THE INFLUENCE OF STATE AND TRAIT ENERGY ON SELF-REGULATORY BEHAVIOUR

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ABSTRACT

Self-regulation is a highly adaptive process that enables goal-directed behaviour; however, individuals often fail to self-regulate successfully. Failures of self-regulation in the domain of health may be particularly harmful especially for those with chronic diseases. The Energy Model articulated by Baumeister and colleagues proposes that all acts of self-regulation rely on a single, finite energy resource. Thus, one possible explanation for self-regulation failure is insufficient energy. In the current research, four studies examine the relationship between the construct of energy, which can manifest in state or trait form, and self-regulatory success. Past research has demonstrated that individuals who perform two sequential tasks requiring self-regulation perform worse on the second task (the self-regulatory fatigue effect). The Energy Model proposes that this performance decrement can be explained by energy depletion. If this is true, then state energy should mediate the self-regulatory fatigue effect. A series of three experimental studies (studies 1-3) were designed to test this hypothesis. In Study 1, participants were randomly assigned to a gaze regulation task or to a no-regulation control group (as in Schmeichel et. al, 2003) before they watched a brief video clip. Following this first task, all participants worked on a second self-regulatory task (solving anagrams). Persistence and performance on this second task were the dependent measures and energy was measured before and after the initial video task. Contrary to the predictions of the Energy Model, the self-regulatory fatigue effect was not replicated in this study and so the mediating potential of energy could not be tested. However, ratings of task difficulty and effort suggested that individuals in the gaze regulation condition did not find this task to be very challenging. Accordingly, a second study was designed that added an additional level of self-regulatory demand by asking participants to rehearse a 7-digit number during the video clip (memory regulation). When this was crossed with the gaze regulation manipulation, four conditions were created: no regulation, gaze regulation only, memory regulation only and memory + gaze regulation. Study 2 then followed the same approximate procedure as Study 1, with individuals randomly assigned to one of the four conditions. The results of this study were consistent with Study 1 in that the self-regulatory fatigue effect was not replicated. However, the manipulation check suggested that some of the participants in the gaze regulation conditions may not have adhered to experimental instructions and the conditions may have differed in the degree to which they were enjoyable and interesting to participants. Accordingly, a third study used an eye-tracker to assess self-regulation during the video task and evaluated aspects of task engagement. Study 3 followed the same procedures as Study 2. Eye-tracker data verified significant differences between the groups in terms of self-regulation during the initial video task; however, there were no other significant between group differences. Taken together, these 3 studies indicate that the self-regulatory fatigue effect may be less robust than previous research would suggest. An unexpected finding was the high degree of variability in the energy measures, which implied that individual differences in energy may be important to consider. Accordingly, Study 4 prospectively examined the role of dispositional energy in the self-regulation of diet and exercise behaviour by testing whether energy moderated intention-behaviour concordance in a sample of individuals newly diagnosed with Type 2 diabetes. This study demonstrated that energy predicted future exercise behaviour in this sample and provided some preliminary support for the hypothesis that individuals with higher levels of dispositional energy may show more intention-behaviour concordance than those with lower levels of dispositional energy. Overall, these 4 studies provide some tentative support for the role of dispositional energy in the implementation of health behaviour, but do not support the Energy Model's predictions regarding self-regulatory fatigue.

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LIST OF ABBREVIATIONS

ACC	Anterior Cingulate Cortex
CNS	Central Nervous System
CT	Control (no self-regulation) Condition
GR	Gaze-Regulation Condition
HIV	Human Immunodeficiency Virus
GPA	Grade Point Average
IM	Integrated Model
MFSI-SF	Multidimensional Fatigue Symptom Inventory-Short Form
MR	Memory Regulation
MR+GR	Memory Regulation + Gaze Regulation
NCI	National Cancer Institute
PAR	Physical Activity Recall
PASE	Physical Activity Scale for the Elderly
POMS-SF	Profile of Mood States, Short-Form
SAT	Scholastic Achievement Test
STD	Sexually Transmitted Disease
T1	Time 1
T2	Time 2
T2DM	Type 2 Diabetes Mellitus
TPB	Theory of Planned Behaviour
TRA	Theory of Reasoned Action
TST	Temporal Self-Regulation Theory
WHO	World Health Organization

CHAPTER 1: GENERAL INTRODUCTION

The importance of exerting control over one's thoughts, feelings and behaviours has been almost universally emphasized (Baumeister, 2005). On an individual level, self-regulation allows human beings to resist temptations, to persist in the face of failure and discouragement and to override undesirable habitual responses. Despite the importance of these behaviours, human beings often struggle to self-regulate effectively. While social, economic and political factors undoubtedly contribute, many of the problems facing modern societies, including obesity, overspending, teenage pregnancy, impulsive crime and substance abuse also partially reflect failures of self-regulation (for a review, see Baumeister, Heatherton & Tice, 1994). One possible explanation for the phenomenon of self-regulation failure is insufficient energy (Baumeister, Heatherton & Tice, 1994; Heatherton & Baumeister, 1996). The four studies described in subsequent chapters of this document were designed to investigate the hypothesized relationship between energy (both in state and trait form) and self-regulatory success.

Defining Self-Regulation

Within the psychological research literature, the phenomenon of self-regulation is a topic of considerable interest. A psychINFO search using "self-regulation" as a search term yielded 4,709 unique citations published between the years of 1990 and 2006, from perspectives as diverse as sports psychology, health psychology, industrial/organizational psychology, developmental psychology, forensic psychology, neuropsychology and clinical psychology (see Sniehotta et.al, 2005, Porath & Bateman, 2006, Barrett, 2005, Looman, 2005, Luu , Tucker & Makeig, 2004 and Nigg et al., 2005 for examples). Across these different subject areas, self-regulation has typically been conceptualized in one of three ways: 1) as a cognitive process, 2) as a behavioral act, or 3) as a personality trait encompassing both of the former.

The cognitive approach to self-regulation assumes that human beings are "proactive, aspiring organisms" (Bandura, 1996, p.20), reflecting the notion that the individual is fundamentally agentic. As such, early conceptualizations of self-regulation emphasize its intentional, evaluative and decisional elements. For example, Bandura's (1991) Social Cognitive Theory of self-regulation proposed that human behaviour is regulated by the "exercise of self-influence" and "forethought." Individuals are proposed to monitor their behaviour, judge it with reference to a personal standard and then adapt behaviours accordingly (Carver & Sheier, 1981, proposed a similar model). Accordingly, cognitive models emphasize the role of higher brain functions like planning, goal-setting and self-reinforcement.

Self-regulation can also be defined in purely behavioural terms. Emerging from the field of behavioural economics, these theories use neobehavioristic principles to explain self-regulation (see Ainslie, 1996 and Rachlin, 2000 for examples). Within these models, self-regulation could be operationally defined as a choice of a larger, more delayed outcome over a smaller, less delayed outcome. Some research in animals (for example, pigeons) has demonstrated that non-human animals do, in fact, display behaviour that is suggestive of self-regulation (see Rachlin, 2000; Logue, 1996). Thus, a behavioural approach assumes that self-regulation can be explained purely in terms of environmental contingencies.

A third approach is to understand self-regulation as a personality construct. This approach has its origins with Freud (1923/1960), who postulated that self-regulation was the domain of the Ego, a psychic structure responsible for balancing the desires and demands of the Id, the ideals of the Superego and the limitations imposed by external reality. While theorists today remain divided as to whether self-regulation can be thought of as an independent personality trait or an ability underlying many different facets of personality (see discussion in Gramzow et al., 2004), research in this area does suggest that individuals differ in their ability to self-regulate (i.e., self-regulatory capacity) and that these differences emerge early in life and are stable over time, although they can be modified through training and experience (e.g., Mischel, Shoda & Rodriguez, 1989).

In the current research, self-regulation refers to any effort on the part of an organism to alter thoughts, feelings or behaviours (Baumeister, Heatherton, & Tice, 1994). Common acts of self-regulation that have been studied include controlling emotions, suppressing thoughts, resisting unhealthy foods, coping with stress, and enduring physical discomfort (e.g., Baumeister, Bratslavsky, Muraven & Tice, 1998; Muraven, Baumeister & Tice, 1999; Baumeister, Faber & Wallace, 1999; Vohs & Heatherton, 2000; Tice, Bratslavsky, & Baumeister, 2001; Schmeichel, Vohs, & Baumeister, 2003). Implicit in this conceptualization is the notion that in order to pursue goals effectively, it is often essential to “override” automatic, habitual, or innate behaviours, urges, emotions, or impulses that would otherwise interfere with the achievement of these goals (Baumeister, Heatherton, & Tice, 1994; Kanfer & Karoly, 1972). The term self-regulatory capacity thus reflects an individual’s *ability* to direct their own responses in a manner that facilitates successful goal achievement.

Why is Self-Regulation Important?

Having the ability to self-regulate is often beneficial (Baumeister, Heatherton & Tice, 1994; Baumeister, 2005). Research in this area has demonstrated that there are measurable individual differences in self-regulatory capacity, that these differences are stable over time, and that they can have important implications for physical and social functioning. For example, Mischel, Shoda and Rodriguez (1989) demonstrated that children’s ability to delay an immediate reward in favour of a larger, more valuable reward predicted their social competence, their ability to deal with stress and even their scholastic achievement well into adolescence (Mischel, Shoda &

Rodriguez, 1989; Shoda, Mischel & Peake, 1990). More recently, an empirical study by Tangney, Baumeister and Boone (2004) established that those who scored highly on a scale of trait self-control had higher grade point averages, reported fewer symptoms of psychopathology, demonstrated less binge-eating and alcohol abuse, had better relationships and interpersonal skills, and reported more optimal emotional responses than those scoring lower on the same scale. Failures of self-regulation, on the other hand, have been implicated in a number of harmful behaviours, including substance abuse, crime and violence, gambling and excessive spending, procrastination and sexually transmitted diseases (Baumeister, 2003; Vohs & Baumeister, 2004).

Conscious vs. Automatic Self-Regulation

It is important to emphasize that self-regulation does not occur exclusively on a conscious, deliberative level. In fact, research on self-regulation has demonstrated that a great deal of goal-oriented behaviour, perhaps the majority, occurs at a non-conscious level (Fitzsimons & Bargh, 2004; Bargh & Chartrand, 1999). So, how can goal pursuit occur in the absence of conscious intention? One theory holds that goals or intentions are internally represented in the same way as other cognitive constructs. These representations can then be activated automatically by particular features of the environment, by internal stimuli, or by situational cues strongly associated with the pursuit of these goals (Fitzsimons & Bargh, 2004; Neal, Wood & Quinn, 2006). Research supports the notion that the self-regulation of cognitive processes, emotional states and behaviours can be influenced by goal or task-relevant stimuli of which participants are unaware (e.g., see Bargh & Chartrand, 1999; Bargh, Gollwitzer, Lee Chai, Barndollar & Trotschel, 2001). For example, research on implementation intentions suggests that if individuals consciously form intentions that link a specific situational cue (situation X) to a particular goal-directed behaviour, Y, framing these in terms of if-then contingencies (if X happens, I will do Y), they are more successful at self-regulation than those who do not form such intentions

(Gollwitzer, 1993; Gollwitzer, 1999). It has been hypothesized that this strategy is effective because implementation intentions target specific cues, which then automatically activate goal-related cognitions when encountered. In this way, individuals are able to delegate some control of their behaviour to the environment, a strategy that appears to facilitate self-regulation (see Bargh & Chartrand, 1999).

Bargh and colleagues (2001) and Fitzsimons and Bargh (2004) set out to compare conscious and non-conscious self-regulation. They demonstrated that non-conscious self-regulation manifests many of the same motivational features as conscious self-regulation; that is, individuals pursue goals even in the face of obstacles, nonconscious goals often become stronger over time and individuals continue to pursue goals even after disruption. One area where the two processes appear to differ, however, is in the degree to which they are perceived as effortful; whereas non-conscious regulation occurs automatically and without any exertion, a significant body of evidence now suggests that our capacity for conscious self-regulation relies on a finite energy resource that is quite limited (e.g., Baumeister et al., 1998; Muraven, Tice & Baumeister, 1998; Gailliot et al., 2007).

Given that “automatic” self-regulation appears to be effective and is not subject to the same limitations as conscious self-regulation, one may wonder why conscious, or intentional, self-regulation is necessary at all. One explanation is that it may be that the self-regulation that occurs at a conscious, deliberative level is disproportionately important. Baumeister et al., 1998, offer the analogy of the steering wheel of a car. While a car may be driven straight the vast majority of the time, the very small percentage of the time that it is actively being “steered” strongly impacts the likelihood of the car reaching its destination. By the same token, the relatively few active, conscious, controlling choices we make may greatly increase our chances of achieving our goals.

How Does Conscious Self-Regulation Work?

One of the most influential models of self-regulation in contemporary psychology was proposed by Carver and Scheier (1981) and by Carver (1979). This model proposes that self-regulation typically occurs as a feedback loop, or TOTE (Test-Operate-Test-Exit) loop. One common example of a TOTE loop is a room thermostat: in the initial test phase, there is a comparison of current circumstances (i.e., current temperature) to a standard (desired temperature). If there is a discrepancy, then there is a phase of operation (the thermostat turns on the furnace). Following this, there is another test, to assess whether the goal has been reached or not: if it has, the system exits the loop and the cycle ends (example from Baumeister, Heatherton & Tice, 1994). The feedback loop analogy has been criticized as being overly simplistic (e.g., see Bandura, 1996); however, it remains a useful heuristic to understand self-regulation in general and self-regulation failure in particular. In order for individuals to successfully self-regulate, they must not only have appropriate standards (i.e., goals) and a means to monitor progress towards these, but they must also be able to operate upon themselves or their environment in order to bring about desired changes.

Similarly, in their seminal work, Baumeister, Heatherton and Tice (1994) identify a number of general patterns and mechanisms of self-regulation failure. These can be broadly subsumed under the titles "underregulation" and "misregulation." Misregulation involves the exertion of control over oneself in a way that fails to achieve the desired effect whereas underregulation refers to a failure to successfully exert control. Misregulation may occur in cases where individuals hold goals that are unrealistic or misguided (e.g., by attempting to control something that is not controllable) or when they focus self-regulatory efforts on an irrelevant aspect of a problem. An example of misregulation would be trying to suppress an unwanted thought by forcing it out of mind, an act which is likely to create strong vulnerabilities to resurgences of the unwanted thought (Wegner, 1994). Unlike misregulation, where actions are ineffective, underregulation typically refers to a failure to act, acting with insufficient strength or failing to resist acting. It has been hypothesized that underregulation may occur for a number of different reasons, like goal conflicts (e.g., King, 1996) or intra-psychic processes like denial (e.g., Pervin, 1996). However, the primary reason identified by Baumeister and colleagues for underregulation is a lack of strength or energy (e.g., see Baumeister, Heatherton & Tice, 1994; Heatherton & Baumeister, 1996).

The Energy Model

The concept that self-regulation relies on energy is not a new one. For example, Aristotle envisioned an energetic contest between the rational and the non-rational aspects of the soul, which he termed the "reason" and the "appetite." Much like modern self-regulation research, Aristotle observed that the reason often failed. This "weakness of will" was thought to occur both as a consequence of temporary energy depletion and as a more enduring behavioural pattern. When the appetite consistently overpowered the reason, he argued a character trait called akrasi" which literally translated means "lack of mastery" could develop (Aristotle; Nichomachean Ethics). Akrasia, in turn, could be attributed to either impetuosity or weakness. The former can roughly be equated to modern-day impulsivity, while the latter refers to a chronic deficit of energy. Subsequent theorists have often disagreed as to whether weakness of will should be attributed to situational demands or characterological factors; however, the notion that self-control requires energy is one that has re-emerged a number of times throughout history (Charlton, 1988).

In modern times, the notion that self-regulation relies on energy has been re-introduced several times, and one example is the research by Baumeister and colleagues. Within the framework of this Energy Model, all self-regulation can be conceptualized as a contest of strength; the power of the impulse and its resulting tendency to act, against the power of the self-regulatory mechanism to interrupt that response and prevent that action (Baumeister, Bratslavsky, Muraven & Tice, 1998; Heatherton & Baumeister, 1996). Integral to this model is the notion that the energy available to the self is limited, that it can be depleted, and that it takes time to be replenished. It is also assumed that all acts of self-regulation draw on a common, finite energy source and that when this energy has been drained by prior acts of self-regulation, performance on subsequent self-regulatory tasks will be impaired (e.g., see Baumeister et al., 1998; Vohs & Heatherton, 2000).

What is Energy?

Although the Energy Model proposes that self-regulation relies on energy, the nature of the "energy" involved has not been clearly articulated. However, Baumeister and colleagues (1994) assert that this energy is likely to be "biologically-based," a notion consistent with past conceptualizations (e.g., Freud, 1960). Research on physiological energy has demonstrated that fatigue, defined as a lack of energy, has important affective, motivational, cognitive and physiological consequences (Davis & Bailey, 1997; Blomstrand, 2001; Wessely, 2005). These, in turn, impact significantly on an individual's quality of life (Stahl, 2002).

Fatigue can be conceptualized either in terms of one's subjective experience (i.e., feelings of tiredness, decreased alertness), or in terms of measurable decrements in work or performance following exertion (Torres-Harding & Jason, 2005). While both conceptualizations are important, subjective fatigue complaints do not always correspond with the physiological manifestations of fatigue (Berrios, 1990). Accordingly, a wide range of self-report instruments have been developed to measure subjective fatigue (Christodoulou, 2005).

There is increasing evidence that fatigue is not a unitary construct, and distinctions are often drawn between physical or bodily fatigue and mental fatigue (Christodoulou, 2005). When referring to physical fatigue, it is possible to distinguish between peripheral fatigue and central fatigue (Davis & Bailey, 1997). Peripheral fatigue focuses on measurable dysfunction within the muscles of the body, while central fatigue refers to processes that occur within the Central Nervous System (CNS; Davis & Bailey, 1997). To date, the majority of research conducted on fatigue has focused on peripheral fatigue, and far less is known about central fatigue (Davis & Bailey, 1997; Wessely, 2005). This is striking, especially considering the fact that central fatigue is the most likely cause of fatigue complaints in daily life and it is the form of fatigue most likely to be associated with debilitating illnesses like Chronic Fatigue Syndrome, Multiple Sclerosis and cancer (Davis & Bailey, 1997; Blomstrand, 2001; Swain, 2000; Wessely, 2005). A number of potential neurotransmitters (including serotonin, dopamine and acetylcholine) and neuromodulators (e.g., cytokines, ammonia, amino acids) have been proposed to contribute to central fatigue; however, the mechanism is not well-understood (for a review, see Davis & Bailey, 1997).

One reason that central fatigue may not have received the same level of research attention as peripheral fatigue is that it is difficult to measure objectively (Wessely, 2005). Functionally, central fatigue can be defined as a force generated by voluntary muscular effort that is less than that produced by electrical stimulation (Davis & Bailey, 1997). However, some researchers have advocated for a broader definition, in which central fatigue is defined as a “subset of fatigue (failure to maintain the required or expected force or power output) associated with specific alterations in CNS function that cannot reasonably be explained by dysfunction within the muscle itself” (Davis & Bailey, 1997, p. 47). Central fatigue may be particularly important to studies of self-regulation because it has been shown to be closely tied to perceptions of effort, such that individuals who are centrally fatigued perceive tasks as more effortful (e.g., Blomstrand, 2001). Indeed, it has been noted that the earliest indication that central fatigue may be imminent is an increased perception of effort at the same level of physical demand (Davis & Bailey, 1997).

Central fatigue has also been linked to mental fatigue, and it has been suggested that the two may, in fact, be the same thing (Boksem, Meijman & Lorist, 2006; Watanabe, Kato & Kato, 2002). Mental fatigue is thought to result from either sustained mental effort, or psychological and somatic disorders (van der Linden & Eling, 2006). Research on mental fatigue in recent years has demonstrated that mental fatigue strongly impacts cognitive processes, including those posited to underlie self-regulation. For example, individuals who perform cognitively demanding tasks for 1.5 to 2 hours have been shown to perform worse than controls on subsequent tasks involving behavioural monitoring, attention and executive function (Lorist et al., 2000; van der Linden, Frese & Meijman, 2003; Boksem et al., 2006; Lorist, Boksem & Ridderinkhof et al., 2005). Recent research has linked these behavioural errors to reduced activity in the anterior cingulate cortex, a region of the brain often implicated in planning and regulating behaviour (ACC; Lorist et al., 2005).

Taken together, the research on central fatigue suggests that fatigue, or lack of energy, can have a negative impact on an individual's ability to self-regulate. Interestingly, these deficits appear to be somewhat specific, in that tasks requiring more automatic processing (e.g., simple memory tasks) do not appear to be affected (e.g., see van der Linden et al., 2003). Consistent with the Energy Model, it appears that as energy is depleted through prolonged or repeated exertion, individuals begin to perceive tasks as more effortful and they tend to perform more poorly. These effects can be mitigated somewhat if individuals are sufficiently motivated (e.g., see van der Linden et al., 2003); however, some deficits remain, suggesting that this performance decline is not simply a consequence of conscious disengagement due to a perceived effort/reward imbalance (Lorist & Tops, 2003).

If the performance deficits associated with fatigue are, in fact, the result of low energy, one would expect that these might be offset if fatigued individuals were provided with an energy supplement. Studies investigating the effect of caffeine on cognitive function have examined this question. In a recent review paper, Lieberman (2003) noted the consistent finding that caffeine in rested individuals appears to have a relatively specific function, producing reliable effects on parameters such as vigilance and feelings of fatigue but having limited effects on higher cognitive functions like memory and reasoning. However, when individuals are low in energy it appears that these effects become much more generalized and pronounced. For example, a study by Lieberman, Tharion, Shukitt-Hale, Speckman and Tulley (2002) demonstrated that in sleep-deprived naval recruits the administration of caffeine mitigated the effects of stress relative to placebo and sleep on tasks assessing visual reaction time, a matching-to-sample test (assessing short-term spatial working memory and pattern recognition) and a repeated acquisition test (assessing motor learning and short-term memory). Caffeine also decreased ratings of fatigue in a dose-dependent way that correlated with improvements in cognitive function. Similarly, Hogervorst, Riedel, Jeukendrup and Jolles (1996) found that administering caffeine following a vigorous physical workout significantly improved performance on measures of executive function and memory (most notably, on the Stroop color word task, a task requiring self-regulation). These findings are important because they suggest that as long as one has adequate energy reserves, the effects of adding more energy are quite limited. However, in situations where energy has been depleted, even relatively small doses of caffeine (e.g., 200 mg) can significantly “boost” self-regulatory capacity.

A second form of energy has been explored by Gailliot and colleagues (2007), who tested the hypothesis that glucose may act as a “fuel” for self-regulation. In a series of experiments they demonstrated that acts of self-control produced measurable changes in blood glucose and that low levels of glucose after an initial self-control task predicted poor performance on a subsequent self-control task. Consuming a glucose drink also appeared to mitigate the effects of self-regulatory fatigue. Thus, it appears that self-regulation is associated with measurable changes in an energy resource (blood glucose). These results are consistent with research demonstrating that blood glucose is used by brain structures (including those involved in self-regulation; see Mead et al., 2002). The authors propose that perhaps their findings help to explain the self-regulatory fatigue effect, a common pattern of results predicated on the Energy Model of self-regulation.

Self-Regulatory Fatigue

Evidence supporting the Energy Model comes primarily from using an experimental paradigm in which two different tasks requiring self-regulation are administered sequentially. The rationale for this is simple; if self-regulation is dependent on a limited internal energy source, then a first act of self-regulation should expend some of that energy thereby depleting the amount of energy available for subsequent tasks. If this is true, there should be observable differences in performance on a second self-regulation task between groups required to self-regulate and groups not required to self-regulate on an initial task.

Baumeister and his colleagues have demonstrated that performing an initial self-regulation task can impair performance on subsequent tasks, and this impairment does not appear to be domain-specific. For example, it has been demonstrated that both restraining oneself from eating chocolate while forcing oneself to eat radishes and making a difficult choice significantly reduces persistence on a task requiring one to trace an impossible figure (Baumeister, Bratslavsky, Muraven & Tice, 1998). Participants asked to suppress the expression of their emotions during emotionally-charged film clips perform worse than those who simply watch the film clips on tasks involving solving anagrams and holding a handgrip closed (Baumeister et al, 1998; Muraven, Tice & Baumeister, 1998). Participants instructed to not think of a white bear while writing stories performed worse than those who simply wrote the stories on persistence on solving anagrams (Muraven, Baumeister & Tice, 1999). These findings are consistent with the notion of a general resource model where all self-regulatory efforts draw on the same energy source. If this energy source is seen as finite in nature, then one act of self-regulation drains this source, leaving less available for subsequent acts of self-regulation (i.e. self-regulatory fatigue).

Competing Explanations for the Self-Regulatory Fatigue Effect

Time perception hypothesis

It is possible that the self-regulatory fatigue effect could be explained with reference to something other than energy. For example, Vohs and Schmeichel (2003) suggested that perhaps self-regulation alters one's subjective experience of time. In a series of four experiments, they found that participant's perception of the duration of an activity was significantly affected by self-regulation. That is, individuals who regulated their emotions while watching a sad video clip believed the task lasted much longer than individuals who did not actively regulate their emotions while watching the same clip. In a second study, participants who exaggerated their emotions while reading an essay aloud perceived the task to take longer gave up more quickly on the task than those who simply read the essays. The authors conclude that individuals engaged in an effortful self-regulatory task perceive the task to take overly long and give up more quickly than those not engaged in self-regulation. A true test of the Energy Model, therefore, would need to demonstrate that the self-regulatory fatigue effect is due to a decrease in energy, rather than a distortion in one's sense of time.

Mood hypothesis

The mood hypothesis proposes that distressed individuals may fail at self-regulation because they believe that indulging their impulses will help to improve their mood. Support for this hypothesis was found in a series of studies by Tice, Bratslavsky, and Baumeister (2001) who manipulated mood by having participants read either a negative or positive story. They demonstrated that participants in a negative mood self-regulated less successfully than those in a positive mood; however, this effect was only seen when participants believed that their mood was changeable (i.e., when specifically informed that indulging their impulses would not impact their mood due a "mood freezing" manipulation, participants in a negative mood did not perform worse than controls). This pattern was seen on a variety of self-regulation tasks, including resisting unhealthy foods, forcing oneself to practice math equations and delaying gratification on a computer task. Thus, mood may be a competing explanation for the self-regulatory fatigue effect.

Self-Regulation and Health Behaviour

Failures of self-regulation may be particularly harmful in the domain of health behaviour. Many of the well-known risk factors for chronic disease are behavioural in nature, and therefore potentially modifiable. Indeed, the World Health Organization (2005) estimates that if known behavioural risk factors were eliminated (i.e., smoking, physical inactivity and poor nutrition) more than 80% of heart disease and Type 2 diabetes and more than 40% of cancers could be prevented. Currently, 60% of deaths around the world are due to chronic diseases, like heart disease, stroke, cancer, chronic respiratory diseases and diabetes (WHO, 2005, p.1). Chronic diseases account for double the number of deaths from infectious diseases (including HIV/AIDS, malaria and tuberculosis), maternal and perinatal conditions and nutritional deficiencies combined (WHO, 2005, p. 3).

Traditional intervention approaches have tended to focus on health education. However, it has increasingly become clear that individuals sometimes act in health-damaging ways despite having sufficient knowledge of the risks, suggesting that education is a necessary, but not sufficient solution. For example, as part of a national survey in 1996-97, Canadians were asked questions about the effects of tobacco on health. Only 4% of respondents agreed with the statement that that tobacco had “no health risks” (Statistics Canada, 1999). In this same, nationally representative group, 97% of respondents agreed that lung cancer was related to smoking, 95% agreed that respiratory ailments like emphysema and athsma were related to smoking, 94% agreed that heart disease was related to smoking and 85% agreed that smoking was related to stroke. During the same time period, 28% of Canadians admitted to smoking tobacco (Statistics Canada, 1999). This discrepancy suggests despite knowledge of the health risks, a proportion of the population continues to engage in a behaviour that, quite literally, places their lives at risk. Indeed, the human and economic costs of smoking are staggering; recent analyses indicate that the direct and indirect costs of smoking per year in Canada are approximately $7.8 – 11.1 billion dollars (for more detail see Stephens, 2000).

Research suggests that similar patterns exist for other kinds of health behaviour. For example, approximately two-thirds of New Year’s Resolutions refer to health behaviour (especially weight loss, smoking cessation and exercise initiation; see Curry & Marlatt, 1985; Norcross, Mrykalo & Blagys, 2002). Despite these good intentions, as many as 25% of resolutions are broken within the first week alone (Norcross, Ratzin & Payne, 1989) and less than 20% of resolvers remain successful after two years (Norcross & Vangarelli, 1989). It should be noted that those who form intentions to change behaviour are approximately 10 times more likely to engage in the desired behaviours than those who do not form such intentions (Norcross, Mrykalo & Blagys, 2002).

Nevertheless, it is clear that among those who intend to change their behaviour, there is a significant proportion that fails to do so successfully.

Despite this discrepancy, theories of health behaviour tend to focus heavily on intentions. For example, the Theory of Planned Behaviour (TPB; Ajzen, 1991) and the Theory of Reasoned Action (TRA; Fishbein & Ajzen, 1975) posit that behaviour is most proximally determined by intentions to perform the behaviour. Similarly, theories like the Transtheoretical Model (TTM; Prochaska, DiClemente, & Norcross, 1992), which conceptualizes health behaviour as occurring in a series of stages, beginning with pre-contemplation (in which one is not even thinking about changing) and ending with maintenance (in which the desired behaviour has been maintained and individuals are focusing on relapse prevention), also emphasize the intentional nature of health behaviour change by invoking the decisional balance construct, which is thought to mediate stage progression (Janis & Mann,1977).

Fishbein and colleagues (2003) set out to investigate the intention-behaviour link utilizing an Integrated Model (IM) of behavioural prediction based on the Health Belief Model, Social Cognitive Theory, the Theory of Reasoned Action and the Theory of Planned Behaviour. Longitudinal data on HIV and STD risk behaviours, determinants of condom use and biological outcomes was collected at 4 time points. In addition to this, direct and indirect attitudes, subjective norms, self-efficacy, intentions and self-reported use of condoms were assessed. Of those participants who reported high intentions to use a condom consistently with their partners at baseline, only 46% of males and 51% of females reported successfully achieving these goals at follow up (Fishbein, Hennessy, Yzer & Douglas, 2003). The authors conclude that while the social-cognitive variables included in their model were good at predicting intentions to change behaviour, they performed poorly when predicting actual behaviour for individuals who had indicated high intentions to change at baseline.

Similarly, a meta-analytic review by Webb and Sheeran (2006) examined interventions aimed at changing both the intentions and behaviours of individuals. For this review, only experimental studies that manipulated intention and assessed the effect of this manipulation on subsequent behaviour were included, so as to eliminate the influence of spurious intention-behaviour correlations. In the 47 studies that met the inclusion criteria, interventions employed had a medium-to-large mean effect size on intentions, according to Cohen's (1992) criteria (d = .066). The same interventions had a small-to-medium effect on actual behaviour change (d = .036). This finding indicates that while intentions have a significant effect on behaviour, it may be a smaller one than correlational research would suggest.

Intentions clearly are important in predicting both health risk and health protective behaviours, typically explaining approximately 20-40% of the variance in behaviour (Sutton, 1998). However, it is possible that biologically-based variables like energy, which may impact one's ability to implement these intentions (i.e, self-regulatory capacity) explain some of the remaining variance, particularly among motivated individuals (Hall & Fong, 2007).

The Energy Model and Health Behaviour

While research using the Energy Model to examine health behaviour is limited, some studies suggest that energy is an important factor in predicting health behaviour. Vohs and Heatherton (2000) examined the predictions of the Energy Model in a sample of chronic dieters. In a series of three studies, chronic dieters were compared to non-dieters. Following an initial task in which participants were required to self-regulate (e.g., by refraining from eating tempting snacks or suppressing their emotions by inhibiting reactions to a sad video) participants engaged in an ostensibly unrelated second task (e.g., sampling ice cream, working on an unsolvable figure task). In all three studies, the results suggest that both the existence of chronic inhibitions (ie., dieting) and experimental manipulations requiring effortful self-regulation decreased participants' ability to self-regulate. More importantly, when eating ice cream was the dependent measure, dieters who had self-regulated on an initial task ate more ice cream than both non-dieters and dieters who had not self-regulated on the initial task. This suggests that even relatively minor acts of self-regulation requiring energy can impair one's ability to regulate health behaviour successfully.

In another study of male social drinkers, Muraven, Collins and Nienhaus (2002) demonstrated that participants who suppressed their thoughts consumed a higher amount of alcohol and had higher subsequent blood alcohol levels than those who did not suppress their thoughts in a situation where all participants were motivated to limit their intake (participants were told that they would have to complete a driving test later on). In a subsequent study, Muraven, Collins, Shiffman and Paty (2005) tested the Energy Model in a sample of undergraduate drinkers. The influence of intentions to limit alcohol intake on subsequent behaviour were assessed. The use of an electronic diary method allowed the experimenters to examine both individual differences in self-regulation (between-subject analyses) and fluctuations in self-regulatory strength over the course of the day (within-subject analyses). Their results indicate that on days when participants reported experiencing more self-control demands than average, they tended to drink more alcohol, became more intoxicated and were more likely to report violating personal limits on alcohol intake than on days when participants experienced fewer self-control demands after controlling for mood and urge to drink. Ratings of self-control demand were completed prior to drinking behaviour in all cases. However, this relationship was moderated by trait self-control; that is, individuals high in trait self-control were less affected by self-control demands than individuals lower in trait self-control. These findings suggest that both state and trait variations in energy are likely to be important in predicting the self-regulation of health behaviour.

The significance of self-regulation to health behaviour becomes even clearer when health behaviour is considered from the perspective of an emerging theory, Temporal Self-Regulation Theory (TST; Hall & Fong, 2007). TCT emphasizes the fact that the costs and benefits of engaging in health behaviours in the long-term and the short-term are dramatically different. Most health-protective behaviours have benefits in the long term (e.g., better health, improved physical appearance) but are associated with numerous costs in the short term (e.g., inconvenience, discomfort). Health-damaging behaviours, on the other hand, show the opposite pattern. For an overweight individual, eating unhealthy foods may be associated with a variety of immediate benefits, including convenience, feelings of pleasure, avoidance of hunger symptoms and greater comfort in social situations; there are often few immediate costs. In the long-term, however, individuals who are overweight are at increased risk for cardiovascular diseases, Type 2 diabetes, osteoarthritis and certain types of cancer. They are likely to die several years earlier than their normal weight counterparts, and they are far more likely to suffer from disability prior to death (Popkin, Kim, Rusev, Du & Zizza, 2006).

Empirical data supports the theoretical proposition advanced by Hall and Fong (2007). Hall, Fong, Epp and Elias (2006) conducted a study involving 398 young adults who were asked to predict when the anticipated costs and benefits of engaging in health protective behaviours were likely to occur. As predicted, their results demonstrate that the costs of healthy behaviour were perceived to occur, on average, at the time of engaging in the behaviour itself. Benefits, on the other hand, were perceived to occur hundreds of hours after performing the behaviour. Researchers have demonstrated (e.g., see Ainslie, 1996; Frederick, Lowenstein & O'Donoghue,

2003) that humans are disproportionately influenced by short-term rather than long-term contingencies. As such, maintaining a healthy lifestyle can easily be construed as a particularly challenging form of self-regulation. Given that the short-term contingencies are those most salient at the moment where one makes a decision to engage or not to engage in a given behaviour, self-regulation is often required in order to resist tempting health-damaging behaviours and to initiate health-promoting behaviours. If the Energy Model is correct, and these acts of self-regulation require energy, then individual differences in energy should predict health behaviour.

Rationale for Current Research

The notion that successful self-regulation requires energy has a long history, but relatively few studies have examined the relationship between these variables empirically. Research using Baumeister's Energy Model has begun to examine these questions, but some significant gaps in the literature were noted. First, the assumption that the self-regulatory fatigue effect can be explained by energy depletion has not been tested using valid and reliable measures of energy. Second, research on this model has been conducted almost exclusively in undergraduates, and has focused on between-group differences. There is a need to expand this model to include dispositional energy, to examine the relationship between energy and self-regulation in different populations and to study more complex and meaningful self-regulatory behaviors (i.e., health behaviour).

The current research was designed to test the overall hypothesis that energy, which can manifest both as a stable character trait and as a subjectively experienced state, is associated with self-regulatory success. In Studies 1-3, this was accomplished by testing whether energy mediates the self-regulatory fatigue effect. To date, only a few previous studies in this field have examined energy or fatigue, and these have yielded inconsistent results (e.g., see Baumeister, Bratslavsky, Muraven & Tice, 1998; Muraven, Tice & Baumeister, 1998). The current research utilizes more targeted and specific measures of energy, both current (state) and over the past seven days. It also explicitly examines the potentially confounding effects of mood and time perception. Study 3 expands on previous research by introducing a novel and objective measure of self-regulation (an eye-tracker), which allowed for the measurement of differences between the experimental conditions in terms of self-regulation during the initial self-regulation task. Study 4 extends the research into the field of applied health behaviour with a clinical population. If, as the Energy Model suggests, self-regulation relies on energy, then individuals with higher levels of energy may be able to implement their intentions more successfully. Accordingly, this study examines whether dispositional energy is prospectively associated with health-protective behaviours and whether it moderates intention-behaviour concordance with regard to diet and exercise behaviour among individuals with Type 2 diabetes.

Together, these four studies represent an important test of the Energy Model. Studies 1-3 examine a central assumption of the model in a controlled experimental setting. Study 4 expands the scope of the research by testing the model's predictions in a new domain. Thus, these findings not only have theoretical implications for the Energy Model, but also may be relevant to the design and implementation of behaviour change interventions in the domain of health.

CHAPTER 2: INTRODUCTION TO STUDIES 1, 2 & 3

The current research investigates the relationship between self-regulatory success and the construct of energy, which can manifest in state or trait form. The following chapter describes a series of three experimental studies, modeled after those of Baumeister and colleagues, that were designed to test whether “state” energy mediates the self-regulatory fatigue effect.

These studies closely approximated previous studies examining the Energy Model, and used experimental tasks that have been shown to produce and be sensitive to self-regulatory fatigue in the past. In each study, the hypothesized mediator, energy, was measured at two points in time, immediately before and immediately after the initial self-regulation task, and energy over the past seven days was measured at baseline. In addition to including new measures of energy, these studies also tested the predictions of the mood and time perception hypotheses, both of which are competing explanations for the self-regulatory fatigue effect.

Study 1 was designed to test the mediating potential of energy on the self-regulatory fatigue effect in a straightforward conceptual replication of Schmeichel et. al, 2003. However, this study failed to replicate the self-regulatory fatigue effect and so the mediational hypothesis could not be tested. Study 2 addresses some of the limitations of Study 1 by increasing the level of self-regulatory demand. Study 2 revealed some group differences in persistence on the second self-regulatory task; however, these did not follow a pattern typical of self-regulatory fatigue and suggested that aspects of task engagement may be important. It was also possible in Study 2 that individuals in the gaze regulation conditions may not have been self-regulating as instructed. Accordingly, Study 3 included an objective measure of self-regulation (an eye-tracker) to assess self-regulation during the initial video task, and included questions about how interesting and enjoyable the tasks were. Despite measurable differences in self-regulation as assessed with the eye-tracker, no significant between group differences were found. The implications of these findings are discussed.

This series of studies was approved by the Behavioural Ethics Research Board at the University of Saskatchewan on September 22nd, 2004. Modifications for the second study were approved on August 10th, 2005, and the third study was approved on July 26th, 2006.

CHAPTER 3: DOES ENERGY MEDIATE THE SELF-REGULATORY FATIGUE EFFECT?

Self-regulatory capacity refers to an individual's ability to direct thoughts, feelings, impulses and behaviour. This capacity is potentially adaptive in that it allows individuals to respond flexibly to changes in their environments and to forego immediate gratification in favour of long-term rewards. Failures of such instances of self-regulation may contribute to a wide range of difficulties including interpersonal aggression (DeWall et al., 2007), lack of sexual restraint (Gailliot & Baumeister, 2007), impulse buying (Vohs & Faber, 2007) and educational underachievement (Duckworth & Seligman, 2005).

In recent years, there has been increasing interest in the biological underpinnings of self-regulatory capacity. For example, there is strong evidence that cognitive factors are related to behavioural self-regulation (e.g. Hall, Fong, Epp & Elias, 2008; Paus, 2001), and there is increasing evidence that energy (which can manifest in state and trait form) may be an important determinant of self-regulatory success (e.g., Lieberman et al., 2002; Hogervorst et.al, 1996).

Baumeister and colleagues have argued that any effort to control thoughts, feelings or behaviours is subjectively fatiguing (The Energy Model; Baumeister, Heatherton & Tice, 1994; Heatherton & Baumeister, 1996). According to this model, self-regulation requires energy and all acts of self-regulation draw on a common energy resource. However, energy is limited and subject to depletion. Therefore, an implication of this model is that a preceding act of self-regulation may impede ability to perform a subsequent one (e.g., see Baumeister, Bratslavsky, Muraven & Tice, 1998; Vohs & Heatherton, 2000).

As described earlier, the Energy Model primarily has typically been tested using an experimental paradigm in which two different tasks requiring self-regulation are performed in sequence, and decrements in performance are observed on the latter task relative to a control group (the self-regulatory fatigue effect). The primary assumption is that poorer performance on the second task is due to the fact that performance on the first has drained a crucial resource (e.g., energy) that reduces self-regulatory capacity for the second.

Baumeister and his colleagues have generally found support for these propositions. For example, in one study, participants were asked to attend an experiment assessing taste perception after refraining from eating for three hours prior to participating. Upon arrival at the lab, participants were randomly assigned to either a chocolate or radish condition. They were then asked to wait in a room in which chocolate chip cookies had recently been baked. In the chocolate condition, participants were permitted to eat some of the cookies, while in the radish condition participants were instructed to eat radishes and to refrain from eating the cookies. The experimenter then left the participant alone in the room for five minutes. Following this initial task, participants were asked to trace a geometric figure without lifting their pen from the page, a task that was impossible. Participants in the radish condition persisted on this second task for an average of 8.35 minutes, as compared to those who ate chocolate (18.90 minutes) and those control participants who did not participate in the initial "taste test" but went immediately to the second task (20.86 minutes; Baumeister et al., 1998).

This pattern has been replicated in other studies, using different self-regulation tasks. For example, participants asked to suppress the expression of their emotions during emotionally-charged film clips performed worse than those who simply watched the film clips on tasks involving solving anagrams and holding a handgrip closed (Baumeister et al, 1998; Muraven, Tice & Baumeister, 1998). Similarly, participants instructed to not think of a white bear while writing stories gave up sooner on an anagram task than those who simply wrote the stories (Muraven, Baumeister & Tice, 1999). These findings are consistent with the notion of a general resource model where all self-regulatory efforts draw on the same finite energy resource and initial acts of self-regulation impair capacity to perform subsequent tasks.

The following three experimental studies were designed to test whether energy mediates the self-regulatory fatigue effect. They build on the work of Baumeister and colleagues, but utilize more specific measures of current (state) energy, and control for individual differences in baseline energy.

Study 1

Study 1 was a conceptual replication of Schmeichel, Vohs and Baumeister, 2003. To test the hypothesis that initial self-regulation would induce a decrement in subsequent task performance, and that this effect would be mediated by energy depletion, participants were randomly assigned to one of two conditions: 1) Gaze Regulation (GR), and 2) Control (CT). In both conditions, participants viewed a video clip with distracting words shown on the bottom of the screen. In the GR condition, participants were instructed not to look at these words; in the CT condition, participants were instructed to simply watch the clip. Both groups then completed a second self-regulation task (solving anagrams). To test whether or not experimental effects were mediated through energy depletion, energy was assessed using the vigour subscale of the Profile of Mood States, Short Form (POMS-SF) and a subjective energy rating scale.

If the Energy Model is correct, performance of the initial self-regulation task in the GR group should result in lower performance on the second self-regulation task relative to CT (the self-regulatory fatigue effect). If energy mediates this effect, larger decreases in subjective energy and vigour should occur from pre- to post manipulation would occur among those in the GR condition than among those in the CT condition.

The primary mediator, energy, was measured at two points in time (before and after the initial self-regulation task). Average energy over the past 7 days was assessed at baseline using the vigour subscale of the Multidimensional Fatigue Symptom Inventory, Short Form (MFSI-SF). Given that there are other potential mediators of the self-regulatory fatigue effect, including time perception and mood (e.g., see Tice, Bratslavsky, & Baumeister, 2001; Vohs & Schmeichel, 2003), negative affect was assessed using the Profile of Mood States (POMS) depression subscale, and participants were asked to estimate how long the initial self-regulation task took.

Method

Participants

Sample size for this study was estimated based on Cohen's (1992) recommendations. Effect sizes reported in Schmeichel et. al (2003) were large, ranging from d= .97 to d=1.61 . To detect a large effect size with 80% power at an alpha of .05 for 2 conditions, at least 52 participants were required. In total, sixty-four undergraduate psychology students participated for course credit. The mean age of participants was 20.01 years (*SD*= 4.75) and 74.6% of the sample was female (*n*= 47). The majority of participants were Caucasian (*n*= 49); 8.1% self-identified as Asian (*n*= 5), 6.5% as Metis (4), 3.2% as Aboriginal (*n*= 2) and 3.2% as Middle Eastern (*n*= 2). Participants who provided incomplete responses for a given dependent measure were excluded from the relevant analyses for all three studies.

Measures

Measures used in this study can be found in Appendices B and C. They are described in further detail below.

Multidimensional fatigue symptom inventory, short form (MFSI-SF)

The MFSI-SF was originally developed to measure fatigue symptoms in cancer patients (see Stein et al., 1998). It is a 30-item measure that has five empirically-derived subscales: general fatigue, physical fatigue, emotional fatigue, mental fatigue, and vigour. The scale asks participants to think about their fatigue and energy over the past seven days and rate this on a 5-

point Likert scale. Recent factor analyses have confirmed the five factor structure of the MFSI-SF and have provided evidence of construct and convergent validity (Lim et al, 2005: Stein et al., 2004). Cronbach's alpha for the vigour subscale was calculated for these samples, and values ranged from .84- 91. The MFSI-SF has a number of advantages over other commonly-used self-report fatigue scales; however, its most useful feature is that it contains many items that ask about energy (i.e., items are keyed in the positive direction) rather than simply assessing fatigue. This measure has yet to be widely used in healthy populations, however, there are some precedents for doing so (e.g., see Bardwell et al., 2006).

Profile of mood states, short form (POMS-SF)

The POMS-SF is a widely-cited measure designed to assess both mood valence and energy. It consists of 37 adjectives, to which participants respond using a 5-point Likert scale. It yields six subscales: Fatigue-Inertia, Vigour-Activity, Tension-Anxiety, Depression-Dejection, Anger-Hostility and Confusion-Bewilderment. Its psychometric properties were recently evaluated in a review by O'Connor (2004), who concluded that the POMS-SF vigour subscale is a robust measure of energy, with internal consistency estimates (Chronbach's alpha) ranging from .90-.93 in large samples (Curran, Andrykowski & Studts, 1995) and from .86 to .91 in the current research. A significant body of research has demonstrated that the POMS-SF vigour subscale is related to other measures of fatigue and vigour in the expected direction (e.g., Visual Analog Mood Scales, Beck Depression Inventory; Nyenhuis et al., 1999). It has also been shown to correlate with medical data in clinical populations (e.g., those with chronic fatigue have lower vigour scores than matched controls; Garcia-Borreguero et al., 1998) and experimental research suggests that it is sensitive to physiological changes (e.g., the administration of caffeine results in higher vigour scores; Herz, 1999). Test-retest reliability estimates as calculated in these samples were similar to those reported in the literature (values ranged from .76- .81).

Subjective energy rating

Participants also provided a rating of their current perceived energy level on a scale from 1 to 100, using a visual analogue scale. There is established validity for comparable single-item scales that use slightly different wording (i.e., "full of energy" rather than "the most energy possible"). For example, the Visual Analogue Scale for Fatigue (VAS-F) has been shown to correlate significantly with other measures of fatigue (e.g., Multidimensional Fatigue Inventory, Global Perception of Fatigue Scale; Martinez-Martin et. al, 2006) and with decreased performance on tasks requiring vigilance (Ziino & Pomsford, 2006). Detailed information on reliability for this measure was not available, but estimates were calculated for all 3 studies, and the values suggest that the test-retest reliability was good in these samples (.81- .88).

Tasks

The first act of self-regulation in this study involved a computerized task requiring the regulation of attention, using a paradigm originally developed by Gilbert, Krull and Pelham, (1988), and utilized by Schmeichel et al (2003). Participants watched a brief (6-minute) silent video clip of a woman being interviewed For this study, the video clip was obtained from the experimenters whose study was being replicated (Schmeichel et al). Participants were instructed that they should pay attention to the woman, and were told that after the video they would be asked to rate her personality based on her nonverbal behaviour. During the video clip, unrelated "distractor" words were shown in the bottom third of the screen. As per the instructions provided with the video task, participants in the GR condition were instructed not to look at any words that might appear on the screen while participants in the CT condition were instructed to watch the video clip.

Immediately following the video task, participants were asked to freely recall any words that they remembered seeing on the screen after the video task. This served as a manipulation check; participants instructed not to look at the words (i.e., the GR condition) should recall fewer words than participants who were not given these instructions (i.e., the CT condition). Once participants had completed this task, they were provided with a list of words, some of which had been presented during the video task and some of which had not been presented previously. Participants were asked to circle "yes" or "no" to indicate whether they thought that the word had been present during the task or not. The latter was considered a cued recall measure.

The second self-regulation task in this study was an anagram task. Previous research suggested that solving 6-letter anagrams is a complex task that should be sensitive to self-regulatory fatigue (e.g., Baumeister et al, 1998). Persistence in the face of frustration is also a highly valued form of self-regulation, and one that has been frequently used by Baumeister and colleagues in the past (e.g., Muraven, Tice & Baumeister, 1998). Therefore, some of the anagrams in this task were unsolvable. Both the number of anagrams correctly solved and the length of time that participants persisted on the task before giving up served as dependent measures.

Procedure

Participants were randomly assigned to either a GR or a CT condition prior to their arrival. Testing in all three studies was completed by the author or one of two research assistants who were periodically observed to ensure consistency. In all three studies, an instruction script was generated for each condition and the experimenters read these instructions verbatim.

All testing was done in two small, adjoining rooms separated by a window. Upon arrival at the laboratory, an experimenter reviewed the consent form with the participant (see Appendix A) and answered any questions that they had about the study. Participants were then advised to remove wristwatches and turn off cell phones and were given an initial questionnaire packet that included some background demographic questions, a rating of energy and fatigue over the past seven days (the MFSI-SF; Appendix B), a rating of current mood (the POMS-SF) and ratings of current energy (POMS-SF and subjective energy rating; Appendix C). The experimenter then left the room.

Once the participant had completed the questionnaires, they knocked on the window separating the two rooms to indicate to the experimenter that they were finished. The experimenter then returned and gave them instructions for the computer task as per their condition. Participants in the CT condition were informed that they would watch a video clip of a woman being interviewed and then be asked to make judgments about her personality. They were also informed that any words that that might appear on the screen were “not important.” Those in the GR condition were given the same instructions about the video, but were told not to look at any words that appeared on the screen, and to re-direct their gaze immediately if they did look at the words. The experimenter then started the video clip and left the room.

When the video clip had finished, the experimenter returned and asked participants to complete section two of the questionnaire packet, which included a second rating of energy and mood and a task asking participants to recall any words that they remembered seeing on the bottom half of the screen. Participants were also asked to estimate the length of the video clip. When this section had been completed, participants again knocked on the window to indicate that they were finished. The experimenter then returned, collected the second section of the questionnaire packet, and provided the participant with the third section of the questionnaire packet, which contained a cued recall task and the anagram task. When giving the instructions for section three, the experimenter stated that participants should work on the anagrams until they thought that "they would not get any more correct" and then knock on the window, as they had done previously. The experimenter began timing the participant immediately after leaving the room and stopped the stopwatch only after the participant had knocked on the window, up to a maximum of 20 minutes.

Participants were then thanked for their help, given a debriefing form and provided with an opportunity to ask questions and to provide an e-mail address if they wished to have a summary of the results mailed to them.

Results

Demographics, initial mood and energy

The two groups did not differ significantly in terms of age, $F(1,61)= 1.714$, $p=.195$ or ethnicity, $X^2(4, N= 62)= 3.623$, $p=.459$. The two groups also did not differ in terms of negative affect at baseline, as measured by the depression subscale of the POMS, $F(1,61)= .009$, $p=.924$ or reported energy over the past 7 days, as measured by the MFSI vigour subscale, $F(1,53)= 1.935$, $p=.170$. The two groups did differ, however, with respect to gender. Despite random assignment to conditions, the GR group was 64.7% female while the CT (CT) group was 86.2% female, and this was a significant difference, $X^2(1, N=63) = 3.819$, $p= .046$.

Manipulation check

See Table 1 for all means and standard deviations for these analyses. The conditions differed in terms of the number of "distractor" words correctly recalled, with the CT group recalling more words than the GR group, $F(1,61)= 5.309$, $p = .025$. This difference remained significant when controlling for gender, $F(1,59)= 4.392$, $p= .040$. There was no difference between the CT and

GR groups on recognition of the distractor words, $F(1,59) = 2.886$, $p = .095$; however, this difference did become marginally significant when gender was included as a covariate, $F(1,58) = 3.826$, $p = .055$. Overall these findings support the contention that the GR group complied with the instructions to not look at the words.

The GR group rated the task as requiring "very little effort" to "little effort" on average (see Table 1). This rating was not significantly different to that of the CT group, $F(1,61) = .237$, $p = .628$ and it remained non-significant when gender was included as a covariate, $F(1,60) = .318$, $p = .575$. There were also no significant group differences in their ratings of how difficult the video task was, $F(1,61) = 1.501$, $p = .225$, even after controlling for gender, $F(1,60) = .828$, $p = .367$, with both groups rating the task as "somewhat easy" on average.

Mood hypothesis

There was a main effect of time on negative affect, as measured by the depression subscale of the POMS ($F(1,60) = 8.156$, $p = .006$), with both groups decreasing in negative affect from T1 to T2. However, when the analysis was run controlling for the effect of gender, this main effect became non-significant, $F(1,59) = .242$, $p = .624$. The interaction between condition and mood was also not significant, $F(1,60) = .021$, $p = .886$. Therefore, any group differences cannot be explained in terms of differences in mood between the conditions.

Time perception

The groups differed significantly in terms of how long they estimated the video task took, $F(1,61) = 4.806$, $p = .032$. However, contrary to the predictions of the Time Perception hypothesis of Vohs and Schmeichel (2003), the CT group reported that the task took longer than the GR group. This difference was not statistically significant when gender was included as a covariate, $F(1,60) = 3.357$, $p = .072$.

Anagram task

There was no significant difference between the groups on the number of anagrams correctly solved, $F(1,61) = .474$, $p = .494$, and this difference remained non-significant when gender was included as a covariate, $F(1,60) = .063$, $p = .802$. Groups also did not differ in their persistence on solving the anagrams, $F(1, 59) = .642$, $p = .426$, even when gender was controlled for, $F(1,58) = 1.153$, $p = .287$ (see Table 2). Thus, the self-regulatory fatigue effect was not replicated.

Energy analyses

A repeated-measures ANOVA revealed a significant main effect of time on subjective energy rating, $F(1,61) = 5.145$, $p = .027$, and on the vigour subscale of the POMS, $F(1,61) = 10.574$, $p = .002$, indicating that both groups showed a significant decrease in energy from T1 to T2 (See Table 3). The main effect of condition was not significant for vigour, $F(1,61) = 1.240$, $p = .270$, or subjective energy, $F(1,61) = .109$, $p = .742$ and the interaction was not statistically significant in either case, suggesting that the condition did not impact change in energy ratings from T1 to T2.

When gender was included in this analysis, the main effect of time on vigour became non-significant, $F(1,60) = .973$, $p = .328$. Similarly, the effect of time on subjective energy was also non-significant, $F(1,60) = .047$, $p = .829$.

Discussion

It was not possible to examine the mediating potential of energy because in this conceptual replication of Schmeichel et al., the self-regulatory fatigue effect was not reproduced. That is, participants who self-regulated during the initial video task did not solve fewer anagrams correctly or give up more quickly on the anagram task than those who did not self-regulate during the initial task. Moreover, in contrast to previous published research, participants in the

GR group showed a tendency to persist for slightly longer than those in the CT group, although this difference was not statistically significant.

One might question whether this study had adequate power to test these assumptions. Past research suggests that effect sizes for studies examining the self-regulatory fatigue effect are large. For example, Schmeichel et al. (2003), reported effect sizes ranged from d= .97 to d=1.61. A power analysis, using the More Power calculator (Campbell & Thompson, 2002), indicated that the current study offered sufficient power (81%) to detect a medium effect size (an effect size of .5), and so the current sample size should have been adequate to detect effects of comparable magnitude to those reported in the research literature.

Nonetheless, subtleties in design and execution may also explain these null findings. For example, ratings of task difficulty and effort by both groups suggest that the manipulation employed in this study may have been insufficiently taxing with respect to energy resources; it is possible that a more challenging task would yield more robust results. Because no clear between-group differences were found, the mediating potential of energy could not be tested.

Overall, Study 1 was limited by the low level of self-regulatory demand. Although participants in the GR condition recalled fewer distracting words than those in the CT condition on average, it was not possible to determine whether every individual in the GR condition was, in fact, self-regulating in an effortful manner. Therefore, a second study was designed to repeat this experiment with the addition of a second self-regulation task that allowed for the exclusion of participants who did not self-regulate adequately.

Study 2

The lack of between-group differences on Study 1 suggested that the manipulation employed may have been insufficiently challenging to drain self-regulatory resources. Accordingly, a second self-regulatory task was added in order to increase self-regulatory demand. This task was designed to tap memory processes by asking participants to hold a 7-digit number in their head for the duration of the video clip. Initial testing suggested that when this number was "chunked" and presented like a phone number, this task was challenging for undergraduate students; however, the vast majority of them were able to correctly recall the number after 6 minutes. Crossing this "memory regulation" manipulation with the gaze-regulation manipulation used in Study 1 created four cells, representing four different levels of self-regulation, ranging from no self-regulation (CT), Memory Regulation only (MR), Gaze Regulation only (GR) or both Memory Regulation and Gaze Regulation (MR + GR).

Along with the addition of a second self-regulation task, some other minor adjustments were made to the protocol for Study 2. These included having participants repeat the instructions back to the examiner to ensure comprehension and providing the control group with no information about words that might appear on the screen. These modifications are described where relevant in the procedure section.

Method

Participants

In order to detect a large effect with 80% power at an alpha of .05 with 4 conditions, a minimum sample size of 72 participants was required. In total, seventy-one undergraduates with a mean age of 20.76 years (SD = 3.98) participated in exchange for course credit. Participants in the MR and MR+GR conditions who did not correctly recall the number were excluded (10 participants in total), to ensure that individuals included in the analysis were actually self-regulating. Two additional cases were excluded because of atypical response patterns (i.e., one participant marked every answer on every scale at its maximum; the other had significant difficulties speaking English and was unable to complete the questionnaires without assistance). Thus, the final sample size was 59. The sample was predominantly female (62%; n = 38) and

Caucasian (72%; *n* = 43). Sixteen percent of the sample self-identified as Asian (*n* = 7), 5.9% as Aboriginal (*n* = 4), 2.9% as Middle Eastern (*n* = 2), 1.5% as Métis (*n* =1) and 1.5% as Black (*n* =1), respectively.

Measures

The same measures were used as in Study 1.

Procedure

Participants were randomly assigned to one of the four conditions (i.e., CT, MR, GR, MR+GR) upon their arrival. In all cases, participants went through the consent process and then removed their watches and turned off their cellular phones. Participants then completed Section 1 of the questionnaire packet, as in Study 1.

Prior to the video task, participants were given explicit instructions regarding the task. To ensure that these instructions were understood, participants in all conditions were asked to repeat the instructions back to the experimenter. As in Study 1, participants in the CT condition were informed that they would watch a video clip of a woman being interviewed and then be asked to make judgments about her personality; they were not given any specific instructions regarding the words on the screen. Participants in the MR condition were given identical instructions but were also asked to hold a number in their head while they watched the video. They were informed that they would be asked for the number following the video; they were also instructed not to repeat the number out loud or to move their mouths while watching the video. Participants in the GR condition were instructed to pay attention to the woman and not to look at any words that might appear on the screen; they were also told that if they did look at the words, they should re-direct their gaze immediately. Participants in the MR+GR condition were given combined instructions with elements from both the MR and GR conditions; specifically, they were instructed to actively avoid looking at the words presented on the screen, and to hold a number in their heads for later retrieval.

Once the participants had demonstrated that they understood the instructions, the experimenter proceeded as described in Study 1 for all participants. For those individuals in the MR and MR+GR conditions, the experimenter waited until the participant was seated comfortably in front of the computer and the video task was ready to start. Then the experimenter said "I am now going to tell you a number and I want you to hold it in your head. I will not repeat the number, so it is important that you listen closely. Are you ready?" When this participant stated that s/he was ready, the experimenter read a randomly generated 7-digit number as if were a phone number (with an exaggerated pause after the first three digits).The experimenter then went into the adjoining room. When the video clip was over, the experimenter returned to the room and stated "I asked you to hold a number in your head. What was it?" The experimenter then recorded the number reported verbally by the participant.

Results

Demographics and manipulation check

The four groups did not differ significantly from one another in terms of age, $F(3,55)= .259$, $p=.854$, gender, $X^2(3, N= 59) = 1.765$, $p= .623$, ethnicity, X^2 $(15, N= 58)= 14.758$, $p= .469$, or on the vigour subscale of the MFSI-SF, $F(3,53)=.303$, $p=.823$. There was a marginally significant difference in terms of how much effort the groups thought the task took, $F(3,55)=$ 2.664, $p=.057$. However, even participants in MR+GR condition rated the task as requiring only "some effort," suggesting that they did not consider the task to be overly demanding in any absolute sense. However, the four groups differed in terms of how difficult they thought the task was, $F(3,58) = 2.803$, $p=.048$. Individuals in the GR condition rated the task as the most difficult, while individuals in the MR condition rated it as the easiest (see Table 4).

There was a marginally significant group difference on the ability to recall "distractor" words from the video task ($F(3,54)= 2.763$, $p= .051$), with those in the CT condition recalling the most words correctly. There were no significant differences between the groups in terms of their ability to correctly recognize words that had been on the screen, $F(3,55)= 1.863$, $p=.147$. These results suggest that the findings should be treated with some caution, since the degree to which individuals adhered to the instructions they were given are in question.

Time perception

In contrast to the Time Perception hypothesis of Vohs and Schmeichel (2003), participants did not differ significantly on how long they thought the video task took, $F(3,55)= 1.790$, $p=.160$.

Mood hypothesis

Consistent with Study 1, there was a significant main effect of time on negative affect as measured by the POMS depression subscale, such that all groups decreased in negative affect from T1 to T2, $F(1,55)= 5.293$, $p=.025$. However, the main effect of condition was not significant, $F(3,55)= .688$, $p= 563$, nor was the interaction, $F(3,55)=1.354$, $p=.266$, indicating that there were no significant between-group differences on this measure.

Anagram Task

Contrary to the predictions of the Energy Model, the four groups did not differ on the number of anagrams correctly solved, $F(3,55)=1.571$, $p=.207$ (see Table 5). Thus, the self-regulatory fatigue effect was again not replicated.

The four groups differed on the degree to which they persisted on the anagram task, $F(3,54)= 4.015$, $p= .012$; however, these differences did not follow a "dose-response" pattern in accordance with the degree of self-regulation required on the initial task (see Figure 1). Rather, participants in the GR condition persisted for the shortest amount of time and those in the MR condition persisted for the longest.

Energy analyses

Means and standard deviations for these analyses can be found in Table 6. Repeated measures analyses for subjective energy indicated that there were no significant between group differences, $F(1,55) = .269$, $p = .847$, and no main effect of time, $F(1,55) = 2.898$, $p = .094$. The interaction was also not significant, $F(3,55) = 2.178$, $p = .101$.

Repeated measures analyses for vigour revealed a significant main effect of time on vigour, $F(1,55) = 31.46$, $p < .001$. All four groups decreased significantly in vigour from Time 1 to Time 2. The main effect of group was not significant, $F(3,55) = .426$, $p = .735$. The interaction was also not significant, suggesting that the groups were not different from one another in terms of vigour decline, $F(3,55) = 1.667$, $p = .185$ (see Table 7).

Discussion

Overall, this study failed to replicate the self-regulatory fatigue effect in that there were no significant differences between the four conditions on anagram task performance, even with an increased level of self-regulatory demand. However, these null findings should be interpreted cautiously given that the final sample (excluding those who did not self-regulate) was lower than anticipated, potentially reducing power. The only strong group difference in performance emerged for anagram persistence time, which appeared to be significantly longer for the MR group participants than the GR group participants; specifically, those in the MR condition persisted almost twice as long on the anagram task as those in the GR condition. One possible explanation for this finding is that these conditions differed in the degree to which they were viewed as challenging and enjoyable.

Csikszentmihalyi (1990) identifies a distorted sense of time as one of the identifiable characteristics of a “flow” state (a state where a person is immersed and engaged in the task at hand). It may be that participants in the MR condition perceived the task as more engaging and challenging than those in the GR condition and that this altered their perception of time such that they did not feel that the task took as long. There was no clear support of this possibility: though participants in the MR condition rated the initial video task as taking the shortest amount of time, while participants in the GR condition rated it as taking the longest amount of time, this difference did not attain statistical significance.

The work of Muraven and Slessavara (2003) demonstrated that motivation was an important mediator of the self-regulatory fatigue effect. These results raise the possibility that characteristics of the task itself may also influence performance. For example, Csikszentmihalyi (1990) has proposed that tasks most conducive to “flow” experiences are those which activate the individual sufficiently that s/he is not bored, but are not so demanding that they induce anxiety (p.74). Perhaps if individuals in the MR condition were more engaged in the initial task, this would explain their willingness to persist for longer on the subsequent anagram task. Those in the GR condition, on the other hand, appear to be showing more of a typical self-regulatory fatigue pattern. That is, they perceived the initial task as taking longer and they tended to give up more quickly on the subsequent task.

Any interpretation of findings for Study 2 needs to be qualified, however, by the fact that the groups did not differ significantly on the number of “distractor” words that they recalled. This may suggest that individuals in the GR and GR+MR conditions did not fully comply with the instructions not to look at the words; alternately, it might suggest that individuals in the other two conditions were spontaneously restricting their gaze despite receiving no instructions to do so.

Study 2 underscored the need for more objective information about the degree of actual self-regulation occurring within each of the conditions during the initial self-regulation task. For example, information regarding where participants were looking during the video task would help determine whether individuals were adhering to experimental instructions and regulating their gaze according to their condition. Additionally, it seemed possible that aspects of task engagement were influencing the outcome. Accordingly, a third study was designed using the same experimental paradigm, with the addition of an infra-red eye-tracker to assess initial self-regulation and some follow-up questions regarding task engagement.

Study 3

Study 3 was designed to address the limitations noted in study 2. The primary difference between the two studies was the addition of an eye-tracking machine that recorded the eye movements of participants in the different conditions during the initial self-regulation task. In order to assess aspects of task engagement, participants were also asked to rate how interesting and enjoyable they found the task to be once it had been completed.

Method

Participants

One hundred and fifty four students participated in Study 3 for class credit. Forty-two (27.2%) were excluded because valid eye-tracker data could not be obtained due to equipment calibration failure. The eye-tracker data was examined prior to any other analyses. Following a visual inspection of boxplots and z-scores for each eye-tracker variable, eight outliers (scores that lay more than 2 standard deviations from the mean for that variable) were identified. When these particular cases were examined, it was determined that four of these outliers were the result of significant lost eye-tracker data. These cases were excluded. Two cases where individuals clearly looked at the words, despite being instructed not to, were also excluded from subsequent analyses as these reflected self-regulation failure. The two remaining outliers were retained in the analyses.

The final sample consisted of 101 participants, which exceeds the minimum required sample size (n = 72) to detect a large effect with 80% power. Their mean age was 19.83 years (SD= 3.67); 62.4% (n= 63) of the sample was female, and 37.6% (n= 38) were male. 83.2% of participants (n= 84) were Caucasian, 5% (n= 5) were Métis, 3% (n= 3) were Asian, 4% (n= 4) were Black, 2% (n= 2) were Aboriginal, 2% (n= 2) were Middle Eastern and 1% (n= 1) were Mexican/Hispanic.

Participants in the four conditions did not differ significantly from one another in terms of age ($F(3,99)= 1.075$, $p= .364$), gender X^2 $(3, N=101)= 1.553$, $p=.670$), or ethnicity, (X^2 $(18, N= 101)= 20.354$, $p = .313$). They also did not differ at baseline on the vigour subscale of the MFSI, $F(3,99)= .913$, $p=.438$.

Procedure

Participants were randomly assigned to conditions (CT, GR, MR, GR+MR) prior to their arrival. After signing a consent form, they were asked to remove their watches, turn off their cellular phones, and complete the questionnaire package.

Participants then were seated in front of the eye tracker and were asked to sit still while the eye-tracker was calibrated. As in Studies 1 and 2, participants in the CT condition were informed that they would watch a video clip of a woman being interviewed and then be asked to make judgments about her personality. Participants in the Memory Regulation (MR) condition were instructed to pay attention to the woman, to disregard the words, and to hold a number in their head while they watched the video, without repeating it out loud. They were informed that they would be asked for the number following the video. Participants in the Gaze Regulation (GR) condition were instructed to pay attention to the woman and not to look at any words that might appear on the screen; they were also told that if they did look at the words, they should re-direct their gaze immediately. Participants in the Maximum Regulation (MR+GR) condition were given the same instructions as those in the MR and GR conditions.

Once the participants had demonstrated that they understood the instructions, the experimenter proceeded as described in Studies 1 and 2. For those individuals in the MR and MR+GR conditions, the experimenter waited until the video task was ready to start. Then the experimenter said “I am now going to tell you a number and I want you to hold it in your head. I will not repeat the number, so it is important that you listen closely. Are you ready?” When the participant stated that s/he was ready, the experimenter read a randomly generated 7-digit number as if were a phone number (with an exaggerated pause after the first three digits). The experimenter then started the video clip, and began recording the eye-tracker data. When the video clip was over, the experimenter stated “I asked you to hold a number in your head. What was it?” The participant’s response was then recorded.

Eye-tracking

Visual scanning was monitored throughout the 6-minute video presentation using an SMI-REDII iView infrared eye monitoring system. This non-invasive system consists of an infrared emitter and detector positioned below the monitor used to display the video. Eye movements were tracked automatically using a computerized fast tracking mirror system, based on the reflection of light from the retina through the pupil. Samples of eye position were taken at 60 Hz, and the system has spatial resolution accurate to within 0.5 degrees of visual angle.

Data collection followed a 9-point calibration procedure that was completed for each participant prior to starting the video. Data acquisition parameters (ie., limits on pupil diameter, definitions of saccade conditions) were set at iView 3.0 system defaults. The eye-tracking system and the testing program were operated by separate computers, but the two computers were interfaced via a parallel port connection. Eyetracking data was collected and analyzed using SMI's iView 3.0 software, and stimuli were administered on the subject PC using E-Prime (Beta 5) software.

Viewing time was calculated using iView software. Regions of Interest (ROIs; i.e., coordinates corresponding to the woman being interviewed and the distractor words) were defined a priori. Scoring of scanning data was based on the total percentage of time spent viewing the target and the total percentage of time spent viewing the words at the bottom of the screen. In addition to this, the number of times participants re-directed their gaze was recorded.

Results

Eye-tracker analyses

The eye-tracker was introduced in this study as a manipulation check and as a proxy for achieved self-regulation. Of primary interest was the degree to which individuals in the GR and GR+MR conditions adhered to instructions to look only at the visual target (the woman being interviewed) and to avoid looking at the distractors (words). This was assessed by the proportion of time spent looking at the words and the number of times the gaze was re-directed.

The eye-tracker data demonstrates that participants in all four groups spent the majority of time looking at the visual target (the woman; see Table 8). The means of the four conditions did not differ significantly on the number of seconds spent looking at the woman, although this difference approached significance, $F(3,97) = 2.611$, $p = .056$. There was no significant difference on the number of fixations on the woman, $F(3,97) = .980$, $p = .405$. However, there was a significant difference on the percentage of time spent looking at the woman, $F(3,97) = 3.611$, $p = .016$. Participants in the GR condition spent the largest percentage of time looking at the woman, whereas participants in the CT condition spent the least; these results are shown in Figures 2, 3, and 4.

The means of the four groups differed significantly on the number of seconds spent looking at the words, $F(3,97)= 12.996$, $p<.001$, the percentage of time spent looking at the words, $F(3,97)= 12.342$, $p<.001$ and the number of fixations on the words, $F(3,97)= 18.419$, $p<.001$ (see Figures 5-7). Planned contrasts were conducted which demonstrated that the CT group looked at the words significantly more than the GR group, $t(26.052)= 3.230$, $p= .003$, and the MR group looked at the words significantly more than the MR+GR group, $t(26.052)= 4.932$, $p <.001$. This pattern was also true for the number of fixations. The CT group fixated on the words more often than the GR group, $t(97)= 3.461$, $p=.001$, while participants in the MR group fixated on the words more than the MR+GR group, $t(97)= 6.672$, $p<.001$. For all means and standard deviations, see Table 9.

Recognition and recall

Consistent with the eye-tracker data, there was a significant difference between the groups on the ability to recall “distractor” words from the video task, $F(3,93)= 17.588$, $p<.001$. Individuals in the CT and MR conditions recalled 3.88 or 4.02 words on average, whereas those in the GR condition recalled 1.32, and those in the GR+MR condition recalled fewer than one word on average (see Table 9). This is an important contrast to Study 2, where individuals in the GR and GR+MR condition recalled a larger proportion of the words, suggesting that they had not adhered to instructions to not look at the words. Participants in the four conditions did not differ in the number of words correctly recognized, $F(3,97)= .626$, $p=.600$.

Energy analyses

Means and standard deviations for these analyses can be seen in Table 10. A repeated-measures ANOVA for subjective energy indicated that there were no significant between group differences in energy, $F(3,96) = .358$, $p = .783$. There was also no significant main effect of time on energy, $F(1,96) = .966$, $p = .328$. However, the interaction was significant, suggesting that the groups differed significantly from one another in their pattern of energy decline, as shown in Figure 8, $F(3,96) = 2.803$, $p = .044$. A simple main effects analysis was conducted in order to interpret this interaction further (as described in Winer, Brown & Michels, 1991). This demonstrated that only the control group declined significantly in energy ($p = .019$); the change in energy was not significant for the other three conditions (see Figure 8).

Repeated-measures analyses for vigour, however, revealed a significant main effect of time on vigour, $F(1,95) = 23.687$, $p < .001$. All four groups decreased significantly in vigour from Time 1 to Time 2 (see Table 11; Figure 10). There was no main effect of condition, $F(3,95) = .583$, $p = .628$, and the interaction was not significant, suggesting that the groups were not different from one another, $F(3,95) = 1.229$, $p = .303$.

Overall, these analyses suggest that participants in all four groups declined in vigour, but there was no evidence to suggest that the manipulation employed influenced the rate of energy decline in a manner consistent with the energy hypotheses. In fact, the results for subjective energy suggest that the control group was the only group to decline in energy- a finding in direct contrast to the energy hypothesis.

Time perception hypothesis

In contrast to the time perception hypothesis, participants did not differ significantly on how long they thought the video task took, $F(3,93) = 1.268$, $p = .290$ (see Table 12).

Flow hypothesis

Participants in the four conditions did not differ on their ratings of how enjoyable or how interesting the video task was, $F(3,93) = .899$, $p = .445$ and $F(3,93) = .115$, $p = .951$, respectively. Participants in the four conditions also did not differ significantly on their ratings of task effort, *F*(3,93)= .497, *p*=.686, or task difficulty, *F*(3,96)= 1.91, *p*=.318. The means and standard deviations can be seen in Table 12. Thus, the hypothesis that the memory regulation conditions may have been more engaging than the other conditions was not supported.

Mood hypothesis

There was a significant main effect of time on negative affect as measured by the POMS depression subscale, *F*(1,96)= 13.719, *p*<.001. Thus, all four groups decreased in negative affect over time. The interaction was also not significant, indicating that there were no significant between-group differences on this measure, *F*(3,96)= .709, *p*=.549. There was also no significant main effect of condition on mood, *F*(3,96)= .120, *p*=.948.

Anagram task

Contrary to the predictions of the Energy Model, and consistent with Studies 1 and 2, the four groups also did not differ significantly from one another on the number of anagrams correctly solved, *F*(3,97)=.233, *p*=.873 (see Table 13 for means and standard deviations). They also did not differ on the degree to which they persisted on the anagram task, *F*(3,96)=1.621, *p*=.190. Thus, the self-regulatory fatigue effect was not replicated, despite eye-tracker findings that suggested significant differences in achieved self-regulation during the video task.

Discussion

Overall, the data suggest that between-group differences are minimal in this study. Although the eye-tracker and recall data suggest that participants were self-regulating to different degrees during the initial self-regulation task, there was no evidence of self-regulatory fatigue in that participants in conditions demanding more self-regulation during the initial video task did not perform worse on the subsequent anagram task.

Despite the lack of clear group differences by condition, it should be noted that there is considerable individual variability in the data, resulting in large standard deviations on many of the measures (see tables 10, 11 and 13 for examples). Under these circumstances, the probability of obtaining significant between-group differences is substantially reduced. It may be that in this study, the within-group variability was sufficiently large that it overshadowed any between-group differences. Therefore, an individual differences approach may be a more appropriate way to study these differences.

General Discussion

Overall, these three studies were limited in their ability to address the question of whether energy mediates the self-regulatory fatigue effect because the self-regulatory fatigue effect was not replicated. Accordingly, one important question raised by this research is why the current studies failed to reproduce the findings of Baumeister and colleagues with regard to self-regulatory fatigue in three separate studies. One common explanation for null findings is a lack of power to detect a significant difference. While the first two studies did use small samples, the numbers of participants were consistent with those used in the research being replicated (e.g., see Baumeister et al., 1998; Schmeichel et al., 2003) and should have been adequate to detect an effect of the magnitude reported in the literature. Furthermore, the pattern of means in all three studies do not follow the predictions of the Energy Model (e.g., see Tables 5 and 13); this suggests that lack of power would not be a sufficient explanation.

A second possibility is that the self-regulation tasks utilized in this research were not implemented or administered in precisely the same way as they were in the research being replicated. This seems unlikely for several reasons. The video task itself has produced the effect previously as executed in Studies 1 to 3 (see Schmeichel et al., 2003). An instruction script for the task was generated based on the instructions provided with the video task, and the procedures described in published research using this task. While the dependent measure, the anagram task, did not use identical anagrams to those used elsewhere, both previous studies and theoretical rationale strongly suggested that performance on 5-letter anagrams should be influenced by self-regulatory fatigue, and persistence on a frustrating task, including unsolvable anagrams, is a dependent measure that has been frequently used by Baumeister and colleagues in the past (e.g., Baumeister et al., 1998, Muraven, Tice & Baumeister, 1998).

One final possible explanation for the failure to replicate this effect in these studies is the high level of individual variability in the data. Recent research has identified a number of factors that may moderate the self-regulatory fatigue effect, including motivation (Muraven & Slessavara, 2003; Moller, Deci & Ryan, 2006) and positive affect (Tice, Baumeister, Schmueli & Muraven, 2007). Martijn and her colleagues have also highlighted the role of expectancies, and have shown that college students tend to endorse statements indicating that self-control has an energy cost, and to attribute their failures of self-control to physical or mental fatigue (Martijn, Tenbult, Merckelbach, Dreezens & de Vries, 2002). Recent experimental studies have demonstrated that the self-regulatory fatigue effect can be eliminated, and sometimes even reversed, by challenging this schema (e.g., by informing participants that participating in a task requiring emotional regulation will not impair subsequent performance on a handgrip task) or by priming a "persistent" person exemplar (Martijn et al., 2002; Martijn et al., 2007). Clearly, more research needs to be conducted in order to determine which individual factors are important to identify and control for in future research.

Perhaps one of the most striking and unexpected findings across all three studies was the high level of variability on the energy measures themselves. Research on the energy model to date, including the research being replicated here, has focused almost exclusively on the self-regulatory fatigue effect and has largely ignored individual differences in energy that may contribute to self-regulation failure. Of particular interest is dispositional energy, a stable individual difference variable that seems to emerge early in life (e.g., see Thomas & Chess, 1977; Rothbart, Ahadi & Evans, 2000). There was some evidence in these studies that individual differences in energy may be important to consider. For example, when correlations were calculated between energy and vigour ratings and anagram task performance in the control group for Study 3 (n= 29), subjective energy was significantly related to improved task performance, r= .383, p = .040, as was vigour, r= .387, p = .038. While these findings should be interpreted tentatively, they do suggest that individual differences in energy may be important to examine in future studies. As noted above, research also suggests that motivation and the perceived importance of self-regulatory tasks may impact self-regulatory fatigue. Therefore, it may be helpful for future research to examine more complex and meaningful self-regulatory tasks.

CHAPTER 4: INTRODUCTION TO STUDY 4

Research on the Energy Model has typically focused on self-regulatory fatigue and has not examined more stable individual differences in energy that may emerge over time. However, differences in dispositional or "trait" energy may have important implications, particularly for the successful performance of complex self-regulatory tasks, such as changing habitual behaviours (e.g., health behaviour). This study tests the predictions of the Energy Model in a motivated population, using a measure of dispositional energy. Thus, it addresses some of the limitations of the experimental studies; namely, it uses an individual difference approach and it examines behaviours that have meaningful consequences for the individuals performing them.

Temporal Self-Regulation Theory (TST; Hall & Fong, 2007) is a model of health behaviour that explicitly links self-regulation and the performance of health-protective and health-damaging behaviours. This model proposes that while most health-protective behaviours have benefits in the long term, they tend to be associated with numerous costs in the short term, while the reverse is true for health-damaging behaviours. Among individuals motivated to increase health-protective behaviours, energy may facilitate the successful implementation of behavioural intentions. The following study tests the hypothesis that individuals with higher dispositional energy will show greater intention-behaviour concordance in a population of individuals newly-diagnosed with T2DM Mellitus (T2DM).

Diabetes Mellitus is a chronic condition that results from the body's inability to sufficiently produce and/or properly utilize insulin (Health Canada, 2002). While diabetes can take several forms, by far the most common form is T2DM, which accounts for about 90% of cases in the general population (Public Health Agency of Canada, 2005). In Canada, the proportion of the population who reported having diabetes increased by 27% between 1994 and 2000, a trend that is expected to accelerate over time (Public Health Agency of Canada, 2005). The need to address the determinants and management of this disease is particularly urgent in Aboriginal communities where its prevalence is estimated to be 3 to 5 times the national average (Health Canada, 2002; Public Health Agency of Canada, 2005).

In 1999, the Government of Canada allocated $115 million over 5 years for the development of the Canadian Diabetes Strategy (Public Health Agency of Canada, 2005). While it is widely recognized that there are few, if any, modifiable risk factors for Type 1 diabetes, the risks for developing T2DM are similar to those of developing other chronic diseases. Lifestyle alterations, including modifying one's diet and increasing physical activity can help delay the onset of the illness and can be an integral component of self-management after diagnosis (Health Canada, 2002). Individuals newly diagnosed with diabetes are often highly motivated to pursue non-pharmacological strategies for managing their condition, making this an ideal population in which to study behaviour change. This study was approved by the Behavioural Ethics Research Board at the University of Saskatchewan on April 13th, 2006.

CHAPTER 5: DOES DISPOSITIONAL ENERGY MODERATE INTENTION-BEHAVIOUR CONTINUITY IN T2DM SELF-MANAGEMENT?

Diabetes Mellitus is a disease in which the body does not produce or properly use insulin (American Diabetes Association, 2008). While diabetes can take several forms, by far the most common is T2DM Mellitus (T2DM), which accounts for about 90% of cases in the general population (World Health Organization, 2005). The incidence of T2DM is rapidly rising in all countries of the world, leading some experts to refer to this condition as a modern “pandemic” (WHO, 2005). Recent estimates suggest that the prevalence of known diabetes in the United States is now approaching 17.5 million, with as many as 5.7 million people who have diabetes remaining undiagnosed (American Diabetes Association, 2008). Primary and secondary prevention efforts for T2DM are fundamentally dependent on lifestyle alterations, including activity and dietary choice. In particular, choosing a diet that helps to control weight and stabilize blood sugar and engaging in regular physical activity can help to prevent the onset of the illness, to control its progression once it has developed and to prevent or delay the development of serious medical complications (Diabetes Control and Complications Trial Research group, 2007).

The psychological and economic costs of diabetes are substantial. Meta-analytic research has shown that individuals with diabetes are at risk for both depression and anxiety; when present, both have been shown to interfere with glycemic control and reduce quality of life (Anderson, Freedlan, Clouse & Lustman, 2001; Grigsby, Anderson, Freedland, Clouse & Lustman, 2002). In terms of economic costs to society, the estimated cost of diabetes in 2007 was $174 billion, including $116 billion in excess medical expenditures and $58 billion in reduced national productivity (ADA, 2008). Clearly, diabetes is costly from both individual and societal perspectives.

In order to manage this disease in the population in the years to come, there is an urgent need for individuals at risk for diabetes, and those who are newly diagnosed with the illness, to increase their level of physical activity to help regulate metabolism and control weight and to carefully manage intake of calories through alteration of dietary behavior. However, past research indicates that sustained behavior change in the domain of health is challenging to achieve. In a study of individuals enrolled in structured exercise programs, on average only 50% of participants were still exercising after six months (Dishman, 1991), while studies of dietary behavior suggest that fewer than 25% of people who start dieting are still dieting at a 12-month follow-up, regardless of diet type (e.g., Dansinger, Gleason, Grifith, Selker & Schaefer, 2005). This general tendency may be exacerbated in individuals with diabetes; recent evidence suggests that individuals with diabetes may be less likely than the general population to meet government and ADA recommended guidelines for physical activity (Zhao, Ford, Li & Mokhdad, 2008) and diet (Koro, Bowlin, Bourgeois, & Fedder, 2004), with adherence rates as low as 31.1% for fat intake and 19.6% for physical activity (Cheng, Gregg, Pereira & Imperatore, 2007). Given the tremendous importance of changing these behaviors at both an individual and population level, additional research is required to address the reasons why motivated people who intend to change their behavior fail to do so successfully.

Self-Regulatory Capacity

To date, the majority of explanatory models of health behavior have focused on intentions as the proximal determinant of behavior. However, intentions seldom account for more than 40% of the variance in behavior (Sutton, 1998) and intention-based theories cannot explain why a significant proportion of people with high intentions fail to act on these intentions (see Fishbein, Hennessy, Yzer & Douglas, 2003). A recent meta-analysis of experimental studies of intention-behavior relations suggested that moderate-to-large induced increases in intention result in only small-to-moderate increases in behavior. Furthermore, a number of factors, including control over the behavior, appear to moderate the intention-behavior relationship, though such mediators are not modeled in traditionally popular health behavior theories (Webb & Sheeran, 2006). Together these findings suggest that although intention is an important determinant of behavior, it is not the sole determinant, and its influence may be moderated by other variables.

Why is consistently engaging in healthy behavior so difficult? One possible explanation is that the benefits and costs of engaging in health-promoting and health-damaging behaviors occur at different points in time. Most health-protective behaviors have benefits in the long term (e.g., better health, improved physical appearance) but are associated with numerous costs in the short term (e.g., inconvenience, discomfort; Hall & Fong, 2007). Thus, the disjunction in valence (and potency) of immediate versus long-term contingencies creates the potential for cognitive conflict to occur at the time of decision-making around health protective behaviors. In order to resolve such conflict, effective self-regulatory abilities are required, and these have been shown to vary in state- and trait-like ways between individuals (e.g., Baumeister, Heatherton & Tice, 1994; Mischel, Shoda & Rodriguez, 1989).

Some initial investigations of the potential moderating role of self-regulatory abilities on intention-behavior relations has been found for both physical activity and dietary behavior. Hall, Fong, Epp and Elias (2008) demonstrated using a prospective design that individual differences in executive function, as measured using a Go-NoGo inhibition paradigm, mediate intention-behavior continuity. Several studies to date have also shown that cognitive abilities are associated with mortality over the lifespan, and some of these effects are mediated by health behavior patterns (e.g., Whalley & Deary, 2001; Pavlik, de Moraes, Szklo, Knopman, Mosley & Hyman, 2003; Batty, Deary, Schoon & Gale, 2007).

Although biologically-imbued self-regulatory capacity includes cognitive abilities, another (potentially related) facet of self-regulatory capacity may be dispositional energy (e.g., Baumeister, Heatherton & Tice, 1994; Heatherton & Baumeister, 1996). To the extent that acts of self-regulation in line with non-immediate contingencies is draining and requires subjective effort, energy may facilitate or impede the process. In the context of T2DM, those possessing high levels of dispositional energy may be better able to translate intentions into behavior for important self-care behaviors, including physical activity and dietary behavior. In order to test this hypothesis, a sample of individuals diagnosed with T2DM was recruited and asked to indicate behavioral intentions for diet and physical activity. Intention-behavior concordance was then assessed at a 6-month follow-up. It was hypothesized that, 1) dispositional energy at Time 1 would predict health-protective behavior (i.e., higher levels of exercise and lower levels of dietary fat) at Time 2, and 2) individuals with higher levels of energy would show greater correspondence between intentions and subsequent health behavior than individuals with lower levels of energy for both types of health protective behavior.

Method

Participants

Ninety-nine community-dwelling participants who were newly diagnosed with T2DM were enrolled in this study. Of these participants, 78 (79%) participants completed the 6-month follow-up assessment. Participants were recruited from an initial self-management education class in the diabetes education centre of a local hospital. All individuals attended a baseline laboratory session as soon as possible after diagnosis (mean time since diagnosis= 2.5 months). Participants were excluded if they were more than 6 months post diagnosis, or if they had not been officially diagnosed with T2DM by a physician.

The mean age of participants was 58.7 years old (SD= 10.11), with a range from 34 to 79 years. The sample consisted of 55 women (55.6%) and 42 men (42.4%); two participants did not indicate their gender. Participants were primarily Caucasian (n= 86, 86.9%); however 8% (n= 8) identified as Aboriginal or Métis, and 1% (n= 1) were Black, Middle Eastern or Hispanic in origin. These characteristics approximated the demographics of the surrounding cachement area of the hospital.

Study completers did not differ significantly from non-completers on demographic variables, including age, $t(24.903)= 1.179$, $p = .249$, and gender, $X^2(1)= 2.640$, $p = .104$. They also did not differ in terms of trait energy, $t(34.659)= 1.242$, $p = .223$, physical activity intentions, $t(42.107) = .297$, $p = .768$, and physical activity behaviour, $t(53.633) = 1{,}703$, $p= .094$.

Measures

Dispositional energy

Dispositional energy was measured using the “Activity” trait scale, a measure of personality. The activity trait scale consists of eight unipolar trait markers that were originally developed and validated by Goldberg (1992) but cross-validated specifically to measure the activity trait by Saucier and Ostendorf (1999). It has been shown to positively correlate with exercise behavior in undergraduates (e.g., Rhodes, Courneya & Jones, 2004), although its relationship to dietary behavior has not been tested. For this measure, participants are asked to describe themselves as they are “generally or typically” compared with persons they know of the same gender and roughly the same age. Trait markers (e.g., active, energetic) are rated on 9-point scales ranging from 1 (extremely inaccurate) to 9 (extremely accurate). This scale has been shown to be reliable in undergraduate and middle-aged populations in the past, with alpha coefficients ranging from

.72 to .74 (Chapman, 2007). Cronbach's alpha was calculated in this sample and was lower than expected ($\alpha = .56$).

Dietary Behaviour

The National Cancer Institute Fat Screener (NCI screen) was developed by the National Cancer Institute in order to estimate percentage energy intake from fat. This 17-item scale is intended for use in the general population. It asks people to consider their eating habits over the past month and to indicate how often they ate particular foods (ranging from "never" to "2 or more times per day"). This measure was validated on a sample of 9, 323 American adults and demonstrated correlations between 0.5 and 0.8 with estimated true intake (Thompson et al., 2004); this performance is comparable to that of other food frequency questionnaires. The suitability of this scale for use in intervention studies was recently evaluated and it was determined that it has adequate reliability, sensitivity and specificity (Williams et. al, 2008). Here, the NCI fat screener was used both to assess baseline behavior over the past month and dietary intentions for the next month. This measure was selected because reducing dietary fat intake to assist with weight management is part of standard dietary recommendations for this population (American Diabetes Association, 2008b).

Physical Activity

Physical Activity Scale for the Elderly (PASE)

The PASE is a brief physical activity survey designed to assess physical activity in older adults. It is somewhat atypical for a self-report measure in that it is specifically designed to assess physical activity in a variety of domestic domains (e.g., housework, yardwork) in addition to sport and recreation. Research suggests that the PASE has good test-retest reliability (.75; Washburn, Smith, Jette & Janney, 1993) and research showing that it is associated with physiological markers like oxygen uptake, systolic blood pressure and overall health status suggests that it is a valid measure of activity in this population (Washburn, Smith, Jette & Janney, 1993; Schuit, Schouten, Westerterp & Saris, 1997). Furthermore, there is evidence that the magnitude of these associations is comparable to other established measures of physical activity (see Washburn, McAuley, Katula, Mihalko & Boileau, 1999). Recent research also suggests that this measure is appropriate for use with younger, sedentary adults (Washburn et. al, 1999).

Physical Activity Recall (PAR)

This brief measure asked participants to report the number of hours they spent doing vigourous and moderate physical activity (defined using strict behavioral criteria) over the past seven days to the nearest half hour. The version used in this study was based on the Stanford 7-Day Recall Questionnaire (Blair et al., 1985), and has been shown to correlate highly with tri-axial accelerometer-assessed physical activity, suggesting it is valid (Hall, 2008). Research also suggests that this measure has demonstrated sensitivity to behavioral intervention effects (Hall & Fong, 2003). This measure was selected in part because of its brief time frame, which may help to minimize measurement error and maximize the accuracy of recall for this population (as suggested in Shephard, 2002). Furthermore, this measure only assesses moderate and strenuous physical activity, which may be a purer reflection of effortful physical activity than the total activity reported by the PASE.

Intention strength

Behavioral intentions were assessed using a measure constructed in accordance with the guidelines provided by Azjen (2006). Specifically, the wording of the NCI-fat screener and PAR measures were altered to reflect future behavior rather than past behavior, in order to preserve scale correspondence (Courneya & MacAuley, 1994). As such, individuals were instructed to indicate how much physical activity they intended to engage in over the next week and how much fat they intended to consume over the next month.

Procedure

Participants reviewed and signed a consent form upon entry into the lab. After completing a computer task and finger poke blood sample not directly related to the present study, participants completed the measures of personality and behavior, were given $20 for their participation, and were tentatively scheduled for a 6-month follow-up session. Approximately 6 weeks before the 6-month follow-up session, participants were re-contacted via telephone and then attended their second laboratory session. In the second session, participants again provided a second blood sample for analysis. Participants then completed a second questionnaire package containing the NCI fat screener, the PASE and the PAR. Once participants had completed the questionnaire, they were given $10 reimbursement, and a debriefing form. They were invited to ask questions and were thanked for their participation.

Results

To test the hypothesis that trait energy at Time 1 (T1) predicts exercise behavior at Time 2 (T2), hierarchical regression analyses were conducted with demographic variables (age and gender) entered in the first step and Trait Energy at T1 entered in the second step. Physical activity (measured using the PASE and the PAR) and dietary fat intake (using the NCI-fat screener) at T2 were the dependent measures. Correlations among study variables are presented in Tables 14, 15 and 16.

Trait energy predicted unique variance in PASE scores over and above that predicted by demographic variables alone, $\beta = .350$, $p = .001$ (see Table 17). This association remained significant when controlling for past behavior, $\beta = .376$, $p < .001$ (see Table 18). Using PAR vigorous and moderate activity scores as the dependent measure, the pattern of findings was similar (see Tables 19 and 20). Trait energy predicted unique variance in moderate and strenuous physical activity, over and above that accounted for by age and gender, $\beta = .420$, $p < 001$. Again, this pattern remained constant when controlling for behavior over the past week, $\beta = .382$, $p = .001$.

These analyses were repeated for diet (see Tables 21 and 22); however, energy did not predict unique variance in dietary fat intake, $\beta = .132$, $p = .265$. This held when past behavior was included as a covariate, $\beta = .086$, $p = .407$. Thus, contrary to the hypothesis, trait energy does not appear to be an important variable in predicting dietary fat intake in the present sample.

Intention moderating effects of energy

Additional analyses were conducted in accordance with Aiken and West (1991) in order to determine whether energy might moderate the intention-behavior link for physical activity and diet. Scores for trait energy and intentions for physical activity and diet were converted to z-scores and an interaction term was calculated by multiplying the transformed intention and energy scores. Age and gender were again entered in Step 1, followed by main effects for energy and intentions in Step 2, and the interaction term in Step 3 (see Tables 23 – 26). The main effects for energy ($\beta = .399$, $p < .001$) and intentions ($\beta = .299$, $p = .006$) each predicted significant unique variance in physical activity. The interaction showed a trend toward significance ($\beta = .261$, $p = .066$. As depicted in Figure 10, there is a marginally-significant relationship between intention and behavior for those with low energy, but a significant and positive relationship for those with high energy. Thus, as hypothesized, a marginally significant moderating effect of energy on the intention-behavior link was found for physical activity.

For diet, the main effect of intentions was significant, $\beta = .406$, $p = .001$, but the main effect of energy was not, $\beta = .094$, $p = .390$; the interaction term was also not significant, $\beta = .159$, $p = .199$ (see Table 24).

Past behavior

In order to assess whether intentions and energy predict unique variance in future behavior, the previous analyses for vigorous exercise (PAR) were repeated including past behavior as a covariate in Step 1. Its effect was significant, $\beta = .388$, $p = .001$. Importantly, when past behavior was included in the model, the main effect of intentions was no longer significant, $\beta = -.168$, $p = .647$, although the main effect for energy remained significant, $\beta = .376$, $p = .001$. The interaction was not significant, $\beta = .228$, $p = .120$ (see Table 25).

When past behavior was included as a covariate for diet, it was significantly related to behavior at Time 2, $\beta = .505$, $p < .001$. When it was included in the model, the main effect for intentions was no longer significant, $\beta = -.036$, $p = .843$. As previously, the main effect of energy was not significant, $\beta = .086$, $p = .406$, nor was the interaction, $\beta = .150$, $p = .201$ (see Table 26).

Discussion

This study provides some initial empirical support for the hypothesis that dispositional energy is associated with health protective behaviors in individuals living with T2DM. Specifically, dispositional energy is positively associated with physical activity performance over and above the effects of intentions alone. Furthermore, energy remains predictive of future physical activity even when past behavior is included in the model. Finally, and most importantly, these findings suggest that dispositional energy is associated with greater intention-behavior continuity for physical activity. That is, intention was a significant predictor of physical activity behavior for those with high dispositional energy levels, but not for those with lower dispositional energy.

A second important finding of this study is that, unlike energy, intentions no longer predicted future behavior once past behavior was included in the model. This finding is not unique; in one meta-analysis, Hagger, Chatzisarantis and Biddle (2002) concluded that the inclusion of past behavior typically attenuates the relationship between social-cognitive variables and future behavior to a significant degree, sometimes reducing this relationship to zero. This study is consistent with previous findings in that intentions do not appear to add explanatory or predictive power when past behavior is included as a covariate. Some critics have argued that it is theoretically unclear what past behavior is measuring (e.g., habit strength or the operation of social-cognitive variables in the past; see Ajzen, 2002; Wood & Neal, 2007 for more discussion of these issues). However, it may be important for future studies to examine these two variables more critically, particularly in studies of behavior change.

Limitations

There are a number of limitations to this study that should be noted. This study used a relatively small sample, which limits both its statistical power and its generalizability. Furthermore, the measure of self-reported energy displayed lower reliability than expected, and this probably reduced the likelihood of detecting a significant interactive effect with intention. Additional research with larger samples is needed to determine whether these findings would be maintained and whether they would apply to other health populations requiring self-management behaviors (e.g., individuals with cardiovascular disease), or to the Canadian population more generally.

These findings are also constrained by the measures of health behavior that were used. In this study, the predicted relationship between energy and dietary behavior was not found. However, the dietary measure assessed the estimated percentage of calories from fat. It is possible that individuals with T2DM may focus more on limiting their intake of sugar than reducing the amount of fat in their diet. Thus, utilizing a broader measure of dietary intake may be helpful, in addition to including other relevant health behaviors (e.g., smoking, blood glucose monitoring). Future studies may also wish to include a broader range of outcome measures in order to overcome methodological difficulties inherent in the use of self-report measures (for a discussion of these issues see Montoye, Kemper, Saris & Washburn, 1996).

Finally, in this study it was not possible to entirely address the issue of directionality with regard to the energy-physical activity association. The use of a prospective design that controlled for past behaviour does allow for greater confidence in the interpretation that energy is associated with greater intention-behaviour concordance; however, a study that manipulates energy directly and randomly assigns subjects to different conditions would allow for more definite conclusions.

Implications for theory, research and policy

This research suggests that several current health behavior models (e.g., Theory of Reasoned Action; Theory of Planned Behavior), which focus primarily on intentions, may not capture all of the important variables needed to maximize behavioral prediction. In particular, low dispositional energy may explain why some motivated individuals do not act in accordance with their intentions. These findings also highlight the importance of including past behavior in models of behavior change.

These findings may also have implications for interventions in the domain of health. They suggest that at an individual level, interventions that focus primarily on motivating individuals to change (i.e., in helping people to form intentions) may be less effective than interventions that focus on increasing an individual’s self-regulatory capacity. A complementary strategy may involve identifying low-energy individuals in already-established programs and providing them with additional environmental supports that help to decrease self-regulatory demand.

CHAPTER 6: GENERAL DISCUSSION

Taken together, these four studies expand on existing knowledge about self-regulation and energy. Contrary to the predictions of the Energy Model, the experimental studies failed to reproduce the self-regulatory fatigue effect, in that self-regulation during the initial video task was not associated with worse performance on a second self-regulation task. This was true even when objective evidence (the eye-tracker) confirmed that participants were self-regulating to different degrees during the video task. As a result, hypotheses about “state” energy and self-regulation could not be fully tested. However, these studies did not find any evidence for the hypothesis that individuals who self-regulated more on the initial video task would experience a greater decline in energy than individuals who did not self-regulate for this initial task; rather, there were few significant between-group findings on these measures, and those that emerged did not follow the predicted pattern. One unexpected finding of the experimental studies was the high level of variability on all of the energy measures, which suggested that individual differences in dispositional energy may be important. Accordingly, Study 4 examined the relationship between dispositional energy and subsequent health behaviour in a clinical population. This study produced some tentative support for the assumptions of the Energy Model in that dispositional energy at baseline was associated with greater intention-behaviour concordance over a 6-month period. Overall, these studies have implications not only for theoretical accounts of self-regulation, but potentially for the design of behavioural interventions in the domain of health as well.

Theoretical Implications

Self-Regulatory Fatigue: A Reliable Effect?

The current research was informed by two very different lines of study; tightly-controlled laboratory-based experiments utilizing undergraduate students asked to self-regulate for relatively brief periods of time and field-based studies involving exertions of mental and physical energy that can last several hours or even days (e.g., Lieberman et al., 2002; van der Linden et al., 2003). Although both lines of research provide support for the assumptions of the Energy Model, there is some question in the literature as to whether relatively minor exertions of self-control drain energy in an absolute way, as Baumeister and others suggest, or whether more sustained effort over a longer period of time is required. The results from the current research are more consistent with the latter hypothesis. In the experimental studies, there was no evidence that individuals who were self-regulating experienced a greater decrease in energy than individuals who did not self-regulate. These studies also did not provide evidence of self-regulatory fatigue, in that individuals who self-regulated more during an initial task did not show the predicted performance decrement on the second self-regulation task. However, in the prospective study, where prolonged self-regulation over several months was assessed, there was some evidence that energy may facilitate self-regulation.

One possible explanation for these results is that participants in the experimental studies were not sufficiently motivated to self-regulate successfully. Proponents of Self-Determination Theory (SDT: Deci & Ryan, 1980) have challenged the assumption that all goals are created equal, and have argued that that different self-regulatory processes may underlie the pursuit of goals that will help to satisfy psychological needs (autonomous motivation) as opposed to goal pursuits that are externally imposed and do not satisfy psychological needs (controlled motivation; Deci & Ryan, 2000). It is possible that individuals are less likely to expend energy on goals that are not intrinsically satisfying. This may be particularly apparent when considered in the context of a limited energy resource. Muraven and Slessavara (2003) found that when individuals believed that a task would help them, or that their efforts would benefit them directly, they performed better on a subsequent task of self-control than participants who were lower in motivation. This makes sense if one assumes that self-regulation relies on a limited resource that can be depleted by relatively minor exertions; it would be unwise to squander this resource on minor acts of self-control (e.g., resisting a piece of chocolate) if this would then leave insufficient strength for high-priority projects (e.g., not losing one's temper with one's boss).

This "conservation" model was tested by Muraven, Shmueli and Burkley (2006), who manipulated the degree to which individuals anticipated that they would have to engage in future tasks requiring self-regulation. For example, in Study 1, participants completed an initial task either requiring self-regulation (suppressing the thought of a white bear) or not requiring self-regulation (solving difficult arithmetic problems). Participants then completed a second task requiring self-regulation (a cold pressor task where participants had to keep their hands submerged in cold water for as long as they could). Prior to this task, however, half the participants were told that they would have to self-regulate on a third task by controlling their emotions while watching a very funny video. The other half of the participants were simply told that they would watch a video. Consistent with previous research, individuals who had engaged in the initial self-regulation task (thought suppression) withdrew their hands earlier than individuals who had solved arithmetic problems for the initial task (the self-regulatory fatigue effect). In addition to this, individuals who had engaged in the initial task of self-regulation and anticipated having to engage in a subsequent act requiring self-regulation performed significantly worse on the cold pressor task than those in the other three conditions. These results were consistent across three other experiments using the same paradigm, but with different self-regulation tasks (e.g., the Stroop task, an anagram task, a video task). On the basis of these results, the authors concluded that self-regulation failure may often reflect people's unwillingness to exert self-control, rather than their inability to do so.

Similarly, the research of Marijn and colleagues suggests that the self-regulatory fatigue effect may be at contingent on naïve expectancies about the energy-depleting nature of self-control. For example, Martijn, Tenbult, Merckelbach, Dreezens and de Vries (2002) replicated a study performed by Muraven, Tice and Baumeister (1998) that involved asking some participants to suppress their emotions while watching an upsetting video clip, while other participants simply watched the video (control). Performance on a handgrip task served as the dependent measure. In their study, Martijn and colleagues informed half of the participants who regulated their emotions during the initial task that controlling their emotions would not undermine subsequent efforts at self-control while the other participants did not receive these instructions. Consistent with their hypothesis, participants who suppressed their emotions and received an expectancy challenge performed better on the second handgrip task than on the first test, while participants who did not receive the expectancy challenge produced the typical self-regulatory fatigue pattern. Eight items intended to tap subjective fatigue (e.g., I felt drowsy; I was physically tired) also demonstrated that participants in the suppression condition who received an expectancy challenge reported less fatigue at the end of the second measurement than both the suppression and control conditions. In a subsequent study, Martijn and colleagues asked participants to indicate whether they agreed with items that either characterized self-control as requiring energy (e.g., I get tired when I have to control myself) or self-control as a state of mind (e.g., If I am really motivated, I always manage to control myself). Participants agreed more strongly with the statements that implied that self-control requires energy, suggesting that individuals may hold naïve expectancies about the effect that self-control may have on energy (Martijn et al., 2002).

Finally, Martijn et al. (2007) demonstrated that participants who engaged in an initial act requiring high self-control and then read an inspirational story about a persistent athlete who never gave up performed better on a subsequent handgrip task than participants who read a factual text of equivalent length about the International Olympic Committee. Taken together, these studies suggest that individuals are likely to hold beliefs about self-control draining energy; however, when these beliefs are challenged the self-regulatory fatigue effect disappears.

A final possibility is that a different measure of energy might yield different results. Energy is a complex and multifaceted construct, and there is no clear consensus in the literature as to how it should best be measured. Although this research used well-validated and empirically supported measures, comparative studies have shown that there is often little agreement between different energy measures, suggesting that they may be tapping different components of the energy construct (Dittner, Wessely & Brown, 2004). In particular, multidimensional scales like the Multidimensional Fatigue Inventory (MFI-20) differentiate between different kinds of energy (e.g., physical and mental; for a review of commonly used measures of energy and fatigue see Dittner, Wessely & Brown, 2004). Beyond fatigue, sleepiness is a construct that refers to the desire or tendency to fall asleep inappropriately. It is typically measured using the Epworth Sleepiness Scale (Johns, 1991). Despite their conceptual similarity, low correlations between measures of fatigue and measures of sleepiness are commonly reported in both the normal population and in populations with sleep disorders (see Hossein et. al, 2003, 2005).

The Importance of Self-Regulatory Capacity

Most models of health behaviour fail to convincingly account for why some motivated people (i.e., individuals with high intentions) do not succeed in self-regulating. Self-regulatory capacity is a construct that has the potential to enhance the predictive and explanatory power of existing models and generate new, testable hypotheses regarding self-regulation failure. This research examined the influence of energy, a possible component of self-regulatory capacity. Energy was shown to predict exercise behaviour and to moderate the intention-behaviour link for physical activity. This suggests that dispositional variants of self-regulatory capacity may add incremental value to existing health models, although more research is clearly required, given the limitations of Study 4.

While behavioural prediction is important, when these findings are interpreted within a coherent theoretical framework, like Temporal Self-Regulation Theory, they have the potential to help clarify the mechanism of self-regulation in general, and self-regulation failure in particular. Study 4 suggested that individuals who are high in trait energy may be more successful at self-regulating behaviour in accordance with intentions than individuals who are low in trait energy, at least for physical activity. These findings are consistent with past research (e.g., Lieberman et al., 2002) that indicates that lack of energy may be one cause of self-regulation failure in motivated individuals.

Applied Implications

Behaviour change in the domain of health is notoriously difficult. Dishman and Buckworth (1996) published a meta-analytic review of intervention studies with physical activity as the outcome measure. They determined that the type of intervention with the largest effect size was behaviour modification (.92). In contrast, health education interventions had a relatively small effect size (.10). Thus, interventions that focused on altering the antecedents and the consequences of physical activity were relatively successful; in contrast, interventions aimed at providing feedback and information to participants (e.g., fitness tests and risk assessments) did not result in lasting behavioural change. These findings can potentially be understood within a self-regulation framework where health behaviour is seen as effortful and self-regulatory capacity is limited.

An important question that arises from the current research is how can information about trait energy and self-regulation be used to inform interventions in the domain of health? First of all, simply because energy is trait-like does not mean that its capacity cannot be increased over time, within a certain range. Many factors, including disease, nutritional deficiencies, poor sleep habits, stress, psychiatric illness and deconditioning can lead to decreased energy levels (DeLuca, 2005). Effective treatment of any underlying conditions is likely to increase the available energy "pool." There is also now considerable evidence that exercise itself can increase energy levels, even in individuals with serious illnesses (e.g., see Ekkekakis, Hall, VanLanduyt & Petruzzello, 1999; Bixby, Spalding & Hatfield, 2001). While this research is still in its infancy, it suggests that it may be possible to increase one's baseline energy level over time, thus potentially increasing self-regulatory capacity.

Another possible avenue for intervention would be to focus on the strategic application of energetic resources. By following the maxim of "making healthy choices easy choices," environments can be reconfigured in ways that make them more conducive to physical activity, thus easing the self-regulatory burden on individuals (Hall & Fong, 2007). Ecological models of health promotion examine contributing factors at multiple levels of analysis, including interpersonal processes, institutional factors, community factors and public policy (McLeroy, Bibeau, Steckler & Glanz, 1988). Interventions at any, or all, of these levels have the potential to make healthy behaviour easier, thus helping individuals to conserve their limited energy. For example, one policy-level intervention might be to design neighbourhoods that have ready access to green spaces and safe walking paths. In one recent study, a composite index of "walkability" derived from urban land use data predicted physical activity in different Atlanta neighbourhoods, even when relevant demographic, socioeconomic and other factors were taken into consideration

(Frank, Schmid, Sallis, Chapman & Saelens, 2005). Institutional interventions might involve providing workplace incentive programs or making healthful food available and affordable at school cafeterias. Community strategies like making stairways and walking paths well-lit, visible and safe, providing gym memberships at a reduced cost and supporting grass-roots initiatives like walking groups have all been shown to be successful; importantly, many of these do not require overt choice (and therefore the expenditure of energy) by individuals (See Sallis & Owen, 1999, for a summary of this research).

At the individual level, interventions that focus on tailoring one's own environment to support the desired behaviour are likely to be helpful. One such intervention might involve the use of implementation intentions. Implementation intentions are intentions which specifically identify when and where the desired behaviours will be carried out, thus setting up cues that will activate goal-directed cognitions automatically (Gollwitzer, 1993). By helping self-regulation to become more automatic, the need for conscious, effortful self-regulation can be reduced. Research exploring this strategy suggests that implementation intentions have the potential to be very helpful in promoting health protective behaviours (Gollwitzer, 1993; Gollwitzer, 1999; Orbell, Hodgkins & Sheeran, 1997).

Future Directions

When it comes to energy and self-regulation, many questions remain. Increasingly, research in the domain of health is being conducted by interdisciplinary teams. This approach can be particularly beneficial when the topic under investigation is complex and multifaceted, like energy. To date, research progress on energy has been impeded by the lack of integration and consensus in the field. Collaborative research has the potential to help both clinicians and researchers by clarifying key terms (e.g., energy, fatigue), minimizing redundancy across disciplines and potentially creating synergy between different theroretical approaches. There is also a need for basic theoretical models to be tested in populations other than university undergraduates to determine how generalizable these models are. Study 4 attempted to address some of these issues by examining these variables in a medical population (those with Type 2 diabetes). Given the complex nature of energy, it is likely to be desirable for future research endeavours to include other disciplines (e.g., neurology, nutrition, etc).

A second area for future research would be to study the relationship between energy and self-regulation in a more naturalistic way. Daily diary studies may helpful in exploring the relationship between energy and self-regulation on a day-to-day level, and may also help to clarify whether energy plays different roles at different times throughout the process of self-regulation (e.g., do more energetic people set more ambitious goals? Does current energy level predict behavioural choices at the point of decision? Does energy predict success in executing previously determined goals in other domains?). If, as Martijn and her colleagues suggest, human beings hold implicit beliefs about the energy-draining nature of self-regulation, then it will be important for future research to critically examine these beliefs in light of rigorous empirical evidence. These findings suggest that energy may play a role in self-regulation under some conditions, but it remains to be determined when energy is likely to be an important determinant of self-regulation behaviour and when it is not.

Conclusions

Overall, these four studies raise important questions about the Energy Model of self-regulation as it has been articulated to date. The central assumption of this model is that all acts of self-regulation rely on a limited energy resource that can be depleted through repeated use; however, to date there is no empirical evidence that has shown an association between self-regulatory fatigue and subjective measures of energy. Studies 1-3 were designed to test the hypothesis that energy mediates the self-regulatory fatigue effect; however, because this effect could not be replicated the mediating potential of energy could not be tested. In light of recent studies that suggest that the self-regulatory fatigue effect may rely heavily on suggestion (e.g., Martijn et al., 2007; Muraven et al., 2006), there is a need for proponents of the Energy Model to clarify the nature of the proposed energy resource and potential mechanisms for depletion.

One way in which these studies expand on previous research is through the application of the Energy Model to diet and exercise behaviour. In this domain, there was some support for the predictions of the Energy Model in that higher levels of dispositional energy predicted greater physical activity performance and intention-behaviour concordance in Study 4. This is consistent with research showing that being “too tired” is one of the most common reasons given for failure to exercise (e.g., Brownson, Bake, Housemann, Brennan & Bacak, 2001). However, these findings are preliminary and need to be replicated in a larger sample with a wider variety of outcome measures.

Increasingly, health behaviours are recognized as key determinants of disability, disease and death across the globe (WHO, 2005). Research using traditional health behaviour models has provided strong evidence for the role of intentions; however, little is known about why individuals sometimes fail to realize their intentions. Conceptualizing health behaviour as a self-regulatory function may help researchers in the future to identify potential mechanisms of self-regulation failure, and to suggest possible avenues for intervention. One such avenue may involve trying to increase self-regulatory capacity; others might include decreasing self-regulatory demand through environmental restructuring or the formation of implementation intentions. Future research is needed to identify the degree to which models of self-regulation help to answer questions about health behaviour.

REFERENCES

Aiken, L. S., & West, S. G. (1991). *Multiple Regression: Testing and Interpreting Interactions.* Thousand Oaks, CA, US: Sage Publications, Inc.

Ainslie, G. (1996). Studying self-regulation the hard way. *Psychological Inquiry, 7*(1), 16-20.

Ajzen, I. (2006). Constructing a TpB questionnaire: Conceptual and methodological considerations. Retrieved October 22nd, 2008, from http://people.umass.edu/aizen/pdf/tpb.measurement.pdf.

Ajzen, I. (2002). Residual effects of past on later behavior: Habituation and reasoned action perspectives. *Personality and Social Psychology Review, 6*(2), 107-122.

Ajzen, I. (1991). The theory of planned behavior. *Organizational Behavior and Human Decision Processes, 50*, 179-211.

American Diabetes Association (2008a). Total prevalence of diabetes and pre-diabetes. Retrieved August 25, 2008 from http://www.diabetes.org/diabetes-statistics/prevalence.jsp.

American Diabetes Association (2008b). Nutrition recommendations and interventions for diabetes: A position statement of the American Diabetes Association. *Diabetes Care, 31*, S61-S78,

Anderson, R. J., Freedland, K. E., Clouse, R. E., & Lustman, P. J. (2001). The prevalence of comorbid depression in adults with diabetes: A meta-analysis. *Diabetes Care, 24*(6), 1069-1078.

Aristotle. Nichomachean Ethics. In: *John Arthur, Ed*. (2002). *Morality and moral controversies: readings in moral, social, and political philosophy*. N.J: Prentice Hall.

Bandura, A. (1991). Human agency: The rhetoric and the reality. *American Psychologist, 46*(2), 157-162.

Bandura, A. (1996). Failures in self-regulation: Energy depletion or selective disengagement? *Psychological Inquiry, 7*(1), 20-24.

Bardwell, W. A., Burke, S. C., Thomas, K. S., Carter, C., Weingart, K., & Dimsdale, J. E. (2006). Fatigue varies by social class in african americans but not caucasian americans. *International Journal of Behavioral Medicine, 13*(3), 252-258.

Bargh, J. A., & Chartrand, T. L. (1999). The unbearable automaticity of being. *American Psychologist, 54*(7), 462-479.

Bargh, J. A., Gollwitzer, P. M., Lee Chai, A., Barndollar, K., & Trotschel, R. (2001). The automated will: Nonconscious activation and pursuit of behavioral goals. *Journal of Personality and Social Psychology, 81*(6), 1014-1027.

Barrett, K. C. (2005). The origins of social emotions and self-regulation in toddlerhood: New evidence. *Cognition and Emotion, 19*(7), 953-979.

Batty, G. D., Deary, I. J., Schoon, I., & Gale, C. R. (2007). Mental ability across childhood in relation to risk factors for premature mortality in adult life: The 1970 british cohort study. *Journal of Epidemiology and Community Health, 61*(11), 997-1003.

Baumeister, R. F. (2003). Ego depletion and self-regulation failure: A resource model of self-control. *Alcoholism, Clinical and Experimental Research, 27*(2), 281-284.

Baumeister, R. F. (2005). *The cultural animal: Human nature, meaning, and social life.* NY: Oxford University Press.

Baumeister, R. F., Bratslavsky, E., Muraven, M., & Tice, D. M. (1998). Ego depletion: Is the active self a limited resource? *Journal of Personality and Social Psychology, 74*(5), 1252-1265.

Baumeister, R.F., Faber, J.E. & Wallace, H.M. (1999). Coping and ego depletion. In: C.R. Snyder (Ed.), *Coping: The psychology of what works* (pp. 50-69). New York: Oxford University Press.

Baumeister, R. F., Heatherton, T. F., & Tice, D. M. (1994). Losing control: How and why people fail at self-regulation. *.San Diego, CA, US: Academic Press,*

Berrios, G. E. (1990). Feelings of fatigue and psychopathology: A conceptual history. *Comprehensive Psychiatry, 31*(2), 140-151.

Bixby, W.R., Spalding, T.W., & Hatfield, B.D. (2001). Temporal dynamics and dimensional specificity of the affective response to exercise of varying intensity: Differing pathways to a common outcome. *Journal of Sport and Exercise Psychology*, *23*, 171-190.

Blair, S. N., Haskell, W. L., Ho, P., Paffenbarger, R. S.,Jr, Vranizan, K. M., Farquhar, J. W., et al. (1985). Assessment of habitual physical activity by a seven-day recall in a community survey and controlled experiments. *American Journal of Epidemiology, 122*(5), 794-804.

Blomstrand, E. (2001). Amino acids and central fatigue. *Amino Acids, 20*(1), 25-34.

Boksem, M. A., Meijman, T. F., & Lorist, M. M. (2006). Mental fatigue, motivation and action monitoring. *Biological Psychology, 72*(2), 123-132.

Brownson, R. C., Baker, E. A., Housemann, R. A., Brennan, L. K., & Bacak, S. J. (2001). Environmental and policy determinants of physical activity in the united states. *American Journal of Public Health, 91*(12), 1995-2003.

Campbell, J. I. D., & Thompson, V. A. (2002). More power to you: Simple power calculations for treatment effects with one degree of freedom. *Behavior Research Methods, Instruments & Computers, 34*(3), 332-337.

Carver, C. S. (1979). A cybernetic model of self-attention processes. *Journal of Personality and Social Psychology, 37*(8), 1251-1281.

Carver, C. S., & Scheier, M. (1981). *Attention and self-regulation : A control-theory approach to human behavior*. New York: Springer-Verlag.

Chapman, B. P. (2007). Bandwidth and fidelity on the NEO-five factor inventory: Replicability and reliability of Saucier's (1998) item cluster subcomponents. *Journal of Personality Assessment, 88*(2), 220-234.

Charlton, W. (1988). *Weakness of will*. New York: Blackwell.

Cheng, Y.J., Gregg, E.W., Pereira, M.A. & Imperatore, G. (2007, June). Prevalence of adherence to dietary and physical activity guidelines among U.S. adults with diabetes and pre-diabetes: 1999-2004. Poster presented at the 67th annual scientific sessions of the American Diabetes Association. Chicago: Illinois.

Christodoulou, C. (2005). The assessment and measurement of fatigue. In DeLuca, Wessely, Eds. *Fatigue as a window to the brain: Issues in clinical and cognitive psychology.* MIT Press: Cambridge.

Cohen, J. (1992). A power primer. *Psychological Bulletin, 112,* 155-159.

Courneya, K. S., & McAuley, E. (1994). Factors affecting the intention-physical activity relationship: Intention versus expectation and scale correspondence. *Research Quarterly for Exercise and Sport, 65*(3), 280-285.

Csikszentmihalyi, M. (1997). *Finding flow: The psychology of engagement with everyday life.* New York: Basic Books

Curran, S. L., Andrykowski, M. A., & Studts, J. L. (1995). Short form of the profile of mood states (POMS-SF): Psychometric information. *Psychological Assessment, 7*(1), 80-83.

Curry, S. G., & Marlatt, G. A. (1985). Unaided quitters' strategies for coping with temptations to smoke. In S. Shiffman & T. A. Wills (Eds.), *Coping and substance use* (pp. 243-265). New York, NY: Academic Press.

Dansinger, M. L., Gleason, J. A., Griffith, J. L., Selker, H. P., & Schaefer, E. J. (2005). Comparison of the Atkins, Ornish, Weight Watchers, and Zone diets for weight loss and heart disease risk reduction: A randomized trial. *The Journal of the American Medical Association*, *293*(1), 43-53.

Davis, J. M., & Bailey, S. P. (1997). Possible mechanisms of central nervous system fatigue during exercise. *Medicine and Science in Sports and Exercise, 29*(1), 45-57.

Dawson, K. G., Gomes, D., Gerstein, H., Blanchard, J. F., & Kahler, K. H. (2002). The economic cost of diabetes in canada, 1998. *Diabetes Care, 25*(8), 1303-1307.

Deci, E. L., & Ryan, R. M. (1980). Self-determination theory: When mind mediates behavior. *Journal of Mind and Behavior, 1*(1), 33-43.

Deci, E. L., & Ryan, R. M. (2000). The "what" and "why" of goal pursuits: Human needs and the self-determination of behavior. *Psychological Inquiry, 11*(4), 227-268.

DeLuca, J. (2005). Fatigue, cognition and mental effort. In DeLuca, Wessely, Eds. *Fatigue as a window to the brain: Issues in clinical and cognitive psychology.* MIT Press: Cambridge.

Dewall, C. N., Baumeister, R. F., Stillman, T. F., & Gailliot, M. T. (2007). Violence restrained: Effects of self-regulation and its depletion on aggression. *Journal of Experimental Social Psychology*, *43*(1), 62-76.

Diabetes Control and Complications Trial/Epidemiology of Diabetes Interventions and Complications Study Research Group, Jacobson, A. M., Musen, G., Ryan, C. M., Silvers, N., Cleary, P., et al. (2007). Long-term effect of diabetes and its treatment on cognitive function. *The New England Journal of Medicine*, *356*(18), 1842-1852.

Dishman, R. K. (1991). Increasing and maintaining exercise and physical activity. *Behavior Therapy*, *22*(3), 345-378.

Dishman, R. K., & Buckworth, J. (1996). Increasing physical activity: A quantitative synthesis. *Medicine and Science in Sports and Exercise*, *28*(6), 706-719.

Dittner, A. J., Wessely, S. C., & Brown, R. G. (2004). The assessment of fatigue: A practical guide for clinicians and researchers. *Journal of Psychosomatic Research*, *56*(2), 157-170.

Duckworth, A. L., & Seligman, M. E. P. (2005). Self-discipline outdoes IQ in predicting academic performance of adolescents. *Psychological Science, 16*(12), 939-944.

Ekkekakis, P., Hall, E.E., Van Landuyt, L.M., & Petruzzello, S.J. (2000). Walking in (affective) circles: Can short walks enhance affect*? Journal of Behavioral Medicine, 23*(3), 245-275.

Ezzati, M., Lopez, A. D., Rodgers, A., & Murray, C. J. L. (Eds.). (2004). *Comparative quantification of health risks: Global and regional burden of disease attributable to selected major risk factors.* Geneva: World Health Organization.

Fishbein, M., Hennessy, M., Yzer, M., & Douglas, J. (2003). Can we explain why some people do and some people do not act on their intentions? [references]. *Psychology, Health & Medicine, 8*(1), 3-18.

Fishbein, M., & Ajzen, I. (1975). *Belief, attitude, intention, and behavior: An introduction to theory and research*. Reading, MA: Addison-Wesley.

Fitzsimons, G. M., & Bargh, J. A. (2004). Automatic self-regulation. In R. F. Baumeister, & K. D. Vohs (Eds.), *Handbook of self-regulation: Research, theory, and applications* (pp. 151-170). New York, NY, US: Guilford Press.

Frank, L. D., Schmid, T. L., Sallis, J. F., Chapman, J., & Saelens, B. E. (2005). Linking objectively measured physical activity with objectively measured urban form: Findings from SMARTRAQ. *American Journal of Preventive Medicine, 28*(2 Suppl 2), 117-125.

Frederick, S., Loewenstein, G., & O'Donoghue, T. (Eds.). (2003). *Time discounting and time preference: A critical review*.In: Loewenstein, George (Ed); Read, Daniel (Ed); Baumeister, Roy (Ed). (2003). Time and decision: Economic and psychological perspectives on intertemporal choice. (pp. 13-86). xiii, 569 pp. New York, NY, US: Russell Sage Foundation.

Freud, S. (1923/1960). *The Ego and the Id*. New York: Norton

Gailliot, M. T., & Baumeister, R. F. (2007). Self-regulation and sexual restraint: Dispositionally and temporarily poor self-regulatory abilities contribute to failures at restraining sexual behavior. *Personality and Social Psychology Bulletin, 33*(2), 173-186.

Gailliot, M. T., Baumeister, R. F., DeWall, C. N., Maner, J. K., Plant, E. A., Tice, D. M., et al. (2007). Self-control relies on glucose as a limited energy source: Willpower is more than a metaphor. *Journal of Personality and Social Psychology, 92*(2), 325-336.

Garcia-Borreguero, D., Dale, J. K., Rosenthal, N. E., Chiara, A., O'Fallon, A., Bartko, J. J., et al. (1998). Lack of seasonal variation of symptoms in patients with chronic fatigue syndrome. *Psychiatry Research, 77*(2), 71-77.

Gilbert, D. T., Krull, D. S., & Pelham, B. W. (1988). Of thoughts unspoken: Social inference and the self-regulation of behavior. *Journal of Personality and Social Psychology, 55*(5), 685-694.

Goldberg, L. R. (1992). The development of markers for the big-five factor structure. *Psychological Assessment, 4*(1), 26-42.

Gollwitzer, P. M. (1999). Implementation intentions: Strong effects of simple plans. *American Psychologist, 54*(7), 493-503.

Gollwitzer, P. M., & Brandstatter, V. (1997). Implementation intentions and effective goal pursuit. *Journal of Personality and Social Psychology, 73*(1), 186-199.

Gollwitzer, P. M. (1993). Goal achievement: The role of intentions. *European Review of Social Psychology, 4*, 141-185.

Gramzow, R.H., Sedikides, C, Panter, A.T., Sathy, V., Harris, J. & Insk, C.A. (2004). Patterns of self-regulation and the big five. *European Journal of Personality, 18*, 367-385.

Grigsby, A. B., Anderson, R. J., Freedland, K. E., Clouse, R. E., & Lustman, P. J. (2002). Prevalence of anxiety in adults with diabetes: A systematic review. *Journal of Psychosomatic Research, 53*(6), 1053-1060.

Hagger, M. S., Chatzisarantis, N. L. D., & Biddle, S. J. H. (2002). A meta-analytic review of the theories of reasoned action and planned behavior in physical activity: Predictive validity and the contribution of additional variables. *Journal of Sport & Exercise Psychology, 24*(1), 3-32.

Hall, P. A., & Fong, G. T. (2007). Temporal self-regulation theory: A model for individual health behavior. *Health Psychology Review,* (1), 6-52.

Hall, P. A., & Fong, G. T. (2003). The effects of a brief time perspective intervention for increasing physical activity among young adults. *Psychology & Health, 18*(6), 685-706.

Hall, P. A., Fong, G. T., Epp, L. J., & Elias, L. J. (2008). Executive function moderates the intention-behavior link for physical activity and dietary behavior. *Psychology & Health, 23*(3), 309-326.

Hall, P.A. (2007). *Unpublished data.*

Health Canada. (2002). *Diabetes in Canada, 2nd edition*Center for Chronic Disease Prevention and Control.

Heatherton, T. F., & Baumeister, R. F. (1996). Self-regulation failure: Past, present, and future. *Psychological Inquiry, 7*(1), 90-98.

Herz, R. S. (1999). Caffeine effects on mood and memory. *Behaviour Research and Therapy, 37*(9), 869-879.

Hogervorst, E., Riedel, W., Jeukendrup, A., & Jolles, J. (1996). Cognitive performance after strenuous physical exercise. *Perceptual and Motor Skills, 83*(2), 479-488.

Hossain, J.L., Reinish, L.W., Kayumov, L., Bhuiya, P. & Shapiro, C.M. (2003). Underlying sleep pathology may cause chronic high fatigue in shift-workers. *Journal of Sleep Reearch,, 12*, 223-230.

Hossain, J.L., Ahmad, P., Reinish, L.W., Kayumov, L., Hossain, N.K. & Shapiro, C.M. (2005). Subjective fatigue and subjective sleepiness: two independent consequences of sleep disorders*? Journal of Sleep Research, 13*, 245-253.

Janis, I. L., & Mann, L. (1977). Emergency decision making: A theoretical analysis of responses to disaster warnings. *Journal of Human Stress, 3*(2), 35-48.

Johns, M. W. (1991). A new method of measuring daytime sleepiness; the Epworth Sleepiness

Scale. *Sleep, 14*, 540–545.

Kanfer, F. H., & Karoly, P. (1972). Self-control: A behavioristic excursion into the lion's den. *Behavior Therapy, 3*(3), 389-416.

King, L. A. (1996). Who is regulating what and why?: Motivational context of self-regulation. *Psychological Inquiry, 7*(1), 57-60.

Koro, C. E., Bowlin, S. J., Bourgeois, N., & Fedder, D. O. (2004). Glycemic control from 1988 to 2000 among U.S. adults diagnosed with type 2 diabetes: A preliminary report. *Diabetes Care, 27*(1), 17-20.

Lieberman, H. R., Tharion, W. J., Shukitt-Hale, B., Speckman, K. L., & Tulley, R. (2002). Effects of caffeine, sleep loss, and stress on cognitive performance and mood during U.S. navy SEAL training. sea-air-land. *Psychopharmacology, 164*(3), 250-261.

Lieberman, H. R. (2003). Nutrition, brain function and cognitive performance. *Appetite, 40*(3), 245-254.

Lim, W., Hong, S., Nelesen, R., & Dimsdale, J. E. (2005). The association of obesity, cytokine levels, and depressive symptoms with diverse measures of fatigue in healthy subjects. *Archives of Internal Medicine, 165*(8), 910-915.

Logue, A. W. (1996). Self control: An alternative self-regulation framework applicable to human and nonhuman behavior. *Psychological Inquiry, 7*(1), 68-72.

Looman, J. (2005). Review of the self-regulation model of the offense and relapse process: A manual, volume 1. *Journal of Sexual Aggression, 11*(3), 319-321.

Lorist, M. M., Boksem, M. A., & Ridderinkhof, K. R. (2005). Impaired cognitive control and reduced cingulate activity during mental fatigue. *Brain Research.Cognitive Brain Research, 24*(2), 199-205.

Lorist, M. M., Klein, M., Nieuwenhuis, S., De Jong, R., Mulder, G., & Meijman, T. F. (2000). Mental fatigue and task control: Planning and preparation. *Psychophysiology, 37*(5), 614-625.

Lorist, M. M., & Tops, M. (2003). Caffeine, fatigue, and cognition. *Brain and Cognition, 53*(1), 82-94.

Luu, P., Tucker, D. M., & Makeig, S. (2004). Frontal midline theta and the error-related negativity: Neurophysiological mechanisms of action regulation. *Clinical Neurophysiology, 115*(8), 1821-1835.

Martijn, C., Alberts, H. J. E. M., Merckelbach, H., Havermans, R., Huijts, A., & de Vries, N. K. (2007). Overcoming ego-depletion: The influence of exemplar priming on self-control performance. *European Journal of Social Psychology, 37*(2), 231-238.

Martijn, C., Tenbult, P., Merckelbach, H., Dreezens, E., & de Vries, N. K. (2002). Getting a grip on ourselves: Challenging expectancies about loss of energy after self-control. *Social Cognition, 20*(6), 441-460.

Martinez-Martin, P., Catalan, M.J., Benito-Leon, J., Moreno, A.O., Zamarbide, I., Cubo, E. et. al. (2006). Impact of fatigue in Parkinson's Disease: The fatigue impact scale for daily use (D-FIS). *Quality of Life Research, 15*, 597-606.

McLeroy, K. R., Bibeau, D., Steckler, A., & Glanz, K. (1988). An ecological perspective on health promotion programs. *Health Education Quarterly, 15*(4), 351-377.

Mead, L. A., Mayer, A. R., Bobholz, J. A., Woodley, S. J., Cunningham, J. M., Hammeke, T. A., et al. (2002). Neural basis of the stroop interference task: Response competition or selective attention? *Journal of the International Neuropsychological Society : JINS, 8*(6), 735-742.

Mischel, W., Shoda, Y., & Rodriguez, M. L. (1989). Delay of gratification in children. *Science, 244*(4907), 933-938.

Moller, A. C., Deci, E. L., & Ryan, R. M. (2006). Choice and ego-depletion: The moderating role of autonomy. *Personality and Social Psychology Bulletin*, *32*(8), 1024-1036.

Montoye, H. J., Kemper, H. G. C., Saris, W. M. H., & Washburn, R. A. (1996). *Measuring physical activity and energy expenditure*. Champaign, IL: Human Kinetics.

Muraven, M., Baumeister, R. F., & Tice, D. M. (1999). Longitudinal improvement of self-regulation through practice: Building self-control strength through repeated exercise. *The Journal of Social Psychology, 139*(4), 446-457.

Muraven, M., Collins, R. L., & Nienhaus, K. (2002). Self-control and alcohol restraint: An initial application of the self-control strength model. *Psychology of Addictive Behaviors, 16*(2), 113-120.

Muraven, M., Collins, R. L., Shiffman, S., & Paty, J. A. (2005). Daily fluctuations in self-control demands and alcohol intake. *Psychology of Addictive Behaviors*, *19*(2), 140-147.

Muraven, M., Shmueli, D., & Burkley, E. (2006). Conserving self-control strength. *Journal of Personality and Social Psychology, 91*(3), 524-537.

Muraven, M., & Slessareva, E. (2003). Mechanisms of self-control failure: Motivation and limited resources. *Personality and Social Psychology Bulletin, 29*(7), 894-906.

Muraven, M., Baumeister, R. F., & Tice, D. M. (1999). Longitudinal improvement of self-regulation through practice: Building self-control strength through repeated exercise. *Journal of Social Psychology, 139*(4), 446-457.

Muraven, M., Tice, D. M., & Baumeister, R. F. (1998). Self-control as limited resource: Regulatory depletion patterns. *Journal of Personality and Social Psychology*, *74*(3), 774-789.

Neal, D. T., Wood, W., & Quinn, J. M. (2006). Habits--A repeat performance. *Current Directions in Psychological Science, 15*(4), 198-202.

Nigg, J. T., Stavro, G., Ettenhofer, M., Hambrick, D. Z., Miller, T., & Henderson, J. M. (2005). Executive functions and adhd in adults: Evidence for selective effects on ADHD symptom domains. *Journal of Abnormal Psychology, 114*(4), 706-717.

Norcross, J. C., Mrykalo, M. S., & Blagys, M. D. (2002). Auld lang syne: Success predictors, change processes, and self-reported outcomes of new year's resolvers and nonresolvers. *Journal of Clinical Psychology, 58*(4), 397-405.

Norcross, J. C., Ratzin, A. C., & Payne, D. (1989). Ringing in the new year: The change processes and reported outcomes of resolutions. *Addictive Behaviors*, *14*(2), 205-212.

Norcross, J. C., & Vangarelli, D. J. (1989). The resolution solution: Longitudinal examination of new year's change attempts. *Journal of Substance Abuse, 1*(2), 127-134.

Nyenhuis, D. L., Yamamoto, C., Luchetta, T., Terrien, A., & Parmentier, A. (1999). Adult and geriatric normative data and validation of the profile of mood states. *Journal of Clinical Psychology, 55*(1), 79-86.

O'Connor, P. J. (2004). Evaluation of four highly cited energy and fatigue mood measures. *Journal of Psychosomatic Research*, *57*(5), 435-441.

Ohinmaa, A., Jacobs, P., Simpson, S., Johnson, J. (2004). The projection of prevalence and cost of diabetes in Canada: 2000 to 2016. *Canadian Journal of Diabetes, 28*(2), 116-123.

Orbell, S., Hodgkins, S., & Sheeran, P. (1997). Implementation intentions and the theory of planned behavior. *Personality and Social Psychology Bulletin*, *23*(9), 945-954.

Pavlik, V. N., de Moraes, S. A., Szklo, M., Knopman, D. S., Mosley, T. H., & Hyman, D. J. (2003). Relation between cognitive function and mortality in middle-aged adults: The atherosclerosis risk in communities study. *American Journal of Epidemiology*, *157*(4), 327-334.

Pervin, L. A. (1996). Does it take a gun to the head to assess problems of volition? *Psychological Inquiry*, *7*(1), 72-74.

Popkin, B. M., Kim, S., Rusev, E. R., Du, S., & Zizza, C. (2006). Measuring the full economic costs of diet, physical activity and obesity-related chronic diseases. *Obesity Reviews*, *7*(3), 271-293.

Porath, C. L., & Bateman, T. S. (2006). Self-regulation: From goal orientation to job performance. *The Journal of Applied Psychology*, *91*(1), 185-192.

Prochaska, J. O., DiClemente, C. C., & Norcross, J. C. (1992). In search of how people change: Applications to addictive behaviors. *American Psychologist*, *47*(9), 1102-1114.

Public Health Agency of Canada. (2005). *Building a national diabetes strategy: Synthesis of research and collaborations*. Ottawa: Minister of Health.

Rachlin, H. (2000). *The science of self-control*. Cambridge, Mass.: Harvard University Press.

Rhodes, R. E., Courneya, K. S., & Jones, L. W. (2004). Personality and social cognitive influences on exercise behavior: Adding the activity trait to the theory of planned behavior. *Psychology of Sport and Exercise*, *5*(3), 243-254.

Rothbart, M.K., Ahadi, S.A. & Evans, D.E. (2000). Temperament and personality: Origins and outcomes. *Journal of Personality and Social Psychology*, *78*(1), 122-135.

Sallis, J.F., & Owen, N. (1999). Physical Activity and Behavioral Medicine. Thousand Oaks, CA: Sage.

Saucier, G., & Ostendorf, F. (1999). Hierarchical subcomponents of the big five personality factors: A cross-language replication. *Journal of Personality and Social Psychology, 76*(4), 613-627.

Schmeichel, B. J., Vohs, K. D., & Baumeister, R. F. (2003). Intellectual performance and ego depletion: Role of the self in logical reasoning and other information processing. *Journal of Personality and Social Psychology, 85*(1), 33-46.

Schuit, A. J., Schouten, E. G., Westerterp, K. R., & Saris, W. H. (1997). Validity of the physical activity scale for the elderly (PASE): According to energy expenditure assessed by the doubly labeled water method. *Journal of Clinical Epidemiology, 50*(5), 541-546.

Shoda, Y., Mischel, W., & Peake, P. K. (1990). Predicting adolescent cognitive and self-regulatory competencies from preschool delay of gratification: Identifying diagnostic conditions. *Developmental Psychology, 26*(6), 978-986.

Sniehotta, F. F., Scholz, U., Schwarzer, R., Fuhrmann, B., Kiwus, U., & Voller, H. (2005). Long-term effects of two psychological interventions on physical exercise and self-regulation following coronary rehabilitation. *International Journal of Behavioral Medicine, 12*(4), 244-255.

Stahl, S. M. (2002). The psychopharmacology of energy and fatigue. *The Journal of Clinical Psychiatry, 63*(1), 7-8.

Statistics Canada (1999). *Statistical report on the health of Canadians.* Retrieved September 10, 2008 from http://www.statcan.ca/english/freepub/82-570-XIE/82-570-XIE.pdf.

Stein, K. D., Jacobsen, P. B., Blanchard, C. M., & Thors, C. (2004). Further validation of the multidimensional fatigue symptom inventory-short form. *Journal of Pain and Symptom Management, 27*(1), 14-23.

Stein, K. D., Martin, S. C., Hann, D. M., & Jacobsen, P. B. (1998). A multidimensional measure of fatigue for use with cancer patients. *Cancer Practice, 6*(3), 143-152.

Stephens, T., Kaiserman, M.J., McCall, D.J. & Sutherland-Brown, C. (2000). School-based prevention: Economic costs versus benefits. *Chronic Diseases in Canada, 21*(2), 62-67

Sutton, S. (1998). Predicting and explaining intentions and behavior: How well are we doing? *Journal of Applied Social Psychology, 28*(15), 1317-1338.

Swain, M. G. (2000). Fatigue in chronic disease. *Clinical Science (London, England : 1979), 99*(1), 1-8.

Tangney, J. P., Baumeister, R. F., & Boone, A. L. (2004). High self-control predicts good adjustment, less pathology, better grades, and interpersonal success. *Journal of Personality, 72*(2), 271-324.

Thomas, A. & Chess, S. (1977). *Temperament and development*. New York: Brunner/Mazel.

Thompson, F. E., Midthune, D., Subar, A. F., Kahle, L. L., Schatzkin, A., & Kipnis, V. (2004). Performance of a short tool to assess dietary intakes of fruits and vegetables, percentage energy from fat and fibre. *Public Health Nutrition, 7*(8), 1097-1105.

Tice, D. M., Bratslavsky, E., & Baumeister, R. F. (2001). Emotional distress regulation takes precedence over impulse control: If you feel bad, do it! *Journal of Personality and Social Psychology, 80*(1), 53-67.

Tice, D. M., Baumeister, R. F., Shmueli, D., & Muraven, M. (2007). Restoring the self: Positive affect helps improve self-regulation following ego depletion. *Journal of Experimental Social Psychology, 43*(3), 379-384.

Torres-Harding, S. & Jason, L.A. (2005). What is fatigue? History and epidemiology. In DeLuca, Wessely, Eds. *Fatigue as a window to the brain: Issues in clinical and cognitive psychology*. MIT Press: Cambridge.

van der Linden, D., Frese, M., & Meijman, T. F. (2003). Mental fatigue and the control of cognitive processes: Effects on perseveration and planning. *Acta Psychologica*, *113*(1), 45-65.

van der Linden, D., & Eling, P. (2006). Mental fatigue disturbs local processing more than global processing. *Psychological Research*, *70*(5), 395-402.

Vohs, K. D., & Heatherton, T. F. (2000). Self-regulatory failure: A resource-depletion approach. *Psychological Science : A Journal of the American Psychological Society / APS*, *11*(3), 249-254.

Vohs, K. D., & Faber, R. J. (2007). Spent resources: Self-regulatory resource availability affects impulse buying. *Journal of Consumer Research*, *33*(4), 537-547.

Vohs, K. D., & Schmeichel, B. J. (2003). Self-regulation and the extended now: Controlling the self alters the subjective experience of time. *Journal of Personality and Social Psychology*, *85*(2), 217-230.

Vohs, K. D., & Baumeister, R. F. (2004). Ego depletion, self-control, and choice. In J. Greenberg, S. L. Koole & T. Pyszczynski (Eds.), *Handbook of experimental existential psychology* (pp. 398-410). New York, NY, US: Guilford Press.

Vohs, K. D., & Heatherton, T. F. (2000). Self-regulatory failure: A resource-depletion approach. *Psychological Science, 11*(3), 249-254.

Washburn, R. A., McAuley, E., Katula, J., Mihalko, S. L., & Boileau, R. A. (1999). The physical activity scale for the elderly (PASE): Evidence for validity. *Journal of Clinical Epidemiology, 52*(7), 643-651.

Washburn, R. A., Smith, K. W., Jette, A. M., & Janney, C. A. (1993). The physical activity scale for the elderly (PASE): Development and evaluation. *Journal of Clinical Epidemiology, 46*(2), 153-162.

Watanabe, A., Kato, N., & Kato, T. (2002). Effects of creatine on mental fatigue and cerebral hemoglobin oxygenation. *Neuroscience Research, 42*(4), 279-285.

Webb, T. L., & Sheeran, P. (2006). Does changing behavioral intentions engender behavior change? A meta-analysis of the experimental evidence. *Psychological Bulletin, 132*(2), 249-268.

Wegner, D. M. (1994). Ironic processes of mental control. *Psychological Review, 101*(1), 34-52.

Wessely, S. (2005). Foreward. In DeLuca, Wessely, Eds. *Fatigue as a window to the brain: Issues in clinical and cognitive psychology*. MIT Press: Cambridge.

Whalley, L. J., & Deary, I. J. (2001). Longitudinal cohort study of childhood IQ and survival up to age 76. *British Medical Journal, 322*(7290), 819.

Winer, B. J., Brown, D. R., & Michels, K. M. (1991). *Statistical Principles in Experimental Design*. New York, NY: McGraw-Hill.

Williams, G.C., Hurley, T.G., Thompson, F.E., Midthune, D., Yaroch, A.L., Resnicow, K. et. al (2008). Performance of a short percentage energy from fat tool in measuring change in dietary intervention studies. *Journal of Nutrition, 138*(1), 212S- 217S, Wood, W., & Neal, D. T. (2007). A new look at habits and the habit-goal interface. *Psychological Review, 114*(4), 843-863.

World Health Organization. (2005). *The world health report 2002: Reducing risks, promoting healthy life*. France: World Health Organization.

Zhao, G., Ford, E. S., Li, C., & Mokdad, A. H. (2008). Compliance with physical activity recommendations in US adults with diabetes. *Diabetic Medicine : A Journal of the British Diabetic Association, 25*(2), 221-227.

Ziino, C. & Ponsford, J. (2006). Vigilance and fatigue following traumatic brain injury. *Journal of the International Neuropsychological Society*, *12*, 100-110.

Table 1

Manipulation Check (Study 1)

	Condition				
	GR		CT		
	M	*SD*	*M*	*SD*	*F*
Words Recalled	2.48	1.68	3.62	2.19	5.31*
Words Recognized	17.57	5.90	20.29	6.55	2.89
Task Difficulty (1,6)	4.38	.95	4.03	1.30	1.50
Task Effort (1,5)	2.68	.98	2.55	1.01	.240

Note. GR = Gaze Regulation (n= 33), CT = Control (n= 29)
* = significant at the .05 level

Table 2

Means and Standard Deviations for Anagram Task (Study 1)

	Condition				
	GR		CT		
	M	*SD*	*M*	*SD*	*F*
Total Anagrams Solved (0,9)	5.26	2.27	5.65	2.21	.47
Persistence on Anagrams (0,20)	10.82	6.07	9.67	4.96	.64

Note. GR = Gaze Regulation (n= 33), CT = Control (n= 29)
* = significant at the .05 level.

Table 3

Repeated Measures Analyses for Subjective Energy and Vigour (Study 1)

	Condition/Time		*M*	*SD*	*F*
Subjective Energy					
Time					5.15*
		T1	58.86	17.96	
		T2	55.73	16.89	
Time x Condition					.167
	GR				
		T1	59.76	19.96	
		T2	56.12	19.07	
	CT				
		T1	57.81	15.58	
		T2	55.28	14.26	
Vigour					
Time					10.57**
		T1	13.56	4.92	
		T2	12.24	4.29	
Time x Condition					.37
	GR				
		T1	14.0	5.17	
		T2	12.91	4.65	
	CT				
		T1	13.03	4.64	
		T2	11.45	3.76	

Note. GR = Gaze Regulation (n= 33), CT = Control (n= 29), T1= Time 1, T2= Time 2
* = significant at the .05 level
** = significant at the .01 level

Table 4

Means and Standard Deviations for Manipulation Check (Study 2)

	Condition	*M*	*SD*	*F*
Difficulty				2.80*
	CT	4.53	1.30	
	MR	4.83	1.27	
	GR	3.63	1.26	
	GR+MR	4.75	1.34	
Effort				2.66
	CT	2.20	.56	
	MR	2.92	1.08	
	GR	2.81	.98	
	GR+MR	3.06	.94	
Recall				2.76*
	CT	3.93	2.99	
	MR	2.0	1.23	
	GR	2.73	1.75	
	GR+MR	2.25	1.18	
Recognition				1.86
	CT	21.13	6.86	
	MR	16.75	5.83	
	GR	20.75	2.54	
	GR+MR	18.94	5.48	

Note. CT = Control (n= 15), MR= Memory Regulation (n= 16), GR= Gaze Regulation (n= 16), MR+GR= Memory and Gaze Regulation (n = 19)
* = significant at the .05 level

Table 5

Means and Standard Deviations for Anagram Task (Study 2)

	Condition	*M*	*SD*	*F*
Total Correct				1.57
	CT	4.40	3.02	
	MR	6.08	2.19	
	GR	4.13	2.39	
	GR+MR	5.31	2.80	
Persistence (minutes)				4.02*
	CT	10.37	4.27	
	MR	14.15	4.27	
	GR	7.87	4.39	
	GR+MR	10.61	5.69	

Note. CT = Control (n= 15), MR= Memory Regulation (n= 16), GR= Gaze Regulation (n= 16), MR+GR= Memory and Gaze Regulation (n = 19)
* = significant at the .05 level
** = significant at the .01 level

Table 6

Means and Standard Deviations for Repeated Measures Analyses (Subjective Energy) Study 2

	Condition	Time	*M*	*SD*	*F*
Energy					
Time					2.90
		T1	59.58	18.85	
		T2	57.43	17.62	
Time x Condition					2.18
	CT	T1	57.64	19.17	
		T2	57.73	16.19	
	MR	T1	61.25	14.63	
		T2	61.25	14.48	
	GR	T1	63.47	17.90	
		T2	56.53	16.02	
	MR + GR	T1	56.24	22.78	
		T2	55.16	22.95	

Note. CT = Control (n= 15), MR= Memory Regulation (n= 16), GR= Gaze Regulation (n= 16), MR+GR= Memory and Gaze Regulation (n = 19), T1= Time 1, T2= Time 2

Table 7

Means and Standard Deviations for Repeated Measures Analyses (Vigour) Study 2

	Condition	Time	*M*	*SD*	*F*
Vigour					
Time					31.46**
		T1	14.92	5.21	
		T2	12.73	4.82	
Time x Condition					1.67
	CT	T1	15.40	5.90	
		T2	13.13	5.15	
	MR	T1	15.75	4.29	
		T2	12.92	4.25	
	GR	T1	15.69	5.62	
		T2	12.69	4.61	
	GR+MR	T1	13.06	4.71	
		T2	12.25	5.47	

Note. CT = Control (n= 15), MR= Memory Regulation (n= 16), GR= Gaze Regulation (n= 16), MR+GR= Memory and Gaze Regulation (n = 19)
* = significant at the .05 level
** = significant at the .01 level

Table 8

Means and Standard Deviations for Eye-tracker Analyses (Study 3)

	Condition			
	CT	MR	GR	GR+MR
	M (*SD*)	*M* (*SD*)	*M* (*SD*)	*M* (*SD*)
Time (sec) (face)	254.37 (69.91)	260.59 (52.24)	298.23 (43.89)	282.80 (74.13)
Percentage (face)	68.52 (18.24)	71.78 (14.55)	83.05 12.21	78.04 20.61
Fixation (face)	776.96 (274.57)	674.59 (192.40)	723.27 (313.04)	669.04 (261.12)
Time (word)	4.16 (6.90)	10.23 (10.93)	0.13 (0.20)	0.15 (0.30)
Percentage (word)	1.15 (1.97)	2.74 (3.02)	0 (0)	0 (0)
Fixation (word)	40.63 (52.06)	77.52 (63.98)	1.86 (2.92)	1.64 (2.36)

Note. CT = Control (n= 27), MR= Memory Regulation (n= 27), GR = Gaze Regulation (n= 22), GR + MR = Memory and Gaze Regulation (n= 25). Time when participants did not look at the words or woman (e.g., blinking) is not included in these estimates.

Table 9

Recall and Recognition of Words presented during the Video Task (Study 3)

	Condition				
	CT	MR	GR	GR+MR	
	M *(SD)*	*M* *(SD)*	*M* *(SD)*	*M* *(SD)*	*F*
Words Recalled	3.88 (2.36)	4.28 (3.02)	1.32 (1.43)	.67 (.96)	17.58**
Words Recognized	22.70 (4.05)	21.74 (5.50)	18.54 (4.53)	21.76 (20.70)	.626

Note. CT = Control (n= 27), MR= Memory Regulation (n= 27), GR = Gaze Regulation (n= 22), GR + MR = Memory and Gaze Regulation (n= 25).
** = significant at the .01 level

Table 10

Repeated Measures Analyses for Subjective Energy (Within-Subject Effects) Study 3

	Condition	Time	*M*	*SD*	*F*
Subjective Energy					
(Time)					.966
		T1	56.5	20.0	
		T2	55.5	18.7	
Time x Condition					2.803*
	CT	T1	60.7	18.4	
		T2	56.3	19.5	
	MR	T1	55.2	24.0	
		T2	55.8	22.5	
	GR	T1	54.3	18.2	
		T2	51.6	15.6	
	MR+GR	T1	54.9	18.8	
		T2	57.7	16.3	

Note. CT = Control (n= 27), MR= Memory Regulation (n= 27), GR = Gaze Regulation (n= 22), GR + MR = Memory and Gaze Regulation (n= 25).
* = significant at the .05 level

Table 11

Repeated Measures Analyses for Vigour (Within-Subject Effects) Study 3

	Condition	Time	*M*	*SD*	*F*
Vigour					
Time					23.69**
		T1	13.9	4.9	
		T2	12.5	4.7	
Time x Condition					
	CT	T1	14.6	4.0	1.23
		T2	12.6	4.6	
	MR	T1	13.1	4.9	
		T2	12.4	5.0	
	GR	T1	13.4	5.4	
		T2	11.5	4.5	
	MR+GR	T1	14.5	5.4	
		T2	13.5	4.5	

Note. CT = Control (n= 27), MR= Memory Regulation (n= 27), GR = Gaze Regulation (n= 22), GR + MR = Memory and Gaze Regulation (n= 25).
* = significant at the .05 level
** = significant at the .01 level

Table 12

Means and Standard Deviations for Time Perception and Flow Analyses (Study 3)

	Condition				
	CT	MR	GR	GR+MR	
	M *(SD)*	*M* *(SD)*	*M* *(SD)*	*M* *(SD)*	*F*
Interesting	2.04 (1.07)	2.12 (1.09)	1.95 (.79)	2.00 (1.02)	.12
Enjoyable	1.77 (.76)	2.04 (1.02)	1.78 (.81)	2.08 (.88)	.45
Task Difficulty	1.69 (.68)	1.84 (.75)	1.68 (.95)	2.08 (.97)	1.91
Task Effort	2.81 (.98)	2.76 (.72)	2.73 (1.08)	3.04 (1.12)	.50
Length of Video Task (sec)	351.0 (218.1)	259.4 (132.8)	337.4 (183.6)	319.7 (169.8)	1.27

Note. CT = Control (n= 27), MR= Memory Regulation (n= 27), GR = Gaze Regulation (n= 22), GR + MR = Memory and Gaze Regulation (n= 25).

Table 13

Means and Standard Deviations for Anagram Task (Study 3)

	Condition				
	CT	MR	GR	GR+MR	
	M SD	*M SD*	*M SD*	*M SD*	*F*
Persistence on Anagram Task (time in seconds)	12.52 (3.88)	11.61 (4.42)	13.15 (4.95)	14.36 (5.03)	1.62
Number of Anagrams solved	5.30 (2.49)	5.63 (2.08)	5.76 (2.52)	5.60 (2.31)	.233

Note. CT = Control (n= 27), MR= Memory Regulation (n= 27), GR = Gaze Regulation (n= 22), GR + MR = Memory and Gaze Regulation (n= 25).

Table 14

Means, Standard Deviations, and Intercorrelations of Study Variables for the PASE Analyses (Study 4)

	1	2	3	4	5
1. Age	--	.030	-.242*	.204*	-.330**
2. Gender		--	-.211*	-.112	-.264*
3. PASE T1			--	-.119	.386**
4. Energy				--	.314**
5. PASE T2					--
M	57.98	1.57	164.13	5.27	150.20
SD	10.76	.498	91.03	.833	86.23

Note. PASE = Physical Activity Scale for the Elderly; T1 = Time 1; T2 = Time 2
*p < .05, **p < .01

Table 15

Means, Standard Deviations, and Intercorrelations of Study Variables for the Physical Activity Recall (PAR) Analyses (Study 4)

		1	2	3	4	5	6
1	Age	--	.030	.204*	-.002	.031	.032
2	Gender		--	-.112	-.297*	-.088	-.116
3	Energy			--	.445**	.104	.147
4	PAR T2				--	.371	.420**
5	Intentions					--	.949**
6	PAR T1						--
M		57.98	1.57	5.27	7.67	9.85	8.63
SD		10.76	.498	.833	8.76	13.2	12.33

Note. PAR = Physical Activity Recall; T1 = Time 1; T2 = Time 2
*p < .05, **p < .01

Table 16

Means, Standard Deviations, and Intercorrelations of Study Variables for the National Cancer Institute (NCI) fat screener (Study 4)

		1	2	3	4	5	6
1	Age	--	.030	.204*	-.043	.111	-.066
2	Gender		--	-.112	-.046	-.203*	-.146
3	Energy			--	.047	.103	.148
4	Diet T1				--	.814**	.510**
5	Intentions					--	.423**
6	Diet T2						--
M		57.98	1.57	5.27	32.34	30.72	31.69
SD		10.76	.498	.833	4.53	4.19	4.53

Note. T1 = Time 1; T2 = Time 2
*p < .05, **p < .01

Table 17

Hierarchical Regression of Demographic Variables and Trait Energy on Physical Activity (PASE) (N = 77) Study 4

Variable	β	F	ΔR^2	Significance of R^2 Change
Step 1		8.19	.18	.001
Age (years)	-.33			
Gender	-.26			
Step 2		12.19	.12	.001
Trait Energy	.35			

Note. Dependent: Overall physical activity at Time 2. Adjusted R^2 = .270. F = F_{change} for each step.

Table 18

Hierarchical Regression of Demographic Variables and Trait Energy on Physical Activity (PASE), including past behaviour (N = 77) Study 4

Variable	β	F	ΔR^2	Significance of R^2 Change
Step 1		8.43	.27	.00
Age	-.28			
Gender	-.19			
PASE T1	.31			
Step 2		16.18	.13	.00
Trait Energy	.38			

Note. Dependent: Overall physical activity at Time 2. Adjusted R^2 = .370. $F = F_{change}$ for each step. T1 = Time 1.

Table 19

Hierarchical Regression of Demographic Variables and Trait Energy on Strenuous Physical Activity (PAR)(N = 74) Study 4

Variable	β	F	ΔR^2	Significance of R^2 Change
Step 1		3.43	.09	.04
Age	.006			
Gender	-.297			
Step 2		15.793	.168	.000
Trait Energy	.420			

Note. Dependent: Moderate and Strenuous physical activity at Time 2. Adjusted R^2 = .224. F = F_{change} for each step.

Table 20

Hierarchical Regression of Demographic Variables and Trait Energy on Strenuous Physical Activity (PAR) with past behaviour (N = 64) Study 4

Variable	β	F	ΔR^2	p
Step 1		6.650	.250	.001
Age	.051			
Gender	-.275			
PAR T1	.388			
Step 2		13.157	.137	.001
Trait Energy	.382			

Note. Dependent: Moderate and Strenuous physical activity at Time 2. Adjusted R^2 = .345. F = F_{change} for each step. T1= Time 1.

Table 21

Hierarchical Regression of Demographic Variables and Trait Energy on Dietary Fat Intake (N = 76) Study 4

Variable	*β*	*F*	ΔR^2	Significance of R^2 Change
Step 1		1.027	.027	.363
Age	-.078			
Gender	-.144			
Step 2		1.265	.017	.265
Trait Energy	.132			

Note. Dependent: Percentage of calories from fat at Time 2. Adjusted R^2 = .004. $F = F_{change}$ for each step.

Table 22

Hierarchical Regression of Demographic Variables and Trait Energy on Dietary Fat Intake, with past behaviour (N = 76) Study 4

Variable	*β*	*F*	ΔR^2	Significance of R^2 Change
Step 1				
Age	-.024	9.239	.278	.000
Gender	-.110			
Fat Intake T1	.505			
Step 2		.697	.007	.407
Trait Energy	.086			

Note. Dependent: Percentage of calories from fat at Time 2. Adjusted R^2 = .245. $F = F_{change}$ for each step. T1 = Time 1.

Table 23

Hierarchical Regression of Demographic Variables, Intentions and Trait Energy on Moderate and Strenuous Physical Activity (PAR) (N =64) Study 4

Variable	β	F	ΔR^2	Significance of R^2 Change
Step 1		3.446	.102	.038
Age	.065			
Gender	-.322			
Step 2		12.561	.268	.000
ZPAInt	.299			
ZEnergy	.399			
Step 3		3.509	.036	.066
ZPAInt*ZEnergy	.261			

Note. Dependent: Moderate and Strenuous physical activity at Time 2. Adjusted R^2 = .355. $F = F_{change}$ for each step. ZPA = centred score for intentions, ZEnergy = centered score for Energy, ZPAInt*ZEnergy = interaction term, PAR= Physical Activity Recall Scale.

Table 24

Hierarchical Regression of Demographic Variables, Intentions and Trait Energy on Dietary Fat Intake (N = 76) Study 4

Variable	β	F	ΔR^2	Significance of R^2 Change
Step 1		1.027	.027	.363
Age	-.078			
Gender	-.144			
Step 2		7.313	.166	.001
ZDietInt	.406			
ZEnergy	.094			
Step 3		1.678	.019	.199
ZDietInt*ZEnergy	.159			

Note. Dependent: Percentage of calories from fat at Time 2. Adjusted R^2 = .156. $F = F_{change}$ for each step. ZPA = centred score for intentions, ZEnergy = centered score for Energy, ZPAInt*ZEnergy = interaction term.

Table 25

Hierarchical Regression of Demographic Variables, Intentions and Trait Energy on Moderate and Strenuous Physical Activity (PAR), Controlling for Past Behaviour (N = 64) Study 4

Variable	β	F	ΔR^2	Significance of R^2 Change
Step 1		6.650	.250	.001
Age	.051			
Gender	-.275			
PAR T1	.388			
Step 2		6.597	.139	.003
ZPAInt	-.168			
ZEnergy	.376			
Step 3		2.496	.026	.120
ZDietInt*ZEnergy	.228			

Note. Dependent: Moderate and Strenuous physical activity at Time 2. Adjusted R^2 = .353. F = F_{change} for each step. T1 = Time 1. ZPA = centred score for intentions, ZEnergy = centered score for Energy, ZPAInt*ZEnergy = interaction term, PAR= Physical Activity Recall.

Table 26

Hierarchical Regression of Demographic Variables, Intentions and Trait Energy on Dietary Fat Intake, Controlling for Past Behaviour (N = 76) Study 4

Variable	*β*	*F*	ΔR^2	Significance of R^2 Change
Step 1		9.239	.278	.000
Age	-.024			
Gender	-.110			
Diet T1	.505			
Step 2		0.363	.007	.697
ZDietInt	-.036			
ZEnergy	.086			
Step 3		1.663	.017	.201
ZDietInt*ZEnergy	.150			

Note. Dependent: Percentage of calories from fat at Time 2. Adjusted $R^2 = .242$. $F = F_{change}$ for each step. ZPA = centred score for intentions, ZEnergy = centered score for Energy, ZPAInt*ZEnergy = interaction term; T1 = time 1.

Figure Caption

Figure 1. Mean number of minutes persisting on anagram task by condition (Study 2)

Figure 2. Mean time in seconds looking at visual target, for participants in the CT (n=27), WM (n=27), GR (n=22) and GR+WM (n=24) conditions (Study 3)

Figure 3. Percentage of time spent looking at visual target during 6 minute video task (Study 3)

Figure 4. Number of fixations on the visual target during 6 minute video task (Study 3)

Figure 5. Mean time in seconds looking at visual target during 6 minute video task (Study 3)

Figure 6. Percentage of time looking at distractor words during 6 minute video task (Study 3)

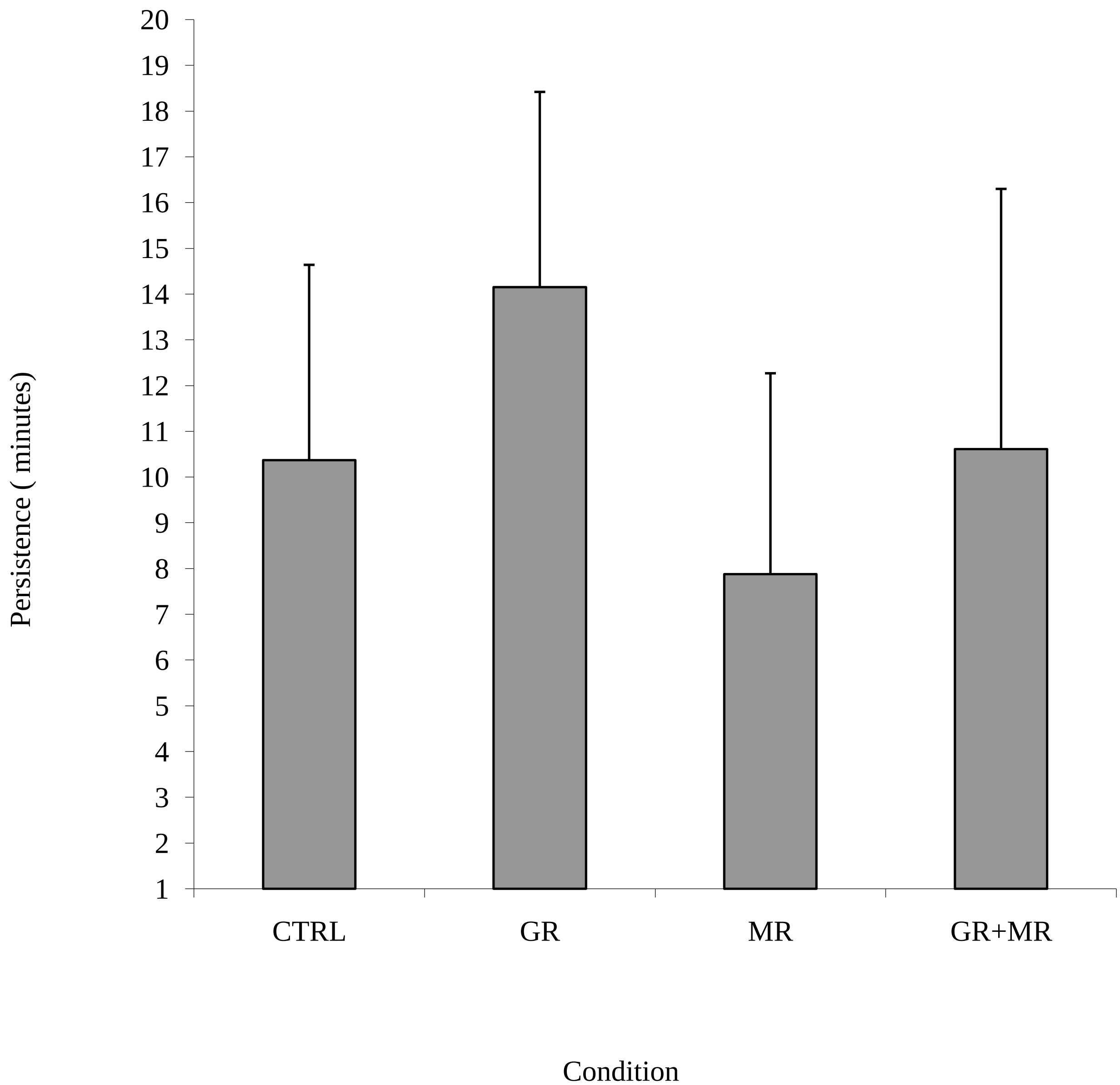
Figure 7. Number of fixations on the distractor words during 6 minute video task (Study 3)

Figure 8. Mean rating of subjective energy at Time 1 (before video task) and at Time 2 (after video task; Study 3).

Figure 9. Mean rating of vigour by condition at Time 1 (before video task) and at Time 2 (after video task; Study 3)

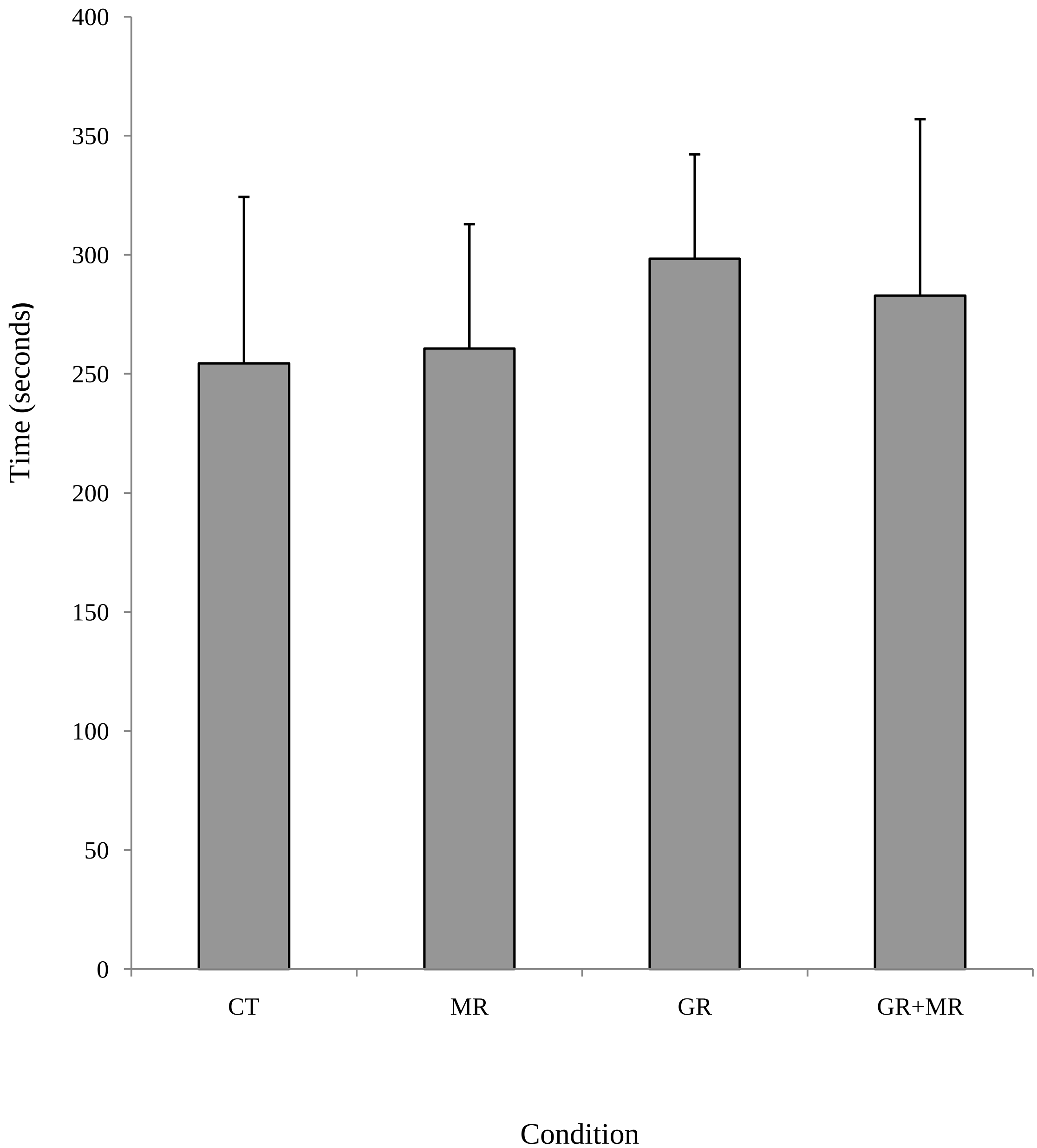
Figure 10. The intention mediating effects of energy (Study 4)

Figure 1



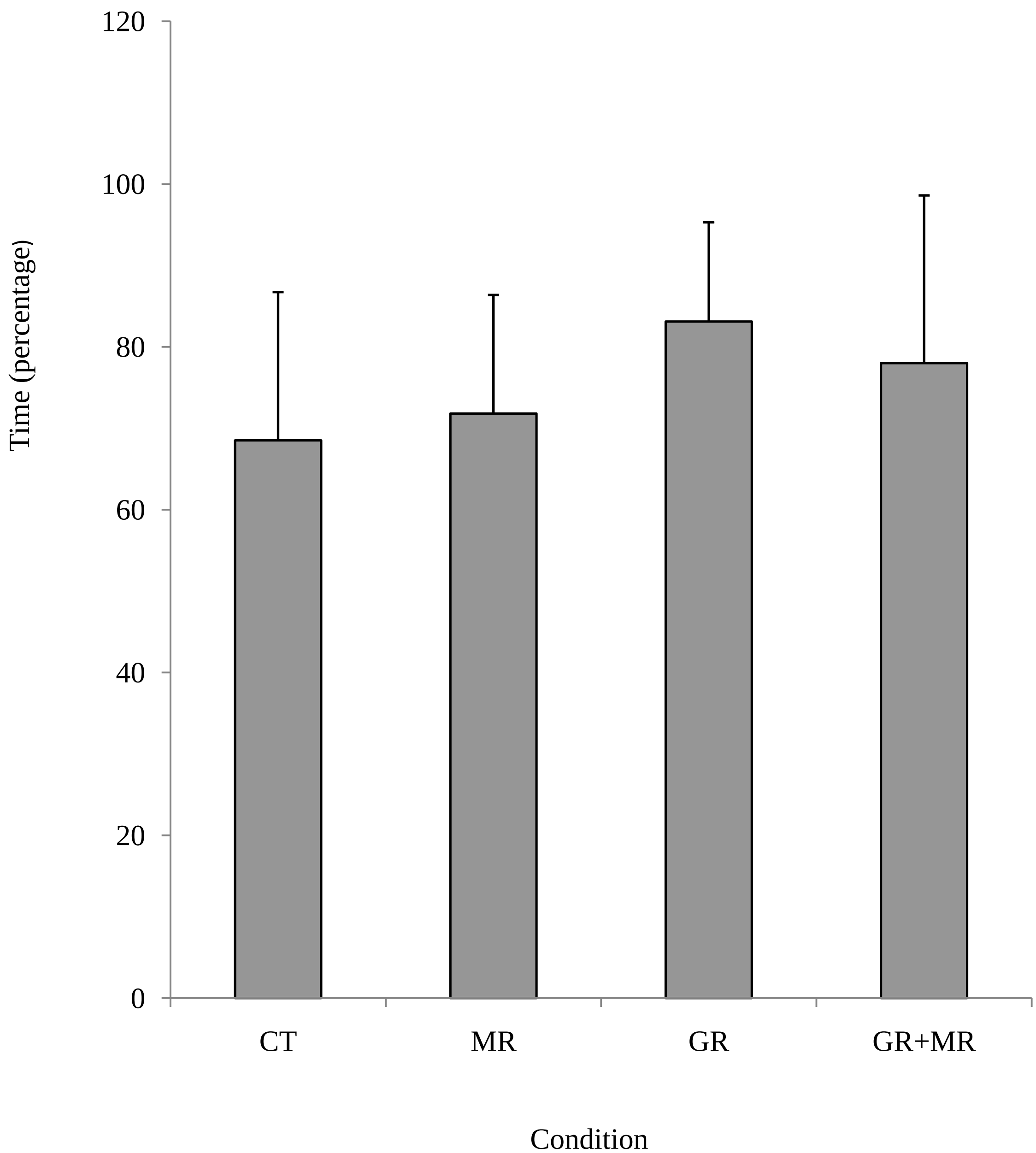
Note: standard deviations shown.

Figure 2



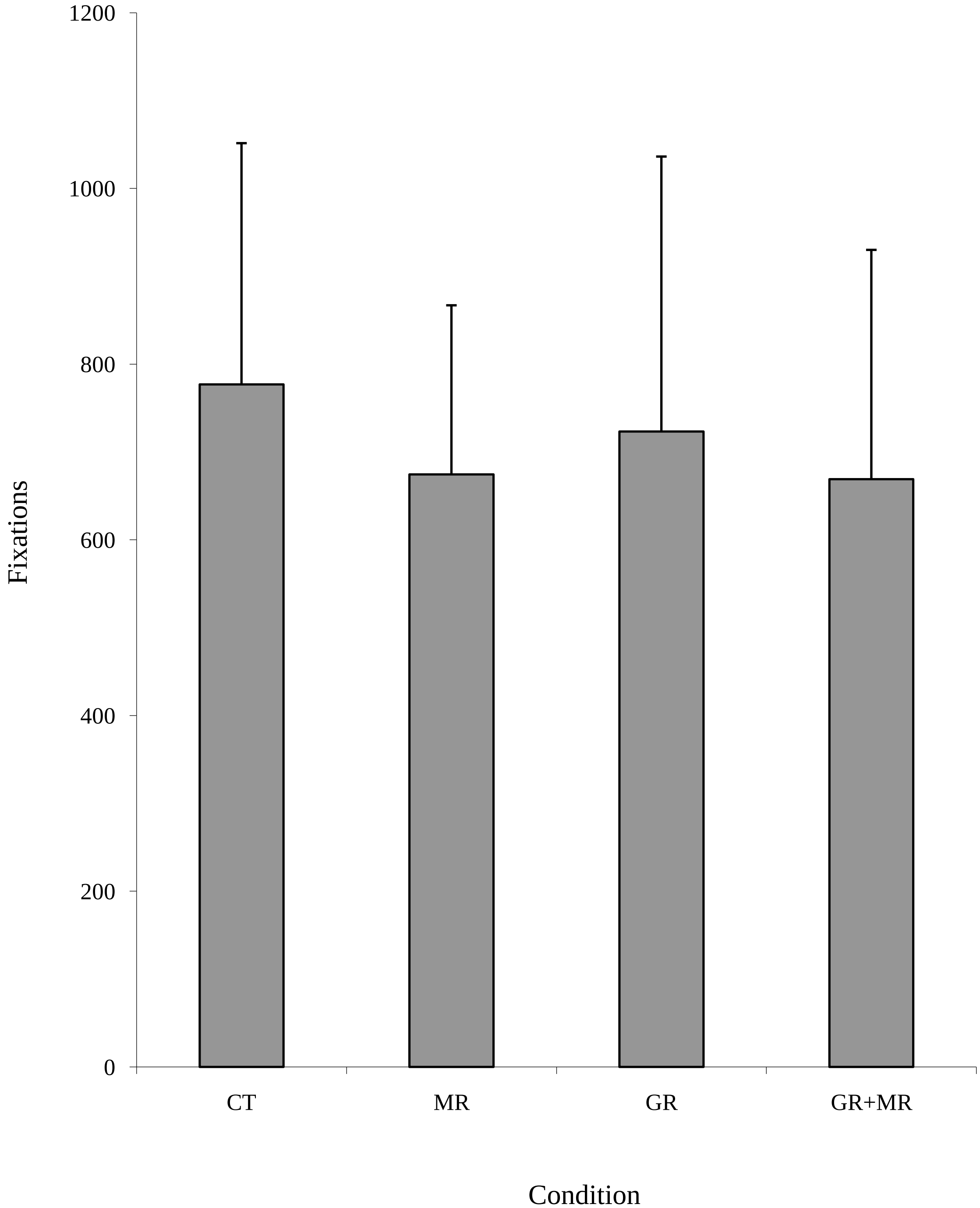
Note: standard deviations shown.

Figure 3



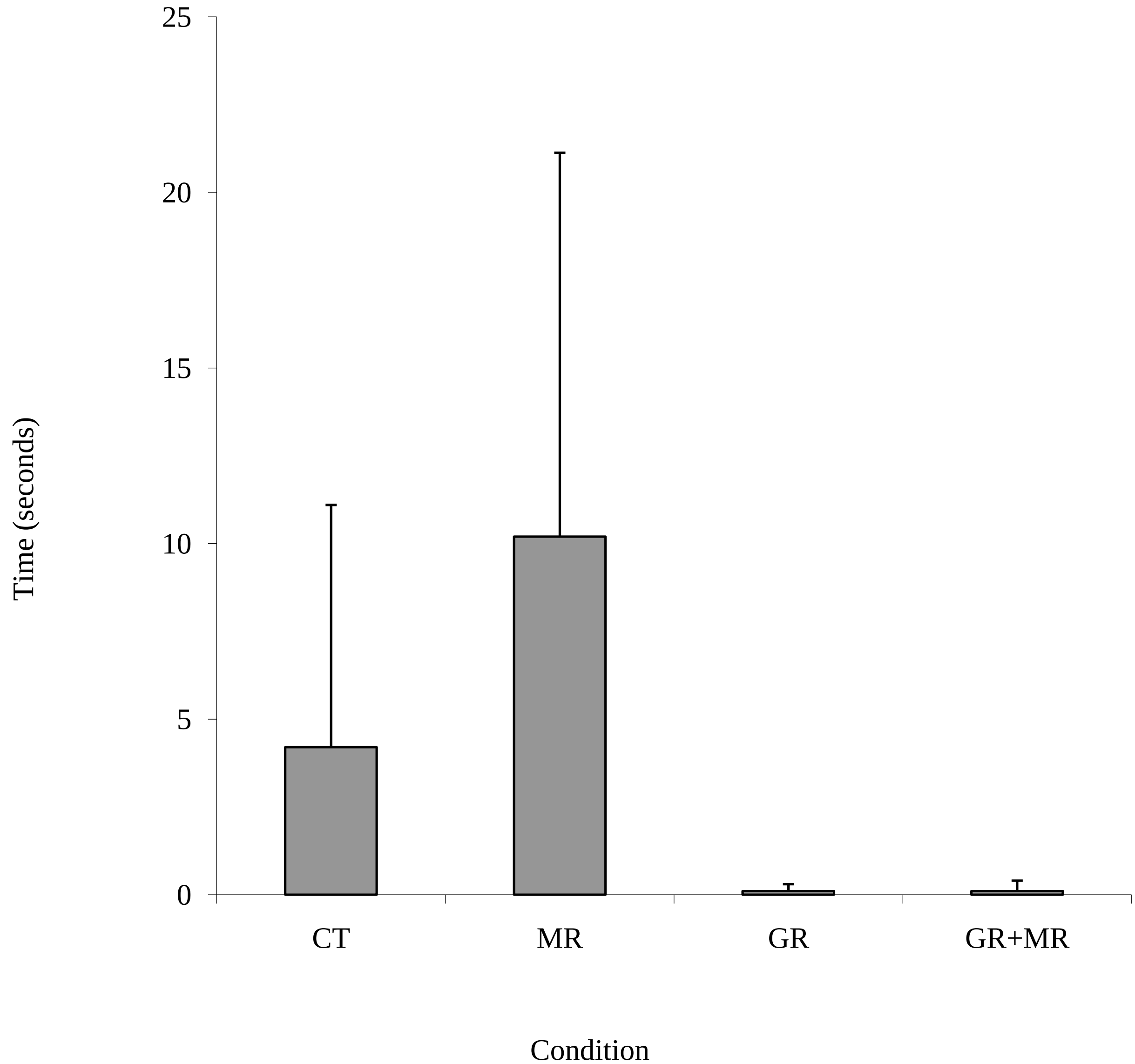
Note: standard deviations shown.

Figure 4



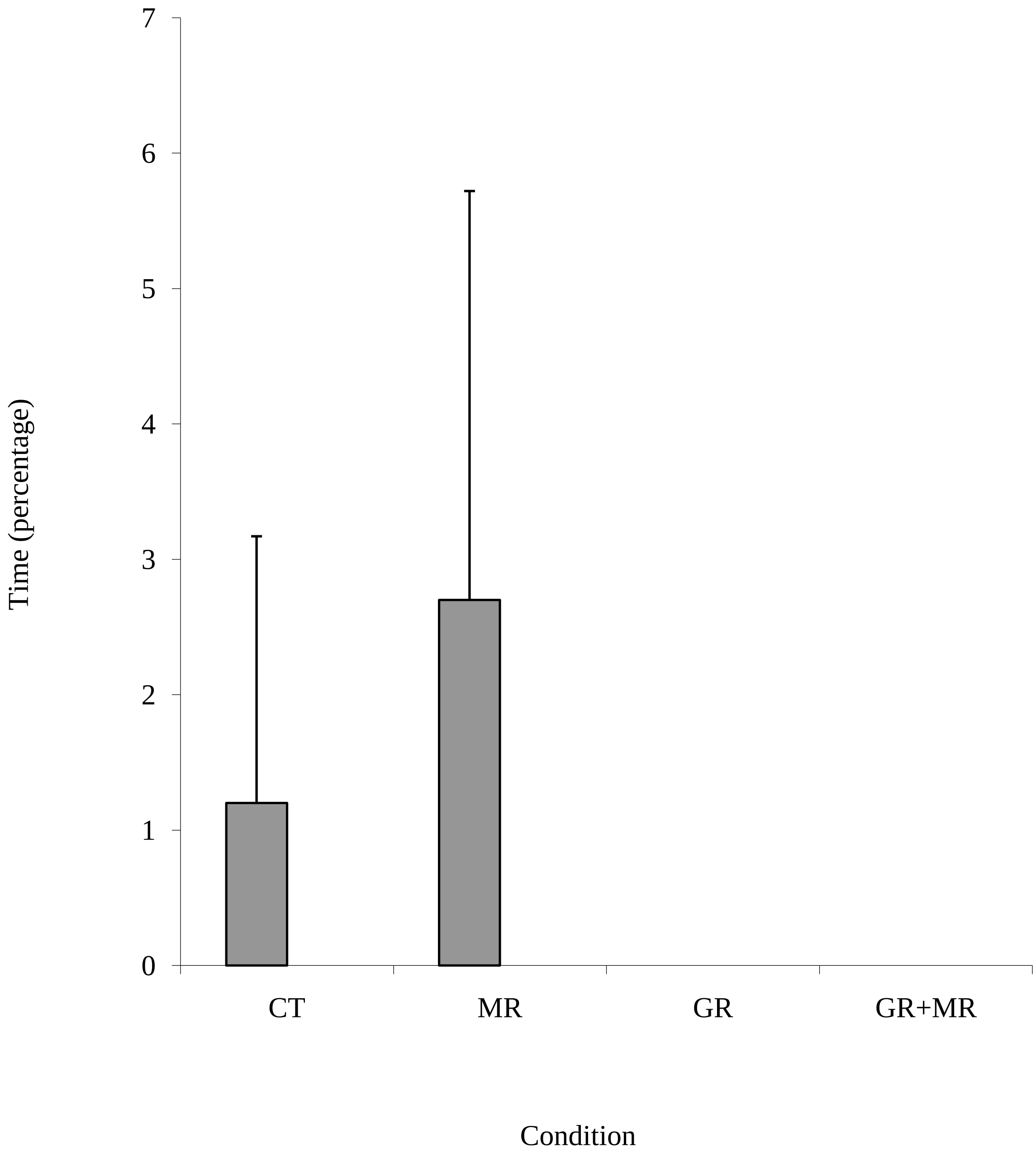
Note: standard deviations shown.

Figure 5



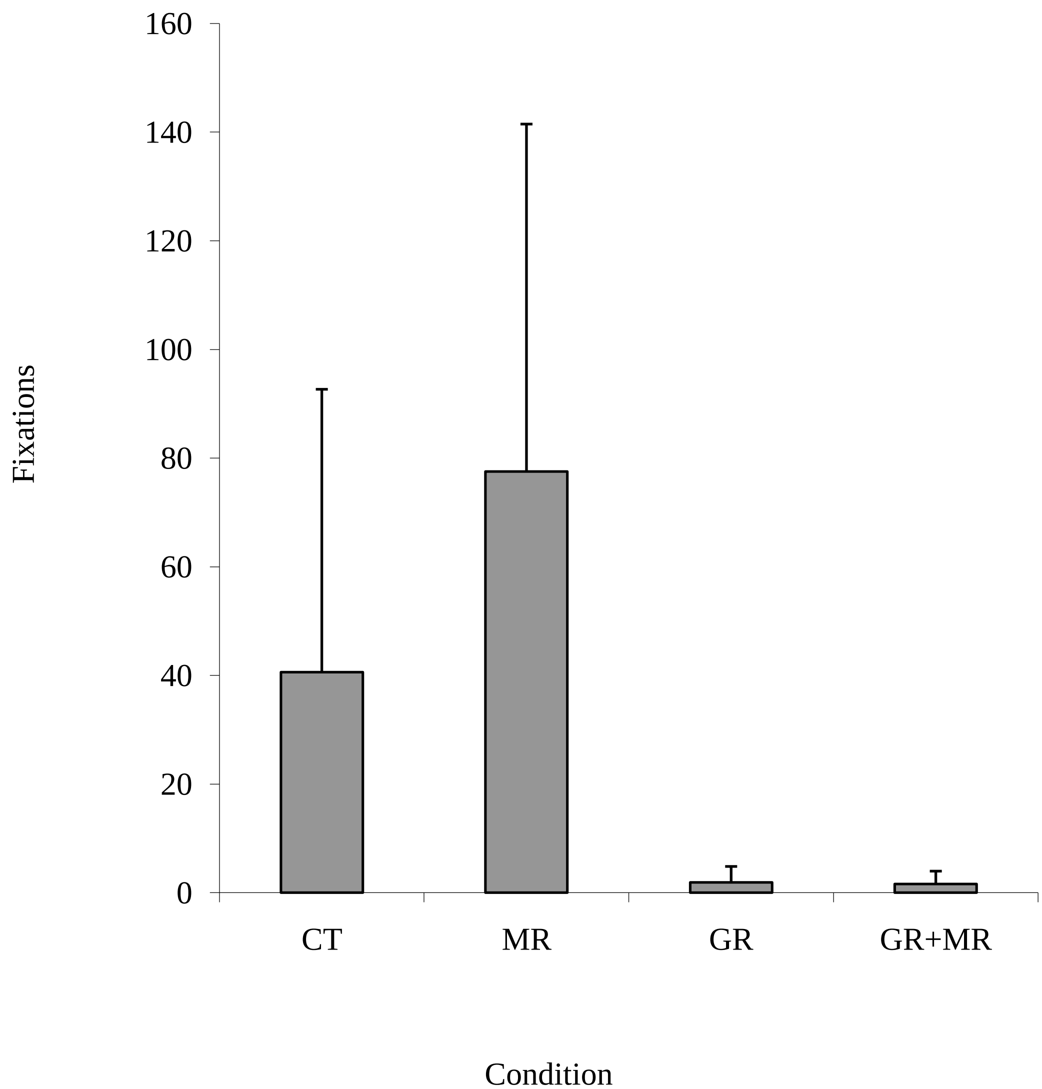
Note: standard deviations shown.

Figure 6



Note: standard deviations shown.

Figure 7



Note: standard deviations shown.

Figure 8

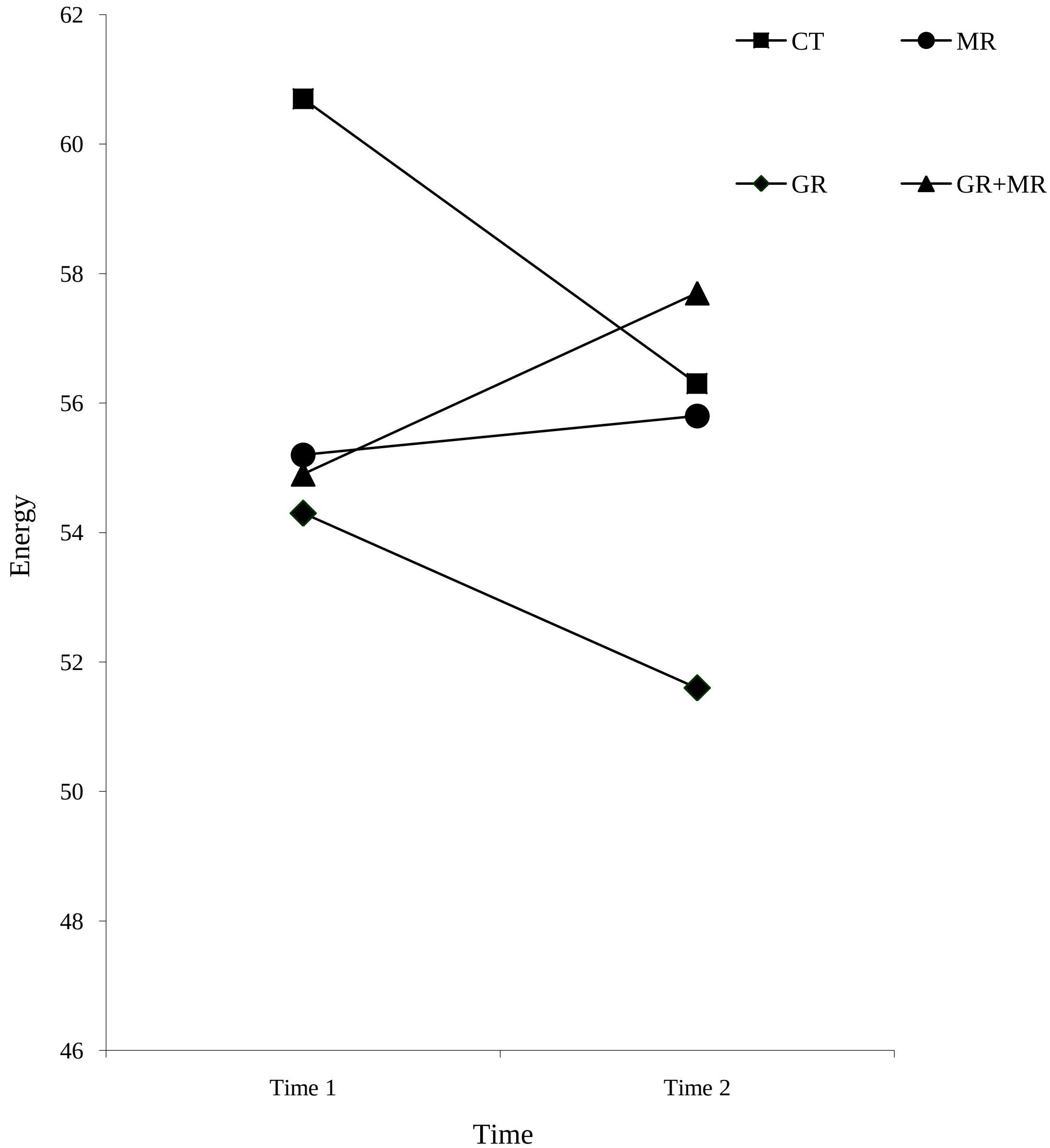


Figure 9

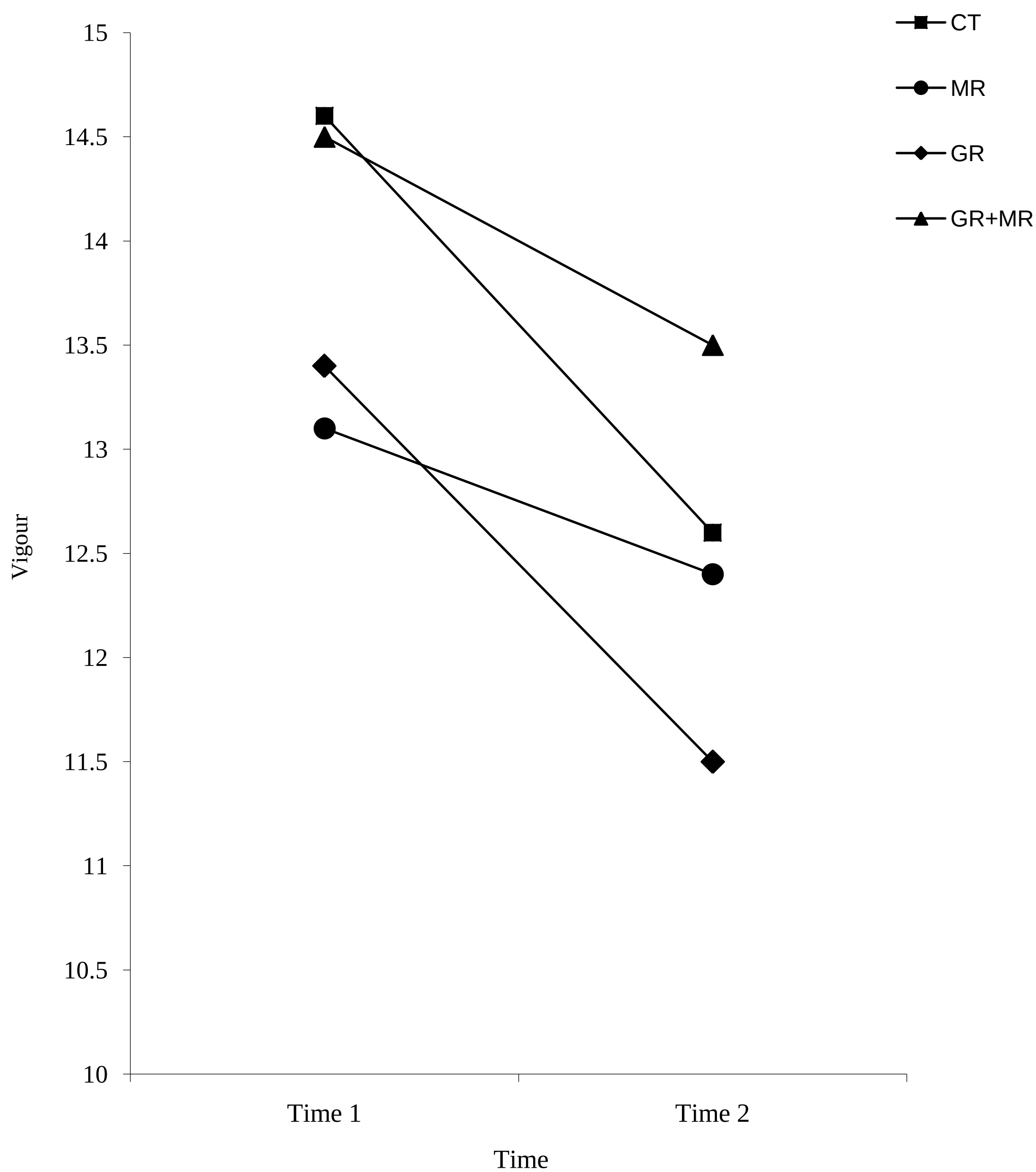
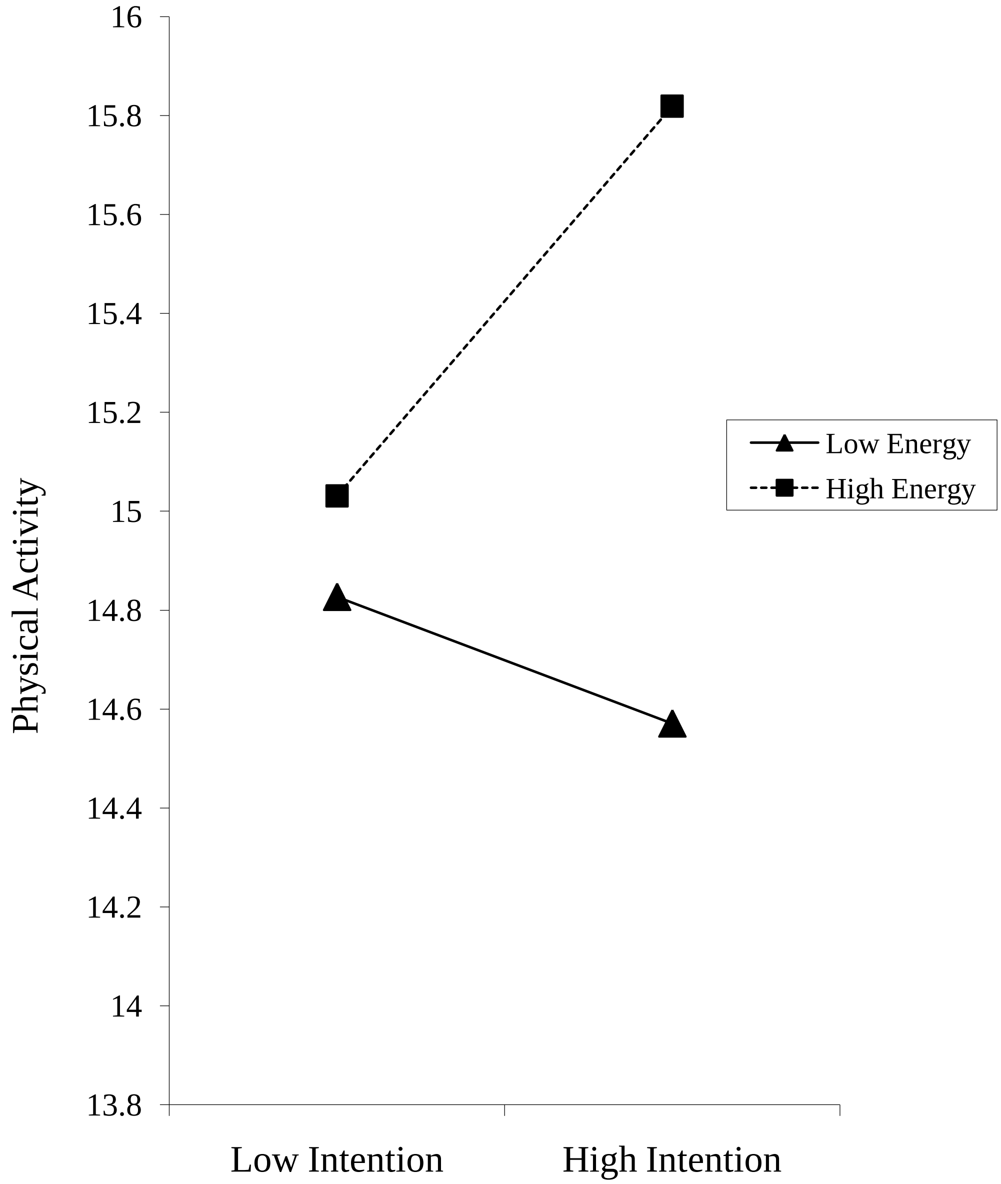

CT
MR
GR
GR+MR
15
14.5
14
13.5
13
12.5
12
11.5
11
10.5
10
Vigour
Time 1
Time 2
Time

Figure 10


16
15.8
15.6
15.4
15.2
15
14.8
14.6
14.4
14.2
14
13.8
Physical Activity
Low Energy
High Energy
Low Intention
High Intention

APPENDIX A: Consent Form for Experimental Studies

Participant Consent Form

<u>Energy and Self-Regulatory Capacity</u>

<u>Purpose:</u> You are invited to participate in a research project entitled "Energy and Self-Regulatory Capacity." The purpose of the current study is to examine how certain variables (e.g., mood, energy level) impact performance on a task requiring the regulation of attention and on a subsequent verbal task. It will take approximately one hour to complete this study.

This research will help to expand our understanding of self-regulation. Most importantly, this and other research projects may indicate a way to increase people's capacity for self-regulation. The proposed research project was reviewed and approved on ethical grounds by the University of Saskatchewan Advisory Committee On Ethics in Behavioural Science Research in September, 2004. Prior to consenting to participate in this study, it is important that you understand the following information:

<u>Participants</u>: This study will involve approximately 120 undergraduate students.

<u>Procedure</u>: You will be asked to complete some questionnaires asking about your mood and energy level. You will then watch a short video while a machine records your eye movements. This process will not cause you any discomfort. You will then be asked to answer some questions about the video, and then you will complete a brief verbal task.

<u>Freedom to Withdraw</u>: You may withdraw from this study at any point, for any reason. Should you wish to do so, any completed test materials will be destroyed. You may also choose not to answer individual questions. Participation in this project is completely voluntary. Withdrawal from this study will not affect your academic status, and you will still receive class credit. Your reasons for leaving will not be questioned. You may be asked to discontinue your involvement in the study. This would only occur if you seem to be experiencing undue discomfort during the study, or if unforeseen circumstances arise that compromise successful data collection.

<u>Confidentiality</u>: The information that you provide will remain completely anonymous and confidential. Your name will not be released to any source, and will not appear on any completed materials. Study materials and results will remain securely stored for a minimum of five years.

<u>Risks and Benefits</u>: There are no anticipated risks associated with participation in this study. This line of research will help to clarify the role of energy in self-regulation. Ultimately, it may suggest a way in which self-regulatory capacity; that is, a person's ability to successfully self-regulate, can be increased. This would have wide-reaching implications, but one area of particular benefit would be the design of behavioral interventions in the domain of health, especially those aimed at populations for whom inadequate self-regulation may result in disability or even death.

<u>Use of Research Findings</u>: This research is being conducted as part of a doctoral dissertation. Data collected may be published or presented at a future date. However, only aggregate data, not individual scores, will be reported.

Debriefing: Following your participation in this study, a research assistant will review the investigation and dissemination of research findings with you. This individual will also review procedures designed to ensure confidentiality during data collection and storage, and you may have any questions answered at this time. You will also receive a written document containing this information, and you may choose whether you wish to receive a copy of a summary of the findings of this study by e-mail when the study has been completed.

You are encouraged to ask any questions that you may have about your participation in this study. If you have any questions about this study or your rights as a participant in a research study, you may contact Maxine Holmqvist, Department of Psychology, University of Saskatchewan (966-2851 or maxine.holmqvist@usask.ca), Dr. Peter Hall (Department of Psychology, 966-6671, peter.hall@usask.ca) or the Office of Research Services (966-2084).

Please complete the following form.

I, ________________________________, acknowledge that I have read the contents of this form and understand what my participation in this study entails. I have had the opportunity to ask any questions relevant to my participation, and have had them answered to my satisfaction. I now consent to participate in this study. I have received a copy of this form for my records.

_________________________ _________________________

Signature of Participant Signature of Researcher

_________________________ _________________________

Date Date

APPENDIX B: MFSI-SF

Below is a list of statements that describe how people sometimes feel. Please read each item carefully, then circle the one number next to each item which best describes how true each statement has been for you in the **PAST WEEK (7 DAYS)**.

		Not at all	A little	Moderately	Quite a bit	Extremely
1.	I have trouble remembering things	0	1	2	3	4
2.	My muscles ache	0	1	2	3	4
3.	I feel upset	0	1	2	3	4
4.	My legs feel weak	0	1	2	3	4
5.	I feel cheerful	0	1	2	3	4
6.	My head feels heavy	0	1	2	3	4
7.	I feel lively	0	1	2	3	4
8.	I feel nervous	0	1	2	3	4
9.	I feel relaxed	0	1	2	3	4
10.	I feel pooped	0	1	2	3	4
11.	I am confused	0	1	2	3	4
12.	I am worn out	0	1	2	3	4
13.	I feel sad	0	1	2	3	4
14.	I feel fatigued	0	1	2	3	4
15.	I have trouble paying attention	0	1	2	3	4
16.	My arms feel weak	0	1	2	3	4
17.	I feel sluggish	0	1	2	3	4
18.	I feel run down	0	1	2	3	4
19.	I ache all over	0	1	2	3	4
20.	I am unable to concentrate	0	1	2	3	4
21.	I feel depressed	0	1	2	3	4
22.	I feel refreshed	0	1	2	3	4
23.	I feel tense	0	1	2	3	4
24.	I feel energetic	0	1	2	3	4
25.	I make more mistakes than usual	0	1	2	3	4
26.	My body feels heavy all over	0	1	2	3	4
27.	I am forgetful	0	1	2	3	4
28.	I feel tired	0	1	2	3	4
29.	I feel calm	0	1	2	3	4
30.	I am distressed	0	1	2	3	4

APPENDIX C: POMS-SF and Subjective Energy Rating

POMS-SF

Please circle the answer that best applies to you how you feel **RIGHT NOW**.

	Not at all	A little	Moderately	Quite a bit	Extremely
1. Tense	1	2	3	4	5
2. Peeved	1	2	3	4	5
3. Sad	1	2	3	4	5
4. Hopeless	1	2	3	4	5
5. Restless	1	2	3	4	5
6. Active	1	2	3	4	5
7. Bewildered	1	2	3	4	5
8. Discouraged	1	2	3	4	5
9. Fatigued	1	2	3	4	5
10. Anxious	1	2	3	4	5
11. Cheerful	1	2	3	4	5
12. Uncertain	1	2	3	4	5
13. Exhausted	1	2	3	4	5
14. Blue	1	2	3	4	5
15. Miserable	1	2	3	4	5
16. Angry	1	2	3	4	5
17. Worthless	1	2	3	4	5
18. Annoyed	1	2	3	4	5
19. Vigorous	1	2	3	4	5
20. Grouchy	1	2	3	4	5
21. Resentful	1	2	3	4	5
22. On Edge	1	2	3	4	5
23. Bitter	1	2	3	4	5

24. Unable to Concentrate	1	2	3	4	5
25. Furious	1	2	3	4	5
26. Full of pep	1	2	3	4	5
27. Uneasy	1	2	3	4	5
28. Lively	1	2	3	4	5
29. Nervous	1	2	3	4	5
30. Bushed	1	2	3	4	5
31. Helpless	1	2	3	4	5
32. Confused	1	2	3	4	5
33. Unhappy	1	2	3	4	5
34. Energetic	1	2	3	4	5
35. Forgetful	1	2	3	4	5
36. Worn out	1	2	3	4	5
37. Weary	1	2	3	4	5

Finally, how would you rate your energy level **RIGHT NOW?**

1-------10-------20-------30-------40-------50-------60-------70-------80-------90-------100

No Energy
At All

The Most
Energy Possible

Write the number here: _________

APPENDIX D: Manipulation Check and Experimental Tasks

Please circle the answer that best applies to you.

1. How **difficult** was it to ignore the words on the screen during the video task?

1	2	3	4	5	6
Very Difficult	Difficult	Somewhat Difficult	Somewhat Easy	Easy	Very Easy

2. How **difficult** was this task ***overall***?

1	2	3	4	5	6
Very Difficult	Difficult	Somewhat Difficult	Somewhat Easy	Easy	Very Easy

3. How **much effort** did that the video task take?

1	2	3	4	5
No Effort	Very little Effort	A little Effort	Some Effort	A lot of Effort

4. **How long** do you think this task took?

It took _____________ minutes and _____________seconds.

During the video, there were a number of words shown on the screen. Often people find that even when they are not looking directly at the words on the screen, they are able to remember some of them afterwards. Please write all of the words that you remember below:

_____________________ _____________________ _____________________
_____________________ _____________________ _____________________
_____________________ _____________________ _____________________
_____________________ _____________________ _____________________
_____________________ _____________________ _____________________

This task is looking at your ability to *recognize* words shown on the screen during the video task. Please circle yes if the word was shown on the screen, and no if it wasn't.

Tree	Yes	No	Hair	Yes	No	Sing	Yes	No
Horse	Yes	No	Sole	Yes	No	Dog	Yes	No
Hard	Yes	No	Shine	Yes	No	List	Yes	No
Glue	Yes	No	Barn	Yes	No	Bull	Yes	No
Gate	Yes	No	Tire	Yes	No	Fly	Yes	No
Kite	Yes	No	Cane	Yes	No	Cart	Yes	No
Ode	Yes	No	Boil	Yes	No	Take	Yes	No
Smile	Yes	No	Hole	Yes	No	Pulse	Yes	No
Pile	Yes	No	Shirt	Yes	No	Point	Yes	No
Ping	Yes	No	Large	Yes	No	Book	Yes	No
Horn	Yes	No	Oak	Yes	No	Ding	Yes	No
Tape	Yes	No	Shoe	Yes	No	Disk	Yes	No

These letters in these words can be rearranged to form other English words. Please solve as many of these anagrams as possible. When you believe that you will not be able to answer any more, you may return the booklet to the experimenter.

1. swipe = _____________ 2. trams = _____________

3. zoned = _____________ 4. apple = ______________

5. tough = ______________ 6. unite = ______________

7. French = _____________ 8. votes = ______________

9. causes = _____________ 10. thing = ______________

11. dashed = _____________ 12. waste = _____________

APPENDIX E: Consent Form for Diabetes Study

Diabetes
Behavioral
Management
Study

Diabetes Behavioral Management Study
Consent Form

Title
Diabetes Behavioural Management Study (DBM-1)

Name of primary investigator
Peter A. Hall
Department of Psychology
University of Saskatchewan
306.966.6671
peter.hall@usask.ca

Purpose
The purpose of this investigation is to understand how personal attributes (in the form of personality traits, attitudes, and thinking styles) relate to patterns of health behavior (e.g., dietary choices, physical activity) and diabetes self-management.

Benefits
There are no direct or immediate benefits associated with your participation in this research project. However, the information collected will be of benefit to society as a whole. It may help to inform how we understand healthy practices, and how to influence them for the sake of disease self-management, treatment and prevention.

Procedures
For this study, you will be asked to complete several questionnaires and computer-based laboratory tasks. Next you will have an A1C blood test by a Registered Nurse. She will poke your finger and use one drop of blood. There will be two separate sessions, six months apart. You will do the same tasks at both sessions. All information provided on the questionnaires, as well as your results from the A1C blood test will be kept strictly confidential and stored in a secure and locked location. It is expected that the first session will take 1 hour and 30 minutes to complete, and the second session will take about 30 minutes, for a total of 2 hours. As a thank-you for your time and effort, we will give you $20 at the end of the first session, and $10 at the end of the second session, for a total of $30.

Risks and ability to withdraw
There are no anticipated risks associated with your participation in this study. If, however, for any reason you chose to withdraw from the study, you may do so at any time without loss of any privileges or access to services. Specifically, your choice whether or not to participate, or to withdraw at any time will have no negative impact upon your access to the services offered by the Diabetes Education Centre or other health care providers. Any data collected from you up to that point will be destroyed. At the beginning of your second session, we will review this information with you, and will confirm with you that you wish to continue your participation in this study. The name and number of the primary investigator are provided on this form. You are welcome to contact him if you have any questions about the study or any risks associated with it.

Confidentiality
All data collected will be stored electronically using only an anonymous identification number. No names will be part of this data file. Any paper copies of data will be kept in a secure and locked room under the responsibility of the principal investigator (P. Hall). Only the principal investigator and students or research assistants under his direction will have access. In accordance with university regulations, all data will be stored for a minimum of 5 years. Every effort will be made to ensure that participants are not individually identifiable in the stored data. Confidentiality will be protected at all times, however it is possible for information that is provided to be subpoenaed by a court of law if deemed relevant for a court proceeding during the interim between starting and completing this study.

Use of Data and Dissemination of Results
Data will be used for research purposes only, and no data will be presented in such a way as to allow for identification of any individual. Aggregate (i.e., summarized) findings will be disseminated via conference presentations, scientific journals, or other scholarly publications.

Additional information
If any new information comes to light during this investigation that might influence your decision to continue in this investigation, you will be informed of the information and asked whether or not you want to continue with the investigation.

Debriefing
Upon completion of your participation, a research assistant will review with you the purpose of the study and how the findings will be used. She will also review procedures designed to ensure confidentiality during data collection and storage. You may have any questions answered at this time. If you indicate interest, you can receive a copy of a summary of the findings of this study by mail when it has been completed.

Participation
You have the right to withdraw from this study at any point or refuse to answer any questions without penalty, loss of payment for attended sessions, or any other negative result. Whether or not you participate or continue to participate in this study will not affect the services you receive at the Diabetes Education Centre or from your health care providers.

Contact Person

If you have any questions about the study or your participation in it, please contact Dr. Peter Hall at 306.966.6671. Additionally, you may contact the Office of Research Services at 306.966.2084 if you have any questions regarding your rights as a participant in a research project.

Signature and consent form
(Diabetes Behavioural Management Study)

I have read and understood the description of this research study and I agree to participate. I have had the study explained to me and I have had any questions I had about the investigation answered. By signing below I acknowledge that I am willing to participate in this study on diabetes behavioural management, and that I have received a copy of the consent form for my records.

This research was approved by the University of Saskatchewan Behavioral Research Ethics Board on November 19, 2004.

____
Name of participant (please print)

____
Signature of participant

____
Date

____
Witness

APPENDIX F: Activity Trait Scale

Please use this list of common human traits to describe yourself as accurately as possible. Describe yourself as you see yourself at the present time, not as you wish to be in the future. Describe yourself as you are generally or typically, as compared with other persons you know of the same sex and of roughly your same age.

Before each trait, please write a number indicating how accurately that trait describes you, using the following scale:

Inaccurate					Accurate			
Extremely	Very	Quite	Slightly	Neither	Slightly	Quite	Very	Extremely
1	2	3	4	5	6	7	8	9

_____Active

_____Unadventurous

_____Adventurous

_____Competitive

_____Unenergetic

_____Daring

_____Rambunctious

_____Uncompetitive

APPENDIX G: NCI Fat Screener

FOOD CHOICES OVER PAST MONTH

Think about your eating habits over the **PAST MONTH**. About how often did you eat or drink each of the following foods? Remember breakfast, lunch, dinner, snacks, and eating out. Blacken in only one bubble for each food.

TYPE OF FOOD	Never	Less than Once Per Month	1-3 Times Per Month	1-2 Times Per Week	3-4 Times Per Week	5-6 Times Per Week	1 Time Per Day	2 or More Times Per Day
Cold cereal	○	○	○	○	○	○	○	○
Skim milk, on cereal or to drink	○	○	○	○	○	○	○	○
Eggs, fried or scrambled in margarine, butter, or oil	○	○	○	○	○	○	○	○
Sausage or bacon, regular-fat	○	○	○	○	○	○	○	○
Margarine or butter on bread, rolls, pancakes	○	○	○	○	○	○	○	○
Orange juice or grapefruit juice	○	○	○	○	○	○	○	○
Fruit (not juices)	○	○	○	○	○	○	○	○
Beef or pork hot dogs, regular-fat	○	○	○	○	○	○	○	○
Cheese or cheese spread, regular-fat	○	○	○	○	○	○	○	○
French fries, home fries, or hash brown potatoes	○	○	○	○	○	○	○	○
Margarine or butter on vegetables, including potatoes	○	○	○	○	○	○	○	○
Mayonnaise, regular-fat	○	○	○	○	○	○	○	○
Salad dressings, regular-fat	○	○	○	○	○	○	○	○

Rice	○	○	○	○	○	○	○	○
Margarine, butter, or oil on rice or pasta	○	○	○	○	○	○	○	○

2. Over the past month, when you prepared foods with margarine or ate margarine, how often did you use a reduced-fat margarine?

○	○	○	○	○	○
DIDN'T USE MARGARINE	Almost never	About 1\4 of the time	About 1\2 of the time	About 3/4 of the time	Almost always or always

3. Overall, when you think about the foods you ate over the past month, would you say your diet was high, medium, or low in fat?

○	○	○
High	Medium	Low

4. Overall, how much do you usually watch what you eat?

○	○	○	○	○	○
Never	Almost never	About 1\4 of the time	About 1\2 of the time	About 3/4 of the time	Almost always or always

FOOD CHOICES OVER NEXT MONTH

Think about your eating habits over the **NEXT MONTH**. About how often do you plan to eat or drink each of the following foods? Remember breakfast, lunch, dinner, snacks, and eating out. Blacken in only one bubble for each food.

TYPE OF FOOD	Never	Less than Once Per Month	1-3 Times Per Month	1-2 Times Per Week	3-4 Times Per Week	5-6 Times Per Week	1 Time Per Day	2 or More Times Per Day
Cold cereal	○	○	○	○	○	○	○	○
Skim milk, on cereal or to drink	○	○	○	○	○	○	○	○
Eggs, fried or scrambled in margarine, butter, or oil	○	○	○	○	○	○	○	○
Sausage or bacon, regular-fat	○	○	○	○	○	○	○	○
Margarine or butter on bread, rolls, pancakes	○	○	○	○	○	○	○	○
Orange juice or grapefruit juice	○	○	○	○	○	○	○	○
Fruit (not juices)	○	○	○	○	○	○	○	○
Beef or pork hot dogs, regular-fat	○	○	○	○	○	○	○	○
Cheese or cheese spread, regular-fat	○	○	○	○	○	○	○	○
French fries, home fries, or hash brown potatoes	○	○	○	○	○	○	○	○
Margarine or butter on vegetables, including potatoes	○	○	○	○	○	○	○	○
Mayonnaise, regular-fat	○	○	○	○	○	○	○	○
Salad dressings, regular-fat	○	○	○	○	○	○	○	○
Rice	○	○	○	○	○	○	○	○

Margarine, butter, or oil on rice or pasta	○	○	○	○	○	○	○	○

5. **Over the NEXT MONTH, when you prepare foods with margarine or eat margarine, how often do you plan to use a reduced-fat margarine?**

○	○	○	○	○	○
DIDN'T USE MARGARINE	Almost never	About 1\4 of the time	About 1\2 of the time	About 3/4 of the time	Almost always or always

6. **Overall, are you planning for your diet to be high, medium, or low in fat over the NEXT MONTH?**

○	○	○
High	Medium	Low

APPENDIX H: PASE

Instructions: Please place a check mark in the box corresponding to your answer, and fill in the blanks as applicable.

Leisure Time Activity

1. Over the past 7 days, how often did you participate in sitting activities such as reading, watching TV or doing handcrafts?

NEVER (go to question 2)	SELDOM (1-2 days)	SOMETIMES (3-4 days)	OFTEN (5-7 days)
☐	☐	☐	☐

1. (a) What were these activities? ____________________

____

____

1. (b) On average, how many hours per day did you engage in these sitting activities?

Less than 1 Hour	1 but less than 2 hours	2 to 4 hours	More than 4 hours
☐	☐	☐	☐

2. Over the past 7 days, how often did you take a walk outside your home or yard for any reason? For example, for fun or exercise, walking to work, walking the dog, etc.?

NEVER (go to question 3)	SELDOM (1-2 days)	SOMETIMES (3-4 days)	OFTEN (5-7 days)
☐	☐	☐	☐

2. (a) On average, how many hours per day did you spend walking?

Less than 1 Hour	1 but less than 2 hours	2 to 4 hours	More than 4 hours
☐	☐	☐	☐

3. Over the past 7 days, how often did you engage in light sport or recreational activities such as bowling, golf with a cart, shuffleboard, fishing from a boat or pier or other similar activities?

NEVER (go to question 4)	SELDOM (1-2 days)	SOMETIMES (3-4 days)	OFTEN (5-7 days)
☐	☐	☐	☐

3. (a) What were these activities? ______________________

____

____

3. (b) On average, how many hours per day did you engage in these light sport or recreational activities?

Less than 1 Hour	1 but less than 2 hours	2 to 4 hours	More than 4 hours
☐	☐	☐	☐

4. Over the past 7 days, how often did you engage in moderate sport and recreational activities such as doubles tennis, ballroom dancing, hunting, ice skating, golf without a cart, softball or other similar activities?

NEVER (go to question 5)	SELDOM (1-2 days)	SOMETIMES (3-4 days)	OFTEN (5-7 days)
☐	☐	☐	☐

4. (a) What were these activities? ______________________

____

____

4. (b) On average, how many hours per day did you engage in these moderate sport and recreational activities?

Less than 1 Hour	1 but less than 2 hours	2 to 4 hours	More than 4 hours
☐	☐	☐	☐

5. Over the past 7 days, how often did you engage in strenuous sport and recreational activities such as jogging, swimming, cycling, singles tennis, aerobic dance, skiing (downhill or cross country) or other similar activities?

NEVER (go to question 6)	SELDOM (1-2 days)	SOMETIMES (3-4 days)	OFTEN (5-7 days)
☐	☐	☐	☐

5. (a) What were these activities? ____________________

____

____

5. (b) On average, how many hours per day did you engage in these strenuous sport and recreational activities?

Less than 1 Hour	1 but less than 2 hours	2 to 4 hours	More than 4 hours
☐	☐	☐	☐

6. Over the past 7 days, how often did you do any exercises specifically to increase muscle strength and endurance, such as lifting weights or pushups, etc.?

NEVER (go to question 7)	SELDOM (1-2 days)	SOMETIMES (3-4 days)	OFTEN (5-7 days)
☐	☐	☐	☐

6. (a) What were these activities? ____________________

____

____

6. (b) On average, how many hours per day did you engage in exercises to increase muscle strength and endurance?

Less than   1 but less   2 to 4 hours   More than 4

1 Hour	than 2 hours		hours
☐	☐	☐	☐

Household Activity

7. During the past 7 days, have you done any light housework, such as dusting or washing dishes?

NO	YES
☐	☐

8. During the past 7 days, have you done any heavy housework or chores, such as vacuuming, scrubbing floors, washing windows, or carrying wood?

NO	YES
☐	☐

9. During the past 7 days, did you engage in any of the following activities?

Please answer YES or NO for each item by checking the appropriate box.

		NO	YES
a.	Home repairs like painting, wallpapering, electrical work, etc.	☐	☐
b.	Lawn work or yard care, including snow or leaf removal, wood chopping, etc.	☐	☐
c.	Outdoor gardening	☐	☐
d.	Caring for another person, such as children, dependent spouse, or another adult	☐	☐

Work-Related Activity

10. During the past 7 days, did you work for pay or as a volunteer?

NO ☐ YES ☐

(If YES:)

10. (a) How many hours per week did you work for pay and/or as a volunteer?

__________ HOURS

10. (b) Which of the following categories best describes the amount of physical activity required on your job and/or volunteer work?

☐ Mainly sitting with slight arm movements.
[Examples: office worker, watchmaker, seated assembly line worker, bus driver, etc.]

☐ Sitting or standing with some walking.
[Examples: cashier, general office worker, light tool and machinery worker.]

☐ Walking, with some handling of materials generally weighing less than 50 pounds.
[Examples: mailman, waiter/waitress, construction worker, heavy tool and machinery worker.]

☐ Walking and heavy manual work often requiring handling of materials weighing over 50 pounds.
[Examples: lumberjack, stone mason, farm or general labourer.]

THANK YOU FOR COMPLETING THESE QUESTIONS.

APPENDIX I: Physical Activity Recall Questionnaire

1. During the **NEXT WEEK**, how much total time do you plan to spend doing VIGOROUS physical activity and MODERATE physical activity? Record only time that you actually engage in the activity (ignore breaks, rest periods, etc.). Please do not record any LIGHT physical activity (office work, light housework, very light sports such as bowling, or any activities involving sitting).

	Total hours for next 7 days to nearest 1/2 hour
VIGOROUS ACTIVITY (jogging or running, swimming, strenuous sports such as singles tennis or racquetball, digging in the garden, chopping wood, etc.)	______
MODERATE ACTIVITY (sports such as golf or doubles tennis, yard work, heavy housecleaning, bicycling on level ground, brisk walking, etc.)	______

2. During the **PAST WEEK**, how much total time did you spend doing VIGOROUS physical activity and MODERATE physical activity? Record only time that you actually engaged in the activity (ignore breaks, rest periods, etc.). Please do not record any LIGHT physical activity (office work, light housework, very light sports such as bowling, or any activities involving sitting).

	Total hours for last 7 days to nearest 1/2 hour
VIGOROUS ACTIVITY (jogging or running, swimming, strenuous sports such as singles tennis or racquetball, digging in the garden, chopping wood, etc.)	______
MODERATE ACTIVITY (sports such as golf or doubles tennis, yard work, heavy housecleaning, bicycling on level ground, brisk walking, etc.)	______

3. How physically active are you USUALLY during the course of a typical week?

1	2	3	4	5
Not at all active				**Extremely active**