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ASSOCIATION FOR
PSYCHOLOGICAL SCIENCE

Directed Attention as a Common Resource for Executive Functioning and Self-Regulation

Perspectives on Psychological Science
5(1) 43-57

DOI: 10.1177/1745691609356784
http://pps.sagepub.com
SAGE

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Abstract

Research on executive functioning and on self-regulation have each identified a critical resource that is central to that domain and is susceptible to depletion. In addition, studies have shown that self-regulation tasks and executive-functioning tasks interact with each other, suggesting that they may share resources. Other research has focused specifically on restoring what we propose is the shared resource between self-regulation and executive functioning. Utilizing a theory-based natural environment intervention, these studies have found improvements in executive-functioning performance and self-regulation effectiveness, suggesting that the natural environment intervention restores this shared resource.

Keywords

fatigue, restoration, attention, executive functioning, self-regulation

According to an old but memorable story, an inmate in an insane asylum protested that he was sane and demanded a hearing before a judge. The hearing was granted and the inmate gave a brilliant half-hour long presentation supporting his sanity. The judge was impressed; he informed the inmate that all he had to do was sign a document and he was a free man. The inmate signed his name as "Jesus Christ" (James, 1892).

Although everyday lapses are typically not this dramatic, running out of steam is by no means an unusual experience. Failures of competence and civility occur on a daily basis. If such symptoms are due to a great variety of deficiencies, then the problem will not be resolved quickly or simply. However there is growing evidence that a wide range of problems reflect the absence of a common resource. If this is indeed the case, then a solution might be more readily found. A further encouraging development is the discovery that depletion of what appears to be a similar resource can be corrected in a way that is inexpensive, low on negative side effects, and widely available.

This article grew out of what we see as an opportunity to encourage the study of an interrelated cluster of topics of considerable theoretical importance, which has substantial practical significance as well. Our goal is to show how these painful problems might be more effectively addressed through a synthesis of research and theory that draws upon a common resource to help explain cognitive patterns and adaptive approaches to self regulation.

Consider, for example, that recovering cancer patients are known to have severe work and marital difficulties well after they are considered to be in good health from a medical point of view (Winningham et al., 1994). Public housing, the object of enormous financial investments, offers another pertinent example. In several well-publicized instances, these expensive housing facilities have been considered so ineffective or counterproductive that they have ultimately been dynamited. Both of these problems (and many more like them) have resisted solution despite considerable (and sometimes heroic) effort. We will discuss these problems later in the manuscript, and show how a simple intervention can lead to improved outcomes in these settings. Therefore, this article offers not only theory, but also examples of positive applied results of the theory.

We begin by examining the evidence that *executive functioning*,[1] a high level cognitive mechanism, and *self-regulation* (Baumeister & Vohs, 2004; Bronson, 2000), a mechanism involving the capacity to behave oneself and resist temptation, are both dependent on a common resource. In order to make this argument convincing, we rely on the following types of evidence. The term *resource* implies that there is something in the system that is finite in quantity and depleted by heavy demands. Thus to demonstrate that executive functioning and self-regulation are both resource based, one should find that a demanding task in either domain leads to lowered effectiveness

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in that domain. In addition, to demonstrate that the same resource is common to both domains, one should find that heavy demands in either domain reduces the effectiveness of performance in the other. Furthermore, performance in either domain should be impaired by simultaneous demands for performance in the other domain. We cite evidence in each of these areas to support our hypothesis that there is a shared resource necessary for both self-regulation and executive functioning.

After establishing this link, we review a relevant body of theoretical work in environmental psychology that has spawned a variety of studies, many of which have surprising results. Both the theory and the resulting studies could in principle provide a framework for understanding this cross-domain convergence. Lastly, we both present an intervention aimed to restore this resource and describe subsequent research that has shown the efficacy of this intervention.

We are not claiming that the evidence supporting either the apparent convergence or the potentially relevant theoretical work is conclusive; rather, this cluster of theory and data constitutes a tantalizing possibility that is urgently in need of further study. We do feel that when this diverse body of material is brought together, the case it makes is reasonably compelling. Furthermore, we are convinced that the theoretical implications and potential applications are sufficiently important to merit more systematic and far-ranging study. Thus, the primary purpose of this article is to make the case that this emerging set of possibilities is thoroughly worth intensive investigation by many more researchers.

In Search of a Common Thread

To show that executive functioning and self-regulation share resources, we first describe studies in which the two tasks interact with each other. In these studies difficult acts of self-regulation alter executive-functioning performance and vice versa. After establishing this concept, we point to one of the resources/functions that is shared between these two tasks: namely, the need to direct or fix attention on certain stimuli while suppressing other stimuli. This ability has been known as an important operation in both the attention and memory literature, but it has not been applied systematically to self-regulation.

Linking of Executive Functioning and Self-Regulation

The crux of much of our theorizing relies on a shared resource between effortful self-regulation and executive-functioning tasks. These tasks all require effort, which depends on a resource that is finite in amount and relatively easily depleted. The following paragraphs cite evidence that the effort required for self-regulation is the same as that required for executive functioning; thus, persisting on a difficult self-regulation task will interact with and impair performance on an executive-function task and vice versa.

William James (1892) would hardly have been surprised to hear that self-regulation and executive function tasks seem to draw on the same resource. Although he did not speak of resource depletion or fatigue directly, he was quite clear about the issue of effort, from which one might reasonably infer that fatigue would follow. James proposed that volitional effort was characteristic of both self-regulation and what we would now call executive functioning, due to the centrality of attention for both. As he succinctly put it, ''Volitional effort is the effort of attention'' (1892, p. 317). The parallel experiential component in both cases suggests a possible evolutionary function. Effort could signal the potential exhaustion of a finite and valuable resource, thus making its cautious use more likely. Although James did not propose such a function, as a dedicated Functionalist he would presumably have favored it.

This is an important issue from a theoretical point of view. James hypothesized that nebulous concepts such as willpower and effort are composed of more concrete processes such as attention. This idea of attention underlying willpower and effort is a central theme of this article, and it will help us to more specifically identify the shared resource common to self-regulation and executive-function tasks.

Some of the strongest results linking self-regulation abilities with executive-functioning abilities come from Baumeister and colleagues. These controlled experiments center around the concept that the authors termed as *ego depletion*, which exemplify how acts of self-control can temporarily deplete self-regulation capacity (Baumeister, Bratslavsky, Muraven, & Tice, 1998; Tice, Baumeister, Shmueli, & Muraven, 2007; Vohs, Baumeister, & Ciarroco, 2005; Webb & Sheeran, 2003). In one of the first studies of ego depletion, Baumeister et al. (1998) found that being forced to eat radishes in the face of more attractive cookies or suppressing one's emotional expression and feelings both made participants less persistent when solving puzzles and less effective at solving those puzzles than participants in non-ego-depleting conditions. Here the task of self-regulation worsens performance on an executive-function task, suggesting that the two types of tasks share resources. Baumeister and colleagues have replicated similar findings in other ingenious paradigms, which all show an interaction between self-regulation and executive functioning (Schmeichel, Vohs, & Baumeister, 2003; Webb & Sheeran, 2003). In fact, in Box 1 of Baumeister, Vohs, and Tice (2007), many executive functions (e.g., fixing attention) and self-regulatory behaviors (e.g., managing emotions) are listed as being affected by the depletion of a shared resource.

In another example, Schmeichel et al. (2003) have shown that ignoring extraneous stimulation or stifling emotional distress responses worsens executive-functioning performance as measured by intellectual aptitude tests such as the Graduate Record Examination (GRE). It is interesting to note that these interactions between self-regulation and executive functioning only appear during the more difficult forms of information processing and do not worsen performance in general. These studies all provide evidence for the existence of resources common to both executive functioning and self-regulation.

In another study, Blair and Razza (2007) explored how self-regulation and executive functioning affect math and verbal ability in kindergarten-aged children. The authors found that executive-function ability (both inhibitory control and attention switching)[2] was correlated with self-regulation ability (parent- and teacher-reported effortful control) and that both of these abilities were correlated with math and verbal aptitudes. In addition, both executive-functioning and self-regulation abilities explained unique variability in predicted math and verbal aptitudes, suggesting that although both self-regulation and executive functioning are highly related, each may make unique contributions to learning.

In considering work of this kind, it is important to distinguish the core of the self-regulation concept from the various ways it is expressed. Self-regulation tends to pit one's intention against one's inclination: for example, refraining from performing an action that one is inclined to do (e.g., eating an unhealthy but tasty food) versus remaining true to one's intention (e.g., to maintain a healthy diet). Another example would be keeping a clean house (intention) versus walking away from a mess (inclination). Thus inhibiting a response can be seen as a common factor. Research in this area carried out by social psychologists often involves inhibiting socially inappropriate behavior. A good example of this is the work of von Hippel and Gonsalkorale (2005), who have shown that participants who have stronger cognitive inhibitory abilities (as measured by the Stroop task) are less likely to make a socially inappropriate response when asked by a Chinese experimenter to eat a chicken's foot (a Chinese delicacy). It is interesting that when participants were forced to divide their attention (by memorizing an eight-digit number throughout the experiment), they were unable to inhibit socially inappropriate responses regardless of their initial inhibitory abilities, suggesting that we are all limited in our capacity for response inhibition.

Another area of research is also relevant here: *stereotype threat*, which involves the fear of confirming a negative stereotype about one's group (e.g., Steele & Aronson, 1995). In these studies, when participants are made aware or are implicitly reminded of their group's negative stereotype, such as having poor performance on certain tasks, they perform worse on those tasks than if they are not made aware of these negative stereotypes (Steele & Aronson, 1995). These effects may be mediated by the fear of confirming the negative stereotype, creating a distraction that is difficult for participants to suppress as they perform the experimental tasks (and may be a reason why they exhibit impaired performance; Inzlicht & Good, 2006). Schmeichel et al. (2003) suggest that coping with stereotypes may deplete the self's executive and regulatory resources, which could lead to poorer performance on executive function tasks. Thus stereotype threat may provide one more example of how self-regulation (in this case coping with the fear of confirming a negative stereotype) interacts with executive functioning (performance on a standardized test). Although this connection is admittedly speculative, given the problems created by this phenomenon it seems well worth further exploration.

Other researchers have shown that after having persisted too long on a cognitive task that requires some form of inhibition, one is then impaired on a task requiring self-regulation and vice versa (Baumeister et al., 1998; Cohen & Spacapan, 1978; Glass & Singer, 1972; Richeson et al., 2003). These findings are also consistent with research focused on populations that show impaired performance on executive functioning and self-regulation tasks, presumably because of lower inhibitory capabilities and thus impaired attention (elderly, Castel & Craik, 2003; attention-deficit/hyperactivity disorder—ADHD, Schmitz et al., 2002; depression, Watkins & Brown, 2002; schizophrenia, Sapir, Henik, Dobrusin, & Hochman, 2001).

There are also neuroimaging data that support the notion that executive functioning and self-regulation share resources. For example, Posner, Rothbart, Sheese, and Tang (2007) point to evidence that the control of cognitions and of emotions are heavily reliant upon the anterior cingulate cortex.

In addition to the evidence linking shared resources between executive functioning and self-regulation, there are also indications that this resource is finite. Namely, one can engage in these executive-functioning and self-regulation tasks for only so long before one becomes depleted (Bargh & Chartrand, 1999; Baumeister et al., 1998; Baumeister et al., 2007)

All of these studies support the hypothesis that the processes and resources required for difficult cognition or executive functioning draw on many of the same resources as those required for self-regulation and that these resources are finite.

The Adaptive Value of a Limited Resource

Thus, there is evidence suggesting that self-regulation and executive functioning are likely to depend on a common resource. As these resource-dependent activities are important to survival, it might seem surprising that this resource is in limited supply. However, it must be remembered that the activities it supports can potentially interfere with other important activities. Consider the implications of possessing an unlimited quantity of this resource. This would make it possible, for example, to focus on certain portions of the environment for as long as one would like. This, in turn, gives one the capacity to ignore everything else for an indefinitely long time. Just as wild ungulates cheerfully consuming a patch of delicious foliage look up intermittently (reducing the likelihood that anything could sneak up on them), being too preoccupied to scan for potential hazards would also have been dangerous for our ancestors. Comparably, being able to resist temptation for an indefinitely long time would also have been maladaptive. Eating, mating, and responding sharply to an intruding neighbor are all activities that require control, especially for a social animal. But having the capacity to resist acting on any of these inclinations for indefinitely long periods of time would also be maladaptive. Although somewhat counterintuitive and admittedly speculative, we consider the limited quantity of this resource to be adaptive in the sense that having the ability to constantly override more innate tendencies is not always ideal

and that many innate processes are more efficient and favor selection.

There is another reason for suspecting that this sort of control would not serve us well if it were indefinitely resilient and was not experienced as costly. As we have seen, there are adaptive reasons for the limitation of this resource. Thus, if we had no warning that we were expending something that might urgently be needed at some later time, we might be tempted to use it in excess, not stopping until it was completely depleted. We would propose that in this way the experience not only of effort, but of increasingly great effort as we persevere, may serve as an indication that this precious resource is in danger of running out. As a consequence, moderation would automatically be fostered by the discomfort that accompanies resource depletion. In fact, Baumeister et al. (2007) offer a similar analysis in their statement that "ego depletion effects may occur because people start conserving their remaining strength" (p. 353).

Taken together, these various constraints suggest that it is not surprising that resource utilization requires effort. From an evolutionary perspective, effort may well serve both as a signal to the body that there is a cost involved in what it is doing, as well as an inducement to back off if possible, thus reducing expenditure of this important resource.

Attention Restoration Theory (ART)

Although the diversity of activities impacted by a depletion of this resource attests to its importance, it also presents a major challenge with respect to identifying the resource involved.

Two Types of Attention: Voluntary and Involuntary

ART (Kaplan, 1995, 2001) offers an approach to understanding what is being fatigued or depleted in these studies and suggests how this element or resource can be restored. ART is based on an extension of James's (1892) approach. James identified two types of attention, distinguished in terms of the effort involved in their use. One type, which he called *involuntary attention*, refers to attention that requires no effort, such as when something exciting or interesting occurs. James described stimuli that bring forth involuntary attention as having a "direct exciting quality." With characteristic exuberance, he listed examples of such stimuli: "strange things, moving things, wild animals, bright things, pretty things, metallic things, words, blows, blood, etc. etc. etc" (James, 1892, p. 88). James included in his list of involuntarily interesting stimuli such things as wild animals. One might interpret this as simply an act of "looking to discover what is going on" and hence assume that these interesting stimuli invoke an excitatory form of attention. However, an additional adaptive benefit of this rather powerful inclination may well lie in the greater safety of keeping a potential source of danger in sight as opposed to turning one's back to it.

A vivid illustration of the power of involuntary attention is provided by watching a young child experience his/her first snake in the wild. It is as if everything else in the world has disappeared. For this very reason, the strength of an innately fascinating stimulus constitutes a potential source of severe distraction such that an accident could readily occur (Larson & Merritt, 1991).

In contrast, forcing oneself to pay attention to something that is not particularly interesting requires a good deal of effort. James referred to this as *voluntary attention*; clinical neurologists now refer to it as *directed attention* (Morecraft, Geula, & Mesulam, 1993). Unlike involuntary attention, directed attention is not tied to particular stimulus patterns—it is generic or content-free. Another potential difference between directed attention and involuntary attention is the dependence on frontal and parietal brain regions that are involved in cognitive control; directed attention is more reliant on these frontal and parietal cognitive control structures whereas involuntary attention is less so (Corbetta & Shulman, 2002; Fan, McCandliss, Fossella, Flombaum, & Posner, 2005). It is these neural networks that mediate cognitive control processes that we believe underlie the resource in question.

Automaticity can also be used to distinguish between involuntary and directed attention; involuntary attention is automatically activated, whereas directed attention is not. As it turns out, however, there may not be a simple definition for what constitutes an automatic or nonautomatic process. In Moors and De Houwer's (2006) thoughtful review of this topic, they described automaticity as varying on a number of dimensions such as intentionality, goal directedness, goal dependence, controllability, bottom-up stimulus dependence (i.e., stimulus driven), consciousness, efficiency, and speed. To further complicate matters, each individual dimension does not exist in an all-or-nothing fashion (Bargh, 2006a, 2006b; Moors & De Houwer, 2006). We would argue that involuntary attention is more automatic than directed attention, as it is more autonomous and stimulus-driven and less goal-directed and controlled than is directed attention.

Just as it is difficult to define an action as being entirely automatic or not, we would argue that tasks of attention are not necessarily entirely voluntary or entirely directed; rather, tasks of attention vary in the proportion of involuntary and directed attention that is invoked. In addition, tasks that were once highly controlled as evidenced by performance and brain activation patterns can become less controlled and more automatic with practice as evidenced by changes in performance and brain activation (Chein & Schneider, 2005). These data suggest that tasks can change from requiring more directed attention to requiring less, thus becoming more involuntary in nature.

There are also neural data showing that, as we suggested earlier, directed attention and involuntary attention may have some different neural foci. For example, it could be argued that involuntary attention has some similarities to bottom-up attention, whereas directed attention may have more similarities to top-down attention. We make these comparisons because directed attention is less stimulus-driven than involuntary attention and thus would be more related to top-down attention, whereas involuntary attention would be more related to

bottom-up processing. Work on nonhuman primates has shown that bottom-up attention is driven more by parietal lobe neurons, whereas top-down attention is driven more by pre-frontal cortex (PFC) neurons (Buschman & Miller, 2007). Dissociations have also been found in human participants where top-down attention is mediated by more dorsal-anterior or dorsal-frontal and parietal cortical structures, whereas bottom-up attention is mediated more by the ventral frontal and temporal cortex as well as more subcortical structures (Corbetta & Shulman, 2002; Fan et al., 2005). It seems then that the two types of attention have some dissociable neural signatures, suggesting that the psychological processes mediating the two types of attention are likely to be at least somewhat distinct.

Attention and Effort

Some investigators in this area have questioned the correctness of James's assertion that involuntary attention is in fact effortless. Thus, for example, Ruff and Rothbart (1996, p. 29) pointed out the following:

> James suggested that voluntary attention always involves secondary or derived motivations. That is, involuntary attention is immediate and motivated by the intrinsic appeal of the topic or object; in contrast, voluntary attention is directed toward something intrinsically uninteresting because it serves a remote, but important, goal. James thus considered involuntary attention to be passive and effortless. Kahneman (1973, p. 4), however, writes: "Voluntary attention is an exertion of effort in activities which are selected by current plans and intentions. Involuntary attention is an exertion of effort in activities which are selected by more enduring dispositions." Enduring dispositions are defined as responses to factors such as novelty and to motivationally important features of events. We [Ruff and Rothbart] adopt Kahneman's view that both involuntary and voluntary attention can be either focused and effortful or dispersed and casual.

There exists widespread agreement that effort is an important component of voluntary or directed attention. The difference of opinion concerns whether all attention involves effort (as Kahneman asserts) or if automaticity in the domain of attention reduces or eliminates effort. At a phenomenological level, it seems clear that watching a lion hunting in its natural setting not only requires less effort than watching the derivation of a complex theorem (at least for many of us), but would be difficult not to watch.

There is also empirical evidence supporting the claim that all attention is not effortful. Abroms, Gottlob, and Filmore (2006) showed that alcohol only affected selective or directed attention as measured with a delayed ocular response task, but did not affect performance on a saccadic interference task in which attention is captured automatically and resolved automatically by inhibitory processes of the superior colliculus (Dorris & Munoz 1998; Munoz, Dorris, Pare, & Everling, 2000; Munoz & Istvan 1998; Reingold & Stampe 2002). Therefore, alcohol seemed only to affect the more effortful and intentional aspects of attention and not all types of attention. Research on ADHD has shown similar results in which children with ADHD were deficient on effortful attention tasks (such as memory recall) but not on more automatic attention tasks (e.g. recognition memory; Borcherding et al., 1988). This indicates that not all attention is effortful, as ADHD children can perform as well as controls on tasks that do not require effortful control of attention. In addition, Baumeister and colleagues would also argue against all attention being effortful as shown in their depletion studies in which effortful executive function tasks suffer from ego depletion and more automatic processes do not (Baumeister, Muraven, & Tice, 2000; Schmeichel et al. 2003). Likewise, Schneider and Chein (2003) theorize, as would Moors and De Houwer (2006), that effort level may distinguish automatic from controlled processing. Therefore, it seems that automatic or involuntary attention can be evoked without effort or at least with very little effort.

Judging from Kahneman's claim that "variations of physiological arousal accompany variations of effort" (Kahneman, 1973, p. 10), it appears that his position is based on his decision to use arousal as an indication of either stress or difficulty. Kahneman is undoubtedly correct in indicating that attempting to perform an effortful action is likely to lead to an increase in arousal. This is, however, not sufficient to award arousal the status of being an indicator of effort. In Kahneman's Figure 1-2 (Kahneman, 1973, p. 10) it is clear that there are other factors ("Miscellaneous Determinants") that also could lead to an arousal increase.

Although Kahneman does not specify what these other factors are, arousal plays a key role in memory enhancement (Kleinsmith & Kaplan, 1963, 1964; Kleinsmith, Kaplan, & Tarte, 1963). In this role, one might expect arousal to increase when something particularly noteworthy occurs, whether it is dangerous or unusual or even strikingly beautiful. The adaptive significance of this is clear. Of particular interest for present purposes is the fact that this category of events is distinctive for being particularly interesting, and research has shown that arousal levels increase when viewing interesting stimuli (Lang, Greenwald, Bradley, & Hamm, 1993). This would presumably include the many things that attract involuntary attention. It further seems reasonable to assume that paying attention to something that is noteworthy would not require effort. On the contrary, it would require effort not to pay attention to it. Thus, it appears to be highly unlikely that arousal is an appropriate choice as an index of effort. It would also appear to be highly unlikely that involuntary attention would require effort. In sum, there can be occasions when arousal does not signal effort, as shown by involuntarily interesting stimuli that are arousing but not effort-inducing to process.

From an evolutionary perspective, effort would be expected to serve as a negative feedback mechanism, encouraging the organism to cease its current activities before resource depletion becomes severe. This would seem to make sense with respect to overuse of muscles, as well as overuse of directed attention. It would seem far less sensible in the case of learning

material that is interesting, related to danger, or is otherwise arousal-increasing. This also seems to fit the intuitive notion that people encouraged to stop working and take a rest would be far more likely to do so than would people watching something of great interest.

If indeed some attention is characterized by automaticity (whether learned, innate, or a combination of both), then we are left with an interesting question: If effort is a correlate or signal of the depletion of a common resource, then might the automatic (and effortless) mode of attention provide an occasion for the organism to replenish that resource? If so, it would help explain why certain activities and certain environments appear to support such replenishment.

The Centrality of Attention

Before explaining the theory more fully, we should comment on a potential area of misunderstanding. In our theoretical treatment of the resource required for executive functioning and self regulation, our focus is on attention. Thus our analysis is premised on the paramount importance of attention in the behavior of the more cognitively oriented members of the mammalian species. It might appear that controlling attention is just one of many things the brain does and, as such, deserves no special notice. To understand why this is not the case, a historical perspective might be useful. One of the most important events in the understanding of the relation between brain and behavior was the overthrow of Behaviorism, which viewed the brain as a black box of no relevance to the study of psychology. Instead, Behaviorists focused on the role of the environment on behavior. The environment does, of course, have an important effect on behavior; their error was to assume that it was essentially all that mattered. In his counterattack on the behaviorists' view, Hebb highlighted the pivotal role of attention. In laying the groundwork for his analysis in *The Organization of Behavior*, he states, "In the simplest of terms, *attention* refers to a selectivity of response. Man or animal is continuously responding to some events in the environment and not to others that could be responded to (or 'noticed') just as well" (Hebb, 1949, p. 4).

In other words, if an organism were able to select which stimulus to focus on and which to ignore, the influence of the environment would be greatly reduced and the simplicity promised by Behaviorism would be revealed to be an illusion. It is for this reason that attention is not just another of the many things an organism can do, on par with wiggling a toe. The capacity to attend or ignore potential inputs radically changes the name of the game.

Attention in Context

Involuntary attention must have been at one time a profoundly adaptive force, as it automatically directed the organism's information processing toward things of importance in the environment. In the modern world, however, much of what is involuntarily interesting is not important. For example, images of things that were once important have been hijacked by advertisers and media managers for their own purposes. At the same time, as any grade school student could tell you, much of what is believed to be of great importance in the modern world is not all that interesting. Thus, in a world where the interesting may no longer be important and the important may no longer be interesting, a strange thing has happened. Involuntary attention, once a highly adaptive mechanism, is now often used against one's own best interests. Thus, directed attention becomes essential in pursuing one's purposes, especially as involuntary attention is increasingly irrelevant or even counter to these goals. In this very changed world, directed attention is called upon far more often than it once was and perhaps at times more often than it is capable of responding to.

An ART-Based Intervention

If indeed directed attention is, relatively speaking, overused in the modern world and still of great adaptive importance, depletion of this mechanism is a serious matter that is capable of causing considerable hardship and suffering. How can we restore such a vital resource?

ART has proposed a potential approach to facilitating recovery. It is based on the simple premise that directed attention might be more likely to recover if it is allowed to rest. There would appear to be three primary means of helping such rest occur. One could sleep (although the body only seems to put up with a certain amount of sleep). One could meditate, which does appear to be effective, although it takes knowledge and skill—and a bit of patience (Kabat-Zinn, 1990). The third means would be to utilize involuntary attention so as to not utilize directed attention. This idea is consistent with Bargh and Chartrand's (1999) conclusion that more automatic mental processes free one's limited voluntary (or conscious) attentional processes (Kahneman, 1973; Miller, 1956; Posner & Snyder, 1975).

That is, the requirement for directed attention in such environments is minimized, and attention is typically captured in a bottom-up fashion by features of the environment itself. Crucially, in ART, such bottom-up attention needs to be sufficiently gentle so as not to interfere with other thoughts and is referred to as *soft fascination*. Natural environments, such as parks, gardens, and lakefronts, are able to capture involuntary attention without monopolizing attentional channel capacity. At the same time, the requirements to direct attention are minimized. It is therefore hypothesized that after an interaction with natural environments, one is able to perform better on tasks that depend on directed attention abilities (Berman, Jonides, & Kaplan, 2008; Kaplan, 1995). Natural environments are certainly not the only environments capable of attracting involuntary attention without interfering with other thoughts, but do serve as good candidate environments that have been shown to restore directed attention abilities across a wide array of populations and situations.

Unlike natural environments, urban environments tend to be poor environments for restoring directed attention. Urban

environments tend to contain bottom-up stimulation that preempts capacity for other thoughts and also requires directed attention to overcome that stimulation (e.g., avoiding traffic, ignoring advertising), thus making urban environments less restorative (Berman et al., 2008). Therefore, what makes an environment restorative is the combination of attracting involuntary attention softly while at the same time limiting the need for directing attention.

Although ART derives from James's distinction between voluntary and involuntary attention, it also acknowledges a number of complications that call for a subtler theoretical formulation. First, the presence of automatic, effortless attention-holding stimuli (fascination) that softly attracts attention is very likely not the only factor that must be present for restoration to take place. ART posits three additional factors that contribute to restoration.

In addition to being fascinating, the environment in question must be compatible. In other words, the environment must not interfere with whatever purposes brought one to the setting. Thus, if one is in a hurry to get home before it rains, an otherwise lovely creek that stands in the way of the route home would fail the compatibility test. It also helps if the environment appears to be large enough to permit one to explore it or at least imagine exploring it. Thus, a single potted plant would fail the requirement for extent. And finally, a store filled with flowering plants would not meet the requirement for "being away" if it looks just like the workplace one is seeking a break from. Thus, although fascination is an essential aspect of a restorative environment, the other three requirements also play important roles.

It is important to explore the fascination concept in more depth to understand why soft fascination is so pertinent to recovery. Unlike soft fascination, *hard fascination* precludes thinking about anything else, thus making it less restorative. This may explain the limited restorative value of watching athletic events (Canin, 1991). Other examples of hard fascination include watching violence, sex, and intense competition. Soft fascination is exemplified by looking at a scenic view or an interesting painting, which allows for reflection.

Along these same lines, Zeigarnik (1927) demonstrated that unresolved problems tend to lead to persisting memories; further, such unresolved problems could produce interference and thus hinder cognitive functioning for other tasks (Berman, Jonides, & Lewis, 2009; Jonides et al., 2008; Lewandowsky, Geiger, & Oberauer, 2008; Wixted, 2005). Therefore, these unresolved problems could create a kind of internal noise that would lead to excessive demands on directed attention. This might not have occurred if these problems had been worked through and put to rest (i.e., had been reflected upon). Informal observation suggests that people often welcome involuntarily interesting stimuli that are so powerful that one is not disturbed by whatever is on one's mind. Such choices are essentially escapist; in other words, they preclude the very reflection that could facilitate the resolution of the disturbing cognitive process. Recent research has corroborated these themes. Pennebaker and colleagues have shown that writing about one's feelings and experiences can have therapeutic value by promoting reflection and limiting brooding (Gortner, Rude, & Pennebaker, 2006). In addition, such writing may also reduce the inclination to suppress the thoughts and feelings that lead to stress (Pennebaker, 1997). Kross and Ayduk (2008) have shown that self-distanced perspective taking can lead to better emotion regulation than distraction or self-immersed perspective taking. Distraction was shown to have only short-term benefits, whereas self-distanced perspective taking (i.e., reflection) had both long-term and short-term benefits. Taken together, these results suggest that reflecting on problems in constructive ways leads to their resolution, whereas distraction does not.

Television: A Popular Self-Distraction Device

As the analysis of the importance of reflection suggests, modern life brings with it innumerable complexities, puzzles, and frustrations. Although reflection can be helpful in reducing the internal noise, the process is not necessarily pain free. Many a modern individual would welcome a means of shutting down this internal clutter, and television offers a quick and effortless way to achieve this.

One might think that, far from being a problem, this handy electronic internal-noise-management system presents an ideal solution to this endemic problem. As we have seen, however, it does not. As television takes advantage of involuntary attention, it is easy to assume that watching is also effortless. However, there are certain contexts in which involuntary attention can lead indirectly to considerable effort. Consider what can occur in the context of conflict. When one's gaze is held by something painful to look at (such as a face disfigured by an accident), effort is often involved in trying to resolve the conflicting inclinations: to look and to look away.

Television is, as Mander (1978) so effectively points out, exquisitely designed to discourage one from leaving the channel one is watching. In other words, television creates attentional capture. One indication that this is an unsatisfactory state of affairs is that a large percent of television watchers wish that they could spend less time watching (Kubey & Csikszentmihalyi, 2002). Thus, the very act of watching would be likely to create a conflict situation. One indication that this is the case is that the longer people watch television, the more irritable they become. Thus the very activity that many people think of as recreational is in fact increasing mental fatigue rather than reducing it.

Although conflicted fascination is for the most part rare, it is not only common in the context of television, but possibly central to understanding its effects. As guilt and discontent are fairly common reactions to watching television (Kubey & Csikszentmihalyi, 1990), it is reasonable to assume than many people watch television more than they intend to. A growing body of research points to what is called a television addiction. In other words, people are unable to resist spending more time engaging in this activity than they would consider healthy or desirable. Therefore, it is not surprising that people report

Table 1. Summary of Studies Using Nature Interventions

Study	Sample	Nature contact	Design	Psychological outcome measures
Berman et al. (2008), Study 1	College students	2.8 mile walk	Within-subject	DSB
Berman et al. (2008), Study 2	College students	Slides	Within-subject	ANT, DSB
Berto (2005)	College students	Slides	Random assignment	SART
Cackowski & Nasar (2003)	College students	Video	Random assignment	Frustration tolerance
Canin (1991)	AIDS caregivers	Listed activities	Correlational	Questionnaire-based: robust functioning, restorative evaluation, caregiver fatigue
Cimprich (1993)	Cancer patients	20 min outdoors, three times/ week—primarily walking and gardening	Random assignment	Reciting the alphabet backwards, DSB, DSF, letter cancellation, SDMT
Cimprich & Ronis (2003)	Cancer patients	120 min of outdoor time per week	Random assignmaent	DSB, NCPC, SDMT, Trail-Making Tasks A and B
Kaplan (1984)	Wilderness program participants	10-day wilderness program	Pre–post	Questionnaire-based: psychological energy, simple life style, positive outlook, "hassle"
Kaplan (1993)	Office workers	Window view	Correlational	Questionnaire-based: job challenge, task enthusiasm, patience, general health
Kuo & Sullivan (2001a)	Public housing residents	Presence of trees and grass near residence	Random*	DSB, conflict tactics scale
Moore (1981)	Prison inmates	Prison cell view	Random*	Frequency of visits to health care facility
Ottosson & Grahn (2005)	Residents of home for elderly	1 hr outdoors and1 hr indoors	Within-subject	DSB, DSF, NCPC, SDMT
West (1986)	Prison inmates	Prison cell view	Random*	Frequency of visits to health care facility

Note. DSB = digit-span backwards; ANT = attention network task; SART = sustained attention to response test; DSF = digit-span forward; SDMT = symbol digit modalities test; NCPC = Necker Cube pattern control.
* Indicates that assignment was random, but the randomization was not experimentally controlled.

lower life satisfaction and more anxiety after watching TV (Frey, Benesch, & Stutzer, 2007).

Incisive and thoughtful as Mander's perspective is, it would be more reassuring if there were data that spoke directly to these issues. Fortunately, such data have been collected. Vividly aware of the problem of post hoc verbal report, Kubey and Csikszentmihalyi (1990) developed the experience sampling method, which they have used extensively.

As we have seen, Kubey and Csikszentmihalyi (1990) report that "guilt about watching TV is fairly common" (p. 145). Further, consistent with the nonrestorative effect, we hypothesized, "viewers tend to feel passive and less alert after viewing" (p. 172). Other indications that viewing does not produce the positive effects of the typical restorative environment are also evident from Kubey and Csikszentmihalyi's (1990) analysis of their data: "... people reported feeling relatively less relaxed, happy, and satisfied after viewing than after the other activities studied" (p. 134). In addition, they noted that "viewing is often driven by the wish to escape" (p. 172), which is, consistent with our hypothesis that television is not a healthy solution to the internal noise problem. Therefore, we conclude that TV is a counterproductive means of restoring directed attention.

Thus the short-term payoff of the distraction provided by highly fascinating stimulation (i.e., hard fascination) is obvious. However, the long-term outcome might be that the very problems that might benefit from some reflection do not get resolved. By contrast, the soft fascination offered by natural environments has been found to facilitate such needed reflection.[3] In the end, this needed reflection will expedite problem solving and free directed attention resources from having to manage these persistent problems in the long run.

Attention Restoration Studies

At this point, we have explained the theoretical basis of ART and how natural environments can serve to restore directed attention abilities. In this section, we summarize empirical evidence supporting this theory. Table 1 provides a sampling of the diversity of populations, settings, and sources of nature in studies generated by ART. Cumulatively, we believe these studies offer some support for ART; we also include them because one of the primary motivations for writing this article is to make the diversity of opportunities for research and treatment suggested by these findings more visible.

The studies presented in the table are unusual not only in using the natural environment as an independent variable, but also in their applied contexts. Applied research rarely permits random assignment or control over as many extraneous variables as would be possible in the laboratory. Nonetheless, applied contexts can reveal practical implications of realistic interventions.

Resource depletion is, of course, a common theme across all studies in this area, although the sources of the depletion vary. The lab studies tend to use demanding information processing tasks to create this deficit. The application-oriented studies, in contrast, identify individuals or groups experiencing the sorts of life problems that typically drain one's resources. They include being diagnosed with a life-threatening illness, caring for a partner with AIDS, being sufficiently old and functionally compromised to have been placed in a home for the elderly, being incarcerated, living in the uncertain and hazard-filled environment of a large urban public housing project, and (admittedly mild by contrast) coping with a demanding job or academic schedule.

Although the studies differ widely in context, there are many overlaps in the dependent variables. Many of the studies—both applied and lab-based—include performance measures that provide relatively objective assessments of attentional functioning. Other studies use these in combination with self-report measures or rely exclusively on participants' assessment of their functioning.

The table lists the studies in alphabetic order. A more informative grouping, however, may be in terms of their context. Many of the earliest studies (Canin, 1991; Cimprich, 1993) focused on issues of health or health care. Several studies under the direction of Kuo and Sullivan (2001a, 2001b) were carried out in the context of a bleak public housing facility in Chicago. Other studies involved a wide range of topics and contexts related to outdoor settings, including recreational hiking and a 2-week wilderness program, as well as more passive contact with nature provided by the view from the window (e.g., in dormitories, prisons, and workplace). More recently, several researchers have focused on studying these issues in the laboratory context, using information processing tasks and restorative interventions involving either nature scenes or walks in a natural environment.

It may be useful to discuss a few of these studies in more detail. Cancer patients are known to have work and marital difficulties well after they are considered to be in good health from a medical point of view (Winningham et al., 1994). Based on the hypothesis that the problem might be attentional, Cimprich (1993) studied breast cancer patients during the course of treatment and recovery. Participants were randomly assigned to either the experimental or control group for the 12-week duration of the study. The former involved having each participant sign a contract agreeing to participate in three restorative activities (lasting at least 20 min each) per week. The control group was not told about restorative activities until the study was completed. Although the notion of restorative activities was explained in broad terms, participants generally selected nature-based activities (such as walking in nature and gardening) to fulfill their contracted time.

Performance on the set of attention measures used in this study (digit span forward, DSF; digit span backwards, DSB; and two trail-making tasks) revealed severe performance deficits shortly after surgery for some participants. Over the course of the ensuing treatment (either radiation or chemo), the participants were repeatedly tested using these measures. The experimental (restorative) group showed steady improvement; the control group did not. Further, the restorative-group participants went back to work sooner and were more likely to return to full-time work. Another striking difference was the inclination of members of the restorative group to start new projects (e.g., learning a language or losing weight). The control-group participants reported no new projects. Finally, experimental-group members showed significantly greater gains on quality-of-life ratings.

What is particularly remarkable about this study is the effect of a very modest intervention (an activity of at least 20 min carried out three times per week) on a problem that, according to the literature in this area, has the capacity to undermine people's lives for a matter of years (Blesch et al., 1991; Winningham et al., 1994).

A Chicago public housing facility provided the context for a research program conducted by Kuo, Sullivan, and their students. Although self-selection is a likely threat to validity in residential contexts, in this case, as documented by Kuo (2001), the study can assume random assignment given the constraints placed on residents in being placed in the housing project. The research program concerns the impact of access to natural environments (with a particular emphasis on trees) on cognitive abilities. The participants, however, did not consider vegetation in making their choice when offered a housing unit. When the researchers inquired about this issue, almost all participants (93%) indicated it made no difference; vegetation was no differently available for the remaining 7% than it was for the rest of the sample.

Kuo and Sullivan (2001a) found that residents who had nature near their apartments were less likely to use aggression and violence in dealing with problems. For our purposes, another striking aspect of their findings was that a statistical analysis showed that this effect could be explained by differences in attention and memory capacity as measured by DSB (i.e., those with nature views had greater attention and memory capacity, which may have mediated their lower aggression levels).

Ottosson and Grahn (2005) studied the effects of nature on elderly people in a nursing home. Each participant performed the DSF, DSB, and the Symbol Digit Modalities Test tasks before and after an hour spent either indoors or outdoors to test participants' directed attention capacities. All participants participated in both conditions in a counterbalanced fashion. The results of the study were that the hour outdoors in nature improved directed attention capacity significantly more than the indoor intervention. This study was particularly interesting in finding significant results on each of these measures of attention, despite a small sample.

Cackowski and Nasar (2003) studied the possibility that the availability of nature views while driving might reduce the incidence of road rage. Participants watched one of three videos taken while driving on highways with different amounts of vegetation and different degrees of spatial edges provided by trees. The higher the level of natural scenery, the greater the

frustration tolerance the participants demonstrated on a subsequent task.

Berto (2005) provides another current example of the positive effects of nature. The study involved performing the sustained attention response task (SART), which is a modified go/no-go task, before and after viewing pictures. These pictures consisted of restorative environments (lakes, trees, mountains, etc.), nonrestorative environments (skyscrapers, buildings, streets, etc.), or geometric figures, depending on the group. Participants who viewed the restorative pictures improved their performance on the SART task (as measured by reaction time and sensitivity). Participants who viewed either of the other two categories of pictures showed no improvement in SART performance.

In addition, Berman et al. (2008) have shown that simple walks in a park can have restorative effects on working memory as measured by the DSB task, which has a large attentional component as items must be moved in and out of the focus of attention. The participants in these studies were healthy college-age students, which suggests that the benefits of restoration can be applied to a wide range of people. In addition, these same findings were replicated when participants viewed pictures of nature. It is important to note that when the attention network test (Fan et al., 2005; Fan, McCandliss, Sommer, Raz, & Posner, 2002) was used as a dependent measure, only the executive portions of the task that required directed attention were improved, showing the selectivity of improvement to directing attention.

Sleep and meditation may also have restorative benefits similar to nature interventions. Chervin et al. (2006) found that children previously diagnosed with ADHD show reductions in ADHD-like symptoms after having tonsillectomies, which improve sleep in these children. In fact, a year after having tonsillectomies, half of the children once diagnosed with ADHD were no longer diagnosed with ADHD. Here, it seems that improvements in sleep were associated with improvements in self-regulation.

Kaplan (2001) has also hypothesized that meditation may be able to restore directed-attention abilities, and others have found that meditation did alter activity in brain circuits that are active in executive functioning and self-regulation tasks, as well as performance on such tasks (Cahn & Polich, 2006; Davidson et al., 2003; Tang et al., 2007). In addition, Tang et al. (2007) found other physiological changes with meditation such as reductions in cortisol concentration.

Researchers have also found other ways to restore directed attention by offsetting the effects of ego depletion. For example, Webb and Sheeran (2003) found that forming implementation intentions, which are subordinate goal intentions (e.g., "Once situation *X* occurs, I will do *Y*"), offset the effects of ego depletion, lengthened the amount of time participants would work on insolvable puzzles, and improved Stroop performance to nondepleted participant levels. In addition, improving mood by watching a comedy video or receiving a surprise gift has also been shown to reduce the effects of ego depletion (Tice et al., 2007).

However, it is important to note that these interventions (forming implementation intentions and improving mood) may not actually restore cognitive abilities, but may instead raise participants' pain thresholds to continue performing arduous cognitive tasks, even though continuing is quite uncomfortable. In fact Baumeister et al. (2007) point out that "... none of these procedures clearly counteracts the depleted state in the sense of replenishing the depleted resource. Rather, they may all operate by inducing the person to expend more of the depleted resource" (p. 353). It would thus be dangerous to advocate any of these procedures as a means to improve self-regulation and executive functioning. In fact, Muraven, Shmueli, and Burkley (2006) show that people attempt to preserve self-control resources knowing the scarcity of their resources, but such interventions may hide how depleted a person is and worsen performance even further on future tasks.

Thus evidence from a variety of sources speaks to the potential usefulness of an intervention based on ART to improve cognitive executive functioning and self-regulation. Although contact with natural environments is not unique in its therapeutic value, it has been tested and found to be a successful restorative intervention across many domains, tasks, and participant populations.

Today's world presents numerous challenges to maintaining one's focus. It offers a plentiful supply of interesting but unimportant stimulation, whereas many important stimuli lack interest. Thus, people must ignore much of what surrounds them. This act seems to require frontal and parietal brain mechanisms that mediate cognitive control and are susceptible to fatigue. In order to replenish these resources, a person should engage in activities high in soft fascination that will activate involuntary attention in nonconflicting ways. We have cited a variety of studies that show how interacting with such environments can restore and even improve directed attention abilities.

Challenges

The Glucose Alternative

Other researchers have argued for a different shared resource between executive functioning and self-regulation. Gailliot et al. (2007) have found that low levels of glucose in the blood stream are related to worse executive-functioning and self-regulation performance. Further, when glucose levels are elevated by consuming a glucose drink, performance on these measures improves. In addition, glucose levels seem only to affect the more difficult executive-functioning and self-regulation tasks, and do not affect performance in general, which is in line with our predictions that only difficult executive-functioning and self-regulation tasks will deplete directed attention capabilities, as directed attention is not needed for more automatic forms of processing. Masicampo and Baumeister (2008) also found that consuming glucose (drinking lemonade) eliminated more heuristic decision making amongst fatigued participants but drinking lemonade with artificial sweeteners had no impact. In addition, consuming

glucose only improved performance for participants who were fatigued, suggesting that the effect of glucose is most pronounced amongst fatigued individuals. Lastly, Gailliot (2008) has suggested that glycogen, stored energy in the brain, may also have strong associations to executive functioning and self-regulation.

It is, therefore, interesting to consider the possibility of multiple shared resources between executive functioning and self-management. For example, other physiological measures, such as heart rate variability, have been found to be reliable forecasts of self-regulatory effort and can predict persistence on a cognitive task (an anagram task; Segerstrom & Nes, 2007). In addition, it would be interesting to uncover the interactions between directed attention fatigue and glucose depletion.

Along these same lines, Baumeister et al. (2007) list a myriad of behaviors that may be affected by resource depletion, and it is quite possible that such a variety of behaviors would be affected by multiple resources. It is important, then, to consider the ways glucose and nature restoration differ with respect to the behaviors that are affected, the durability of the effects, and the contexts in which they can be applied.

Who's in Charge: The Chain of Command Alternative

The idea that the shared resource between executive functioning and self-regulation is based on frontal and parietal cognitive control mechanisms might lead one to wonder "who's in charge" of directed attention.

It is, however, not unusual for behavior to depend on the activity of a sequence of brain structures, such that damage to any one of them can undermine the capacity to generate that behavior. For example, Davidson and colleagues have shown that the regulation of negative emotions is mediated by a neural circuit involving the PFC and the amygdala in which inhibitory connections from the PFC to the amygdala suppress negative emotions (Davidson, Jackson, & Kalin, 2000; Davidson, Putnam, & Larson, 2000). Dysfunctions in this neural circuit may lead to susceptibility to depression and violence (Davidson, Jackson, & Kalin, 2000; Davidson, Putnam, & Larson, 2000) and therefore undermine successful cognitive functioning.

In this situation, one might argue that the PFC is controlling or regulating amygdala activation to suppress emotional responding as an autonomous controller. Alternatively, one could view the relationship between the PFC and the amygdala as a chain of command or network with different nodes having different responsibilities and functions. In many cases, it is important to regulate emotions; in others, it is not. Therefore we would assume a relationship between the PFC and amygdala in which neural signals could flow in both directions, rather than a hierarchical relationship of PFC commanding the amygdala. This same conceptualization could be applied to the different neural mechanisms involved in directed and involuntary attention; Corbetta and Shulman (2002), for example, outline a model of the relationship between these two networks in the service of attention.

Conclusion

The parallel findings across different methods, contents, and problems are noteworthy. They point to the existence of a resource that plays a wide-ranging role in self-regulation activities, is central to information processing or executive-functioning tasks, and is susceptible to depletion.

We have discussed both theoretical and empirical grounds for concluding that this resource may well be what William James called *voluntary attention* (and what clinical neurologists call *directed attention*). Using an evolutionary perspective (and with more than a little help from James), ART posits a means of facilitating the recovery of directed attention. ART has received support from a variety of studies utilizing different methods and different participant groups.

ART would appear to offer the potential to contribute in a wide variety of contexts. It offers an intervention with no known side effects that can be taken in a wide range of dosages. Initial studies have shown this approach to be helpful in treating a broad range of psychological problems, from information processing limitations, to aggression, to recovering from the disturbing cognitive side effects of cancer. At the same time, however, it is not an approach that has been widely adopted.

We have identified a variety of circumstances that appear to involve a resource deficiency that responds to a natural environment intervention. Our focus on natural environments is due to the quantity of work already done in this area, which provides a basis for confidence in the effectiveness of this kind of intervention. Although the diversity of problems studied might be regarded as a collection of special cases, it is striking that many of these phenomena have long been known to be problematic but have not been identified as different versions of the same underlying malady. On the surface, for example, the struggles of a recovering cancer patient and the difficult lives of residents of public housing might be thought of as having little in common. In fact, researchers hypothesized on theoretical grounds that directed attention depletion is common to both groups.

This raises the possibility that there might well be a variety of circumstances that reflect similar underlying problems and might respond to similar interventions. Schäfer (2002) raised a comparable theme with respect to neurasthenia. He suggested that this once common, fatigue-centered malady might have resurfaced as one or another of what he calls "its modern variants."

Given the variety of unexpected discoveries of underlying impairments that respond to the same intervention, it seems likely that there may be others as well. Thus, a broad-based program of research seems called for. Clearly, it would involve a focus on fatigue and fatigue-like states that might accompany a wide variety of life challenges.

What makes this area particularly exciting at this time is the existence of two apparently quite distinct interventions. In addition to the natural environment intervention, the glucose intervention has been found to be effective under carefully controlled conditions. As we have seen, the natural environment

interventions have been studied with a diverse range of participants in a variety of real world contexts. It would be most interesting to find out if the glucose intervention is similarly broad in its effectiveness and to study the relationship, if any, between these two apparently dissimilar approaches.

Other areas of needed research involve studies of the effectiveness of the different interventions on both the currently identified resource-deficient circumstances and those uncovered by the proposed expanded focus on the ailments whose common bond is the presence of debilitating fatigue.

1. The growing recognition of resource depletion (that is both due to and necessary for self management and executive functioning) points to the importance of both identifying the resource and determining if some means exist for facilitating its recovery.
2. Research and theory in environmental psychology point to certain kinds of environments that have the capacity to play this role. For pragmatic and theoretical reasons, natural environments have been the most frequently studied restorative interventions, with a relatively high success rate.
3. Further research is needed in several related areas. First, the range of contexts and illnesses in which resource depletion of this kind might play a role is large. Psychologists from many backgrounds would be needed to study these possibilities. In addition, the parallel emergence of two quite different interventions for aiding the recovery of the resource raises numerous fascinating questions. It would be most helpful to know how long each lasts, how general their respective effects are, and whether either is subject to habituation.

We hope that by gathering multiple sources of evidence and offering a theoretical basis for the effectiveness of an intervention that is little known but has received considerable attention outside of psychology, more research will follow. Studying the range of potential impact of such interventions would benefit from the skills and knowledge of psychologists representing most if not all of the many specialties within the field.

Notes

1. Executive functions represent a set of cognitive control processes that are thought to mediate attention and memory. Executive functions are heavily involved in planning or decision making, error correction or troubleshooting, unlearned actions and responses, dealing with dangerous or challenging situations, and overcoming strong habitual responses or temptations (Norman & Shallice, 2000). These functions are mediated neurally by frontal brain systems.
2. The authors used a peg-tapping task to measure inhibitory control and an item selection task to measure attention switching.
3. Cimprich (1993; Cimprich & Ronis, 2003) has long worked with recovering cancer patients, including attending support group meetings. She reports (personal communication) that it is common at these meetings for recovering patients to talk about how supportive of reflection they find being in nature. This is consistent with the work of Herzog, Black, Fountaine, and Knotts (1997), who report that participants rate natural environments as being more likely to support reflection than other environments.

Acknowledgments

This work was supported in part by the National Science Foundation Graduate Research Fellowship Program and the Cognitive Science Cognitive Neuroscience Certificate program. We would also like to thank Rachel Kaplan for her many helpful suggestions and insights.

Declaration of Conflicting Interests

The authors declared no conflicts of interest with respect to the authorship and/or publication of this article.

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