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Commentary:

In the Zone: A Biobehavioral Theory of the Flow Experience

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Introduction

In the last thirty years, an extensive literature has accumulated that has established the existence of a state of pleasure, well being, and increased cognitive efficiency that occurs when one is performing an absorbing task. This flow state occurs in a perceptual channel or 'zone' that reflects a matching of demand to skill, and frequently occurs in creative, sporting, or other circumstances that demand total attention. Explanations for flow primarily consist of a host of inferred mental states that are ungrounded to actual bio-behavioral processes. In particular, the somatic, musculo-skeletal, and neural concomitants of the flow response have been scarcely investigated, and have never been systematically addressed. The purpose of this article is to integrate current research in learning theory and neuro-psychology with these observations, and to provide a synthetic theory of the flow experience that will account for all manifestations of the experience, and provide clear and testable predictions related to its elicitation and control.

The Flow Experience

In the early seventies, the psychologist Mihaly Csikszentmihalyi discovered from the basis of thousands of interviews a common subjective experience of pleasure, interest, and even ecstasy that was derived from activities that perfectly matched one's skills with the demands for performance. Rock climbers, musicians, chess players, surgeons all reported this "flow" state when their activities possessed this perceptual structure (Csikszentmihalyi, 1977), and subsequently reported a greater interest in these tasks as a result of this experience. Csikszentmihalyi defined the flow response as a "holistic response" or an "optimal state of experience is one in which there is order in consciousness." "This happens when psychic energy, or attention, is invested in realistic goals, and when skills match the opportunity for action." (Csikszentmihalyi, 1990) Flow "provides a sense of discovery, a creative feeling of transporting a person into a new reality. It pushes a person to higher levels of performance, and leads to previously undreamed of states of consciousness. In this growth of self lies the key flow activities." "Potentially negative experiences can be transformed into flow by 1) setting clear goals to strive toward, 2) becoming immersed in the activity chosen, 3) paying attention to what is happening, and 4) learning to enjoy immediate experiences." The flow state has been defined as "an intrinsic reward for participation in an activity (Csikszentmihalyi, 1977), as an optimal state that occurs when there is a balance between the perceived challenges of a situation and a person's skills or capabilities for action (Csikszentmihalyi, 1990), and as a centering of attention on a limited stimulus field (Webster, Trevino, and Ryan, 1993). Flow is also characterized by a heightened sense of playfulness (Webster and Martocchio, 1992), self control (Ghani and Deshpande. 1994), increased learning (Canter, Rivers and Storrs, 1985), and increased positive subjective experiences (Csikszentmihalyi, 1997). In keeping with the implied reality of multiple motivational processes, these definitions scarcely refer to information but rather to mind states such as levels of consciousness, attention, or playfulness or states of intentionality such as intrinsic reward, self control, goal setting, etc.

What is immediately distinguishing about almost all commentary on the flow experience is its thoroughgoing metaphorical content. Flow occurs because psychic energy is invested, consciousness is ordered, undreamed states of consciousness are reached, and when we are immersed into activity. Flow doesn't refer to behavioral, neural, or somatic variables, but to other domains of perceptual experience that reflect disembodied levels of experience. Flow is composed of distinctive rational, perceptual, and emotional domains that follow with each other like the chain of boxes in a flow chart. Thus a

demand/skill match is followed by attention that is followed or attended to by 'senses' of playfulness, self control, enjoyment, etc. All of these different domains act as different segmented psychological faculties. These domains represent different psychological phenomena, and are seen as separate but interacting agencies. Flow is distinctive among motivating processes because it is not only signaled by a perception of a matching of skill and demand, but also incorporates other inferred motivating processes such as hypnosis, play, self actualization, and psychic energy (attention). Indeed, the critical element of purely informative or perceptual events such as the matching of skill to demand seem almost incidental when lost in this profuse list of motivational processes which are incorporated into the flow construct.

In contrast to the profusion of interpretive or metaphorical characteristics of flow, the physiological correlates to flow have been scarcely investigated and have been only generally or partially described, or in the case of somatic and neural responses, not described at all. Indeed, the neural correlates to flow have been reduced to metaphorical representations of the mind that engage hydraulic or electromechanical models that render the mind with cartoonish simplicity. Thus, flow is depicted as the result of the vaguely defined containment, channeling and alignment of emotions, feedback loops, attentional energies and forces, mental "cool" states, or as the tuning of the arousal and inhibition of neural circuitry (Goleman, 1995). More remarkably, there has been no experimental investigation into the nature of the somatic states that parallel flow. Specifically, the visceral and musculoskeletal concomitants to flow have never been examined.

The Need for a Synthetic Theory of Flow

Any scientific theory must be ultimately judged by how well it describes the subject matter it purports to explain. Because it does not account for the physiological correlates of reported feelings of pleasure and absorption, a satisfactory flow theory does not exist. A flow theory must explain and integrate the behavioral, cognitive, and neuro-psychological events that comprise flow experiences. By synthesizing different 'levels' of observations that descend from molar (subjective experience, absorption) to molecular detail (neural processes), fine grain predictions can be made regarding the latency, duration, and scalability of flow, and the underlying physiology of enhanced creativity and reported pleasure.

Behavioral Measures of Flow

Flow occurs when the demands of a task match but to not surpass the skill available to complete that task. This perceptual set, or 'flow channel' represents a class of information that that both elicits and it the object of attentional focus. This information may in turn have normative implications that vary from high to low. From self-reports of individuals, flow seems to scale or increase as the implications of behavior increase. Thus, intense and ecstatic flow experiences are commonly reported among individuals who are absorbed in demanding tasks that have critical implications, such as surgery, mountain climbing, and creative behavior. In contrast, less intense or no flow experiences are reported among individuals who are engaged in absorbing but less critical tasks such as reading, video game playing etc. Besides scaling with the importance of the task, the emotional concomitants to flow occur when an individual anticipates a task that commands total absorption, and subsequently to flow eliciting behavior. For example, Csikszentmihalyi noted that individuals reported flow like states as they prepared for flow producing activities like skiing (Csikszentmihalyi, 1990). Finally, higher behavioral efficiency and creativity have been commonly attributed to the influence of the flow state (Canter, Rivers and Storrs, 1985).

Cognitive Measures of Flow

In addition to these behavioral indices of flow, cognitive measures of flow have focused on one primary variable, namely cognitive absorption or focused attention. The implicit assumption of a corollary and perhaps causal relationship between focused attention and flow follows the pattern of a stimulus-response mechanism. That is, the occurrence of the stimulus event (attention) is followed by an almost reflexive response (emotion). Nonetheless, whether or not this paradigm may be of any practical validity depends upon the status of attention as a definable stimulus event, and the degree to which specific correlations can be drawn between various levels of attention and emotional states.

The important question is whether attention as commonly defined displays the expected attributes of a stimulus event. Certainly, the many definitions that may be given to attention do not provide for a simple answer to this question. For example, Candland (1969) maintains that attention can represent a variety of phenomena, such as general alertness, selective focusing, flexibility in shifting focus, and capacity to sustain focused alertness. In addition, the concept of attention does not reflect on localized process, but is best viewed as a taxonomy for a multitude of processes that modulate the afferent signal from a sensory receptor along its sensory pathway (Hilgard, 1975). Supporting this perspective, the neurophysiological correlates of attention as revealed by a variety of researchers (Hernandez-Peon, Spong, Haider, and Lindsley, 1965; Deutsch and Deutsch, 1963) discredit the implicit judgment that attention represents a stimulus like event. Rather, attentional processes assume the aspect of a homeostatic mechanism that allows certain streams of sensory information to be processed to the exclusion of other incoming information. That is, rather than representing a stream of information that is transmitted through certain afferent and efferent neural passageways, attention represents the process that permits such information streams to be enhanced or diminished.

However, the physiological correlates to focused attention may be inferred from a related experience to flow called meditation. Conditions that elicit focused attention as well as its unique experiential characteristics are generally shared by and may be subsumed under the class of 'meditative' experiences that have been studied far more exhaustively. Pleasant emotional experiences that are characteristic of meditation have long been associated with strict attentiveness to specific stimuli or stimulus classes and seen as a byproduct of that attentiveness (Goleman, 1976). Like flow, meditation has been associated with unique physiological and experiential states (Goleman, 1976, Brown, 1977; Deikman, 1963), but unlike flow, the neurophysiological and somatic correlates to meditation have been exhaustively studied Fenwick (1977),Michaels (1976), Wagstaff (1975), Pagano and Warrenburg (1983), Holmes (1984, 1988), and have been found to represent no unique neurophysiological or somatic state, but are merely relaxation. The fact that meditative experiences represent no unique physiological state calls into question the validity of similar claims that flow is elicited from focused attention, but as has been noted, there are many different varieties of attention.

Albeit the matching of demand to skill demands an absorption in the task at hand, the flow response universally requires the rapid consideration and choice between many cognitive precepts or events. Thus a mountain climber, surgeon, or poet would have to rapidly choose between many variants of each successive behavior or cognitive precept, each of which if chosen wrong could result in a bad fall, a dead patient, or the loss of inspiration. Can rapid attentional set shifting between a cascade of salient cognitive precepts account for flow? Recently, new neuro-psychological evidence has been assembled that suggests that it can.

Neuro-psychological Measures of Flow

Like all behavioral responses, flow is instantiated by neural processes. But what candidate processes exist that can explain flow? A common suggestion is that flow reflects a reduction in brain metabolism, as represented by indices of cortical activity, such as the EEG (Goleman, 1995). In actuality, the cerebral

cortex is enervated, and no manner of direct stimulation, electrical, physical or otherwise results in sensations that would otherwise be reported as pleasurable or painful. On the other hand, direct stimulation of mid brain organelles such as the thalamus, amygdala, etc. commonly evokes sensations of pleasure or pain. The essence of emotion, if referred to the sensations that are at the core of feeling, must engage the activity of mid brain structures as mediated by neuro-chemical processes. Indeed, the cerebral cortex is largely the recipient of emotional influences rather than the generator of various emotional states (Panksepp, 1998). The facts of experience, as represented by the information we constantly perceive both consciously and non-consciously continually integrate higher (neo-cortical) and lower (midbrain) neural processes. In a review of recent findings in neuro-psychological Ashby, Isen, and Turkel (1999) concluded that rapid attentional set shifting between salient cognitive precepts does indeed correlate to feelings of elation and satisfaction, and that the neurochemical processes that enable this shifting also increase cognitive efficiency and creativity. In a similar vein, the behavioristic psychologists John Donahoe and David Palmer (1993) identified cognitive set shifting with dopamine release, and in turn with the concept of reinforcement.

On the behavioral level of description, the selection of a particular environmental behavior relation or cognitive precept can be defined as reinforcement, which on the neural level causes the neurotransmitter dopamine to be liberated in synaptic clefts between coactive pre- and post synaptic neurons (Donahoe and Palmer, 1993). The functional role of dopamine stabilizes active neural representations in the prefrontal cortex (i.e., attention), and thereby protects goal related delay activity against interfering stimuli, (Durstewitz et al. 1999). Dopamine labels stimuli with appetitive value, and may provide advance reward information before behavior occurs (Schultz, 1999). Dopamine also mediates the cognitive effects of pleasant feelings that may be denoted by self reports of pleasure, happiness, or satisfaction (Ashby, Isen, & Turken, 1999).

In particular, mesolimbic dopamine (DA) activity has been conceptualized as a reward signal that marks the importance of perceptual events (Horvitz, Stewart, and Jacobs 1997), and promotes the effective processing of afferent signals simultaneously arriving at the midbrain. A cascade of multiple salient perceptual events would presumably accentuate DA activity and facilitate the switching among alternative cognitive perspectives, and thus enhance decision making and creative thinking (Ashby, Isen, and Turken, 1999). This neuro-chemical activity would not only facilitate the rapid and efficient focusing of the mind on a wide range of images, but would also be frequently interpreted as highly pleasurable. Preliminary confirmation of this has been provided by neuro-imaging studies that demonstrated the increased release of dopamine during activities (a video game) that required sustained shifting of a cognitive set (Koepp, 1998).

Finally, the greater number of stimuli that are associated with a response, the more likely that any given environment will contain some of those stimuli, and hence the response will reoccur and/or persist. This 'over-expectation' effect, or behavioral momentum (Nevin, 1992) would assign a discriminative function to otherwise neutral stimuli that have been associated with the response. Thus, the continuation of an emotional response long after its proximal causes have ceased may be attributed to remaining in the original environmental setting (office, laboratory) of that response. Hence, as an emotional response, flow would also be predicted to have a behavioral momentum, which subjective reports indicates is the case.

However, this analysis becomes a bit more complicated when situations that elicit the sustained release of dopamine are considered. The positive affect caused by unexpected rewards has been attributed to the release of the neuromodulator dopamine, yet dopamine release continues long after dopamine cells have stopped firing (Ashby, Isen, and Turken, 1999). Although dopamine release has been noted to occur up to thirty minutes after the stimulation of dopaminergic systems, it remains unclear how emotional memory or behavioral momentum may facilitate or inhibit the degree and

persistence of the release of dopamine over time.

Because dopaminergic activity derives from mid brain structures, it is not incompatible with other somatic responses that are also activated by perceptual events. For example, if rapid perceptual set shifting is not perceived to be sufficient in itself in achieving an important goal, other somatic responses (e.g. muscle tension) may be signaled that serve as somatic markers that signal other behavioral strategies that may alter how a problem is appraised, but not how rapidly it is appraised. Thus, an individual taking a difficult test would rapidly shift between different perspectives that allow him to resolve test problems, yet may experience mild anxiety that further sharpens or attenuates his focus. Similarly, an individual may experience intermittent feelings of high alertness or high alertness combined with high anxiety, as when one is absorbed in watching an 'exciting' football game. Because dopamine release is not locked in tandem with other somatic responses, and because subjective appraisals map to input from a collection of neural, somatic, and cognitive systems, dopamine alone is highly correlated with but nonetheless cannot be solely responsible for feelings of ecstasy or bliss.

Miscellaneous Measures of Flow

Flow has been linked to reported states of euphoria or pleasure that occur during and after states of prolonged exertion (Jackson and Csikszentmihalyi, 1999). This euphoric state, or 'runners high', is generally attributed to the release of endogenous opiod-peptides, or endorphins, that are the body's natural way of toning down specific pain responses at different levels. As a result of physical stress, endorphin release produces euphoria, respiratory depression, reduced gastrointestinal motility, and analgesia (Rang, 1995). However, the mapping of euphoric states to physical stressors rather than perceptual events (demand/skill match) cannot account for any of the well established behavioral and cognitive correlates to the flow response. Like dopamine, endorphins are opiods, and presumably would elicit similar subjective feelings. However, since they are elicited by entirely different classes of environmental factors the relationship between flow and a runner's high, they are linked only by their relationship to the similar neurochemical changes they share.

A Bio-Behavioral Theory of Flow

Flow does not represent a separate or distinctive mental or physiological state, but is rather the subjective or felt aspect of a consistent and high level of neural activation or arousal that is unaccompanied by other activating somatic states (e.g. muscle tension).

A bio-behavioral theory of flow explains the latency, duration, and intensity of flow, as well as flow's effect on cognitive efficiency and creativity. In addition, the theory is parsimonious, testable, and integrates the seemingly independent subject matters of phenomenology, learning theory, and cognitive neuro-psychology. Most importantly, a bio-behavioral theory demonstrates that the flow experience cannot be understood through an appeal to phenomenological, cognitive, neurological, or behavioral variables alone, but only through an integration of the respective metaphors that are engaged by these explanatory schemes. Ironically, the systematic integration of these different explanations present a far simpler representation of the flow experience, since different metaphorical and methodological perspectives provide a multivariate perspective on the phenomenon, and correct for conclusions that are skewed by the language itself (Lakoff, 1999).

Conclusion

Theoretical Implications of a bio-behavioral theory of flow

A bio-behavioral explanation of flow underscores much broader issues that radically alter the basic ways we think of motivation. Primarily, the decision making process behind such behaviors as disparate as creative thinking, problem solving, or walking to the store are all dependent upon and influenced by somatic or neural activation variables that are mediated by abstract environmental contingencies. In other words, behavior is inherently embodied, and how we feel while performing an action is modulated by the contingency between action and outcome, and that feeling not only alters how we perform and judge that action, but is altered by the results of that action itself. In practical terms, we cannot gauge the effectiveness of a teaching style, a leisure or work activity, or even the desirability of moral acts unless we can conceive of the concurrent presence and influence of the abstract environment contingencies that modulate cognitive shifting and its neurological and somatic concomitants. Thus, motivation is not just a function of a rational economic calculus of static motivating events that have separate and unchanging value, but is crucially dependent upon a non-conscious mapping of psychological space. This mapping can only be accomplished using a simple contingency-based data language that is the lingua franca of contemporary behaviorism.

Finally, separate idiosyncratic mind states such as flow, intrinsic motivation, autotelic personality etc. are ultimately empty concepts, since they cannot account for the abstract environmental contingencies and somatic and neuro-chemical processes that activate behavior. In other words, they have poor semantics, since they are only partially or obscurely rooted in the empirical facts of behavior.

Practical Implications of a bio-behavioral theory of flow

The flow experience does not represent a separate or distinct neuro-psychological event. Rather, flow represents a neurological event that differs in degree rather than type from other similar events, and is no more distinctive than high anxiety is from low anxiety, or running from walking. Moreover, flow is subject to the same principles of learning that govern other involuntary and voluntary behaviors. That is, the processes that underlie flow display the same lawfulness that governs responses as disparate as salivation, emotion, walking, or talking.

The practical implications of a bio-behavioral explanation for flow greatly refine Csikszentmihalyi's own prescriptions for the replication of flow in everyday life, and make those prescriptions much clearer by discarding spurious mental processes such as intrinsic motivation, autotelic personality, and the like. For example, short bursts of absorbing activity (e.g. writing sonnets, creating art) that are paced at separate intervals during the day will elicit a high level of neural arousal will have enough 'momentum' to span those intervals, and create a state of pleasurable alertness that can be extended all day.

Secondly, because flow is a scalable response, lower levels of activation are still desirable, even if they may not produce self-reports of elation or satisfaction. School curricula that are designed to cultivate a child's shifting focus on diverse aspects of a subject matter that may be inherent in or denoted by that subject matter will arouse his attention, and thus seem to be 'intrinsically reinforcing'. Third, by stressing the importance of activating neural processes in environments that require exacting levels of performance (e.g. education, work), learning technologies can be readapted to more accurately fit the facts of behavior, and with subsequent increases in their effectiveness as well as comprehensibility.

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