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Introduction: Toward a Theory of Attention That Includes Effortless Attention and Action

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Attention and action require effort, and, under normal circumstances, the higher the demands of a course of action, the greater the effort required to sustain a level of efficacy (Grier et al. 2003; Kahneman 1973). Although a clear distinction is rarely made, effort is generally presumed to be both objective (as calories consumed) and subjective (as experienced effortfulness). There are times, however, when attention and action seem to flow effortlessly,[1] allowing a person to meet an increase in demand with a sustained level of efficacy but without an increase in felt effort—even, at the best of times, with a decrease (Csikszentmihalyi 1975; Csikszentmihalyi and Csikszentmihalyi 1988; Dobrynin 1966).

Under normal circumstances, the expectation is that expenditure of effort increases with the level of demands until effort reaches a maximum point at which no more increase is possible (Kahneman 1973; see figure I.1).

Sometimes, however, when the level of demand reaches a point at which one is fully engaged, one is given over to the activity so thoroughly that action and attention seem effortless (see figure I.2).

That subjective effort can follow this path of unexpected decrease without a decrement in performance is clearly supported by the literature (Csikszentmihalyi, this volume; 1975; Dormashev, this volume; Ullén, this volume; Csikszentmihalyi and Csikszentmihalyi 1988; Dobrynin 1966; Jackson and Csikszentmihalyi 1999). Whether objective effort follows the same path is less clear, but there is evidence to suggest that it is possible (Wulf and Lewthwaite, this volume). Either way, because the objective–subjective distinction is rarely made in regard to discussions about effort, evidence shows that the accepted theoretical framework of increased effort to meet increased demand falters. This failure of our accepted framework to accommodate effortlessness has likely been the reason for its long neglect as a subject of serious investigation and for artists and philosophers to attribute its causes to the mystical, the divine, or the Freudian unconscious.

Mihaly Csikszentmihalyi (1975) identified the phenomenon of effortlessness as autotelic experience—when a person's full engagement in an activity provides ongoing

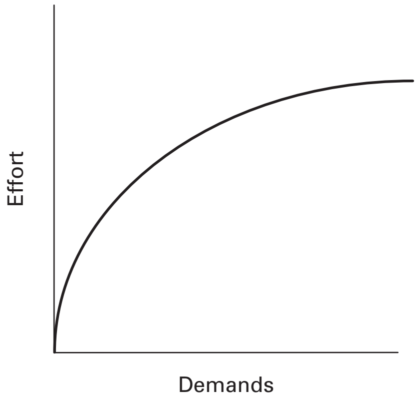

Figure I.1
Effort versus demands in effective action—normal experience.

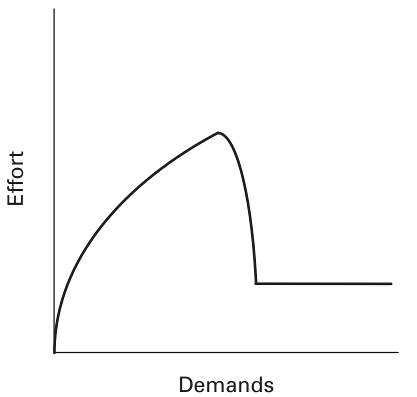

Figure I.2
Effort versus demands in effective action—effortless experience.

impetus for attention and action—and found it across a wide variety of activity domains, from rock climbing to chess, from factory line working to intimate conversation.[2] Using a novel data collection procedure (Hektner, Schmidt, and Csikszentmihalyi 2007) that allowed for better monitoring of naturalistic activities, Csikszentmihalyi achieved a great deal on the descriptive level, isolating the phenomenon and detailing the manner of its occurrence, its duration, its depth, its phenomenal characteristics, its variability, its breadth across populations, its parameters of occurrence, and its psychological value. Through his work, autotelic experience (commonly known as "flow") has entered both the scientific and the vernacular vocabularies (see box I.1 for

Box I.1

Example

A professor who has given the same classroom lecture 10 times over the past five years gives it again on two occasions over two semesters.

Effortful Experience

Outside of class, the professor is struggling with a particularly trying bit of research, a student he failed for cheating has taken the matter to the administration, a recent faculty meeting exploded in accusations and acrimony, and a close family member is ill. Inside of class, he is in an unfamiliar room, his new shoes are hurting his feet, the temperature is unusually warm, and students are lethargic. Under these conditions,* the professor experiences a frustrating lecture. Examples fall flat, insightful points come haltingly, if at all, and conclusions feel awkward and indecisive. Unexpected questions from students are met with hems and haws. There is a feeling of self-consciousness—that the lecture is not going well. There is a feeling of interminability during the lecture and of relief and fatigue after the lecture.

Effortless Experience

Outside of class, the professor just sent off a revised manuscript for publication, he recently won an award for teaching excellence, and his new research assistant is buoyant and eager. Inside of class, conditions are familiar, and students are responsive. The lecture goes smoothly, punctuated at appropriate moments by examples and insightful asides that meet bright eyes and nods of understanding. Unexpected questions are deftly assimilated to the material with humor and aplomb. Conclusions neatly wrap up sections and lead naturally to subsequent sections. There is no feeling of self-consciousness during the lecture but a retrospective feeling of diminished sense of time and that the lecture came off automatically and with ease. There is a feeling after the lecture of zest and that it could have been continued indefinitely without fatigue.

* There are many possible obstacles to effortlessness; others could be extreme demands, low demands, lack of interest, unexpected interruptions, lethargy, negative affect, and so on. (The effect of unfavorable conditions is not a necessary one. Conceivably, in the first experience the professor could have overcome the obstacles and experienced an effortless lecture.)

an illustration of how the same activity can be carried out with and without a feeling of flow).

Because of its occurrence largely in naturalistic settings, however, and perhaps due to its vestigial mysteriousness, autotelic experience has been resistant to explanatory analysis. Therefore, fundamental questions regarding the cognitive science of effortlessness have, until now, been neither asked nor answered.

In a separate program in the Soviet Union, descriptive research was conducted by N. F. Dobrynin, D. I. Gatkevich, and N. V. Lavrova (Dobrynin 1966; Dormashev, this volume) under the rubric of postvoluntary attention—attention that was neither voluntary (effortful) nor involuntary (automatic). Postvoluntary attention is characterized in the literature as attention that has been captured by an absorbing, interesting, and meaningful activity and that can be sustained willingly and productively for a long period of time. Unfortunately, the bulk of this literature remains untranslated.

Despite the difficult questions remaining, research into effortless attention and action should be viewed not as an esoteric discipline but instead as a welcome challenge to test, refine, and even alter current models of attention and action. In order for any model of behavior to be considered comprehensive, it must be able to account for all types of human action. As Daniel Kahneman and Anne Treisman have said, "While we continue to work within the old framework [of attention], we should remain alert to the possibility that it could soon become obsolete" (Kahneman and Treisman 1984, p. 57). Bernhard Hommel recommends that in order to make future advances in developing a full model of human action, our most basic concepts must be clarified (Hommel 2007). The present volume submits the concept of effortless attention for such consideration.

In this introduction, I isolate seven topics concerning which scholars have produced theories and results pertinent to a nascent theory of effortlessness. I offer a summary of these ("Overview"), show how the topic of effortlessness may reveal gaps in the current literature and challenge current theoretical models ("Challenges–Gaps"), delineate potential aspects of a future theory of effortless attention and action ("Theory"), and discuss how the chapters in this volume mark advances in that direction ("Advances"). The categories do not necessarily reflect the intentions of the contributors or fully encompass current paradigms in cognitive science, and they are best considered one possible attempt at a heuristic for approaching this unwieldy topic. Further, the "Advances" discussions are necessarily brief and discuss how each chapter contributes to our understanding of only one issue in particular. Readers will find that the chapters are usually broader than that, often speaking importantly on several of these issues.

Topic 1: Effort

Overview

Two general kinds of effort have been distinguished in the literature—mental effort and physical effort (Smit, Eling, Hopman, and Coenen 2005), which are conceptually dissociable. For instance, in the development of overlearned action, the same level of physical effort is subject to decreasing amounts of mental effort. Nevertheless, mental effort must also have a physiological basis and has been approached by researchers and theorists under two general headings: attention and self-regulation (see box I.2 for terminology relevant to this field of inquiry).

William James defined attention as the effortful holding of something before one's mind (James 1983). Daniel Kahneman (1973) identified attention as mental effort, postulating that maintenance of attention can be under voluntary control but intensity of attention cannot. William Sarter has delineated a neuronal model of "attentional effort" that describes the mechanisms for initiation of top–down control of attention (Sarter, Gehring, and Kozak 2006). According to Sarter, when attention is threatened, performance monitoring (prefrontal–anterior cingulate) and motivational (mesolimbic) systems are recruited and integrated, manifesting as attentional effort.

Philosophers have long used "will" as a term that indicates subjective effort (Schulkin 2007). Research psychologists have preferred "self-regulation" or "self-control" (Baumeister and Vohs 2005; Rothbart 2005; Vohs and Baumeister 2004)—the

Box I.2

Working Definitions

Objective effort (exertion) an increase in the metabolic or physiological processes of movement (physical effort) or thought (mental effort).

Subjective effort the feeling of exertion.

Effortful description of attention or action in which there is subjective effort under normal conditions.

Autotelic description of an experience in which one feels that the activity provides the impetus for action, involving a challenging activity that requires skill, the merging of action and awareness, clear goals and immediate feedback, concentration on the task at hand, a feeling of being in control, a loss of self-consciousness, and an altered sense of time.

Effortless description of attention or action that (1) is not experienced as effortful or (2) involves exertion and, due to the autotelicity of experience, subjective effort is lower than in normal conditions, with effectiveness maintained at a normal or elevated level.

Postvoluntary effortless (2).

ability to accomplish one's goals and to refrain from actions that contravene one's goals. Studies have shown that self-regulation is a limited resource, that this resource can be depleted through prior effort (e.g., choices), and that its maintenance can be affected by cognitive states such as bias or a feeling of autonomy (Baumeister, Bratslavsky, Muraven, and Tice 1998; Inzlicht 2006; Moller, Deci, and Ryan 2006; Muraven, Tice, and Baumeister 1998; Schmeichel and Baumeister, this volume).

Challenges–Gaps

Current theories of attention identify attention with effort and rarely distinguish between objective and subjective effort. Such theories are unable to account for attention that is high in intensity but low in subjective effort. Is a synchronic decrease in *objective* effort also possible without a performance decrement? If so, is it akin to, or dependent on, the efficiency of overlearned action achieved diachronically? How can the two be distinguished on functional and physiological levels?

Further, the phenomenon of effortlessness complicates the notion of executive control. In autotelic experience, subjects report that they are able to exert exceptional control over the subtlest responses in an activity but without a *feeling* of executive control. They report that they can be completely focused on a task but feel as if only a slight effort is expended (Csikszentmihalyi 1975; Csikszentmihalyi and Csikszentmihalyi 1988). Lionel Naccache and colleagues report that executive control and the feeling of effort are dissociable (Naccache et al. 2005; see also Lafargue, Paillard, Lamarre, and Sirigu 2003).

These two challenges to current models raise many fundamental questions about the relationship between attention and effort and even about the nature of mental effort, itself.

Theory

Nearly five decades ago Gunnar Borg (1962) demonstrated a reliable correlation between objective and subjective physical effort that is still the basis of psychophysiological instruments today. A similar correlation between objective and subjective mental effort has been presumed but not verified. Several scales of subjective workload are used in human factors research, but none of the major scales distinguish clearly between mental and physical subjective effort (Rubio, Díaz, Martín, and Puente 2004). Any presumption of an outright correlation between objective and subjective mental effort appears to have been contradicted by Csikszentmihalyi's and Dobrynin's findings.[3] A theory of effortlessness will have to clearly define objective and subjective mental effort by delineating their functional and physiological features.

Advances

1. *Shared resources of self-regulation and attention* In their chapter for this volume, Brandon Schmeichel and Roy Baumeister demonstrate that under normal circum-

stances attention and self-regulation draw from a shared limited resource. Research with colleague Gailliot (Gailliot et al. 2007) suggests that this resource is glucose. Thus, under normal circumstances, objective mental effort (in the form of attention and self-regulation), like objective physical effort, appears to have a measurable and manipulable physiology.

2. *Decrease in objective effort during attention* Gabriele Wulf and Rebecca Lewthwaite show in this volume that the normal reduction in physical and mental objective effort (coupled with an increase in efficacy) that is achieved through typical diachronic practice can be enhanced synchronically. Through a slight shift in the focus of attention—from internal to external—subjects have consistently decreased their objective effort while increasing their efficacy. In other words, there is a direct correspondence between attention and effort such that both physical and mental effort can be reduced while one's prior level of attention is maintained.

Topic 2: Decision Making

Overview

The study of decision making is now a mainstay of economics research (Tomlin et al. 2006) and moral psychology (Greene, Nystrom, Engell, Darley, and Cohen 2004). Less attention has been focused on the fact that every action a person makes involves a choice of some kind, whether fully conscious or not. Jeffrey Schall has shown that choice (selection from among alternatives) is conceptually dissociable from both decision making (deliberation about selection) and action (overt indication of selection; Schall 2001).

Working within a more traditional framework, Mariano Sigman and Stanislaus Dehaene have reported that of the three stages of an action (perceptual, central, and motor), the first and third can work in parallel on different stages of different tasks, and only the central must work serially, hence accounting for time delay in deliberative action (Sigman and Dehaene 2005).

A link between the autonomic nervous system and automatic action was rarely considered until Antonio Damasio and colleagues demonstrated that the autonomic nervous system plays a crucial role in some forms of decision making that lead to action (Damasio 1996, 1994). In essence, the autonomic nervous system sets the body and mind in proper form for reacting to uncertain but familiar circumstances.

A key component of automaticity is an individual's level of response inhibition. Antoine Bechara, working with Damasio, has conducted seminal research into the role of response inhibition in decision making (Bechara, Damasio, Tranel, and Damasio 1997; Bechara, Damasio, and Damasio 2000, 2003; Bechara 2004). In impulsive behavior, according to Bechara, response inhibition fails, the decision-making process never engages, and a response based on previous success is initiated automatically. Different areas of the brain, he says, may be active, depending on which of three types of decision (under certainty, under risk, and under ambiguity) is being made. If decisions under ambiguity are more likely, they will involve the orbitofrontal region and thereby engage the autonomic nervous system, which would slow processing down considerably.

Arne Dietrich has postulated that autotelic experience involves a decrease of neural activity in executive regions of the brain, specifically the anterior cingulate cortex (Dietrich 2004), which has been confirmed to be directly associated with the feeling of effort (Mulert, Menzinger, Leicht, Pogarell, and Hegerl 2005).

Challenges–Gaps

The above findings suggest that a complete theory of choice and decision making in human behavior would do well to include the actual neurophysiology of such processes. Effortless attention complicates any such model because the distinction between executive control and decision making vanishes. Decision making in flow is fast and precise, implicating automatic action, but also creative and flexible, implicating processes that are normally associated with executive control—though executive control processes are generally considered slow. Actually monitoring activation of brain areas in effortless attention may shed some light.

Theory

Recognizing Schall's distinction between choice, decision making, and action and then identifying the neural mechanisms underlying each may be important in accounting for the precision of effortless action and the rapid choices that precede it. Under Sigman and Dehaene's model, does effortless action (where rapid and accurate responses are characteristic) leave out the middle—deliberative—step, is it somehow integrated in a parallel fashion, or is there another way to account for it? Damasio and Bechara's work may point to an important role for something like confidence in effortlessness—familiarity with an activity and confidence in one's ability may (artificially?) push the subjective level of engagement from ambiguity toward certainty.

Advances

1. *Response conflict, effort, and decision making* In their contribution to this volume, Joseph McGuire and Matthew Botvinick show that an integral part of the decision-making process involves evaluating the demand for cognition in a prospective task. Drawing on numerous studies, they postulate that the anterior cingulate cortex and nearby medial frontal cortex monitor the current output of cognitive resources and compare that to expected demand, resulting in a projected increase or decrease in needed cognition. This projected amount of control is then balanced against projected reward (nucleus accumbens), resulting in either an adjustment in cognitive resources

to meet expected demand or in avoidance. McGuire and Botvinick demonstrate, therefore, that mental effort is dissociable from cognitive control. Cognitive control is an ongoing process, and subjective mental effort is associated with the change in that process rather than with the process, itself. This shows us how it is possible that there can be a high level of cognitive control but a low level of subjective effort.

2. *Effort in deliberative problem solving* It is natural to think that the greater the effort applied to a task, especially one that is exclusively cognitive, the better the outcome will be. Marci DeCaro and Sian Beilock demonstrate that although effortful (i.e., linear, rule-based) problem-solving strategies often result in better performance, under real-world conditions they can lose out to less effortful (i.e., associative, heuristic) strategies. Such results provide another avenue for demonstrating that effortful attention and performance are dissociable.

3. *Executive control is not necessarily conscious* The status of executive control as a defining feature of the explicit processing system is called into question by Chris Blais. Blais shows through his research and studies by others that an instance of executive control that is generally taken as a paradigm case of executive control by researchers actually occurs outside of conscious awareness. Blais, therefore, calls into question the need for a distinction between explicit and implicit systems of control. The very phenomenon of effortless attention, as explained above, seems to lead in the same direction, and Blais's work may help in resolving this conundrum.

Topic 3: Action Syntax

Overview

Joaquín Fuster has examined the temporal role of executive function in attention and action, in which the automated behavior that is integrated into lower neural stages (premotor cortex, basal ganglia, hypothalamus, or other subcortical structures) is activated and modulated by the anterior cingulate cortex (high motivation, resolution of conflict), areas of lateral prefrontal convexity (set, integration of information across time), and orbital areas (inhibitory control). Temporal integration of behavior, Fuster says, is closely related to negotiating a syntax. Although syntax is most commonly associated with language, Fuster says that "linguistic syntax and motoric syntax seem to have a common phyletic origin" (Fuster 2003, p. 180). If the perception–action cycle involves the same, or functionally similar, neural mechanisms as those that allow us to negotiate grammar, it would go a long way in explaining certain elements of effortless action.

Matthew Botvinick (Botvinick and Plaut 2004; Botvinick 2007) has developed a recurrent connectionist network model that accounts for decision-making behavior in everyday routine tasks through transient, flexible hierarchies that rely on concurrent representation rather than enduring schemas. The resulting hierarchies are context dependent and, as such, are appropriately vulnerable to distraction errors common in everyday behavior. Among other things, Botvinick's computational model may help elucidate the role of attention in complex sequential actions.

Among other things (Ivry and Helmuth 2003), sequential actions involve neural timing mechanisms, particularly in the cerebellum (Ivry 1997; Ivry and Richardson 2002; Ivry, Spencer, Zelaznik, and Diedrichsen 2002; Ivry and Spencer 2004a; Ivry and Spencer 2004b; Spencer, Ivry, and Zelaznik 2005), neural systems for force control and special trajectory planning (Diedrichsen, Verstynen, Hon, Zhang, and Ivry 2007; Spencer et al. 2005), and response selection (Bischoff-Grethe, Ivry, and Grafton 2002; Diedrichsen, Verstynen, Hon, Lehman, and Ivry 2003).

Challenges–Gaps

Syntax consists in a set of goals arranged in a hierarchy (within a circumscribed domain) that is constituted by defeasible rules temporally executed. Since effortless action is most often achieved in a well-demarcated activity, with constitutive rules, effortlessness (of attention and action) may be closely related to the process of negotiating syntax. The notion of action syntax is still a novel one and must be integrated into any comprehensive model of action (Costanzo 2002). One important issue that it brings to the fore is the distinction between explicit rule following and optimal action within constraints (Langlois 1998). When adding cream and sugar to a cup of coffee (Botvinick and Plaut 2004), how does one decide which to add first? When playing a sequence of notes on the piano, how does one decide on the particular dynamics? Assimilating explicit rules (Bunge 2004) is only one step in executing action. Another step is applying the rules appropriately according to context, which can never be completely identical from one instance to the next.

Theory

A theory of effortlessness should embrace action syntax and explain at functional and physiological levels what it means to negotiate a syntax. It should distinguish between explicit rule syntax and constraint–parameter syntax and thereby account for the role of appropriateness in effective action (how quickly to stir, how much arc to put on the basketball, how to express a chord, whether to bluff or not, etc.). Such a theory should also elucidate the role of attention in complex, sequential actions. Where, when, and how is attention directed to relevant cues, and how is that relevance determined? Further, determining these aspects of attention will have important implications for training and education.

Advances

1. *Action representation drives attention* Where is one's attention in downhill skiing? The pace of the activity is too fast for deliberation in conscious processing, and yet we

do attend fleetingly to this curve and that bump. Bernhard Hommel offers a theory for conceiving of attention not as necessarily consciousness driven and not as a system for managing scarce cognitive resources but as a "by-product of action control in a distributed processing system" (chapter 5, this volume). Hommel demonstrates that at its most fundamental level, attention is the process of perceptual systems filling parameters in preestablished action programs as those action programs successively come online. A skier (on a good day) attends effortlessly to curves and bumps as needed to maintain success. Attention, according to Hommel, is normally experienced as effortless, and it is only when something comes between endogenous motivation and relevant external cues (as in artificial laboratory tasks) that it is experienced as effortful. The apparent integration of perception and action in a single representational system appears to allow for immediate action-driven processing of syntactic cues.

2. *Effortlessness as domain specific* Through their unique methods of measuring dimensions of activities under normal circumstances, Mihaly Csikszentmihalyi and Jeanne Nakamura in their contribution to this volume demonstrate that effortless attention is most likely to be achieved under domain-specific conditions: clear, sequential, short-term goals; immediate feedback; and a balance between opportunities for action and the individual's ability to act. When these conditions are met under conducive circumstances, effortless attention is most likely to ensue. Further, they show that in circumstances of high attention experienced as effortless (as opposed to high attention experienced as effortful), subjects feel more involved, in control, unselfconscious, relaxed, and as if they are putting their skills to more use.

3. *Effortless attention in the lab* Can these conditions be replicated in the laboratory? While Hommel suggests that the limitations of the laboratory setting are problematic in understanding effortless attention, and while Csikszentmihalyi and Nakamura have overcome those limitations by taking their research outside the lab, there is still something to be said for the prospect of introducing a naturalistic activity into the lab such that effortless attention can be induced in a setting that would allow for more systematic study and more intense monitoring. In their contribution to this volume, Arlen Moller, Brian Meier, and Robert Wall examine the attempts of several laboratories, including their own, to induce flow by manipulating the balance between challenge and skills for subjects playing video games. While these teams have been successful in inducing many of the features of flow, the laboratory setting, itself, still presents a number of challenges. Moller, Meier, and Wall go on to examine such challenges and formulate suggestions for future research.

4. *Syntax and the draw of attention* In his contribution, Brian Bruya offers a new model of attention. Rather than a spotlight, or a filter, and so on, this model posits that attention may be profitably conceived of as a mechanism of sensitization that draws information relevant to dynamic contextual structures of reference through dynamic processing pathways. Contextual structures of reference compete spontaneously for

predominance in processing pathways, with predominance shifting rapidly and constantly over time, accounting for transient selective attention. A semblance of sustained, focused attention may be precariously achieved by inhibiting the intrusions of competing structures of reference, usually experienced as effortful to some degree. Occasionally, activity domains stabilize as temporary, predominant structures, inhibiting competing structures of reference by virtue of the activity's autotelicity, thereby allowing for sustained, focused attention that feels effortless.

Topic 4: Agency

Overview

David LaBerge's triangular circuit theory of attention (LaBerge 1995, 1998, 2000) postulates an important role for the thalamus in attentional processing. According to the triangular circuit theory, attention just is conscious attention, or what LaBerge more precisely calls awareness. This theory postulates an internal representation of the self directly associated with the thalamus that provides the motivation or interest that amplifies preattentively selected stimuli for sustained attention.

Walter Freeman views the brain as a fundamentally intentional system (in the tradition of John Dewey) that essentially creates itself through goal-directed activity. Freeman views brain waves as the multiple manifestations of self-organizing nonlinear dynamic systems rooted in the electrochemical activity of neuron populations. Freeman's data (Freeman 2004a, 2004b, 2005, 2006), he says, support a view that neuron populations are self-organizing systems in which transient activity arises spontaneously, spreads across populations following basins of attraction, and then subsides, to be replaced by the next wave of activity. These basins of attraction represent confluences of meaning. One of the characteristics of effortless attention and action is heightened sensitivity to stimuli. Freeman's theory of nonlinear dynamic systems in neuron populations provides a model for this kind of readiness, or preafference, as he calls it (Freeman 1999, 2000).

Transient selfhood has been a central concern of the philosopher Thomas Metzinger, who has developed a theory of the self that coheres with the latest results of neuroscientific research, especially research related to the broad functionality of the motor system (Metzinger and Gallese 2003; Metzinger 2003). According to his work, we can consider the self a unitary entity only in a phenomenal sense. In a functional sense, it is constructed and continuously remade (determined at the physiological level by particular neural processes).

Susan Hurley created a model of intentional action that links action, imitation, and simulation, and she speculated widely on the implications for this research with regard to social philosophy and ethics (e.g., Hurley and Chater 2005; Hurley 2005).

A decision to act is not isolated but arises as a response to past events and in expectation of future events. Marc Jeannerod, working closely with philosophical theory on the one hand and neuroscientific studies on the other, has contributed significantly to the transformation of our understanding of the motor functions of the brain from noncognitive action deployment to full-blown centers of planning, perception, prediction, and complex social behavior (Jacob and Jeannerod 2003; Jeannerod 1988, 1997, 2006). How the sense of agency is constructed and maintained is one of Jeannerod's primary concerns because it appears to be at the heart of motor cognition. Without agency, there is no goal setting or subject of simulation or prediction.

Challenges–Gaps

A core challenge that effortlessness research poses to current models of attention and action is to answer the following question: When a decision to act is made, who is doing the deciding? Effortlessness brings to the foreground two issues fundamental to action: (1) When an act is attributed to a self, what exactly is a self, and (2) as mentioned above, is there really a clear demarcation between executive control and automaticity? There are obviously distinct neuronal systems handling overlearned actions on the one hand and executive control on the other; effortless action highlights the need to study their integration because in this highly achieved form of action, a person seems to draw from them both with exquisite mastery. Freeman's dynamic systems framework may help close these gaps by supplying to current models a kind of spontaneous sensitivity (see Alicia Juarrero 1999 for an insightful examination of dynamic systems theory, agency, and action).

LaBerge points out that awareness involving a self-representation is distinct from self-awareness. Nonetheless, the same question asked above may be asked here (applicable also to Jeannerod): How can such a theory account for the commonly reported phenomenon of a dropping away of a distinct sense of self in effortless attention and action? Also, is a self-representation solely a function of the thalamus, or are there important contributions from other specific areas of the brain, such as the medial cingulate where attributions to self and other are formed (Tomlin et al. 2006)?

When attention is invested in an activity, it can be perceived as purely voluntary or carry a sense of compulsion. According to Csikszentmihalyi (1978) and Dobrynin (1966), effortless action is more likely achieved when attention is not only highly focused but also entirely voluntary—in pursuits that a person finds intrinsically worthwhile. Because effortlessness is often reported as a desirable state for both the enjoyment and the efficacy of action that it affords (Csikszentmihalyi 1975), it exposes a gap in current literature with regard to the optimal structuring of an individual's life. How can the achievement of effortless attention, on personal, pedagogical, and managerial levels (Dobrynin 1966) be cultivated and encouraged for the sake of the acting agent?

Moving from the individual agent to the social agent, social behavior involves executing appropriate actions according to complex circumstances—evaluating subtle cues and responding without time for deliberation. Insofar as mirror neurons have been implicated in social action, as Hurley (among others) has done, many questions can be asked with regard to how much of social behavior is automatic and how much is voluntary and with how much robustness this distinction can even be maintained. Are the same mechanisms of effortless action also at work in social action (see also under "Automaticity" below)? If so, given that effortless attention and action are often cultivated in a practice regime, what are the implications for the possibility of achieving expertise in social action? Could such knowledge be applied at a personal or even a pedagogical level? What are the ethical implications?

Theory

Effortless attention and action may simply be the free running of Freeman's intentional system, but what does that mean for a persistent sense of self, especially if such a sense of self falls away during effortless activity? Because reports of effortlessness often involve the loss of coherence of a phenomenal sense of self (Csikszentmihalyi 1975; Csikszentmihalyi and Csikszentmihalyi 1988; the feeling that the piano is playing itself or one is on "autopilot"), some aspects of functional selfhood seem to dissociate also. A comprehensive theory of perception and action would account not only for the role of the self in motivation but for the dissolution of the self in effortless attention and action. Further, it would explore the implications of "nonagentive" action in ethics, education, law, and public policy.

Advances

1. *Self and the thalamus* An important repository of anecdotal and speculative literature regarding effortless attention and action lies in the Asian philosophical traditions. In Zen Buddhism, for example, there are countless stories of acolytes who have practiced meditation for long periods and then, on encountering an unexpected, nondescript stimulus, suddenly experience a number of the hallmarks of effortless attention. In his contribution to this volume, neurologist James Austin considers how the sudden experience of a dropping away of a sense of self may have direct neurophysiological correlates. Drawing on research that distinguishes two attentional systems, he shows that distinct pathways between thalamic nuclei and the two attentional systems are likely implicated in the experience of a loss of a sense of self. He suggests that the blinking out of self-consciousness in a Zen enlightenment experience, and in effortless attention and action more broadly, may be due to deafferented cortical areas of the dorsal (egocentric) attentional system, traceable to deactivated thalamic nuclei. The

entire process is achieved, he suggests, through long practice regimens and their resulting neurophysiological effects.

2. *Ethics and agency* The findings in cognitive science that call into question the traditional conception of a unitary rational agent have profound implications for contemporary ethical theory. In his contribution to this volume, Edward Slingerland integrates results from the cognitive science of action with an ethical theory that takes effortless action to be the epitome of virtuous action. Through a detailed examination of philosophical and cognitive scientific accounts of human action, Slingerland concludes that ethical human action is best characterized on a descriptive level in terms of a virtue ethics broadly construed. In other words, he says, humans generally act not from active cognitive control but from self-activating effortless dispositions that can be cultivated through introspection and education.

3. *The person level in activity* Researchers in twentieth-century Russian psychology recognized the primary importance of syntax in attention and action, adopting the rubric *activity theory* to describe their overall psychological framework. Yuri Dormashev, in addition to giving an extraordinary introduction to activity theory in general and postvoluntary attention in particular, explains in his contribution to this volume that attention is best understood in terms of activity, functioning as a *gestalt* and focused on a limited range of objects. In postvoluntary attention, activity is organized at the person level, or *personality* (understood as the focal point of the driving hierarchy of motives in the cultural sphere). On this basis, Dormashev suggests that an important element missing from accounts of autotelic experience is that of *personal taste*—the interest, or broad aesthetic sense, that acts as a motivating force outside of organic and social motivations. The sense of transactional, embedded attention and action inherent in this view serves to unify the autonomous individual with the social and organic milieus in which—and through which—the individual develops.

Topic 5: Automaticity

Overview

Kahneman and Treisman point out that there has been a running debate among researchers of attention as to the role of automaticity in attention, with some researchers emphasizing early onset attention (selective processing–filtering) and some late onset (mental set/efficiency of action), and suggest that research into automaticity may help us bring the two closer together and away from mutual exclusivity (Kahneman and Treisman 1984; see also Pashler 1998).

In his analysis of available data, Marc Jeannerod (2006) suggests that the automated steps of an action come in for conscious access when there is discord between intention and actuality—when the perceptual representation does not match the action representation.

John Bargh, researching the automaticity of social behavior, has concluded that much more of behavior than previously thought is outside of voluntary consciousness (Bargh 2000; Bargh and Chartrand 1999). He has recently proposed that a cascade model of language be applied to behavior (Bargh 2006; Ackerman and Bargh, this volume), explaining how actions proceed spontaneously from parallel processed goal activation, just as conversation occurs spontaneously while also being goal directed and falling within strict syntactic and semantic parameters.

Related to the cascade model is the theory of event coding put forward by Hommel, Müsseler, Aschersleben, and Prinz (2001; Hommel, this volume). Working in the tradition of Dewey (1896) and Gibson (1979), they suggest, as discussed briefly above, that perception and action are encoded in the brain in unitary fashion, accounting for the functional linking of the two as one. One result of this model is the postulate that actions are encoded in terms of their effects rather than in terms of explicitly understood movements. The practical result of this is that attention in learning an action must be focused not on the intentional, voluntary aspect of a movement but on the effects of the movement (Wulf 2001, this volume).

Challenges–Gaps

These theories and findings, coupled with those under "Agency" and "Action Syntax" above, highlight a shift in research models from stimulus–response to what one might call sensitivity–responsiveness. Whereas the behaviorist model cut out intentional agency completely, the new models replace it with a multimodal agent, which, while not exactly being metaphysically free, is a bundle of preafference and readiness potentials created in a complex array of self-organized neuronal populations, with their representational (or other) associations constantly arranged and rearranged through phylogenetic and historical factors. In many circumstances, the responsiveness of the agent appears to be a function of these associations.

Theory

If Jeannerod is correct that actions come into consciousness when perception does not match intention, it would help explain why effortless action, which reportedly occurs when expectations are consistently met, often seems outside of conscious awareness. On the other hand, it would also seem to leave high-level effortless action as purely automated, thereby seeming to preclude credit to a subject for creativity, insight, emotional expression, and so forth. A cascade model of behavior may work well for effortless action; in fact, effortless action, being generally domain dependent, may prove to be the best testing ground for establishing the basis for such a theory. The theory of event coding may help explain why the precision of effortless action can appear "nonintentional" while attention is intensely focused on rapidly arising cues.

Advances

1. *Social automaticity* In their contribution to this volume, Joshua Ackerman and John Bargh review the extensive literature on the automaticity of social coordination, suggesting three general mechanisms that may account for it: simple dynamical systems at the level of mechanics (e.g. synchronized rocking in rocking chairs), shared perception–action representations (e.g., priming), and active motivations. They conclude that the automaticity of social coordination has several qualities that may be relevant to corollary qualities in flow: reduced experience of effort, transcendence of the negative aspects of the self, positive affect, and interpersonal fluency. Ackerman and Bargh go on to make a case for flow's being a special case of automaticity, explaining that the conscious awareness does not, itself, drive the experience of flow and is, instead, a passive spectator.

Topic 6: Expertise

Overview

Attention and its relation to performance have been an intense topic of research, exemplified by the conference and volume *Attention and Performance*'s appearing biennially since 1966. There appears to be a very close link between expert performance and effortlessness. Although the learning of a highly refined skill involves intense effort over extended periods (Ericsson and Lehmann 1996), its execution at the highest level is often characterized from a first-person perspective as feeling effortless and from a third-person perspective as appearing effortless. How to build this level of expertise and how it is executed have been the object of a number of interesting lines of research.

For instance, Sian Beilock and colleagues (Beilock, Bertenthal, McCoy, and Carr 2004; Beilock, Carr, MacMahon, and Starkes 2002) have found, when comparing sport performance of novices and experts, that experts perform better at full attentional capacity, even if their attention is occupied by irrelevant details, such as distractors or an artificial speed requirement.

Focused attention is attention that is voluntarily concentrated on a single domain of stimuli. The limited attention of lower animals can be understood as involuntarily focused attention. Ethologist Reuven Dukas (2002) has suggested that limited attention in lower animals may have an adaptive advantage, and Csikszentmihalyi (1978) has noted the advantages of focused attention in autotelic experience. Drawing from a series of studies involving computer simulations, Dehaene and Changeux (2005) have postulated that when human attention is captured in high-level cortical activity, the processing of domain-specific stimuli is facilitated while that of other stimuli is inhibited, perhaps accounting for the phenomenon of inattentional blindness.

Challenges–Gaps

Effortlessness is often characterized by an experience of completely focused attention. It is a mystery, however, as to why attempting to give full attention to an activity at which one is completely competent and which *does not require* full attention should result in a performance decrement. It may be that sustaining full attention in a task that does not demand it is simply not possible for any length of time (but why?) and that free cognitive resources will be involuntarily drawn to competing targets of attention, drawing with them some of the cognitive resources required for the original task.

Theory

The Dehaene and Changeux model (2005) seems to most easily match autotelic experience—as opposed to normal experience—because full attention that inhibits non-domain stimuli is difficult to maintain outside of autotelic experience. A theory of effortlessness should include the mechanisms for the capture and release of full attention in autotelicity and seek to answer the question of whether the capturing can be facilitated or the releasing can be inhibited through training.

Advances

1. *The explicit system and perfectionism* Related to the chapters by Austin, DeCaro and Beilock, and Wulf and Lewthwaite mentioned above, the contribution to this volume from Arne Dietrich and Oliver Stoll considers evidence, first, for the downregulation of specific brain areas during effortless attention and, second, for the important relationship between attention and performance. Dietrich and Stoll begin by explaining the explicit–implicit distinction in cognitive processing and suggest that some activities can facilitate a neurophysiological process that shuts down modules of the explicit system. They then weigh in on the long-standing issue of the value of perfectionism by distinguishing two kinds, one of which draws processing through the explicit system and the other through the implicit system—the former being deleterious in attempts to achieve flow.
2. *The physiology of flow* Related to the work of Moller, Meier, and Wall described above, Fredrik Ullén, Örjan de Manzano, Töres Theorell, and László Harmat have successfully induced flow in the lab and examined its physiological correlates. Through these studies, they have found that the physiological correlates (measured in skin conductance, electromyography of facial muscles, and respiratory and cardiovascular dimensions) of effortless attention are, indeed, unique, sharing some features with the state of joyous arousal and importantly distinct from the state of effortful attention. Through further measurements of personality traits, including flow proneness, they found that flow proneness is not correlated with the capacity for sustained effortful attention, nor with general intelligence in leisure activities, and is negatively correlated with general intelligence in maintenance and professional activities.

Topic 7: Mental Training

Overview

In the West, expertise has traditionally been viewed as a combination of inborn ability and effortful practice. While some valuable attempts have been made on a descriptive level (Jackson and Csikszentmihalyi 1999; Kremer and Scully 1994; Moran 1996) and while there have been calls for a program of research in this area (Moran 1996)—and while popular psychology has been flooded with speculation and anecdotal evidence of the efficacy of mental training (Grout and Perrin 2004; Kauss 2001; Kuehl, Kuehl, and Tefertiller 2005; Millman 1999)—just as with the topic of effortlessness, comparatively little progress has been made in explaining scientifically the processes and effectiveness of mental training. In the East, we find a situation in which effortlessness and mental training have been topics of philosophical speculation for millennia. Edward Slingerland (2003) has documented a direct concern with effortless action across numerous schools of thought in ancient China, Brian Bruya (2010) has taxonomized effortlessness as spontaneity in early China and identified allied notions in the history of Western philosophy, and volumes too numerous to mention have been written on the methods of meditation and mindfulness in Hindu and Buddhist philosophy.

Over the past few decades, these methods and concerns have gradually been trickling into the cognitive science literature—for example, in Maturana and Varela's concept of autopoiesis (Maturana and Varela 1980), Ellen Langer's work on mindfulness (Langer 1989), and James Austin's neurological analysis of meditation (Austin 1998, 2006, this volume).

Effortlessness involves two important characteristics: (1) full attention and (2) a dropping away of a salient sense of self. Meditation practices involve the cultivation of these two mental states, and recent research has shown that neural plasticity in adult humans is more extensive than previously believed. Bengtsson and Ullén have shown that piano practice can influence white matter structure well into adulthood (Bengtsson et al. 2005). In separate studies, Lutz and colleagues (Lutz, Greischar, Rawlings, Ricard, and Davidson 2004) and Davidson and colleagues (Davidson et al. 2003) have shown that long-term meditators can alter neuronal structures that are implicated in high-attention states. Their results show that their subjects are able to voluntarily induce not only high-amplitude gamma oscillations but also long-distance gamma synchrony. Equally important is that these subjects' baseline EEG spectral profiles differed significantly from those of the control subjects, demonstrating the possibility of long-term neural changes through meditative practice.

B. Rael Cahn and John Polich undertook a comprehensive review of neurological studies of meditation (Cahn and Polich 2006) that confirms the positive effects of meditation on attention. B. Alan Wallace, a former Tibetan Buddhist monk and now an active scholar, has produced a series of books that explain the elements of attentional training in the Buddhist idiom (Wallace and Houshmand 1992; Wallace and Houshmand 1999) and has more recently attempted to interpret these in relation to advances in cognitive science (Wallace 2003; Wallace and Tsoçn-kha-pa Blo-bzaçn-grags-pa 2005; Wallace 2007). According to Wallace, Buddhists view meditation as a metaskill, a skill that is applicable to multiple domains. This skill, he says, can be cultivated by anyone and begins with a concerted effort to diminish self-centeredness. The result of the training, he says, is extensive cognitive–affective control, positive affect, and a robust prosocial attitude.

John Kabat-Zinn reports that an 8- to 10-week group program in mindfulness meditation training can produce short- and long-term positive results in reducing anxiety and pain (Kabat-Zinn et al. 1992; Miller, Fletcher, and Kabat-Zinn 1995). Wallace claims that it takes six months to a year of full-time meditation practice, under conducive conditions and with appropriate preparation and instruction, for a person to achieve a state of sustainable effortless attention (Wallace and Houshmand 1999).

Challenges–Gaps

While researchers have had significant success in examining the neural correlates of attention on the one hand and the parameters for improving performance within a domain of activity on the other, the neural confluence of these two topics has been relatively neglected. According to Marc Jeannerod (2006), evidence supports the hypothesis that representing an action and executing it are distinct but functionally equivalent. If representing an action is essentially practicing an action, then visualization, observation, and any steps that support or promote these will have an impact on cultivating skills that contribute to high-level effortless action.

In the East, many claims have been made regarding taxonomies of higher levels of focused attention/concentration/absorption, but there is little agreement on particular terminology or functional demarcations. It is unclear with how much precision we can conceptualize any natural neurological and developmental boundaries of different kinds of attention and of levels of focused attention for objective study.

Theory

A question that a theory of effortlessness must attempt to answer is to what extant mental training conducted in one domain is transferable to other domains. Further, is there such a thing as metamental training—mental training that is conducted outside of a specific domain but which is applicable across domains? Anecdotal evidence from Buddhist publications suggests that meditation and mindfulness training could offer such a metamethod. If such a claim turns out to be supported by empirical evidence, it could have broad implications for clinical application, formal education, and other kinds of training.

A complete theory of effortless attention and action would include not only precise definitions of basic terms of attention but also a taxonomy of stages of attentional training.

Advances

1. *Evidence for improved attention through general training* In their contribution, Michael Posner, Mary Rothbart, M. R. Rueda, and Yiyuan Tang trace measurements of temperamental effortful control in parents and children to specific brain networks and the brain networks to specific gene alleles, demonstrating natural individual differences in attentional capacity. They go on to demonstrate that these differences can be significantly influenced through environmental factors. Testing the potential of attentional training, Posner and colleagues found that five days of computerized task training in young children can result in increased activity in the anterior cingulate cortex, a general and persistent increase in IQ, and an increase in affective regulation. In adults, in a double-blind study in which subjects were trained for only 20 minutes per day over five days in a systematic method of mind–body attention, subjects showed improvement in executive attention, lower negative affect, lower fatigue, and lower stress compared to both controls and subjects who underwent generic relaxation training.

Conclusion

The phenomena of effortless attention and action provide an unexplored opportunity to test and probe current models of attention and action and extend them in directions that not only are valuable academically but could potentially have a significant impact on human flourishing. Each of the chapters in this volume has implications that bear on a variety of different aspects of attention and action discussed above.

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Notes

1. Reduction in effort is often associated with a concomitant reduction in attention (Dehaene, Kerszberg, and Changeux 2001). Here, however, "effortless" means a reduction of felt effort only, with attention preserved or even enhanced.

2. Action in autotelic experience should be distinguished from overlearned action. Overlearned action is a reduction in effort in the face of a sustained high level of challenge within a domain *diachronically*, whereas action in autotelic experience is a reduction in effort in the face of a sustained high level of challenge *synchronically*. The execution of action in autotelic experience typically depends on overlearned action, whereas overlearned action does not necessarily entail the achievement of autotelic experience. Also, overlearned action seems to reduce effort by bringing action out of attention, freeing up cognitive resources for other things, whereas autotelicity is marked by the paradox of minutely sensitized attention coupled with a diminution of subjective will.

3. If objective effort in autotelic experience is found to decrease along with subjective effort, while efficacy is maintained, the standard models would be challenged even more radically.