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Review Article

Outline of a Model of Progressive Flow Absorption

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Abstract

Flow is a state of profound task-absorption and intense concentration that creates a sense of oneness with the activity. Flow has been traditionally described as both an "experiential" phenomenon and an "optimal experience". The present study outlines a flow model that disentangles flow states that are cognitively productive, and hence "optimal", from flow states that are not, thus constituting an initial step toward studying flow objectively, in terms of its underlying neural and cognitive processes, and not simply as a subjective phenomenon. The model provides a multi-layered framework designed to explain the mechanism behind achieving immersive flow states during goal-oriented tasks. It involves the interplay of two cognitive systems, System 1 (the faster, automatic, and subconscious processing) and System 2 (the slower executive control-based processing constrained by active maintenance/working memory limits) and introduces the concept of thresholds that moderate the dominance of each system. The model highlights the role of information gaps, prediction, and reward in driving the immersion process, and outlines the progression from the outer to most inner ring – immersive flow – through four key thresholds, also contemplating various possibilities of failure in achieving flow. The model predicts the possibility of augmenting cognitively productive flow states through experimental manipulations aimed at enhancing goal and time perception when reaching immersive flow. The opportunities and challenges of testing, modifying, and refining the model are discussed.

Keywords: Flow immersion model; Balance between challenges and skills; Concentration; Absorption; Self-consciousness; Goal setting; Clear feedback; Time perception; Information gap; Threshold

Introduction

Flow is a state of profound task-absorption and intense concentration that creates a sense of oneness with the activity [1]. Later, flow was conceptualized as a state, a broad disposition, and a domain-specific disposition [2]. Flow is believed to have a positive relationship with enhanced performance in physical [3] and cognitive [1] domains, leading to benefits ranging from improved performance [4] to enhanced psychological wellbeing [5]. Initially defined by [1], flow consisted of three dimensions: (1) focused concentration on the present activity, with attention centered on a narrow stimulus field; (2) merging of action and awareness; and (3) loss of self-consciousness. Over time, the number of flow dimensions expanded to nine [3,6]. These dimensions include: (4) control over one's actions; (5) an intrinsically rewarding experience (referred to as "autotelic"); (6) clear feedback from the activity; (7) a dynamic balance between challenges and skills; (8) clear proximal goals; and (9) a loss of time-awareness or time acceleration. Presently, there is a consensus that dimensions 1 through 5 constitute flow, dimensions 6 through 8 are its antecedents [7,8], while dimension 9 is considered an additional indicator of concentration [9].

Flow has been observed across various cognitive and physical tasks and professions [10]. It appears to be largely independent of the complexity of the task itself, occurring naturally when the perceived skill-to-challenge ratio is balanced. However, existing evidence supporting the link between flow and cognitive productivity has been mainly correlational or qualitative. For instance, a ten-year follow-up study found that executives felt five times more productive in flow compared to non-flow states [11]. Notably, no empirical studies have investigated whether flow states increase cognitive productivity regardless of how the flow state is achieved. This suggests that flow research has implicitly assumed that "if it feels like flow, it must be flow, and thus, an optimal experience."

This assumption may be attributed to early pioneers who described flow as both an "experiential" phenomenon and an "optimal experience" [1]. These characterizations have unintentionally created a dogmatic view of flow research. There seems to be an unwavering reluctance to challenge these central tenets, even when neuropsychological techniques offer opportunities to move away from a subjective-experiential paradigm and quantitatively test the objective-economic usefulness of flow.

To overcome the current impasse in flow research, it is crucial to develop models of the stage processes involved in flow, grounded in recent advances in neuropsychology. [12] proposed that flow is achieved through an optimization process, where absorption in the task increases while isolation from the sensory and social environment grows. According to their perspective, as this process unfolds, task absorption reduces the rate at which feelings and emotions enter consciousness. From this dynamic standpoint, whether a flow state is an “optimal experience” depends on whether it was attained through a process of progressive task absorption, and if so, its optimality needs to be tested in a variety of problem-solving tasks that allow for a valid and reliable measurement of performance. The following section outlines a model of progressive flow absorption that is grounded in neuroscience, identifies key factors supporting progressive absorption, and is testable by manipulating experimentally the hypothesized key factors.

Discussion

The Flow Immersion Model is a stage process breakdown of the mechanism responsible for immersion when there is a goal and an active toward-goal task. It assumes that the engine motivating action is an implicit drive to reduce uncertainty by closing perceived information gaps. It makes a number of distinctions. It primarily highlights that there are two cognitive systems at play, System 1 and System 2. System 1 can be considered an automatic processor where its cognitive function does not create conscious awareness; it is faster than System 2. System 2 can be considered an executive control processor where its cognitive function does create conscious awareness; it is constrained by active maintenance/working memory limits. The model adds to this by introducing the concept of thresholds, which serve to moderate the dominance of either system.

The model proposes a skill/challenge differential mechanism that moderates the dominance of System 1 and System 2 and underpins the implicit drive to recursively chain information gap cycles into an immersive flow state. Specifically, it posits a scenario where the current challenge creates an information gap, which can be closed by an unconscious (System 1) prediction-action-feedback loop. Experientially this would be categorised as a skill/challenge “imbalance”; however, defining it as a “differential” introduces the implicit drive to reduce uncertainty by closing perceived information gaps. The presence and strength of that implicit drive, together with the perception of an information gap, are posited to trigger the immersion process. Crucial to the emergence of immersive flow is that any attempted closure of an information gap: (a) creates feedback that meets a non-conscious, novelty-salience threshold, and (b) opens a new, chained information gap that also meets a non-conscious, novelty-salience threshold.

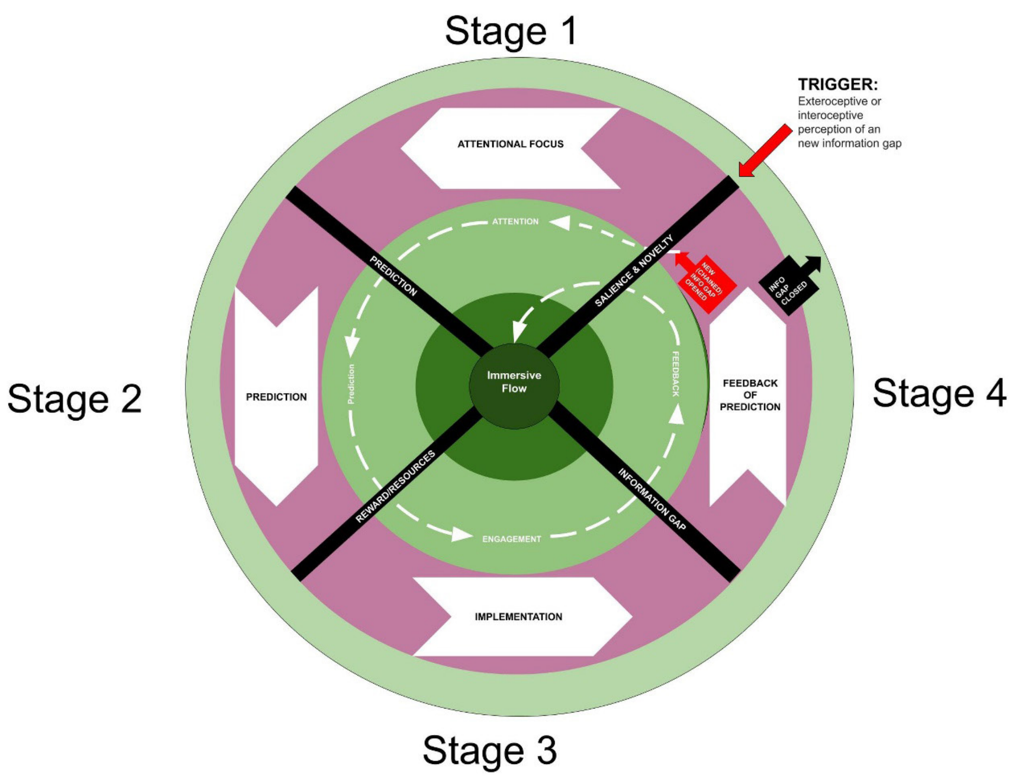

Figure 1: A graphic representation of the Flow Immersion Model.

Figure 1 illustrates the information gap-prediction-outcome cycle. Proceeding from outer to inner rings:

1. The outer green ring represents System 1, which sustains attention and performs background scanning, both exteroceptive and interoceptive, of possible information gaps.

2. The next and pink ring represents System 2, which sustains conscious cognition and is mainly dominant; in particular, it is responsible for goal setting relative to the task and makes intensive use of working memory.

3. The three progressively darker inner green rings represent the working of System 1 at progressively lower levels of conscious awareness and progressively higher levels of dominance (Figure 1).

The process to reach the state of immersive flow begins in the outer green ring representing System 1, and proceeds through the inner pink ring representing System 2, toward the most inner green ring subject to the outcome of four key thresholds represented as black barriers. In each ring, the thresholds will determine whether the process will continue in that ring, will return to the outer ring, or will advance to the inner ring. The process is represented counterclockwise, proceeding from stage1 to 4.

The salience and novelty threshold refers to how the original information gap is perceived, as well as what competence the problem solver has to evaluate it. If the outer ring of System 1 perceives an information gap, it will activate System 2, with three possible outcomes:

1. The information gap lacks salience and/or novelty with either unconscious incompetence or conscious competence; this would lead out of the spiral, back into the outer System 1 ring.

2. The information is perceived as salient and/or novel with conscious competence; this would keep the process in the System 2 ring, sustaining attentional focus until an unconscious competence is achieved.

3. The information is perceived as salient and/or novel with unconscious competence; this would lead into the inner System 1 ring.

The prediction threshold refers to whether one predicts that the information gap can be filled. A negative answer will lead back to the outer ring, whereas a positive answer will keep the process in the current ring, focusing on designing a possible solution.

The reward/resources threshold refers to the value of the predicted reward in case of success relative to the cost of implementing a possible solution to the problem and the available resources. There are three possible outcomes:

1. The reward is less than the cost with either conscious competence or conscious incompetence; this would lead out of the spiral, back into the outer ring.

2. The reward is greater than the cost with either conscious competence or conscious incompetence; this would keep the process in the current ring, implementing the designed solution in order.

3. The reward is greater than the cost with unconscious competence; this would lead into the inner ring.

Finally, the information gap threshold refers to the evaluation of whether the implemented action closed the original information gap. If the information gap is not closed, processing will continue in the same ring, assuming it continues to meet the conditions set by the other thresholds. If the gap is closed, there are two possible outcomes:

1. No new, chained information gap is opened.

2. A new, chained information gap is opened.

The first outcome would lead to a return to the outer ring. The second outcome would open two possibilities:

1. The new gap does not meet the novelty-salience threshold.

2. The new gap meets the novelty-salience threshold.

The first outcome would lead to a return to the outer ring. The second outcome would lead to diving into the inner ring.

Crucial to the emergence of immersive flow is that any closure of an information gap can open a new, chained information gap that also meets a novelty-salience threshold, thus creating an immersive spiral. By analogy, the situation resembles that of a series of interconnected doors, each leading to a new room with novelty-salience rewards. When entering a room, one is rewarded with a novel and salient treasure; and as the door behind closes and the door to the next room opens, one is tempted to walk into the next room to earn a new reward. The cycle continues, as each closure brings both a reward and a new mystery, driving one deeper into the immersive experience.

It is hypothesized that different stages are supported by particular neuropsychological patterns. Starting with the antecedents of flow and proceeding toward the state of immersive flow, a propositional model is posited to support the initial setting of clear goals, whereas a procedural model guides the process of taking action toward the goal and gathering immediate feedback. The process of achieving a balance between skill and challenge of the activity will require a sub-threshold information update of both the propositional and the procedural models. When the absorption process begins, concentration deepens, self-consciousness fades, and the problem solver becomes one with the activity; this progressive process is hypothesized to require attention circuit blocks (via the basal ganglia and thalamus gate) of non-salient information (e.g., temporal markers) from mechanisms that support conscious awareness, thus reducing the active maintenance workload. The absorption is expected to become cognitively productive if the goal objective display frequency and temporal cost display increases, thus augmenting attention and working memory. As such, the model implies that cognitive performance can be enhanced by controlling or externalizing non-task/goal salient cognitive intensive processes that would exceed the novelty-salience thresholds and push the problem solver from System 1 to System 2, thus not breaking the immersion spiral.

The model departs from previous flow models in that it introduces a distinction between two different types of immersive flow. The state of immersive flow defined to date involves loss of time perception, but, from the perspective of the new model presented here, this may not yield the peak of cognitive productivity. The new model posits that to achieve productive cognitive flow one will need to be keenly perceptive of goal and time information to enable the necessary reward/resources calculations. This implies that states of immersive flow accompanied with goal and time perception will tend to yield higher levels of cognitive productivity than states of immersive flow without goal and time perception. Using an analogy, a chess player who is keenly aware of the time limits set for the game and doses the thinking time of each move according to a time-strategic plan will be more likely to win than a chess player of equal ability who is fully immersed in the probing of all possible variants and combinations.

The model predicts the possibility of augmenting cognitively productive flow states through experimental manipulations. In particular, the role attributed to goal and time perception in immersive flow can be tested experimentally by monitoring the problem-solving journey and providing synchronous feedback on goal and time right in the full immersion phase. If the model is correct and a minimally intrusive feedback feeding is devised, then such intervention should result in higher cognitive performance relative to a control condition.

The proposed model converges with three conceptualizations of flow and contributes additional insight to each. Firstly, [13] developed the hypofrontality theory to explain the seemingly effortless information processing that characterizes flow. The theory postulates the existence of two neural systems. The explicit system exerts the higher cognitive functions grounded in the frontal and medial temporal lobes, whereas the implicit system exerts the skill-based functions grounded in the basal ganglia. The former fosters cognitive flexibility, whereas the latter fosters efficiency. Based on the distinct functions of the two systems, flow would be a period during which a skill that has been acquired, practiced, and consolidated in the implicit system is deployed with no interference from the explicit system. The temporary suppression of communication between the frontal lobe and other regions of the brain can explain a number of components of flow, such as the loss of self-consciousness and time-awareness. The Flow Immersion Model contributes additional layers to explain the progressive shift from System 1 to System 2, as well as the uncertainty nodes caused by the four key thresholds.

Secondly, [14] proposed and successfully tested a cusp catastrophe model of flow. The key feature of the model is the presence of a bifurcation edge, which is the source of instability. When skill is greater than challenge, there is no cusp, so that progress toward flow is characterized as a smooth, progressive process. When instead challenge is greater than skill, there is a cusp that makes progress toward flow turbulent and unstable, also yielding a high risk of failure. The model posits that it is the resolution of the tackled problem in the cusp area that results in flow, and [15] suggested that authentic flow (i.e., cognitively productive flow) can only be achieved through the cusp (i.e., information gap) area, whereas a state of deep absorption achieved through the smooth, non-cusp area is not flow. The Flow Immersion Model contributes additional layers to explain how the information gap, which occurs when challenge is greater than skill, is solved, as well as the various ways in which the process may abort.

Lastly, [16, 17] developed the concept of metacognitions about the flow state, representing one's awareness of and beliefs about the flow state and its consequences, and about strategies for achieving and maintaining flow. Two flow metacognitive traits can be validly and reliably measured: (a) beliefs that flow fosters achievement, and (b) confidence in ability to self-regulate flow. Interestingly, preliminary evidence indicates that only the latter, representing the self-regulatory component of flow, predicts intensity of flow. Individuals with high confidence in the ability to self-regulate flow may be using flow as an adaptive way of coping with challenging situations. This perspective opens the possibility of investigating individual differences in the self-regulation of flow through the lens of the Immersion Flow Model. In particular, it will be relevant to assess whether individuals with high flow metacognition make a more strategic use of flow by remaining perceptive to goal and time when reaching flow immersion.

Conclusion

The Flow Immersion Model constitutes an initial step toward studying flow objectively, in terms of its underlying neural and cognitive processes, and not simply as a subjective phenomenon. The model allows a distinction between flow states that are cognitively productive, and hence "optimal", from flow states that are not. The model suggests the possibility of enhancing cognitive performance in flow states in experimental conditions by monitoring the process and providing unobtrusive feedback on the goal and time when a study participant enters the state of immersive flow. However, the model is more complex than any prior model of flow, and hence its excess complexity needs empirical justification. Moreover, the proposed experimental testing strategy faces the challenge of devising a monitoring and intervention software platform that is minimally disruptive for the study participants. Despite its limitations, the proposed model constitutes a useful tool for thought experiments leading to specific hypothesis testing. To assess the validity and usefulness of the model will require extensive empirical testing, modification, and refinement.

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Conflict of interest

None.

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