# Deep Breathing as a Tool to Promote and Enhance Flow State

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## Abstract

This research was conducted to investigate if voluntary regulation of breath can facilitate entering or enhancing flow state. Deep breathing, also known as yogic or diaphragmatic breathing, consists in consciously and actively using the diaphragm to increase the inflow and outflow of air, as well as to decrease the frequency of each breathing cycle (Russo et al., 2017), as a potential flow state promoting or inhibiting tool via vagus nerve stimulation and other physiological mechanisms. We hypothesized that, since deep breathing is an efficient way to promote relaxation, oxygenate the body, and reduce stress, it can be used as a simple, free, and actionable tool to create an optimal mental state when the sympathetic activity is too intense to enter or maintain flow (i.e. by a challenge perceived as superior to the skill), as well as a post-flow aftercare technique to limit the negative effects of the physiological arousal state, such as increased sympathetic nervous system arousal, which could potentially lead to stress-related cardiovascular effects (Murch et al., 2020) and high cortisol (a stress hormone) levels (Peifer et al., 2015).

**Keywords:** Flow State, Deep Breathing, Peak Experience

## Introduction

The term “flow state” was coined by the psychologist Csíkszentmihályi in his groundbreaking book *Beyond Boredom and Anxiety* (Csíkszentmihályi, 1975). The author defined flow as “a state in which people are so involved in an activity that nothing else seems to matter; the experience is so enjoyable that people will continue to do it even at great cost, for the sheer sake of doing it” (p. 71). Flow state is a pleasant state of absorption of a person during an optimally challenging activity. During flow, time perception is typically distorted, and self-referential thoughts fade out of the mind as a subject shows undivided attention to a limited stimulus field. This experiential state occurs when skills of a person and demands of the activity are in balance, and both above average (Csikszentmihalyi & LeFevre, 1989; Rheinberg, 2008).

Csíkszentmihályi, a distinguished Professor of Psychology and Management at Claremont Graduate University, previously holding the position of chief of the department of psychology at the University of Chicago, was one of the world’s leading researchers in positive psychology, a branch of the field focused on optimizing behaviors for success. He wanted to investigate flow state as a possible antidote to the post-World War II existential anguish that many experienced at that time, as most people dealt with loss of family members, jobs, homes, and the overall sense of safety and purpose. He developed a questionnaire on activities that produce the deepest enjoyment and the greatest satisfaction and, after analyzing the data, he concluded that when people are highly concentrated and optimally challenged while being in control of the action has the most positive impact even when the tasks are lacking external rewards. Csikszentmihalyi and LeFevre (1989) called the flow experience the ‘‘optimal experience’’ and later mentioned happiness as part of flow. This idea was also reinforced in a later article, which the authors stated: ‘‘Flow is defined as a psychological state in which the person feels simultaneously cognitively efficient, motivated, and happy’’ (Moneta & Csikszentmihalyi, 1996) (p. 277). This is relevant because, according to Csikszentmihalyi, most people spend more than half their time in a dissatisfied state of mild anxiety and mind wandering, particularly during their unstructured leisure time. “Structuring time around building a sense of autonomy, mastery and purpose in work and leisure activities lead to the most significant increase in overall happiness” (Csikszentmihalyi, 1975).


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## A Historical Perspective on Flow

Prior to Csíkszentmihályi, Maslow (1954) investigated the concept of “peak experience,” described as “a moment of awe, ecstasy, or sudden insight into life as a powerful unity transcending space, time, and the self” (p. 160). In his book *Motivation and Personality*, Maslow studied exemplary “self-actualized” people and identified some of their common traits. One of them is the ability to have “peak experiences,” such as Albert Einstein sailing to the middle of Lake Geneva to gaze at the stars, in wonder. Maslow proposed that this type of experience helped Einstein “crack the code” of the universe. He found that peak experiences were more likely to occur for individuals in their pursuit of self-actualization, their internal drive and the hyperfocus that come with it representing its own reward and less likely in individuals who are unmotivated and non-striving. Following his research on self-actualized individuals, Maslow coined the term “positive psychology" in *Motivation and Personality*, in contrast with the psychological approaches focused on pathologies. Maslow believed that psychology's preoccupation with disorder and dysfunction lacked an accurate understanding of the human potential and he emphasized the importance of studying multiple aspects of an individual, especially those related to their potential for growth.

Flow was probably achieved in shamanic trace or other types of mystic ecstatic practices across millennia. Ancient Greeks believed that being divinely inspired was foundational for any act of creation. The seven muses, ruled by Apollo, the god of medicine, music and divine guidance, were invoked before artistic endeavors in order to achieve divine inspiration - θεόπνευστος - theópneustos (Theos - God and pneuma - dynamic movement of air or breath, literally meaning “God-breathed” or “divinely inspired”). It is worth mentioning that the word “music” derives from the Greek word “μοῦσαι” - muses - which were thought to be goddesses who preside over the process of creation in arts and sciences, bringing humans remembrance of joy and forgetfulness of pain.

Dao De Jing, a sacred text from Ancient China, attributed to Lao Tzu, introduced the concept of “wu wei” 無爲, literally meaning "inexertion," "inaction," or "effortless action," being at one with an activity performed in a state of profound plasticity: "That which offers no resistance, overcomes the hardest substances/. Those that have no substance can penetrate the

solid./ Therefore I know non-action wins success./ Teaching without words,/ Succeeding without action,/ These are understood by the very few" (Lao Tzu, 2020, ch. 43).

Flow was probably experienced by Sufi mystics when they entered “hal” - a state of ecstasy in which the divine became manifest. During the Islamic golden age, when the Islamic world leaped ahead in mathematics, poetry, and the sciences, building on a foundation of Greek and other ancient texts translated into Arabic, many innovators freed themselves from authorship to “merge with the divine” through their art and inventions (Frishkopf, 2003). With the advent of the Renaissance, arts and sciences started to flourish in Europe and extraordinarily gifted individuals in flow such as Michelangelo, Leonardo Da Vinci, or Giordano Bruno helped shift Western values towards a freer and more open-minded view of the world in an ultra-conservative environment strictly controlled by the church.

## Method

For the first part of the study, we reviewed literature that described psychological and neurobiological models of flow. Our search was not intended to be exhaustive, but included the most recent studies of Google Scholar, Web of Science, and PubMed. Key words used to retrieve relevant studies included “characteristics of flow,” “neurobiology of flow,” and “flow and sympathetic nervous system,” and “flow and vagus nerve.”

For the second part of the study, we reviewed the literature on vagus nerve and breathing and breathing and flow. Then we conceptualized a model of voluntary control of breath to optimize flow based on the neurobiological models of flow found in the first part of the study. Our hypothesis is that deep breathing could be used as a simple and efficient way to promote relaxation when the sympathetic activity is too high to enter or maintain flow (i.e. by a challenge perceived as superior to the skill), as well as in the post-flow aftercare, to limit the negative effects of the physiological arousal state, such as increased sympathetic nervous system arousal, which could potentially lead to stress-related cardiovascular effects (Murch et al., 2020) and high cortisol (a stress hormone) levels (Peifer et al., 2015). We hope this hypothesis will be tested in a future study.

## Results

In the original flow model, described by Csikszentmihalyi in 1975, flow occurs in the goldilocks area of the balanced challenge/skill ratio (Fig. 1, left-hand): in this state of balance, one feels both


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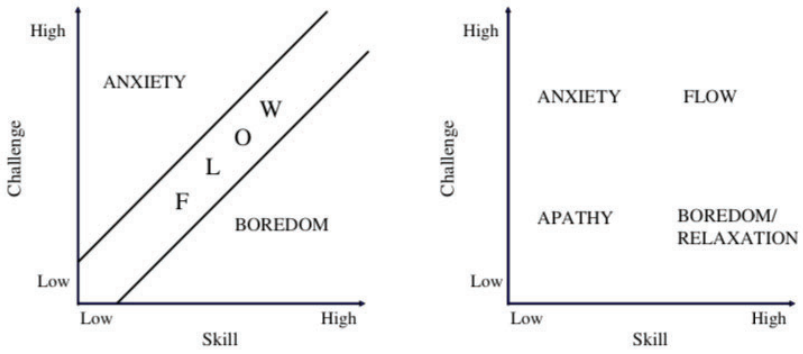
optimally challenged and confident that the task to fulfill is under control. When a challenge is too low for the skill, boredom arises; when the challenge surpasses the skill, anxiety arises. Due to theoretically inconsistent results, this model was reformulated by Csikszentmihalyi and Csikszentmihalyi (1988). The revised model (Fig. 1, right-hand) proposes that flow is experienced only when challenge and skill are both high. This model is sometimes referred to as the ‘‘four channel model,” or quadrant model.

**Fig. 1 Original Flow Model (left-hand side; Csikszentmihalyi 1975) and reformulated quadrant Model of Flow (right-hand side; Csikszentmihalyi and Csikszentmihalyi 1988)**




However, even this model presents conceptual challenges. First of all, not everyone has the same propensity to experiencing flow states. Individuals intrinsically motivated such as creative individuals and high achievers have a higher propensity to flow, described by Csikszentmihalyi (1975, 1990) as having an autotelic personality. On the other hand, neurotic personality types, those with high self-criticism and those experiencing high levels of stress and anxiety have a lower one (Ullén et al., 2012). Empirical evidence reported by Moneta and Csikszentmihalyi (1996) also pointed to other individual differences. They found that the balance of challenge and skill does not go hand in hand with high values in the flow indicators such as high concentration for all individuals. When looking at the achievement motivation research, the individual differences could easily be explained by differences in the achievement motive: the assumption that some people experience balance as positive and some as negative forms the core of the risk-taking model of Atkinson (1957); Brunstein (2008). According to this model, highly achievement-motivated individuals prefer tasks of medium difficulty (e.g. tasks in which the balance of difficulty and skill is present). In contrast to this hope of success-aspect of the achievement motive, individuals with a strong motive of fear of failure even avoid tasks of medium difficulty. The assumption that the achievement motive moderates the effects of the

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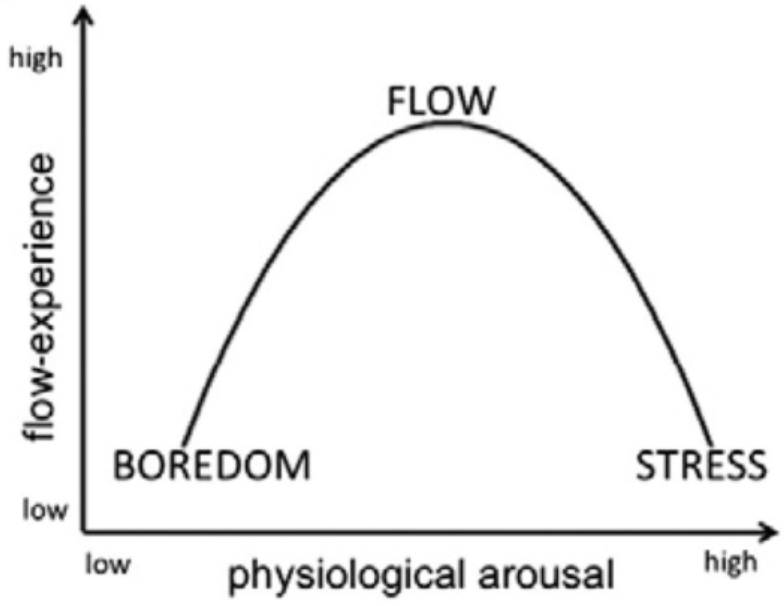
balance seems even more plausible considering that ‘‘the flow model may be more applicable to social contexts and activities where achievement plays a dominant role’’ (Moneta & Csikszentmihalyi, 1996).

Recent researchers started to study flow not only based on the one component (the skill-challenge ratio), evaluated based on the questionnaires in the Appendix, but also on physiological indicators such as heart rate variability and cortisol levels. From a neurobiological perspective, flow is a state of relaxed but heightened arousal marked by a "yin-yang" balance of the two branches of the autonomic nervous system - the sympathetic nervous system with its "fight-or-flight" mechanism and the parasympathetic nervous system, with its "rest-and-digest" mechanisms. Anxiety and stress are states of high physiological arousal, as indicated by increased sympathetic nervous system and HPA-axis activation; boredom and relaxation are characterized by low physiological arousal.

**Fig. 2 The relationship of flow-experience and physiological arousal is an inverted u-curve (Peifer, 2014)**





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Peifer et al. (2014) found that the highest flow values occurred when high parasympathetic activation was combined with moderate sympathetic activation, which supports their hypothesis of an inverted u-shape relationship between flow and sympathetic activation, where more physiological arousal is associated with reduced flow. These results contradict findings of Keller and colleagues, who found a negative relationship between flow and parasympathetic activation (Keller et al., 2011). Peifer et al. concluded that flow is associated with moderate forms of arousal that are experienced as challenging and it is reminiscent of moderate and positive forms of stress, known as "eustress."

A study on transcutaneous stimulation of the vagus nerve during flow showed that direct stimulation of the vagus nerve during flow state resulted in inhibitory effects on maintaining flow (Colzato et al., 2018). This undoubtedly shows that the vagus nerve is modulating flow. The vagus nerve is part of the parasympathetic nervous system, which is responsible for a vast array of crucial bodily functions, including control of mood and stress response. Thus, this study provides evidence for a positive relation between flow and parasympathetic activation.

One key physiological mechanism of the flow is the locus coeruleus - norepinephrine system, which regulates task engagement through different modes of norepinephrine release. This system is crucial for maintaining the balance between task engagement and disengagement, with flow states being associated with intermediate levels of arousal, fitting an inverted U-shaped relationship.

Additionally, electroencephalogram (EEG) studies have shown that flow states are associated with increased frontal theta activity and moderate frontocentral alpha rhythms. These EEG patterns suggest high levels of cognitive control and immersion in the task, without excessive working memory load (Katahira et al., 2018).

The interaction of large-scale brain networks also plays a significant role. The Default Mode Network (DMN), Central Executive Network (CEN), and Salience Network (SN) are involved in the strong task engagement and low self-referential thinking typical of flow. Dopaminergic and noradrenergic systems mediate the intrinsic motivation and positive mood states associated with flow (Van der Linden et al., 2021).

## Discussion

Strategic deep breathing during the flow activity at intervals when the actor feels a decrease in performance could relieve some of the stress and anxiety that hinders entering and maintaining

flow. Vagal activation, resulting in an increase in dopamine levels in the brain, leading to a greater sense of pleasure, along with overall increase in body oxygenation, would support the performer's effort to meet the challenge perceived as overpassing the skill. Deep breathing has been shown to influence various physiological parameters that are closely linked to the flow state. For instance, deep breathing can modulate cerebral circulation and enhance cerebral blood flow, as demonstrated by Li (Li et al., 2023). This improved cerebral circulation can facilitate cognitive functions and mental clarity, which are essential components of the flow state.

Additionally, deep breathing has been found to affect the autonomic nervous system by promoting parasympathetic activity and reducing sympathetic activity. This autonomic modulation can lead to physiological relaxation and improved heart rate variability, as discussed by Noble and Hochman (2019). Enhanced heart rate variability is associated with better emotional regulation and cognitive performance, both of which are critical for achieving a flow state.

Deep breathing has been proven to reduce stress in adults (Hopper et al., 2019). According to a January 2023 study published in Cell Reports Medicine (Balban et al., 2023), daily 5-minute breathwork and mindfulness meditation can both improve mood and reduce anxiety. The researchers found that breathwork may be more effective than mindfulness meditation for improving mood and physiological arousal. In particular, the researchers found that cyclic sighing, a type of breathwork, was the most effective at improving mood and reducing respiratory rate. The researchers also found that both breathwork and mindfulness meditation can reduce negative emotions, such as anxiety.

Also, researchers have shown that deep breathing can help athletes improve their performance by helping them focus, reducing anxiety, and increasing oxygenation (Hunt et al., 2018). Moreover, deep breathing can synchronize brain rhythms, particularly in the alpha range, which are associated with a relaxed yet alert state of mind. Hsu et al. (2020) demonstrated that slow-paced inspiration could organize cortical phase activity in a structured manner, potentially facilitating a state of focused attention and relaxation.

Future studies could help identify a simple deep breathing protocol to be implemented at intervals to modulate the challenge/skill ratio (i.e. when performance is perceived to decrease due to stress), determining specifics of the timeline when this protocol could be used to enter or maintain flow. Post flow, deep breathing could help switch autonomous nervous system states


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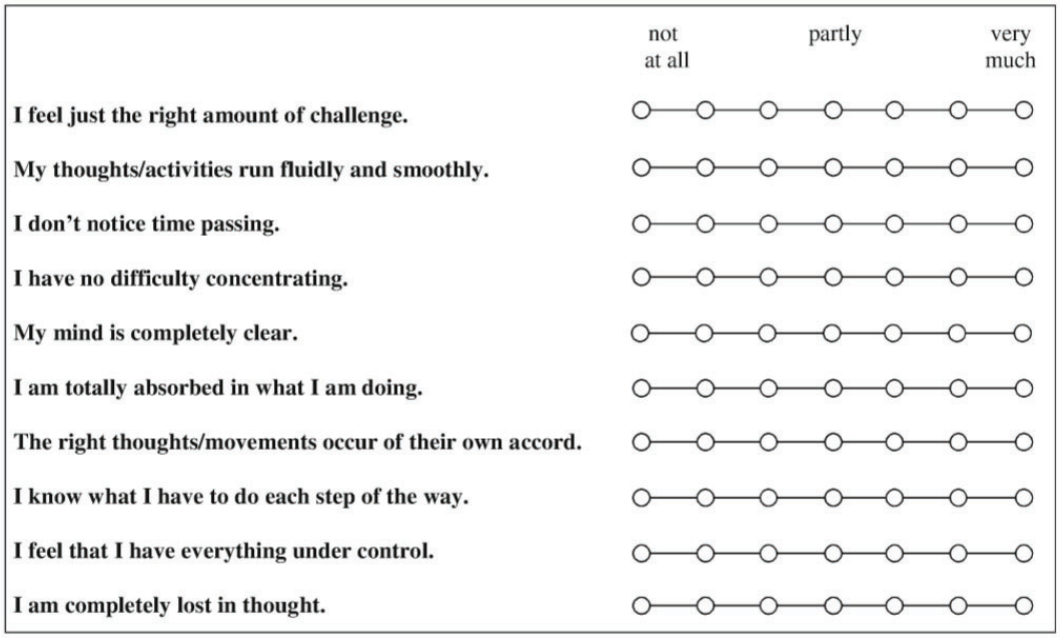
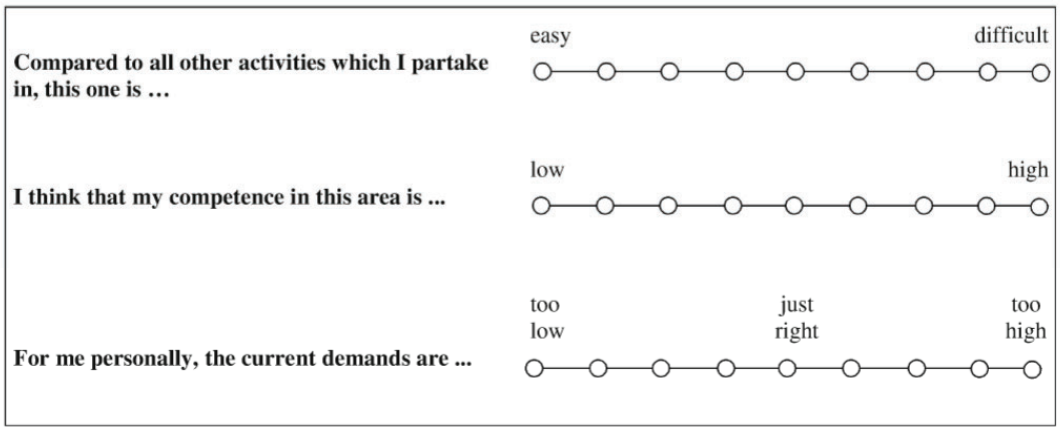
from relative sympathetic dominance to parasympathetic (rest and digest) state. Cortisol levels and heart rate variability could be measured in a future study comparing a deep breathing post flow group with a control group. Post flow, deep breathing could help to reduce stress and return the heart rate to a relaxed state, especially if the flow activity included a physical dimension, such as sports or other types of embodied performance requiring physical effort.

## Conclusion

Flow is a complex mental state, and current research is still being done to uncover all its neurophysiological correlations. Multiple neurocognitive parameters have to coexist to create the optimal conditions for flow: full task engagement, reduced self-referential thinking, a sense of control, and effortless attention. These translate from a neurophysiological standpoint as the activation of the locus coeruleus - norepinephrine system, specific electroencephalogram (EEG) patterns, the interaction of large - scale brain networks, and characteristic cardiovascular and respiratory changes. While there is no shortcut for entering or maintaining flow state, and it is obvious that flow cannot be achieved like flipping a switch, implementing simple tools such as deep breathing might help performers, including musicians, increase their productivity, improve their performance, minimize the effects of physiological arousal and increase their overall well-being. There is sufficient evidence that deep breathing can modulate flow state by enhancing cerebral circulation, promoting autonomic balance, and synchronizing brain rhythms, thereby creating an optimal physiological environment for achieving flow. Future clinical studies could help clarify if and how deep breathing could be implemented to modulate the challenge/skill ratio during flow and as a post flow aftercare technique.

## Appendix - Flow Short Scale (Engeser & Rheinberg, 2008)





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