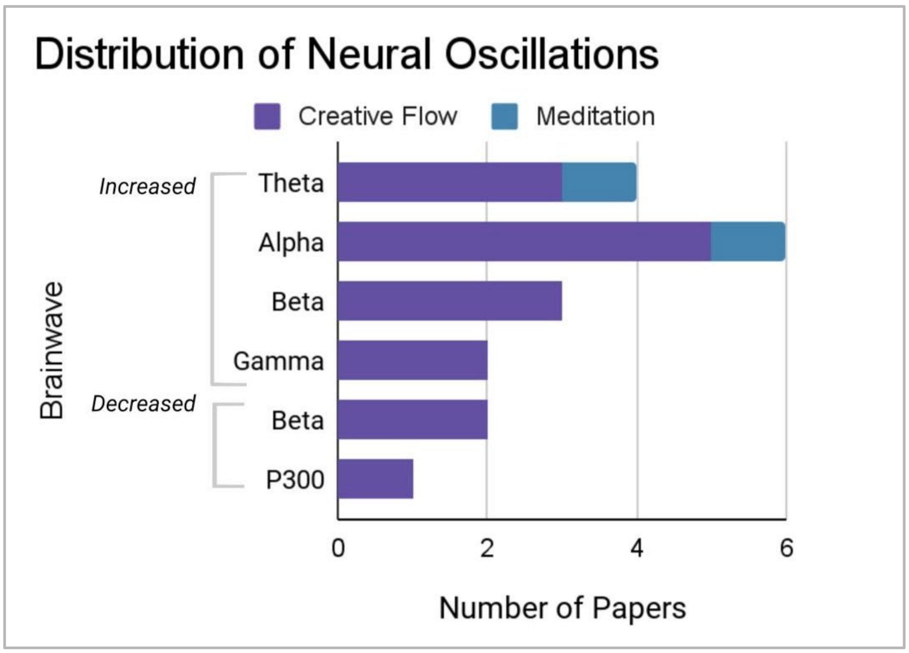

Figure 5. Brainwaves representing increased and decreased oscillations across empirical work on meditation and creative flow.

Increased alpha oscillations represent the inhibition of irrelevant information, and increased theta oscillations represent more executive neural processing (Katyal & Goldin, 2021). This corroborates the main trend throughout neuroscientific results that both meditation and creative flow inhibit processing of irrelevant external and internal stimuli, such as sensory and environmental processing and self-referential thinking. The increased activity in theta oscillations also correlates with activations in the PFC and CEN, as represented in dimension 1. Finally, since only creative flow papers represented increased gamma and beta waves, it should be noted that meditation studies analyzed for content analysis represented inconsistent patterns for gamma, beta, and delta waves. Therefore, no existing trends could be observed for decreased neural oscillations across meditation and creative flow.

A formative 2021 study should be noted for its demonstration of shallower levels of meditation beginning with increased theta and lower alpha, and deeper levels of meditation resulting in decreased theta and higher alpha. This illustrates a complex, inverse relationship of brainwaves depending on meditation depth (Katyal & Goldin, 2021). This represents not only the nuances in measuring meditative states, but also how different meditative depth levels will affect the neurological signature of meditation. Further complications to this trend include a 2016 paper on creative flow, which was analyzed in content analysis and resulted in no correlation with alpha and beta waves. This clearly contradicts this research paper's trend of increased alpha oscillations across meditation and creative flow (Wollseiffen et al., 2016).

Limitations & Implications

As mentioned throughout this research paper, the main limitation is the empirical heterogeneity and scarcity evident in the neural basis of meditation and creative flow. These methodological shortcomings were necessary in order to pursue a more holistic, broader scope of research analysis, especially as neuroscientific research calls for more qualitative reviews determining potential trends between meditation and creative flow (Sonnenburg & Primus, 2020). These trends, however, cannot solidify neural correlates for the optimized human brain due to the inadequate amount of neuroscientific literature available for both conscious states. The trends aligned for both conscious states are further limited by the disproportionate number of papers on creative flow compared to meditation, and the majority of inconclusive results. Therefore, future researchers can further saturate empirical work on creative flow, and on meditation *and* creative flow in controlled conditions together, to decrease the heterogeneity in empirical work.

In conclusion, despite these limitations, comparing the neural correlates of meditative and creative flow has demonstrated four potential trends that require further investigation in order to identify unifying neurophysiological processes for the flourishing human brain. These four trends are summarized below:

1. Increased activity in the DLPFC, parietal regions, and theta and alpha oscillations represent enhanced attentional regulation
2. Decreased activity in the AMY represents enhanced emotional regulation
3. Increased activity in the VLPFC represents enhanced attentional and emotional regulation
4. Deactivated DMN (especially mPFC and PCC regions) and activated CEN represent enhanced attentional regulation

Overall, these findings help address the gap in neuroscientific literature, as illustrated in the 2020 article's section "Gaps In Flow Research," which calls for a neuroscientific comparison between two positive brain states in order to identify any key trends in existing empirical literature (Sonnenburg & Primus, 2020). The four trends this research paper has identified support the significance of emotional and attentional regulation in order to potentially attenuate mental health disorders and yield positive health outcomes. This has major implications specifically for individuals struggling with chronic depression or attention deficit hyperactivity disorder (ADHD), which are associated with underdeveloped PFC regions (Straub et al., 2019; Vaidya, 2011). Since specific regions that meditation and creative flow actively engage are the DLPFC and VLPFC, reaching these brain states can help attenuate these mental health disorders with engagement over time. A continued engagement in these interventions can also invoke positive physical and mental health habits, which have been proven to successfully replace harmful habits, such as smoking and substance abuse (Schwartz, 1992; Wielgosz et al., 2019). Experiencing these long-term enhanced emotional and attentional outcomes can also apply beyond clinical populations, as these positive health outcomes can optimize one's brain functioning, experiences, and overall human flourishing. Hopefully, these findings can encourage a diverse set of populations with diverse interests to engage in meditative practices or creative flow activities and implement these practices in order to care for their emotional and mental wellbeing.

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