The Effect of Cognitive Factors on Chronic Disease Self-Management

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I. Introduction

Chronic diseases—such as diabetes, heart disease, hypertension, and stroke—create an enormous health and economic burden in the United States and around the world. Self-management of these diseases is an essential element in addressing and reducing this burden. Health behavior change interventions designed to facilitate self-management of chronic diseases typically ask people to implement several specific changes in their behavior. However, effective self-management of these conditions relies on adequate skills and resources. What factors may prevent an individual from successfully making these changes? Is behavior change primarily an issue of "self-control" or "willpower"? Are some behaviors harder to change than others? When considering these questions, it is important to reflect on what limitations individuals may have that could be a barrier to successful chronic disease self-management.

Researchers in the fields of applied psychology and neuropsychology study how cognitive factors affect task performance. In other words, what kinds of cognitive demands do certain tasks require and what determines whether people have the cognitive capacity and motivation to complete those tasks? It is important to recognize how complex and cognitively demanding self-care behaviors may be. Asking individuals to engage in several new behaviors at once may be an unreasonable demand. However, in the field of public health, the cognitive demands required by these tasks are seldom explored. Are our expectations reasonable and do we understand how demanding the tasks we request are to do?

In general, it seems that public health professionals are unaware of the important impact of cognitive factors on the ability to successfully complete health behavior self-management tasks. A better understanding of these factors may lead to better behavior change interventions and more opportunity for successful chronic disease self-management.

This review is divided into three sections. In the first section, I define and explore several important cognitive factors that affect task performance and that are commonly studied in the field of applied psychology. These factors center around the concept of attentional resource capacity, and include task demands, skill acquisition, cognitive interference, and self-management. In the second section I apply these concepts to an example of chronic disease self-management—namely, the American Association of Diabetes Educators (AADE) seven self-care behavior tasks. Finally, I conclude the review with a summary of the potential impact of cognitive factors, their implications for health behavior change interventions and chronic disease self-management, and the gaps that currently exist in the Public Health literature.

II. Cognitive Factors and Task Performance

Many cognitive factors influence an individual's effectiveness at task performance. Applied psychologists have extensively examined these factors, and have used theories about cognitive function to improve learning behavior in classroom settings and task performance in the workplace. Although some theories of health behavior, such as Social Cognitive Theory and the Theory of Reasoned Action, are founded on the understanding of these cognitive factors, the exploration of the public health impact of these factors has been limited. Careful consideration and further understanding of how these cognitive factors affect the performance of self-management tasks such as blood glucose monitoring, healthy eating, active living etc., may contribute to a deeper understanding of how best to promote self-care behaviors and self-regulation that lead to better health outcomes.

II.a. Attention and Attentional Resource Capacity

The concepts of attention and attentional resources have been studied extensively, particularly in the psychology literature. These concepts are important to consider when analyzing task performance because they help explain the cognitive processes—and limitations—of the individual. Three underlying conceptualizations of attention serve as the basis for much of the literature (Parasuraman & Davies, 1984). First, attention can be viewed as a mechanism for separating information into things that are noticed and things that are not noticed. In other words, analyzing how and why some information is perceived by an individual, while other information is ignored. Research in this area of attention tends to focus on this selective process and the factors that influence it.

Second, attention can be viewed as an information processing resource. It is widely accepted in the field that individuals possess a fixed amount of attentional resources (Kahneman, 1973). As a simplified example of attentional capacity, assume that an individual has 100 units of attentional resources per unit time to process information. If the individual is given two tasks to complete in one unit of time that each require 75 units of attention, there are many possibilities for how these attentional resources might be allocated. For example, the individual may do the tasks consecutively, which means one task would be completed (using 75 units of attention), whereas the other would be only partially completed (25 out of 75 of the units of attention needed would be allocated). Or the individual may attempt to do the tasks simultaneously, which would necessitate that the individual switch attentional resources back and forth between the tasks, leading to only partial completion of one or both tasks. In either scenario, combining tasks in which attentional capacity is exceeded (150 units required when only 100 are available) is likely to result in reduced or incomplete task performance (Schneider et al. 1984).

Finally, attention is discussed in terms of types of information processing. This area of study focuses around the theory that there are two qualitatively different processes of human performance (Chaiken & Trope, 1999; Schneider et al., 1984). One type of processing is a fast and fairly effortless process, which is often referred to as “automatic.” Automatic processing is generally not under direct control of the individual. In other words, individuals are seldom conscious of the automatic information processing that takes place. The other type of processing is characterized as slow, effortful, regulated processing, and is sometimes referred to as “control.” Control processing is typically used to deal with novel tasks or information. While the distinction between automatic and control processing is an important one, it is also necessary to note that, most likely, all tasks are carried out with some mixture of automatic and control processing (Schneider et al. 1984).

There are several important points that can be made when taking both the limited capacity of attention and the types of information processing into account. Control processing uses most of an individual’s attentional resource capacity. Automatic processing tasks, on the other hand, use very little attentional capacity. Therefore, several automatic processing tasks can be completed successfully even when they are conducted simultaneously and without full awareness of the individual. In contrast, control processing tasks must compete for attentional resources in order for the task to be completed successfully, and individuals are generally well aware of the completion of these tasks. The part of our brains that governs conscious awareness and control processing is estimated to be able to process about 40-60 bits per second, which is roughly equivalent to a short sentence. Yet the overall processing capacity of brain is estimated to be 11 million bits per second, indicating that the vast majority of tasks are carried out automatically (Cohen, 2008; Dijksterhuis et al*.,* 2005).

It is interesting to note that people will have more difficulty controlling and modifying their processing for automatic tasks than for control tasks (Schneider et al. 1984). Individuals usually do not find it difficult to focus on control processing tasks. However, as performance becomes more automatic, people have more difficulty controlling and modifying their processing. For example, automatic processing is generally used when chewing and swallowing food. However, if an individual were asked to make sure that each bite of food was chewed 25 times, then the process of chewing would switch to a control processing task. The individual would have focus on the chewing as well as the counting, and would likely be highly susceptible to distractions, which would cause the individual to revert the chewing back to automatic processing. Focusing on and changing automatic processes is actually quite difficult and consumes attentional resources. Some studies have shown that counter-acting automatic processing requires more attentional resources than normal control processing (Schneider et al. 1984).

The Stroop test is sometimes used to measure attentional resources or attentional fatigue. The test relies on the common ability of people to automatically identify simple, written words. In the test, names of colors are displayed in ink that is a different color from the color named. For example, the word "green" may be written in blue ink. Identifying the word "green" is a faster and more automatic task than identifying the color blue. Therefore, when shown the word and asked what color the ink is, an individual has to use control processing to focus on the color of the ink rather than the word displayed. Individuals with higher levels of attentional resources and less attentional fatigue will complete this task more successfully. (De Young, http://www.snre.umich.edu/eplab/demos/st0/stroopdesc.html)

II. b. Task Demands

Effectiveness at performing a task is also dependent on the demands of that task. Task demands are described in terms of two factors: task difficulty and task consistency. Task difficulty consists of the amount of knowledge that must be learned (Anderson, 1993) and the number of problems that must be solved (Newell, 1990) to perform the task (Steele-Johnson et al., 2000). Paas and Van Merrienboer's (1994) description of "mental load" in terms of the number and nature of component skills involved in task performance is consistent with this definition, as is Wood's model of task complexity (Wood, 1986). For example, an individual may be asked to arrange 100 students into 5 different classrooms. A task with lower difficulty may give the individual only one rule to follow in performing this task (e.g. each classroom must have an equal proportion of male and female students). A task with higher difficulty would have several more rules, which may involve incorporating students' schedules when making classroom assignments, and ensuring that students of varied IQ levels are evenly distributed among the classrooms.

Task consistency involves the level and type of information processing demands. Robert Wood proposed the concept of "component redundancy," which refers to the degree of overlap among the task demands (Wood, 1986). A high level of component redundancy leads to a generally consistent task, i.e. the individual completes the same task over and over again. An inconsistent task is one in which the task demands are changing. For example, if an individual was asked to complete the classroom assignment activity described above three times in a row, each time with a *different* set of rules, this would comprise an inconsistent task. Completing the activity three times in a row with the *same* rules and parameters would be a consistent task.

Task difficulty and consistency can affect the "cognitive load," or amount of attentional resources required for a task (Steele-Johnson et al., 2000). Task consistency, in particular, has been shown to be an important factor in whether a task requires control processing or automatic processing. Several studies have demonstrated that the performance of tasks with consistent information-processing demands can be automatized with task practice, thereby freeing attentional resources (Schneider et al, 1984; Schneider & Shiffrin 1977; Shiffrin & Schneider, 1977). Reading is a good example of a consistent task that can be automatized with practice. When a child first learns to read, control processing is used to deal with the novel information that is presented. As the task of reading is practiced, many of the elements of the task become automatized—the child no longer uses control processing to recognize each letter or to put it into context with the other letters. Because the "rules" that govern reading are generally consistent, the individual is able to practice the task and automatize the processing of the information provided. This frees attentional resources for control processing that allow for understanding and interpretation of the text. The process of automatizing a task is described further below, in the discussion of skill acquisition.

Tasks with inconsistent information-processing demands require continued high levels of attention to successfully perform the task. Because the task demands are changing, the individual cannot automate the process. For example, imagine that an individual purchased a desk, a dresser and a bookshelf from three different manufacturers that all needed to be assembled. For each piece of furniture there is a different set of directions. Following the directions for assembling any of the pieces of furniture takes control processing, as each step requires high levels of attention to the directions. And assembling the desk is unlikely to make assembling the bookshelf any easier, since each process has its own set of directions written by different manufacturers. Assembling these pieces of furniture is an example of an inconsistent task. For inconsistent and novel tasks that require control processing, attentional resources must be allocated among competing tasks.

Task difficulty may also affect whether automatic or control processing takes place. Novel tasks, whether difficult or not, typically require control processing. Although it may seem as though more difficult tasks would require control processing, this has not always been shown to be the case. Automatic processing may not seem possible for the entirety of a difficult task, but it may well be adequate for the consistent aspects of the task. Automatic processes can allow people to perform very complex tasks that are a compilation of smaller, automatic tasks. The example of reading, which is a difficult task, demonstrates that automatic processing can be sufficient for completing many facets of difficult tasks.

II. c. Skill Acquisition

Research on the acquisition of cognitive skill has received a great deal of attention (Anderson, 1982; Fitts, 1964; Fitts & Posner, 1967; Fu, 2008). Skill acquisition is an important aspect of task performance and is often discussed in terms of two components: practice and the development of task strategies. Practice is typically used to shift a new task from control processing to automatic processing, allowing more attentional resources to be available to the individual. The development of task strategies aids in the overall development of schemas.

A schema is defined as a highly integrated representation of complex skills. In lay terms, a schema might be considered a very specific set of instructions about how to do something. As an individual works through a task, he or she makes determinations about how to do each step. With a consistent task, an individual has more opportunity to refine this schema each time the task is performed, with the eventual goal of developing a schema that can be automatized. Consider the example of preparing to go outdoors in the winter. The first time one does this, one might first put on gloves, then a coat, then boots, then a scarf, and then a hat. After this task is completed, one might realize that it is easier to put the gloves on after the coat is zipped, and that the scarf is more effective when worn under the coat. The next time this task was presented, one might follow these new guidelines. Repeated experiences would likely lead to refinements in the "winter wear" schema. After repeating this task several times, a preferred schema might be developed that is acceptable for all future uses. Once the task has been presented several more times and the preferred schema has been used consistently on these occasions, then the task can begin to become automatized. In other words, the person prepares their winter wear without thought, potentially while carrying on other tasks.

Skill acquisition and the use of practice and task strategies are affected by the difficulty and consistency of the given task. For more difficult tasks a larger number of task strategies must be learned before an individual can perform the task effectively. In these cases, skill does not develop from practicing the skill, but rather from practicing and automatizing the consistent components of that skill. For an inconsistent task, effective task strategies might change with task changes. Therefore, practicing the task procedures will have little effect on performance. The processing for inconsistent tasks is unlikely to become automatic, regardless of amount of practice. With the "winter wear" example, consider the consequences if the weather was unpredictably and qualitatively different every day. One day might require a coat and boots and the next would require flip-flops and a sunhat. Each different weather scenario is a new, inconsistent task, and there is no opportunity to develop or refine a schema.

In terms of consistent tasks, Fitts proposes three stages of skill acquisition (Fitts, 1964; Fitts & Posner, 1967). The cognitive phase is when the individual learns the task requirements and uses memory and reasoning processes, such as the initial phase of the winter wear example above. During the cognitive phase, the level of attentional resources required is high. The associative phase occurs when the individual compiles sequences of cognitive and motor processes, and the need for attentional resources declines. In the winter wear example, the associative phase occurs when the schema has been developed and is being practiced. The final phase, the autonomous phase, occurs when the skill becomes more rapid and automatic, at which point a low level of attentional resources is required.

II. d. Cognitive Interference and Ability

Human thought shifts focus at a high rate. In the setting of this review, cognitive interference will be used as a term to describe off-task thoughts that affect task performance (Sarason et al., 1996). Using attentional resources for off-task thoughts--i.e. worrying about what someone else is thinking about you instead of attending to the task—may take away from task performance. Others set forth that some types of cognitive interference may be useful or enhance task performance (Miller, 1996). While the presence of both the thoughts and the interference are considered normal mechanisms of human thought (Klinger, 1996) it is important to consider their influence on task performance as described above. Some forms of cognitive interference may be preventable or controllable, which may lead to overall improvement in task performance.

There are many potential sources of cognitive interference. Some of these sources are considered to be specific to each individual's traits, such as tendency towards anxiety or depression, or ability to cope (Yee and Vaughn, 1996). For instance, multiple studies have demonstrated that anxiety can lead to task performance deficits, likely due to the focus on intrusive threat-related thoughts that occur frequently in anxious individuals (MacLeod, 1996). Depressed persons report particular difficulty with cognitive functioning, such as poor concentration, forgetfulness, and intrusive negative thoughts (Gotlib et al. in 1996). However, the presence and severity of cognitive deficits in depression seems to depend on the situation and type of task. Stress may also lead to cognitive interference. This often depends on whether the stress is self-imposed (a challenge to oneself to do better) or externally imposed (a demand to do better), with externally imposed stress creating greater reductions in task performance.

Self-doubts are worries about ability to attain a goal. Self-doubts can interfere with actions when thoughts about outcome expectations or self-efficacy are intrusive and are connected to the belief that one is unable to attain the goal at hand. The self-doubts interfere with normal self-regulatory processes that allow one to move forward in goal attainment (Schwartzer, 1996). Individuals may also differ in the extent to which they are capable of filtering irrelevant information, leading to cognitive interference from relative distractibility. Furthermore, individuals who are stigmatized may experience higher levels of cognitive interference from worrying about what other people think of them. Physiological states, such as fatigue, substance abuse, and poor physical well-being, can also affect cognitive functioning, or can reduce the overall cognitive capacity of an individual (Sarason et al., 1996).

II. e. Self-Monitoring

Albert Bandura (1986) provided a theoretical framework for analyzing human motivation, thought and action called Social Cognitive Theory. According to Bandura, in a social cognitive view human functioning is explained in terms of a model of reciprocality in which behavior; cognitive and other personal factors; and environmental events all react with one other. The term environment refers to the objective, external factors that can influence an individual's behavior. Social cognitive theory is helpful in understanding and predicting individual behavior and in identifying methods with which behavior can be changed.

Self-Regulatory Processes

Bandura examined the processes by which individuals regulate their behavior through internal standards and self-evaluative reactions to their own behavior (Bandura, 1986), leading to the development of three important self-regulatory constructs: self-monitoring, self-evaluation, and self-reaction. Self-monitoring occurs when individuals allocate attention to the actions and consequences of their behavior. Self-evaluation is the comparison of one's current performance to the desired level of performance, and the assessment of the discrepancy between them. Self-reaction processes are achieved by creating incentives and responding evaluatively to one's own behavior, according to an internal standard.

Self-regulatory processes are also considered processes by which individuals allocate attentional resources across tasks (Kanfer et al., 1994). For example, consider an individual who is exercising with two goals: to reach and maintain a certain heart rate, and to walk a certain distance within a given period of time. As the individual exercises, he uses a heart rate monitor, a watch, and a distance marker to monitor and evaluate his performance. The individual might notice that his heart rate has gotten too high, so he will slow down and spend more attentional resources on attending to the heart rate monitor. As he reaches his heart rate target, he may switch focus and realize that he needs to adjust his walking in an effort to meet his distance goal. As he monitors and evaluates his performance, he switches attentional resources from one task to another.

Several studies of attentional resources have indicated that self-regulatory processes themselves may require attentional resources, which could disrupt control processing of a task and negatively affect task performance (Steele-Johnson, et al., 2000; Kanfer & Ackerman, 1989; Kanfer et al., 1994). In particular, these studies posit that assignment of specific, difficult goals triggers higher levels of self-regulatory processes, and may detract attentional resources from developing necessary task strategies for completing the task.

A few studies have countered this determination by measuring "leftover" attentional resources during task performance and demonstrating that the self-regulatory processes themselves may not be responsible for the decrease in task performance. These studies contend that the goal-setting and performance evaluation components included in self-regulatory processes are highly automated due to extensive practice in everyday life (Lord and Levy, 1994). Therefore monitoring, detecting, and reacting to discrepancies should be able to be performed automatically. Rather, the reduction in performance may be due to the pressure to perform manifesting itself in inefficient rapid hypothesis testing and strategy switching (Earley et al., 1989). For example, imagine that an individual is given a very difficult puzzle to solve in five minutes. She may begin with one strategy, and when it doesn't work within 30 seconds, she switches strategies in the hope that the new one will lead to progress. She may use her attentional resources during the task coming up with new strategies to try instead of focusing on one strategy and following it through.

Self-Efficacy

A key construct of SCT is self-efficacy, or the judgment of one's capability to accomplish a certain level of performance (Bandura, 1986). In terms of the concepts described above, self-efficacy may help explain the relationship between skill acquisition (a concept similar to Bandura's construct of behavioral capability) and task performance. Judgments of self-efficacy may be considered part of the self-reaction component of the self-regulatory processes described above. Therefore, some may consider judgments of self-efficacy to use attentional resources, while others may not.

Environment

Although it seems to be addressed to a lesser extent in the psychology literature, the environment plays a key role in cognitive processing, as well as in Social Cognitive Theory. The environment contains stimuli that can trigger automatic behaviors. As described above, once a task is automatized, it is more difficult to control or change. Therefore environmental stimuli that trigger automatic behaviors can be key in determining task performance, especially when the automatic behavior is counter to the task.

II. f. Allocation of Attentional Resources and Self-Regulation

It is clear that demands are high for diabetes self-management tasks. These tasks must also compete with other, non-diabetes related tasks. Because an individual has limited attentional resources, it is important to consider how these resources are allocated between tasks. What determines which tasks are prioritized?

There are several factors that affect the allocation of attentional resources. Cognitive abilities and task demands affect the level of resources that are allocated to and required by tasks, and therefore the amount of resources available for other tasks. A key concept in regards to resource allocation is motivation. Motivation refers to the direction of attentional effort, the amount of resources directed to the task, and the maintenance of that effort over time (Kanfer and Ackerman 1989, Campbell and Pritchard 1976, Humphreys and Revelle 1984, Kanfer 1987, Kleinbeck 1987). Motivational theorists have focused on the effects of factors such as dispositions, environments, incentive, goal assignments, and self-efficacy expectancies on intended effort, task behavior, and task performance (Bandura 1986, Campbell & Pritchard 1976, Ilgen & Klein 1988, Lawler 1973).

Some theories of motivation distinguish between two types of motivation. For example, Kanfer (1990) has proposed two cognitive resource allocation processes, distal motivation and proximal motivation. Kanfer describes proximal motivational processes as those that determine the distribution of effort during task engagement. Whereas distal motivational processes comprise the choice to engage any, some, or all of one's resources for attainment of a goal. Distal motivational processes therefore would, for example, determine whether tasks are attempted. According to Kanfer, distal motivational processes are determined by the individual's perceptions of how useful the performance of the task will be, how much effort is perceived to be required, and whether the amount of effort is worth the usefulness of the performance of the task.

In terms of cognitive function, forgetting and remembering are interesting processes that are also related to task demands and resource allocation. Interestingly, forgetting is considered critical for the efficient functioning of human memory (Storm, 07; Bjork and Bjork, 1988; Bjork, 1989; Macrae 1997). Without some means of getting rid of outdated or irrelevant information, it would become increasingly difficult to learn and access new and relevant information. There is a dual function to the process of "remembering" that suggests two simultaneous subprocesses, one that brings items to attention and one that filters out everything else (Broadbent 1958). In other words, if we concentrate on attending to one thing, other things are filtered out. If we concentrate on suppressing one thing, we do it by attending to something else (Wegner and Schneider, 1989).

In the field of applied psychology, the self-regulation perspective of motivation is becoming a dominant view (Boekaerts et al. 2005). This perspective focuses on goals and self-efficacy beliefs as main determinants of behavior. However, the role of self-efficacy and its relationship with task performance is not clear. While most researchers have found a positive relationship between self-efficacy and motivation or performance, others have found negative relationships (Vancouver et al. 2008). The positive relationship seems more intuitive—the higher an individual's self-efficacy, the more likely they are to allocate resources to and successfully complete a task (Bandura 1997). However, Bandura also proposed that in early stages of skill acquisition lower self-efficacy may correlate with higher motivation, since the self-doubt may lead the individual to have more incentive to complete the task successfully. Other researchers propose that individuals with higher self-efficacy underestimate the discrepancy between the current and goal states of a task, and therefore allocate too few resources to the task (Vancouver 2001). Thus, while the role of self-efficacy is important, the relationship between it and motivation or performance is somewhat unclear.

II. g. Summary

Referring back to the simplified explanation of attentional resource capacity, assume that an individual has 100 units of attentional resources. How these resources are allocated and how well the tasks are performed depends on several factors. First, what things are affecting the individual's ability or overall capacity for task completion? It is possible that something such as fatigue has already reduced the individual's overall capacity before any tasks are attempted. Therefore the individual may only have 80 or 90 units of attentional resources that can be allocated. Furthermore, cognitive interference, such as worry about completing the task, may also take up attentional resources.

Second, how demanding are the tasks that need to be completed? The demand of the task depends on its complexity as well as the level of skill the individual has for the task. The combination of tasks, along with their complexity and the individual's level of skill will determine the demand on the attentional resources. For example, a task that is novel and difficult may use 60 units of attentional resources, while one that is well-practiced and simple may only take 10 units. A task that is so well-practiced that is has been automatized may require negligible units of attentional resources.

Finally, given that the task demands are higher than total attentional resources, how are the resources allocated to the separate tasks and how does this affect the individual's ability to successfully perform the task? If there are task demands totaling 150 units, but only 100 units of resources, the individual must choose between tasks or complete some tasks only partially.

III. The Role of Cognitive Factors in Self-Management: The Case of Performing Diabetes Self-Management Tasks

Diabetes self-management is an excellent example for exploring the limitations of cognitive factors, because of the specific self-management tasks that have been outlined by the American Association of Diabetes Educators (AADE). The AADE7™ Self-Care Behaviors provide a framework for individual diabetes education and care: healthy eating, being active, monitoring, taking medication, problem solving, reducing risk, and healthy coping (AADE, 2007). Part of the purpose of the AADE7™ is to provide action-oriented, individual goals as well as a common language for communication. The AADE7™ is also purported to be important in providing a platform for supporting the diabetes educator in facilitating behavior change in individuals with diabetes (Tomsky et al, 2008). In terms of diabetes self-management tasks, it is important to consider the cognitive factors described above and to reflect on how they may affect an individual's ability to complete a task successfully.

The following section of this review, first explores the potential task demands of each of the AADE7™ self-care behaviors, and what these demands require in terms of skill acquisition for each of these behaviors. This is followed by a review of some of the common characteristics and co-morbidities of people who have type 2 diabetes and how these may affect cognitive ability or create cognitive interference. Finally, the allocation of attentional resources and the factors that may determine whether diabetes self-management tasks are successfully performed is discussed.

III. a. Task Demands and Skill Acquisition for AADE7™

III. a. 1. *Healthy Eating*

Healthy eating is the first of the AADE7™ self-care behaviors. There is significant evidence in the literature to indicate that adopting healthier eating habits can lead to health improvements, including improvements in weight, lipids, blood glucose, and blood pressure.

Individuals who have diabetes or who are at risk of developing diabetes are instructed to eat a "healthy diet." Many clinicians ask these individuals to count their carbohydrate, fat, and/or calorie intake each day, and provide the individuals with corresponding goals. The recommendation to "eat healthy" is actually very complex. If we consider eating healthy as one task, both the difficulty and complexity of the task would demand high levels of control processing and cause it to be incredibly and unreasonably difficult to perform successfully. Even when the task is broken down, for example, to eat a limited amount of calories each day, it is still a highly demanding task.

Consider the example of a man dining out with the goal of reducing his calorie intake. The seemingly simple task of choosing between menu items is actually quite complex and highly likely to require control processing, especially in the early stages of adopting the new eating patterns. The man must assess the calorie content of each item in order to be able to make a decision. Restaurant foods are difficult to assess for calories, since the customers seldom know what ingredients and cooking methods were used. Therefore, he would either need to have a list of the food items and their calorie values, provided by the restaurant, or would need to ask detailed questions about how the items are prepared. Then he would have to determine which item, or combination of items, would be most appropriate to the goal of reducing calorie intake. Assessing each item and then making a decision between the items are both tasks that require a high level of control processing.

This task is further complicated by the need to assess other aspects of the food items at the same time. For example, it is typical for individuals with diabetes to be asked to adhere to a moderately low-fat, low-calorie, and low-carbohydrate diet. If the individual has other common co-morbidities, such as high blood pressure, it may also be necessary to monitor things such as sodium intake. If we consider again the man in the restaurant choosing among foods, it is clear that assessing the calories, fat, carbohydrates, and sodium simultaneously will be an extremely demanding task, especially given the fact the combination of values are unlikely to align in terms goals. For example, an item low in carbohydrates may also be high in fat and sodium. This process is further complicated by the variety of often-conflicting messages regarding healthy eating patterns that are set forth by external sources such as health professionals, peers, family and the media. Therefore the decision-making process is increasingly difficult to perform successfully.

The complexity of healthy eating creates a problem for self-regulation efforts (Baumeister et al., 1994). Although goals are typically provided to individuals attempting to eat more healthfully, the multiple facets of the behaviors that should be monitored make it more difficult to self-evaluate whether the goals are being met. In addition, because there are often several, simultaneous goals, the self-evaluation is likely to lead an individual to feel as though failure has occurred if any of those goals has not been met. This sense of failure then often leads to a reduced level of self-efficacy, which further inhibits the ability to self-regulate. Chronic dieters often face the problem of counterregulation, which describes a paradoxical eating behavior in which restrained eaters (dieters) are more likely to overeat excessively when they feel that their diets have been "broken" (Herman and Mack, 1975; Herman and Polivy, 1980). Heatherton and Polivy (1992) put forth the idea of the "diet spiral," where each diet failure leads to both an increase in the need to restrict eating (due to weight gain or lack of weight loss) and a decrease in the chance that a future diet attempt will be successful (due to the reduction in self-efficacy).

The task of "healthy eating" is further complicated by the fact that several studies have demonstrated that eating is most often an automatic behavior (Cohen 2008, Blundell and Gillett 2001). In other words, many of the food choices that we make (given we are not "dieting") are influenced strongly by habit, food appeal, biological urges and environmental cues, rather than conscious thought. The fact that portion size strongly affects the amount that an individual eats demonstrates this automaticity. Multiple studies have shown that serving a larger portion of food leads to more of the food being eaten (Diliberti et al. 2004, Levitsky and Youn 2004, Rolls et al. 2002). When presented with a serving of food, an individual tends to eat that amount of food automatically, without awareness of the amount of food that is consumed.

Several studies have demonstrated that dieting, commonly referred to in the literature as "restricted eating," leads to lower cognitive function in other tasks, indicating that it requires substantial control processing. Kemps et al. (2005) investigated the impact of restricted eating on four central cognitive functions. Restricted eaters performed significantly more poorly than non-restricted eaters on three of these four functions. Baumeister et al. (1998) conducted a study in which individuals were seated in a room with a bowl of radishes and a plate of freshly-baked chocolate chip cookies. Some individuals were told to eat radishes, but not the cookies, while the other individuals were instructed to do the opposite. At the completion of the "taste test," the participants were asked to attempt to solve a complicated (in fact, impossible) puzzle, which involved tracing over a complex geometric shape without retracing any lines. They were told that the researchers were interested in how long it took them to complete the puzzle, and that it didn't matter how many times they tried or what strategy they used. They were given a limit of thirty minutes and instructed to ring a bell if they felt they could not solve the puzzle.

The group that had been restricted from eating the cookies gave up on the puzzle significantly sooner and with significantly fewer attempts than those who were allowed to eat the cookies. Furthermore, the group that was restricted from eating the cookies also felt more "tired" at the end of the task. These results indicate that attentional resources are significantly used when restricting food intake, leading to greater fatigue and fewer available resources for other tasks.

III. a. 2. *Being Active*

Another AADE7™ self-care behavior is being active. Reviews of the literature suggest that exercise has a positive effect on blood glucose control and cardiovascular disease risk reduction. According to the Behavioral Risk Factor Surveillance Surveys (BRFSS), conducted by the Centers for Disease Control and Prevention, only 49% of American adults participated in the nationally recommended amount of physical activity in 2007, showing a slight increase from 46% in 2001. And approximately 25% of adults reported no physical activity (including leisure-time activities) in the past month, a figure that has stayed fairly consistent over the past 10 years.

In parallel with the task of "healthy eating," the task of "increasing physical activity" is also complicated and has high task demands. Although some clinicians may provide patients with goals such as 150 minutes of moderate activity a week, the successful performance of this goal depends on the understanding and ability to self-assess "moderate activity." Over the years there have been varied and conflicting recommendations for activity, partially because of the way physical activity is measured and partially because of changing national physical activity guidelines (Wareham and Rennie 1998).

As with eating behaviors, there are numerous environmental cues that trigger sedentary behaviors to be more automatic than active ones. Substantial literature has been published explaining the ways in which the built environment influences physical activity. Increased levels of urban sprawl have been shown to be associated with increased obesity, and decreased physical activity (Ewing et al. 2003, Lopez 2004). Berrigan and Trojano (2002) posited that the presence of sidewalks, streetlights, and interconnectivity of streets appear to encourage physical activity and thus reduce the risk of obesity and related health problems. Whereas other factors – such as cul de sacs, lack of parks, high speed traffic and automobile focused transport – may function to discourage activity and ultimately increase obesity risk. Studies show that neighborhoods with a mixture of land use types including commercial, industrial, residential and office, also appear to promote physical activity (Frank et al. 2005), while neighborhoods consisting exclusively of housing seem to dampen physical activity (Cervero and Duncan 2003).

Other social factors, such as increased time devoted to watching television, using computers, and playing video games, are cited as an important contributing factor to the amount of time spent in sedentary activities (Hill and Peters 1998, Jeffery and French 1998, Robinson et al. 1993). The reliance on automobile use for transportation and the reduction of the workforce in occupations requiring higher levels of physical activity are also cited as reasons for the trend towards lower physical activity levels (Jacobs et al. 1994). The mere increase in availability of televisions, computers, and automobiles are likely to contribute to greater automaticity in sedentary behaviors and greater cognitive resources required to attempt and successfully reach goals to increase physical activity.

III. a. 3. *Monitoring and Taking Medication*

Self-monitoring of blood glucose (SMBG) and taking medication are the next AADE7™ self-care behaviors. According to the AADE, daily self-monitoring of blood glucose (SMBG) provides people with diabetes the information they need to assess how food, physical activity and medications affect their blood glucose levels. The AADE also suggests that individuals with diabetes regularly monitor their blood pressure, urine ketones and weight. Studies have shown that including SMBG as part of diabetes self-management leads to better diabetes outcomes (Blonde and Karter 2005, Sarol et al. 2005). However, patient adherence to SMBG guidelines is distressingly low (Cramer 2004).

The need for diabetes medications depends on several factors, including the type of diabetes, the progression of the disease, and how well the disease is managed. While some individuals with diabetes may take no medications, others may rely on oral medications and insulin injections to reduce the risk of complications from diabetes. For those who rely on medications for glycemic control, SMBG provides important information for adjusting medication dosages (ADA 1994, Renard 2005, Bergenstal and Gavin 2005).

In terms of monitoring of blood glucose, the task itself is fairly straightforward and lends itself to automatization. The task involves several steps including loading a test strip into the monitor, wiping the skin with alcohol, piercing the skin, placing a drop of blood on the test strip, waiting for the glucometer results, and recording the results. None of these steps alone, nor the series of steps, are difficult or complex. While the novelty of the tasks will initially require control processing, practicing the process is likely to lead to schema development, skill acquisition, and eventual automatization. Likewise, the processes of taking oral medication or injecting insulin also have low levels of task demands, and these processes can also be readily automatized.

Understanding the results of these tasks and how they are related to diabetes management is more complex than performing the tasks. Therefore while the monitoring task itself may become automatized, the process of understanding and reacting to the results of the monitoring will likely require control processing. For example, a particular blood glucose reading reflects past physiology and behavior and needs to be interpreted to influence future behavior. An individual conducting this monitoring must be able to interpret the results and determine what past behavior led to the results, how the results compare to goals, and how future behavior may help reach those goals. Because each reading will be based on a unique set of past events (such as food intake, physical activity, medication usage, illness, alcohol consumption, stress, and fluctuations in hormone levels), the interpretation will be different each time, and will therefore require control processing to determine which future behaviors will lead to desired results.

The incorporation of these tasks into daily life is also more complicated and demanding. This is reflected in the extensive literature on the factors that are correlated with monitoring and medication adherence, including age, gender, race, education, duration of the disease, frequency of medical visits, linguistic and cultural barriers, low health literacy and inadequate social support (Karter 2006, Zgibor and Simmons 2002, Davidson 2005). Furthermore, because diabetes is a progressive and chronic disease, the recommendations for frequency of SMBG and the prescriptions for medications will vary over time. This means that even though a certain schedule and process is in place and fairly automatized for an individual, it is likely that goals and recommendations will change. This would once again lead to a demand for control processing.

III. a. 4. *Reducing Risks, Problem Solving & Healthy Coping*

The last three AADE7™ self-care behaviors are reducing risks, problem-solving, and healthy coping. Several clear recommendations for preventing risks are promoted by DSME, such as blood pressure monitoring, eye exams, foot exams, dental exams and smoking cessation. However, adherence to these recommendations is much lower than desired (Lojo et al., 2002).

In fact, each of these elements includes its own set of task requirements and demands. Smoking cessation, for example, has its own set of behavior change behaviors that vary from the AADE self-care behaviors discussed above. It is important to note that the goals associated with each of the reducing risks tasks may differ greatly from the goals of the more direct diabetes self-management tasks, creating difficulties for the individual in terms of self-monitoring and self-evaluation. For example, reducing sodium to aid in blood pressure control may make reducing calories for healthy eating more difficult. Overall, an estimation of the task demands of "reducing risks" would be extensive and is beyond the scope of this review.

The AADE 7™ recommendations for problem solving and healthy coping indirectly acknowledge the importance of cognitive factors in the self-management of diabetes. Problem solving skills have been associated with improved diabetes outcomes (Grey and Berry, 2004). The AADE defines problem solving as "a learned behavior that includes generating a set of potential strategies for problem resolution, selecting the most appropriate strategy, applying the strategy, and evaluating the effectiveness of the strategy" (Mulcahy et al, 2003). The recommendation for problem-solving aligns with the concepts of schema development and skill acquisition. Specifically, the AADE seems to recommend that individuals develop cognitive skills that allow them to improve their control processing in novel situations, perhaps leading to the development of more efficient schemas.

The healthy coping AADE7™ self-care behavior acknowledges that diabetes management takes place in the context of emotional, psychological and behavioral factors. This AADE self-care behavior recognizes the effect of psychological and social factors on health and motivation, a description which parallels with the concept of cognitive interference. In these ways, the AADE recommendations do seem to allude to the potential importance of cognitive factors.

However, the concept of attentional resources is not alluded to or addressed in the description of the AADE 7™ behaviors for diabetes self-management or in the systematic literature reviews that support these behaviors. And this concept is central to assessing the ability of an individual to be successful at self-management. The "problem-solving" element of the AADE 7™ may be viewed as the need to use attentional resources most efficiently. Much of this efficiency depends on the ability of the individual to automatize as many behaviors as possible to allow for more effective control processing when it is needed. Efficiency also depends on the recognition that only a limited amount of control processing can occur at one time, so tasks with high demands should be gradually incorporated over time. This factor seems to be missing from the AADE 7™.

The AADE 7™ recommendation for healthy coping includes improving the individual's ability to manage psychological distress. Likewise, reducing the negative effects of cognitive interference on task performance would include developing strategies to handle high levels of cognitive interference, as well as attempts to reduce the source of cognitive interference.

III. b. Cognitive Capacity and Cognitive Interference

Several barriers to diabetes self-management tasks have been reported in the literature that are likely to affect an individual's overall cognitive capacity or to cause cognitive interference during the performance of a task. Again, in the setting of this review, cognitive interference will be used as a term to describe intrusive thoughts that interfere with task performance (Sarason et al., 1996).

III. b. 1. Glycemic Control

Especially relevant to diabetes, glycemic control has been shown to affect cognitive ability (Biessels et al., 2002; Stewart & Liolitsa, 1999). Cognitive deficits are observed in people with glucose intolerance or untreated diabetes although these deficits appear to be somewhat alleviated by treatments that improve glycemic control. However, even in patients with treated type 2 diabetes, decreases in cognitive function are fairly consistently observed on measures of verbal memory and processing speed. Awad (2004) concluded that, in patients with diabetes who achieve and maintain good glycemic control, type 2 diabetes only has a small impact on cognitive functions before the age of 70 years. However, early onset of type 2 diabetes, poor glycemic control and the presence of vascular disease may interact to produce early cognitive deficits. Studies evaluating the effects of confounding factors associated with type 2 diabetes (i.e., cardiovascular disease) as well as studies assessing risk of cognitive decline and dementia in individuals with type 2 diabetes suggest that over time, cognitive decrements due to poor glycemic control may become irreversible.

III. b. 2. Cardiovascular Factors

Cardiovascular factors have been shown to be independently associated with decrements in cognitive performance (Desmond et al., 1993). Given the relationship of type 2 diabetes and cardiovascular and cerebrovascular factors, it is important to determine the roles of such factors on the cognitive function of individuals with type 2 diabetes. One study on a large British occupational cohort showed that vascular risk factors and indicators of vascular disease are associated with cognitive impairment. According to this study there were clear associations between coronary heart disease and cognition using a range of cognitive tests and the MMSE, a test of global cognitive status. Long standing coronary heart disease, particularly in men, was also associated with poorer cognitive performance (Singh-Manoux, 2008).

Hypertension is also a common co-morbidity in individuals with type 2 diabetes. One study indicated a small inverse association between both diastolic and systolic blood pressure and cognitive performance, independent of age, education, employment grade, smoking status, alcohol consumption, use of antihypertensive medication, diagnoses of diabetes, and cardiovascular disease. Similar associations were seen with prospective and cross-sectional analyses. The effect of hypertension was stronger in women, and stronger for cognitive measures assessing control processing (Singh-Manoux, 2005).

III. b. 3. Overweight and Obesity

According to the National Institute of Diabetes and Digestive and Kidney Diseases (NIDDK) (http://win.niddk.nih.gov/Publications/health_risks.htm#type2), at least 85% of individuals with diabetes are overweight or obese, making weight-related factors significant to a discussion of diabetes self-management. Some factors that are commonly associated with overweight and obesity are likely to increase cognitive interference or reduce cognitive capacity when performing a task. For example, fatigue is a commonly reported problem for individuals who are overweight (Vgontzas et al., 2006), and studies demonstrate that fatigue can reduce attentional resource capacity (Lyznicki, 1998).

Studies have also shown that overweight individuals deal with high levels of stigma in their daily lives (Crandall, 1994; Crocker, 1993). Dealing with stigma has been shown to increase cognitive interference when completing a task (Sarason et al., 1996). Therefore it is likely that stigma creates significant cognitive interference, especially when dealing with tasks that are associated with being overweight, such as eating and exercising. Individuals dealing with stigma devote attentional resources to thoughts about what others think of them (e.g. Is everyone watching what I eat? Do I look silly when I exercise?), causing a reduction in task performance. Mood and attitude can also affect cognitive ability (Yee & Vaughn, 1996). It is common for people who have previously attempted self-management of eating and exercise to feel discouraged or wary when initiating a new effort (Linde, 2004). Low self-efficacy and an attitude of "well, it probably won't work," are likely to lead to cognitive interference during self-management tasks (Sarason et al., 1996).

III. b. 4. Depression

Several studies have shown increased prevalence of depression among type 2 diabetes patients compared to controls (Amato et al. 1996; Lindeman et al. 2001; Tun et al. 1987). In their review, Anderson et al. (2001) concluded that the odds of depression were doubled in individuals with both types of diabetes (type 1 and type 2) compared to the individuals without diabetes. They also noted that major depressive disorder (assessed using diagnostic interviews) was observed in 11% of patients with diabetes whereas elevated depressive symptoms (obtained from self-report measures) were observed in 31% of patients with diabetes. Ciechanowski et al. (2000) further demonstrated that depression symptom severity was associated with functional impairment and poorer diet and medication regiment adherence in individuals with diabetes. Depression is believed to increase cognitive interference due to the invasive, negative thoughts that accompany it (Gotlib et al., 1996). A small number of population-based studies in which neurocognitive tests have been used have reported higher levels of depressive symptoms to be associated with reduced performance on measures of attention, memory, and concept formation (Kizilbash et al., 2002). Stress has also been shown to negatively affect cognition in a number of ways (McEwen, 1995).

It is clear that there are many factors that play a role in determining the cognitive capacity of an individual at a given moment, and other factors that can create significant cognitive interference when attempting a task. It is important to take these factors and the resulting limitations into account when considering the best way to promote successful self-management of diabetes.

III. c. Allocation of Attentional Resources and Consequences for Task Performance

Despite the aligned recommendations, common nomenclature, and focused diabetes education efforts encouraged by the AADE7™, self-management is still often unsuccessful or neglected. The question remains why this is so.

It is clear that demands are high for diabetes self-management tasks. These tasks must also compete with other, non-diabetes related tasks. Because an individual has limited attentional resources, it is important to consider how these resources are allocated between tasks. What determines which tasks are prioritized?

As mentioned in the previous section of this review, there are several factors that affect the allocation of attentional resources. As described above, according to Kanfer (1990), distal motivational processes are determined by the individual's perceptions of how useful the performance of the task will be, how much effort is perceived to be required, and whether the amount of effort is worth the usefulness of the performance of the task. Due to their complexity, diabetes self-management tasks may suffer in the effort-utility evaluation, especially during the early stages of skill acquisition when the demands are especially high.

The dynamics of the environment and the amount of discrepancy between the status of task completion and the goal can also play a role in attentional resource allocation. This is particularly important to the successful performance of diabetes self-management tasks because of their high task demands. If an individual needs to complete more tasks than attentional resources allow, it is more likely that the easier, automatized tasks will be completed than the more demanding tasks. Individuals with diabetes have identified lack of time as a barrier to successful diabetes self-management (Nagelkerk, 2006), but it is important to consider whether this is truly a lack of time, or rather a lack of adequate attentional resources.

“Forgetting” is also considered a barrier to diabetes self-management. In other words, if we concentrate on attending to one thing, other things are filtered out (Wegner and Schneider, 1989). Perhaps when individuals “forget” diabetes self-management tasks, it is the result of concentrating on something else instead. For individuals with diabetes, the “something else” that receives the attentional resource focus may include the self-management tasks required by comorbidities. It is common for individuals with diabetes to have other chronic diseases that also require self-management (Van den Akker et al. 1998, Anderson and Horvath 2004). Therefore self-management tasks will be competing for attentional resources. Furthermore, as described above, the differing nature of the self-management tasks for different chronic conditions may contribute to higher task demands for each of the tasks. For example, Sevick et al. (2007) describe the high demands on individuals with complex chronic disease.

III. d. Summary

Taking all of the above factors into account, it is clear that successful performance of diabetes self-management tasks is quite challenging. First, what things are affecting the individual’s ability or overall capacity for task completion? Physiological and psychological factors can affect both the overall amount of attentional resources available, as well as the portion of those resources that may be directed towards off-task thoughts.

Second, how demanding are the tasks that need to be completed? Diabetes self-management task are numerous, and tend to be quite complex, therefore demanding higher levels of attentional resources. Some of the diabetes self-management “tasks” require high levels of skill acquisition, or are tasks that are continually changing, or inconsistent, and therefore do not benefit greatly from skill acquisition.

Finally, given that the task demands are higher than total attentional resources, how are the resources allocated to the separate tasks and how does this affect the individual's ability to successfully perform the task? It is clear from the high task demands that only a small number of tasks can be attended to at any one time. Decisions that affect the allocation of attentional resources are affected not only by the self-efficacy and the demands of the diabetes self-management tasks, but also by the demands of other, unrelated tasks.

IV. Conclusions and Directions for Future Research

In this review, I have approached the topics of task performance and attentional resource capacity in an effort to understand which cognitive factors may affect an individual's ability or overall capacity for health behavior change. I used the example of diabetes self-management tasks to illustrate these issues. Given that an individual has limited attentional resource capacity, several important questions arise.

First, what specific factors are affecting the individual's ability or overall capacity for task completion? It is possible that some physical or psychological factor has already reduced the individual's overall capacity or caused cognitive interference before any tasks are attempted. Given the example of type 2 diabetes, it is clear that there are several such factors or conditions that are commonly associated with diabetes—such as glycemic control, hypertension, fatigue, stigma, or depression—that also affect available attentional resource levels.

Second, how demanding are the tasks that need to be completed? The demand of the task depends on its complexity as well as the level of skill the individual has for the task. The combination of tasks, along with their complexity and the individual's level of skill will determine the demand on the attentional resources. Given this, it is important to remember that a task that is so well-practiced that is has been automatized may not require any units of attentional resources.

Finally, given that the task demands are higher than total attentional resources, how are the resources allocated to the separate tasks and how does this affect the individual's ability to successfully perform the task? When considering chronic disease management, when and how do self-management tasks take precedence over other tasks? Decisions that affect the allocation of attentional resources are affected not only by the self-efficacy and the demands of the self-management tasks, but also by the demands of other, unrelated tasks.

To date numerous studies in the applied psychology literature have extensively explored the cognitive factors described in this review. Researchers in that field have begun to apply knowledge of these factors to improve industrial and organizational function, such as workplace performance. The concepts have also been used in attempts to improve classroom performance. However there is not a significant literature that explores the application of these concepts and their impact to the field of public health or to health behavior change. Several areas for explanation that would improve our understanding of these concepts and how they can be applied to health behavior change are outlined below.

1. Some "tests," such as the Stroop test described earlier, have been developed that measure "leftover" attentional resources after completing a task. In this way, it is possible to estimate the amount of attentional resources that a task requires. However, it is unclear if the current methods of estimating attentional resource requirements would be sufficient for tasks with this

complexity. Improvement in methods of assessing attentional resource requirements would aid in this estimation.

2. In terms of assessing attentional resources, a major contribution to the research would be some way of assessing the amount of attentional resources that a person has available at any particular time. For example, is there a way to tell if an individual currently has attentional resources available to approach a given task, or are levels of attentional resources too dynamic to be measured? If an individual's current levels could be measured, this would be a key component of determining how to approach the individual in terms of their chronic disease self-management plan.

3. If attentional resource levels could be measured, it may also be possible to examine the amount of attentional resources available over time for a given individual. It would be enlightening to examine the affect of changing attentional resource levels over time. It seems as though there may be the possibility of an individual who experiences chronic limitations of attentional resources, i.e. the amount of resources available for given tasks is always insufficient. What physical or psychological affects might there be on an individual if there is a chronic limitation of attentional resources? What situations would lead to this situation, and what would make it more severe in some cases than others? Population-based studies of adults show a strong association between social factors and cognitive function (Zhao et al., 2005) The higher an individual's socioeconomic position, the higher the cognitive performance and reserve, the slower the cognitive decline (Turrell, 2002; Anstey, 2001). Are there effects of socio-economic status on the limitations of attentional resources?

4. Further exploration of the amount of attentional resources that chronic disease self-care tasks require would be a significant contribution to the literature. For example, although it

seems likely that some of the tasks associated with healthy eating would have high demands, it is difficult to determine the true level of attentional resources that may be required. It may be possible to design a series of experiments in which participants performed certain healthy eating tasks (e.g. eating only half of a served portion), with their level of attentional resources (performance on the Stroop test) measured before and after each of these tasks.

5. It is clear that health behavior change task demands at times exceed attentional resources capacity. It is also clear that automatized tasks require fewer attentional resources than tasks that require control processing. Given this, it may be easier to lead to the automatization of tasks if the environment supports the healthier behavior. A change in environmental cues is likely to lead to easier automatization of some such tasks. For example, reduction of portion sizes in restaurants, cafeterias, vending machines, etc. are likely to lead to an improvement in healthy eating, without requiring attentional resources from the individual. Parking lots or other points of interest that require extra steps may also increase physical activity without the individual using control processing to increase the effort taken. Further research into the impact of changes to environmental cues on the automatization of tasks may lead to additional impetus to change the environment to support healthier behaviors.

The areas for further research outlined above may further elucidate the role of cognitive factors and how they impact chronic disease self-management tasks in general and diabetes self-management in particular. Ultimately, this type of knowledge could be useful for health care providers in their efforts to facilitate self-management of chronic diseases. .

References

Aljasem, L., Peyrot, M., Wissow, L., & Rubin, R. (2001). The impact of barriers and self-efficacy on self-care behaviors in type 2 diabetes. *Diabetes Educator, 27,* 393-404.

Amato, L., Paolisso, G., Cacciatore, F., Ferrara, N., Canonico, S., Rengo, F., & Varricchio, M. (1996). Non-insulin dependent diabetes mellitus is associated with a greater prevalence of depression in the elderly. *Diabetes Metabolism, 22,* 314-318.

American Association of Diabetes Educators. (2009). *Diabetes Education Fact Sheet*. Retrieved from: http://www.diabeteseducator.org/export/sites/aade/_resources/pdf/Diabetes_Education_Fact_Sheet_2009.pdf. Accessed June 6, 2010.

American Association of Diabetes Educators. (2007, June). AADE adopts definition of diabetes education. AADE e-FYI.

American Diabetes Association. (n.d.). *Facts about Type 2 Diabetes*. Retrieved from: http://www.diabetes.org/diabetes-basics/type-2/facts-about-type-2.html. Accessed June 6, 2010.

American Diabetes Association. (1994). Self-monitoring of blood glucose. *Diabetes Care, 17*, 81-86.

Anderson, G., & Horvath, J. (2004). The growing burden of chronic disease in America. *Public Health Reports, 119,* 263–70.

Anderson, J.R. (1993). *Rules of the mind.* Hillsdale, NJ: Erlbaum.

Anderson, J.R. (1982). Acquisition of cognitive skill. *Psychological Review, 89(4),* 369-406.

Anderson, M. C. (2003). Rethinking interference theory: Executive control and the mechanisms of forgetting. Journal of Memory and Language, 49, 415–445.

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.

Anstey, K.J., Luszcz, M.A., Giles, L.C., & Andrews, G.R. (2001). Demographic, health, cognitive, and sensory variables as predictors of mortality in very old adults. *Psychology of Aging, 16,* 3–11.

Awad, N., Gagnon, M., & Messier, C. (2004). The relationship between impaired glucose tolerance, type 2 diabetes, and cognitive function. *Journal of Clinical and Experimental Neuropsychology, 26(8),* 1044-1080.

Bandura, A. (1997). *Self-efficacy: the exercise of control.* New York: Freeman.

Bandura, A. (1995). Exercise of personal and collective efficacy in changing societies. In A. Bandura (Ed.) *Self-efficacy in changing societies.* New York: Cambridge University Press.

Bandura, A. (1986). *Social foundations of thought and action: A social cognitive theory*. Englewood Cliffs, N.J.: Prentice-Hall.

Banerji, M.A., (2007). The Foundation of Diabetes Self-management: Glucose Monitoring. *Diabetes Educator, 33*, 87S.

Baranowski, T., Perry, C.L., & Parcel, G.S. (2002). How individuals, environments, and health behavior interact. In K. Glanz et al. (Eds.), *Health behavior and health education: theory, research and practice* (pp. 165-184). San Francisco: Jossey-Bass.

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

Bergenstal, R.M., & Gavin, J.R. III, on behalf of the Global Consensus Conference on Glucose Monitoring Panel. (2005). The role of self-monitoring of blood glucose in the care of people with diabetes: report of a global consensus conference. *American Journal of Medicine, 118(suppl 9A),* 1S-6S.

Berrigan, D., & Troiano, R. (2002). The association between urban form and physical activity in U.S. adults. *American Journal of Preventive Medicine*, *23(2S),* 74-79.

Biessels, G.J., van der Heide, L.P., Kamal, A. Bleys, R.L., & Gispen, W.H. (2002). Ageing and diabetes: implications for brain function. *European Journal of Pharmocology, 441(1-2),* 1-14.

Bjork, E. L., & Bjork, R. A. (1988). On the adaptive aspects of retrieval failure in autobiographical memory. In M. M. Gruneberg, P. E. Morris, & R. N. Sykes (Eds.), *Practical aspects of memory II*. London: Wiley.

Bjork, R. A. (1989). Retrieval inhibition as an adaptive mechanism in human memory. In H. L. Roediger & F. I. M. Craik (Eds.) *Varieties of memory and consciousness: Essays in honour of Endel Tulving*. Hillsdale, NJ: Lawrence Erlbaum Associates, Inc.

Bjork, E. L., Bjork, R. A., & MacLeod, M. D. (2006). Types and consequences of forgetting: Intended and unintended. In L. G. Nilsson & N. Ohta (Eds.), *Levels of processing in human memory*. Hillsdale, NJ: Lawrence Erlbaum Associates, Inc.

Blonde, L., & Karter, A.J. (2005). Current evidence regarding the value of self-monitored blood glucose testing. *American Journal of Medicine, 118(suppl 9A),* 20S-26S.

Blundell, J.E., & Gillett, A. (2001). Control of food intake in the obese. *Obesity Research, 9*: 263S-270S.

Bodenheimer, T., Wagner, E.H., & Grumbach, K. (2002). Improving primary care for patients with chronic illness. *Journal of the American Medical Association, 2888(14)*: 1775-1779.

Boekaerts, M., Pintrich, P.R., & Zeidner, M. (2005). *Handbook of Self-Regulation.* San Diego, CA: Academic Press.

Broadbent, D.E. (1958). *Perception and Communication.* New York: Pergamon Press.

Campbell, J. P., & Pritchard, R. D. (1976). Motivation theory in industrial and organizational psychology. In M. D. Dunnette (Ed.), *Handbook of industrial and organizational psychology* (pp. 63-130). Chicago: Rand McNally.

Centers for Disease Control and Prevention. (2010). *Diabetes Alert*. Retrieved from: https://www.cdc.gov/Features/DiabetesAlert. Accessed June 6, 2010.

Centers for Disease Control and Prevention. (2008). *2008 Fact Sheet*. Retrieved from: http://www.cdc.gov/diabetes/pubs/pdf/ndfs_2007.pdf. Accessed June 6, 2010.

Centers for Disease Control and Prevention. (2007). *National Diabetes Fact Sheet*. Retrieved from: https://www.cdc.gov/diabetes/pubs/factsheet07.htm. Accessed June 6, 2010.

Cervero, R., & Duncan, M. (2003). Walking, bicycling, and urban landscapes: evidence from the San Francisco Bay Area. *Am J Public Health*, *93(9),* 1478-1483.

Chaiken, S., & Trope, Y. (1999). Dual-process theories in social psychology. New York: Guilford Press.

Ciechanowski, P.S., Katon, W.J., & Russo, J.E. (2000). Depression and diabetes: impact of depressive symptoms on adherence, function, and costs. *Archives of Internal Medicine, 160,* 3278-3285.

Cohen, D.A., & Farley T.A. (2008). Eating as an automatic behavior. *Preventing Chronic Disease, 5(1).* Retrieved from http://www.cdc.gov/pcd/issues/2008/jan/07_0046.htm. Accessed August 15, 2009.

Cooper-Patrick, L., Gallo, J.J., Gonzales, J.J., Vu, H.T., Powe, N.R., Nelson, C., & Ford, D.E. (1999). Race, gender and partnership in the patient-physician relationship. *Journal of the American Medical Association, 282(6),* 583-589.

Cramer, J.A. (2004). A systematic review of adherence with medications for diabetes. *Diabetes Care, 27*, 1218-24.

Crandall, C. S. (1994). Prejudice against fat people: Ideology and self-interest. *Journal of Personality and Social Psychology,* 66 882-894.

Crocker, J., Cornwell, B., & Major, B. (1993). The stigma of overweight. *Journal of Personality and Social Psychology, 64(1),* 60-70.

Davidson, J. (2005). Strategies for improving glycemic control: effective use of glucose monitoring. *American Journal of Medicine*, *118(suppl 9A),* 27S-32S.

De Geus, E.J.C., Wright, M.G., & Martin, N. (2001). Genetics of brain function and cognition, *Behav Genet, 31,* 489–495.

Desmond, D.W., Tatemichi, T.K., Paik, M., Stern, Y. (1993). Risk factors for cerebrovascular disease as correlates of cognitive function in a stroke-free cohort. *Archives of Neurology, 50,* 162-166.

De Young, R. (2010). Stroop test. Retrieved from: http://www.snre.umich.edu/eplab/demos/st0/stroopdesc.html. Accessed March 15, 2010.

Dijksterhuis, A., Smith, P.K., van Baaren, R.B., & Wigboldus, D.H.J. (2005). *Journal of Consumer Psychology, 15(3),* 193-202.

Diliberti, N., Bordi, P.L., Conklin, M.T., Roe, L.S., & Rolls, B.J. (2004). Increased portion size leads to increased energy intake in a restaurant meal. *Obesity Research, 12(3),* 562-8.

Earley, P.C., Connolly, T., & Ekegren, G. (1989). Goals, strategy development, and task performance: some limits on the efficacy of goal setting. *Journal of Applied Psychology, 74,* 24-33.

Ewing, R., Schmid, T., Killingsworth, R., Zlot, A., & Raudenbush, S. (2003). Relationship between urban sprawl and physical activity, obesity, and morbidity. *American Journal of Health Promotion*, *18(1),* 47-57.

Fisher, E.B., Thorpe, C.T., DeVellis, B.M., & Devellis, R.F. (2007). Healthy coping, negative emotions, and diabetes management: a systematic review and appraisal. *Diabetes Educator, 33(6),* 1080-1103.

Fitts, P.M. (1964). Perceptual-motor skill learning. In A.W. Melton (Ed.) *Categories of human learning.* New York: Academic Press.

Fitts, P.M., & Posner, M.I. (1967). *Learning and skilled performance in human performance.* Belmont CA: Brock-Cole.

Frank, L., Schmid, T., Sallis, J., Chapman, J., & Saelens, B. (2005). Linking objectively measured physical activity with objectively measured urban form: findings from SMARTRAQ. *American Journal of Preventive Medicine, 28(S2),* 117-125.

Fu, W.-T. & Anderson, J. (2008). Dual learning processes in interactive skill acquisition. *Journal of Experimental Psychology, Applied. 14* (2), 179-191.

Funnell, M.M., Brown, T.L., Childs, B.P., et al. (2007). National Standards for Diabetes Self-Management Education. *Diabetes Educator, 33(4)*: 599-614.

Glasgow, R.E., Orleans, C.T., Wagner, E.H., et al. (2001). Does the chronic care model serve also as a template for improving prevention? *Milbank Quarterly, 79(4):* 579-612.

Gotlib, I.H., Roberts, J.E., & Gilboa, E. (1996). Cognitive interference in depression. In I.G. Sarason et al. (Eds.) *Cognitive Interference: Theories, Methods, and Findings.* Mahwah, NJ: Erlbaum.

Gray, W. D., Schoelles, M. J., & Sims, C. R. (2004). Learning to choose the most effective strategy: Explorations in expected value. In *Proceedings of the sixth International*

Conference on Cognitive Modeling (pp. 112-117). Pittsburgh, PA: Carnegie Mellon University/University of Pittsburgh.

Green, M.W., Elliman, N.A., Kretsch, M.J. (2005). Weight loss strategies, stress, and cognitive function: Supervised versus unsupervised dieting. *Psychoneuroendocrinology, 30(9),* 908-18.

Greene, J., & Yedidia, M.J. (2005). Provider behaviors contributing to patient self-management of chronic illness among underserved populations. *Journal of Health Care for the Poor and Underserved, 16(4),* 808-824.

Grey, M., & Berry, D. (2004). Coping skills training and problem solving in diabetes. *Current Diabetes Reports, 4,* 126-131.

Heatherton, T.F., & Polivy, J. (1992). Chronic dieting and eating disorders: a spiral model. In J. Crowther, S. Hobfall, M. Stephens, & D. Tennenbaum (Eds.) *The etiology of bulimia: The individual and familial context.* Washington, DC: Hemisphere.

Herman, C.P., & Mack, D. (1975). Restrained and unrestrained eating. *Journal of Personality, 43,* 647-660.

Herman, C.P., & Polivy, J. (1980). Restrained eating. In A.J. Stunkard (Ed.) *Obesity.* Philadelphia: Saunders.

Hill, J.O., & Peters, J.C. (1998). Environmental contributions to the obesity epidemic. *Science, 280*, 1371–74.

Hill-Briggs, F., & Gemmell, L. (2007). Problem solving in diabetes self-management and control: a systematic review of the literature. *Diabetes Educator, 33(6),* 1032-1050.

Hindmarch, I., Kerr, J.S., & Sherwood, N. (1990). The effects of alcohol and other drugs on psychomotor performance and cognitive function. *Alcohol and Alcoholism, 26(1),* 71-79.

Humphreys, M. S., & Revelle, W. (1984). Personality, motivation, and performance: A theory of the relationship between individual differences and information processing. *Psychological Review, 91,* 153-184.

Improving Chronic Illness Care (ICIC) website. (2010). Chronic Care Model. Retrieved from: http://www.improvingchroniccare.org/index.php?p=The_Chronic_Care_Model&s=2. Accessed June 25, 2010.

Jacobs, D.R., Sprafka, J.M., Hannan, P.J., Ripsin, C.M., McGovern, P.G., et al. (1994). Mortality and risk factor trends in Minnesota: Minnesota heart studies. In H. Toshima, Y. Koga, H. Blackburn, & A. Keys (Eds.) *Lessons for Science from the Seven Countries Study: A 35-Year Collaborative Experience in Cardiovascular Disease Epidemiology.* Tokyo: Springer Verlag

Jeffery, R.W., & French, S.A. (1998). Epidemic obesity in the United States: Are fast foods and television viewing contributing? *American Journal of Public Health, 88,* 277–280.

Johnson, R.L., Roter, D., Powe, N.R., & Cooper, L.A. (2004). Patient race/ethnicity and quality of patient-physician communication during medical visits. *American Journal of Public Health, 94(12),* 2084-2090.

Kahneman, D. (1973). *Attention and effort*. Englewood Cliffs, N.J.: Prentice-Hall.

Kanfer, R. (1987). Task-specific motivation: An integrative approach to issues of measurement, mechanisms, processes, and determinants. *Journal of Social and Clinical Psychology, 5,* 237-264.

Kanfer, R. (1990). *Motivation and Industrial and Organizational Psychology.* Consulting Psychologist Press.

Kanfer, R., & Ackerman, P.L. (1989). Motivation and cognitive abilities: An integrative/aptitude-treatment interaction approach to skill acquisition [Monograph}. *Journal of Applied Psychology, 74*, 657-690.

Kanfer, R., Dugdale, B., & McDonald, B. (1994). Empirical findings on the Action Control Scale in the context of complex skill acquisition. In J. Kuhl & J. Beckmann (Eds.), *Volition and personality: Action- and state-oriented modes of control* (pp. 61-77). Göttingen, Germany: Hogrefe & Huber Publishers.

Karter, A.J. (2006). Role of self-monitoring of blood glucose in glycemic control. *Endocrinology Practice, 12(S1),* 110-117.

Kavanagh, D., Gooley, S., & Wilson, P. (1993). Prediction of adherence and control in diabetes. *Journal of Behavioral Medicine, 16,* 509-523.

Kavookjian, J., Elswick, B.M., & Whetsel, T. (2007). Interventions for being active among individuals with diabetes. *Diabetes Educator, 33(6),* 962-988.

Kemps, E., Tiggeman, M., & Marshall, K. (2005). Relationship between dieting to lose weight and the functioning of the central executive. *Appetite, 45(3),* 287-94.

Kizilbash, A.H., Vanderploeg, R.D. & Curtiss, G. (2002). The effects of depression and anxiety on memory performance. *Archives of Clinical Neuropsychology, 17(1),* 57-67.

Kleinbeck, U. (1987). The effects of motivation on job performance. In E Halisch and J. Kuhl (Eds.), *Motivation, intention, and volition* (pp. 261-271). New York: Springer-Verlag.

Klinger, E. (1996). The contents of thoughts: interference as the downside of adaptive normal mechanisms in thought flow. In I.G. Sarason et al. (Eds.) *Cognitive Interference: Theories, Methods, and Findings.* Mahwah, NJ: Erlbaum.

Lee, Y., & Lin, J.L. (2009). The effects of trust in physician on self-efficacy, adherence and diabetes outcomes. *Social Science & Medicine, 68,* 1060-1068.

Levitsky, D.A.,& Youn, T. (2004). The more food young adults are served, the more they overeat. *Journal of Nutrition, 134(10),* 2546-2549.

Linde, J.A., Jeffery, R.W., Finch, E.A., Ng, D.M., & Rothman, A.J. (2004). Are unrealistic weight loss goals associated with outcomes for overweight women? *Obesity Research, 12,* 569-576.

Lindeman, R.D., Romero, L.J., LaRue, A., Yau, C.L., Schade, D.S., Koehler, K.M., Baumgartner, R.N., & Garry, P.J. (2001). A biethnic community survey of cognition in participants with type 2 diabetes, impaired glucose tolerance, and normal glucose tolerance. *Diabetes Care, 24(9),* 1567-1572.

Lojo, J., Burrows, N.R., Geiss, L.S., Tierney, E.F., Wang, J. & Engelgau, M.M. (2002). Preventive care practices among persons with diabetes—United States, 1995-2001. *Morbidity & Mortality Weekly Report, 51,* 965-969.

Lopez, R. (2004). Urban sprawl and risk for being overweight or obese. *American Journal of Public Health, 94(9),* 1574-1579.

Lord, R.G., and Levy, P.E. (1994). Moving from cognition to action: a control theory perspective. *Applied Psychology: An International Review, 43,* 335-367.

Lyznicki, J M., Doege, T C., Davis, R M., & Williams, M A. (1998). Sleepiness, driving, and motor vehicle crashes. Journal of the American Medical Association, 279(23), pp. 1908-1913

MacLeod, C. (1996). Anxiety and cognitive processes. In I.G. Sarason et al. (Eds.) *Cognitive Interference: Theories, Methods, and Findings.* Mahwah, NJ: Erlbaum.

Macrae, C.N., Bodenhausen, G.V., Milne, A.B., & Ford, R.L. (1997). On the regulation of recollection: The intentional forgetting of stereotypical memories. *Journal of Personality and Social Psychology, 72(4),* 709-719.

McAndrew, L., Schneider, S.H., Burns, E., & Leventhal, H. (2007). Does patient blood glucose monitoring improve diabetes control? A systematic review of the literature. *Diabetes Educator, 33(6),* 991-1011.

McEwan, B.S., & Sapolsky, R.M. (1995). Stress and cognitive function. *Current Opinion in Neurobiology, 5(2)*, 205-216.

Miller, S.M. (1996). Monitoring and blunting of threatening information: cognitive interference and facilitation in the coping process. In I.G. Sarason et al. (Eds.) *Cognitive Interference: Theories, Methods, and Findings.* Mahwah, NJ: Erlbaum.

Mulcahy, K., Maryniuk, M., Peeples, M., et al. (2003). Diabetes self-management education core outcomes measures. *Diabetes Educator, 29,* 768-787.

Nagelkerk, J., Reick, K., & Meengs, L. (2006). Perceived barriers and effective strategies to diabetes self-management. *Journal of Advanced Nursing, 54(2),* 151-158.

Newell, A. (1990). *Unified theories of cognition.* Cambridge, MA: Harvard University Press.

Nooyens, A.C.J., van Gelder, B.M., & Vershuren, W.M.M. (2008). Smoking and cognitive decline among middle-aged men and women: the Doetinchem cohort study. *American Journal of Public Health, 98(12),* 2244-2250.

Odegard, P.S., & Capoccia, K. (2007). Medication taking and diabetes: A systematic review of the literature. *Diabetes Educator, 33(6),* 1014-1029.

Paas, F.G.W.C., & Van Merrienboer, J.J.G. (1994). Instructional control of cognitive load in the training of complex tasks. *Educational PsychologyReview, 84,* 426-434.

Parasuraman, R., & Davies, D. R. (Eds.) (1984). *Varieties of attention*. Orlando: Academic Press.

Povey, R.C., & Clark-Carter, D. (2007). Diabetes and Healthy Eating: A Systematic Review of the Literature. *Diabetes Educator, 33(6),* 931-959.

Reder, L.M., & Anderson, J.R. (1982). Effects of spacing and embellishment on memory for the main points of a text. *Memory & Cognition, 10(2),* 97-102.

Renard, E. (2005). Monitoring glycemic control: the importance of self-monitoring of blood glucose. *American Journal of Medicine, 118(S9A),* 12S-19S.

Robinson, T.N., Hammer, L.D., Killen, J.D., Kraemer, H.C., Wilson, D.M., et al. (1993). Does television viewing increase obesity and reduce physical activity? Cross-sectional and longitudinal analyses among adolescent girls. *Pediatrics, 91*, 273–80

Rolls, B.J., Morris, E.L., & Roe, L.S. (2002). Portion size of food affects energy intake in normal-weight and overweight men and women. *American Journal of Clinical Nutrition, 76(6),* 1207-1213.

Sabia, S., Marmot, M., Dufouil, C., & Singh-Manoux, A. (2008). Smoking history and cognitive function in middle age from the Whitehall II study. *Archives of Internal Medicine, 168(11),* 1165-1173.

Sarason, I.G., Pierce, G.R., & Sarason, B.R. (1996). Domains of cognitive interference. In I.G. Sarason et al. (Eds.) *Cognitive Interference: Theories, Methods, and Findings.* Mahwah, NJ: Erlbaum.

Sarol, J.N., Nicodemus, N.A., Tan, K.M., & Grava, M.B.(2005). Self-monitoring of blood glucose as part of a multi-component therapy among non–insulin requiring type 2 diabetes patients: a metaanalysis(1966-2004). *Current Medical Research Opinions, 21,* 173-182.

Schmidt, D., Shi, C., Berry, R., Honig, M., & Utschick, W. (2009). Distributed resource allocation schemes. *IEEE Signal Processing Magazine, 26(5),* 53-63.

Schneider, W., Dumais, S. T., & Shiffrin, R. M. (1984). Automatic and control processing and attention. In R. Parasuraman & D. R. Davies (Eds.), Varieties of attention (pp. 1-27). Orlando: Academic Press.

Schneider, W., & Shiffrin, R.M. (1977). Controlled and automatic human information processing: I. Detection, search and attention. *Pyschological Review, 84,* 1-66.

Schwartzer, R. (1996). Thought control of action: interfering self-doubts. In I.G. Sarason et al. (Eds.) *Cognitive Interference: Theories, Methods, and Findings.* Mahwah, NJ: Erlbaum.

Sevick, M.A., Trauth, J.M., Ling, B.S., Anderson, R.T., Piatt, G.A., Kilbourne, A.M., & Goodman, R.M. (2007). Patients with complex chronic diseases: Perspectives on supporting self-management. *Journal of General Internal Medicine, 22(3),* 438-444.

Shiffrin, R.M., & Schneider, W. (1977). Controlled and automatic human information processing: II. Preceptual learning, automatic attending, and a general theory. *Psychological Review, 84,* 127-190.

Siminerio, L. (2006). Challenges and strategies for moving patients to injectable medications. *Diabetes Educator, 32(S2)*, 82S-90S.

Singh-Manoux, A., Sabia, S., Lajnef, M., Ferrie, J.E., Nabi, H., Britton, A.R., Marmot, M.G., & Shipley, M.J. (2008). History of coronary heart disease and cognitive performance in midlife: the Whitehall II study. *European Heart Journal.* doi:10.1093/eurheartj/ehn298

Small, G.W., Silverman, D.H.S., Siddarth, P, Ercoli, L.M., Miller, K.J., Lavretsky, H., Wright, B.C., Bookheimer, S.Y., Barrio, J.R., & Phelps, M.E. (2006). Effects of a 14-day healthy longevity lifestyle program on cognition and brain function. *American Journal of Geriatric Psychology, 14(6)*, 538-545.

Steele-Johnson, D., Beauregard, R. S., Hoover, P. B., & Schmidt, A. M. (2000). Goal orientation and task demand effects on motivation, affect, and performance. J Appl Psychol, 85(5), 724-738.

Stewart, R., & Liolitsa, D. (1999). Type 2 diabetes mellitus, cognitive impairment and dementia. *Diabetic Medecine, 16(2),* 93-112.

Storm, B.C., Bjork, E.L., & Bjork, R.A. (2007). When unintended remembering leads to unintended forgetting. *Quarterly Journal of Experimental Psychology, 60(7)*, 909-915.

Sweller, J., & Chandler, P. (1991). Evidence for cognitive load theory. *Cognition and Instruction, 8(4),* 351-362.

Tomsky, D., Cypress, M., Dang, D., Maryniuk, M., & Peyrot, M. (2008). AADE Position Statement: AADE7 Self-Care Behaviors. *Diabetes Educator, 34(3),* 445-449.

Tun, P.A., Perlmuter, L.C., Russo, P., & Nathan, D.M. (1987). Memory self-assessment and performance in aged diabetics and non-diabetics. *Experimental Aging Research, 13,* 151-157.

Turrell, G., Lynch, J.W., Kaplan, G.A., Everson, S.A., Helkala, E.L., Kauhanen, J., et al. (2002). Socioeconomic position across the lifecourse and cognitive function in late middle age. *Journal of Gerontology, Psychological Science and Social Science, 57,* S43-S51.

Vancouver, J.B., Thompson, C.M., & Williams, A.A. (2001). The changing signs in the relationships among self-efficacy, personal goals, and performance. *Journal of Applied Psychology, 86*, 605-620.

Vancouver, J.B., More, K.M., & Yoder, R.J. (2008). Self-efficacy and resource allocation: support for a nonmonotonic, discontinuous model. *Journal of Applied Psychology, 93 (1),* 35-47.

Van den Akker, M., Buntinx, F., Metsemakers, J.F., Roos, S., Knottnerus, J.A. (1998). Multimorbidity in general practice: prevalence, incidence, and determinants of co-occurring chronic and recurrent diseases. *Journal of Clinical Epidemiology, 51*, 367-375.

Vgontzas, A.N., Bixler, E.O., & Chrousos, G.P. (2006). Obesity-related sleepiness and fatigue: the role of the stress system and cytokines. *Annals of the New York Academy of Sciences, 1083,* 329-344.

Wagner, E.H. (2002). The changing case of chronic disease care. In: National Coalition on Health Care. *Accelerating change today.* Retrieved from: http://www.improvingchroniccare.org/downloads/act_report_may_2002_curing_the_system_copy1.pdf

Ward, M., & Sweller, J. (1990). Structuring effective worked examples. *Cognition and Instruction, 7,* 1-39.

Wareham, N.J., Rennie, K.L. (1998). The assessment of physical activity in individuals and populations: Why try to be more precise about how physical activity is assessed? *International Journal of Obesity and Related Metabolic Disorders, 22(S2),* S30-S38.

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

Wegner, D. M., & Schneider, D. J. (1989). Mental control: The war of the ghosts in the machine. In J. S. Uleman & J. A. Bargh (Eds.), *Unintended Thought* (pp. 287-305). New York: Guilford Press.

Weissenborn, R., and Duka, T. (2003). Acute alcohol effects on cognitive function in social drinkers: their relationships to drinking habits. *Psychopharmacology, 165(3),* 306-312.

Wood, R. E. (1986). Task complexity: Definition of the construct. *Organizational Behavior and Human Decision Processes, 37(1).*

Yee, P.L., and Vaughan, J. (1996). Integrating cognitive, personality, and social approaches to cognitive interference and distractibility. In I.G. Sarason et al. (Eds.) *Cognitive Interference: Theories, Methods, and Findings.* Mahwah, NJ: Erlbaum.

Zachariae, R., Pederson, C.G., Jensen, A.B., Ehrnrooth, E., Rossen, P.B., & von der Maase, H. (2003). Association of perceived physician communication style with patient satisfaction, distress, cancer-related self-efficacy, and perceived control over the disease. *British Journal of Cancer, 88,* 658-665.

Zgibor, J.C., & Simmons, D. (2002). Barriers to blood glucose monitoring in a multiethnic community. *Diabetes Care, 25,* 1772-1777.

Zhao, J.H., Brunner, E.J., Kumari, M., Singh-Manoux, A., Hawe, E., Talmud, P.J., et al. (2005). APOE polymorphism, socioeconomic status and cognitive function in midlife: the Whitehall II longitudinal study. *Social Psychiatry and psychiatry Epidemiology, 40,* 557-563.

