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PREDICTING MULTITASKING PERFORMANCE FROM SELF-REPORT OF PERSONALITY AND TEMPERAMENT

By

Sarah Pachulicz

A THESIS

Submitted to
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in partial fulfillment of the requirements
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ABSTRACT

PREDICTING MULTITASKING PERFORMANCE FROM SELF-REPORTS OF PERSONALITY AND TEMPERAMENTS

By

Sarah Pachulicz

Approach and avoid temperament were examined as predictors of multitasking performance. The multitasking paradigm was a four-task computer simulation, consisting of a visual, auditory, memory and a math task. The personality traits of extraversion, sensation seeking, and the Behavioral Activation System (BAS) were confirmed to share common variance that loads on the approach temperament. Neuroticism, sensory processing sensitivity (SPS), and Behavioral Inhibition System (BIS) were confirmed to share common variance that loads on the avoid temperament. Especially the avoid temperament was found to be a good predictor of multitasking performance, such that individuals low in avoid temperament performed the best. Individuals were found to employ different strategies for completing or ignoring one or more tasks; implications for prediction of workplace behavior are discussed.

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Introduction

As little as ten years ago, the daily routine of an office worker would have included reading the mail, checking the inbox – not on the computer, but the actual basket on the desk – for memos and new items that had arrived, and completing things that needed to be done in a more-or-less sequential fashion. The increase in technology, most notably, computers, Internet and email, has increased not only the amount of interruption in the workplace ("ding, you've got mail"); it has also raised expectations for higher levels of productivity. This is true for blue-collar workers, who may now have to monitor several machines, gauges or displays at once, and it is especially true for white-collar workers whose jobs involve computers. Email responses are often expected right away, even if it is just a "got it, thanks." In addition to technology increases, the phenomena of downsizing and job enrichment have also contributed to the increased demands placed on today's workers; one employee may be expected to perform the same amount of work that would have been previously expected of two or more employees. The combination of these factors is changing the face of performance at work so that traditional and current notions of job performance are also constantly evolving (Ilgen & Pulakos, 1999).

Successful workers must not only be good at performing each of the tasks they are responsible for; they must now also be good at weaving those tasks together in an environment of interruption and uncertainty (Delbridge, 2000; Persing, 1999). This type of activity is often referred to as *multitasking*. Therefore, predicting multitasking ability in job applicants could contribute to prediction of their performance on the job;

specifically for those jobs with many interruptions and concurrent tasks in light of pressing deadlines.

Multitasking is a concept that is still in its youth within the literature in I/O psychology. Although the term *multitasking* is frequently used colloquially, a precise definition of multitasking is lacking within organizational psychology. Multitasking is perhaps most simply described as the performance of more than one task at a time, either simultaneously or in coordination (Delbridge, 2000). During multitasking, an individual must switch between a number of tasks in a given time period – often a very short period of only minutes or even seconds – at the same time keeping in mind other tasks that must also be performed and remaining on the alert for new or higher-priority tasks (Salvucci, 2005). Multitasking usually requires the pausing of one task before it is complete and the shift of attention and focus to another task or tasks, and the eventual return of attention back to the original task. Oswald, Hambrick, and Jones (2007) have recently described multitasking as a type of performance that occurs in a relatively short time period and involves shifts in attention among multiple tasks. Their definition includes both subjective and objective measures of a short time span and of a discrete task.

As with overall performance, general intelligence has been found to be an important predictor of multitasking performance. Because the task switching required in multitasking results in process losses due to increased demands on working memory and the switching of attention, greater working memory capacity and increased switching speed associated with higher intelligence are associated with higher multitasking performance (Salthouse, Hambrick, Lukas, & Dell, 1996). Although cognitive ability does provide some prediction of multitasking performance, there is reason to believe that personality characteristics can provide incremental validity in the prediction of multitasking performance, similar to how conscientiousness has generally been shown to predict overall performance (e.g. Barrick & Mount, 1991).

Although a number of personality characteristics (Type A Behavior Pattern, e.g., De la Casa, Gordillo, Mejias, Rengel, & Romero, 1998; polychronicity, e.g., König, Bühner, & Mürling, 2005) have been examined in relation to multitasking performance, few have been consistently predictive of multitasking performance. Extraversion and neuroticism have shown some promise in prediction, and there are other traits that may be more proximally related to multitasking performance. For example, Ackerman, Kanfer, and Goff(1995) studied cognitive and noncognitive predictors of complex skill acquisition. They investigated personality traits such as extraversion and neuroticism, cognitive ability, and motivational and self-efficacy constructs. While they did not find support for personality traits as a predictor of performance, they did find that cognitive ability was a strong predictor, as were negative motivational thoughts. They reason that individuals who are unable to suppress these negative motivational thoughts experience interference and thus perform worse. This argument is related to the arousal argument described below, that some individuals are more susceptible to stimuli such as negative thoughts and thus show a performance decrement.

Multitasking Performance

Although *multitasking* it is a well known term in colloquial language, it is less systematically researched in psychology. In 2000, Delbridge stated that "[in multitasking ability], we have an implied individual difference without a real understanding of the underlying mechanisms or related constructs" (p. 9). Delbridge does mention attentional resources and working memory capacity as being related to multitasking, and goes on to explain that some research in applied settings demonstrates the consequences of individual differences in multitasking ability (for example, Kahneman, Ben-Ishai, & Lothan, 1973; Kirmeyer, 1988; Mihal & Barrett, 1976). Some of these studies show that there are individual differences in susceptibility to process losses; for example, some individuals have faster reaction times and perceive the appropriate indicators to switch tasks more quickly than others. How these differences are empirically related to non-cognitive personality traits is unclear so far.

It is important to note that multitasking is viewed as different from performing a single task, both objectively and psychologically. For example, consider the single tasks of 'typing on a keyboard' and 'measuring the boards to frame up a house.' Both tasks take considerable amount of practice and skill. If the person typing on a keyboard were to also check his or her email and respond to the phone in a manner that interweaves these activities, he or she would be engaging in multitasking. By the same token, if the person measuring the boards were talking to the prospective owner of the house and supervising the construction crew at the same time, he or she would also be engaging in multitasking. The single tasks that make up each of these situations require very different skill sets, yet the combination of tasks is what we call multitasking, because each of them requires fast switching between tasks, there are task interruptions, and the person needs to remember where he or she left off before the interruption and then return to that point afterwards.

Moving to the task level of a multitasking situation, there are five descriptors for multitasking tasks as described by Oswald et al. (2007): the characteristics of the tasks (are they visual or auditory, unknown to the individual or familiar, simple or complex); the structure of the tasks (are there two to three tasks or eight to ten, are they independent or interdependent, are they equally important); the timing of the tasks (are they predictable, is someone else dictating the timing, is there a specific order they need to follow); the control over the tasks (can they be rearranged, does the participant have control over aspects of the execution), and finally, the outcomes of the tasks (do they have feedback or rewards, does one carry more weight than another).

Moving up one level, and regarding the multitasking situation as a whole, there are three main characteristics: task switching, time pressure, and environmental uncertainty (Delbridge, 2000). It is at this aggregate level where non-cognitive individual differences have the greatest predictive power. Or, as Oswald et al. put it, a "cool head" (2007, p. 10), implying a degree of calmness and rationality, appears to be a determining factor of successfully completing multiple tasks at the same time. Being faced with the uncertainty of multitasking (e.g., not knowing when the next interruption will come) produces arousal, and individuals who are higher in arousability would be the ones who tend to be most strongly impaired by uncertainty in multitasking situations. In other words, a person's level of arousability, or how much he or she is affected by intense or numerous stimuli, influences his or her ability to deal with the task(s) at hand.

The second characteristic, time pressure, changes the manner in which people perform tasks and make decisions; for example, it tends to increase the amount of attention people pay to negative information, such as an error message after a mistake, relative to a positive message for correct action (Ben Zur & Breznitz, 1981). Time pressure is an important component of multitasking and may also play a role in identifying individual differences in multitasking performance, specifically, individuals who handle time pressure better than others.

The third characteristic, task switching, is influenced mostly by cognitive ability and perceptual speed, since individuals with higher cognitive ability tend to have higher working memory capacity (Engle & Kane, 2004). Delbridge (2000) examined individual differences as predictors of multitasking performance, but did not find support for personality variables such as extraversion and neuroticism as predictors. She did, however, find support for the hypothesis that individuals higher in avoidance generally performed worse on the task. She explained that problem-focused coping and avoidant coping may have an effect on multitasking performance through their association with withdrawal. Her model did not include an approach temperament ('temperament' is defined as "an aspect of an individual's general make-up characterized by dispositions towards particular patterns of emotional reactions, mood shifts and levels of sensitivity resulting from stimulation. There are suggestions that temperament has a significant genetic disposition [...]," Reber & Reber, 2001, p. 740). My current study will include both approach and avoid temperaments in order to fill the gap left by Delbridge's study; individuals in the approach temperament group could potentially perform better than avoiders because they would spend less time ruminating and respond faster to stimuli.

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Given the findings of Oswald et al. (2007), that individuals higher in neuroticism tend to perform worse in faster multitasking situations, and that of Delbridge (2000), that avoidant behavior leads to lower multitasking performance but that neuroticism has no effect, this study seeks to reconcile those findings and to build a broader nomological net that might be able to explain the apparent contradiction. To that end, the introduction of a few additional constructs and the basic conceptual argument is in order.

I will argue that there are two basic, biologically determined temperaments that underlie the expression of more narrow personality traits such as the Big Five. These two temperaments are the approach temperament and the avoid temperament, which have a long history in the research literature (Elliot & Thrash, 2002; Eysenck, 1967; Gray, 1972; Schneirla, 1959). Various streams of literature have used different names for the very same concepts, thereby confusing the matter. In a nutshell, individuals who are approach oriented have also been described as high in sensation seeking or excitement seeking (because they seek out new experiences), low in arousability (because their brains require more stimulation in order to reach a comfortable level of arousal), impulsive (Eysenck, 1967) and dominated by the behavioral activation system (BAS, Carver & White, 1994). On the other hand, individuals who are avoid oriented are characterized by withdrawal, high arousability (because their brains have a naturally high level of arousal, meaning that any incoming stimulation will easily lead to a sense of being overwhelmed and therefore withdraw), anxiety prone (Eysenck, 1967), or dominated by the behavioral inhibition system (BIS, Carver & White, 1994). These basic behavioral temperaments have great potential to be important for the prediction of multitasking performance, because they indicate the manner in which an individual approaches the tasks that are set before him or her in the work environment, and the likelihood of successful completion of the tasks. What follows is a more detailed description of previous research with these constructs, and following that my study will be presented. See Figure 1 for the conceptual model to be discussed.

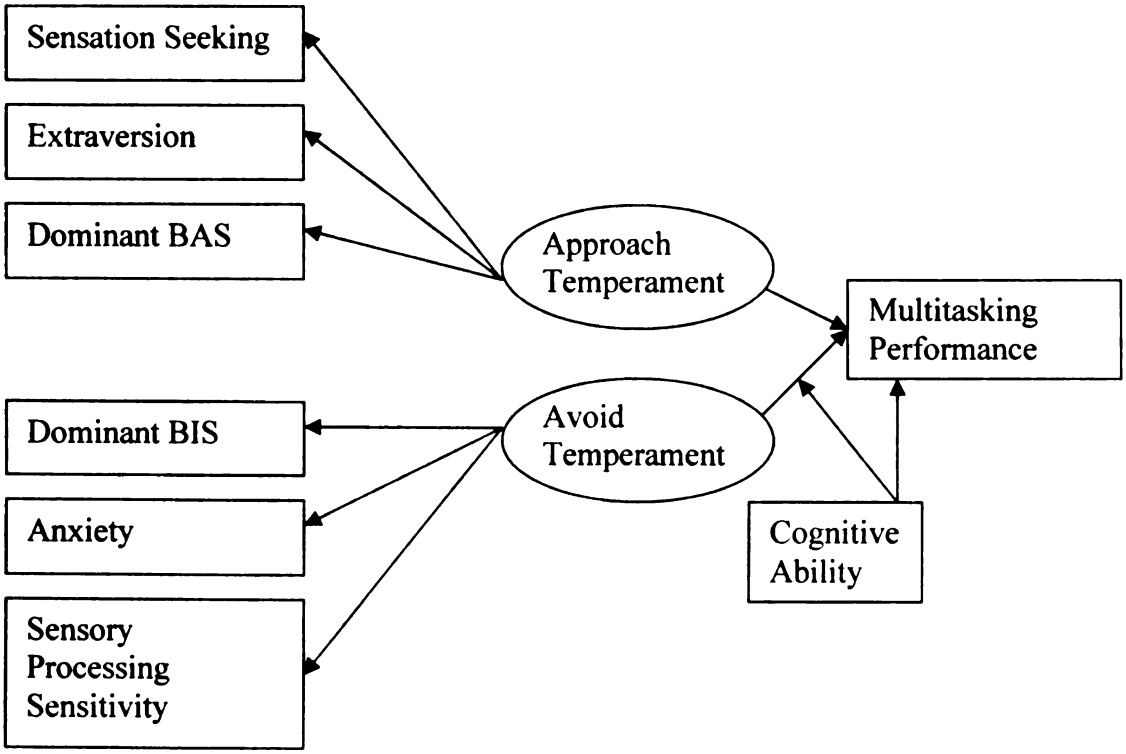

Figure 1. Proposed Relationships between Constructs

Temperaments: Approach and Avoid

The idea of the broad approach and avoid systems governing our behavior dates back at least to Eysenck's (1967) book, *Biological Bases of Behavior*. He held that there were two basic personality traits that govern behavior, extraversion and emotionality. Gray (1972) further developed parallel constructs, which he termed "impulsivity" and "anxiety proneness," respectively, into a motivational system that consists of appetitive motivation and aversive motivation. Almost 20 years later, Elliot and Thrash (2002) incorporated the biologically based constructs of behavioral activation and inhibition, and the personality based impulsivity and anxiety proneness, into the underlying approach and avoid temperaments. They suggested that the approach and avoid temperaments were the underlying behavioral tendencies that give rise to personality traits such as the Big Five (McCrae & Costa, 1987).

According to Elliot and Thrash, the tendency to approach indicates that behavior is motivated by the expectancy of some type of reward, and the tendency to avoid indicates that action (or non-action) is motivated by the desire to avoid punishment. These behavioral tendencies are closer in nature to temperaments (see Buss & Plomin, 1984), because there is "emerging agreement regarding the biological basis of basic personality constructs, (…) and that these constructs are heritable, present in early childhood, relatively stable across the life span and that they include an affective element" (Elliot & Thrash, 2002, p. 805). Each of the following "subconstructs" of the approach and avoid temperaments has been selected because it is very similar, if not identical, in nature and expression to the approach or avoid temperament to which it belongs. In the study that follows each subconstruct will be measured separately with established scales, which will then be used to provide convergent and discriminant validity evidence for the approach and avoid temperaments predicting multitasking performance.

Approach Subconstruct: Sensation Seeking

Sensation seeking can be described in the following manner: Some individuals enjoy activities that give them a "rush" of excitement, for example, base jumping, skydiving, or other adrenaline-pumping activities. For others, these activities would be much too overwhelming or would create anxiety, and these individuals enjoy activities such as reading or gardening – something that the skydivers would find incredibly boring.

Individuals in the first group would score high on a measure of sensation seeking (see Ball & Zuckerman, 1992; de Brabander, Boone, Gerits & Van Witteloostuijn, 1995), whereas individuals in the second group would score low on that same measure. Whether individuals are high sensation seekers or low sensations seekers, is determined in part by the balance of neurotransmitters in their brains. High sensation seekers have higher noradrenaline and dopamine stores than low sensation seekers in parts of the brain called the central catecholaminergic nerves, which enhance transmission capacity and effectiveness in arousing and activating an individual (Lukas, 1987). In turn, these differences in arousal and activation capacity can have effects on performance on tasks with and without distraction, which is the focus of this paper.

As early as 1959, Schneirla described individual differences in temperament which he termed "A" and "W" for approach and withdrawal, respectively. Thirty years later, Zuckerman (1990) commented that "individual differences in reactivity to intense and novel stimulation, that provide the basis for the sensation seeking trait, may be the end result of natural variation evolved in A and W mechanisms in humans" (p. 314). The trait of sensation seeking itself was perceived to be unidimensional, with high sensation seekers on one end and low sensation seekers on the other. However, the combination of this and related constructs (such as behavioral activation and inhibition, see below) into the approach and avoid temperaments led to two separate constructs that are thought to be relatively independent; which means that one person can be high on both, low on both or any combination thereof.

Approach Subconstruct: Extraversion

From the personality perspective, a second construct related to the approach temperament is extraversion. As one of the Big Five personality factors, it especially lends itself to a study related to multitasking. Extraverts, due to their tendency to have a lower baseline level of arousal and higher need for stimulation, tend to perform better than introverts in highly stimulating situations (social and otherwise). Due to the highly stimulating nature of multitasking, extraverts are therefore predicted to perform better than introverts on average (König, Bühner, & Mürling, 2005; Lieberman & Rosenthal, 2001; Szymura & Necka, 1998). Research results in this area have been mixed but are suggestive that further research should be done to explore these relationships.

Szymura and Necka (1998) and Szymura and Wodniecka (2003) examined both extraversion and neuroticism in relation to a computerized dual task involving visual attention performance. Subjects had to identify and respond to certain letters but ignore others, while at the same time keeping a horizontal bar on a display in a static position using the keyboard. In the first group of studies, the authors found support for the arousal model of selective attention; that is, they found evidence that extraverts tend to perform better in both tasks due to low baseline arousal and a desire for highly stimulating activity. In addition, they found that higher levels of neuroticism generally resulted in performance deficits as the stimuli were presented faster. They concluded that it was the speed of stimulus presentation that impaired individuals higher in anxiety.

Approach Subconstruct: Behavioral Activation System (BAS)

The behavioral activation and inhibition systems have long been thought to be two distinct biological systems (Gray, 1972), such that individuals could be influenced mostly by one of the systems or by both systems. Elliot and Thrash (2002) have found Gray's (1972) description of the Behavioral Activation and Inhibition Systems, which have ties to both the physiological and the personality literature, to be related to their approach and avoid temperament, respectively. An individual's behavior – for example, upon seeing a stranger either smiling and preparing to greet vs. turning away and avoiding interaction – will be determined in part by whether the activation or the inhibition system is more strongly influencing the behavior at that moment.

Spontaneous responses and decisions and "doing," rather than "waiting," are governed by the approach temperament. The biological underpinnings of the approach temperament were described by Gray (1972), who called it the *behavioral activation system*, or BAS. A system of brain pathways is implicated when individuals make BAS responses, namely, dopaminergic pathways including the ventral tegmental area and the nucleus accumbens of the ventral striatum (Brenner, Beauchaine, & Sylvers, 2005). The BAS system is found to be sensitive to signals of reward, nonpunishment, and escape from punishment. This system is thought to activate the individual's beginning or increase of movement towards goals, similar to measures of approach temperament and approach goal orientation. According to Gray, the BAS is responsible for experience of positive feelings such as hope, elation, and happiness. This was further supported by Carver and White (1994), who showed that BAS is related to positive affect, and BIS to negative affect (Watson, Clark, & Tellegen, 1988).

According to Carver and White, the BAS scale reflects three subfacets, "drive," "fun seeking," and "reward responsiveness," with alpha reliabilities of .76, .66, and .73, respectively. Items for these subfacets include questions such as "When I want something, I usually go all-out to get it," "I will often do things for no other reason than that they might be fun," or "It would excite me to win a contest," respectively. Scale intercorrelations for the three BAS scales ranged from .34 to .41, and the correlations between the BIS scale and the three BAS scales were -.12 for "drive", -.08 for "fun seeking", and .28 for "reward responsiveness" (the positive correlation between BIS and reward responsiveness could be attributed to the fact that BIS is thought to be sensitive to non-reward (withholding of a reward), so individuals in might still endorse items that ask about receiving rewards).

Individuals who score higher on the BAS scales have a tendency to act more quickly in pursuit of desired goals and a tendency to seek out new and potentially rewarding experiences. Carver and White argue that they have found sufficient convergent and discriminant validity for the measure; in addition, Heubeck, Wilkinson, and Cologon (1998) replicated these findings with an Australian sample, obtaining essentially the same factor structure and discriminant validities.

Avoid Subconstruct: Behavioral Inhibition System (BIS).

Gray (1972) called the aversive system the *behavioral inhibition system*, or BIS, and argued that it is a physiological system (comprising the septohippocampal system, its monoaminergic afferents from the brainstem, and its neorcortical projections in the frontal lobe) that controls the experience of anxiety when faced with anxiety-related cues. The BIS is sensitive to signals of punishment, nonreward, and novelty. It leads individuals to inhibit behavior that may lead to negative or painful outcomes. Individuals with a dominant BIS will display greater fear of failure or punishment and prefer to not attempt something, rather than trying and failing, because an activated BIS is thought to inhibit behavior (Elliot & Thrash, 2002). In addition, Gray argues that BIS functioning is responsible for the experience of negative feelings such as fear, anxiety, frustration, and sadness in response to anxiety-provoking cues. Being higher in BIS sensitivity should lead to greater proneness to anxiety, given the right situational cues. Most measurements of BIS have used Carver and White's (1994) 20-item BIS/BAS scales, which include BIS items such as "If I think something unpleasant is going to happen I usually get pretty 'worked up'," or "I worry about making mistakes." The BIS scale was found to be unidimensional, as determined by a factor analysis of the complete set of items including the BAS scale, with a reliability of alpha = .74.

Avoid Subconstruct: Anxiety

One of the individual difference variables in the cluster of avoid temperaments is anxiety. It has been measured with several, often very similar scales, for example, Goldberg's (1992) TDA (Trait Descriptive Adjectives) scale, the Big Five Inventory (BFI; John, 1990), or McCrae and Costa's (1987) NEO-PI.

Some evidence exists that anxiety does have an impact on performance; for example, Oswald et al. (2007) found that individuals high in anxiety perform worse in certain multitasking situations, and Eysenck, Payne, and Derakshan (2005) found that anxiety leads to decreased performance, especially when the task is cognitively demanding, and when the person has to complete two or more tasks that both tap the central executive (the main attention system of working memory), similar to multitasking.

Avoid Subconstruct: Arousability

The literature on arousal and performance is rich and extensive, going back at least 100 years to Yerkes and Dodson's study of the strength of electrical stimulus needed to facilitate learning in mice (Yerkes and Dodson, 1908). Although the original paper makes no mention of an inverted U-shape or arousal and performance in humans (this was developed later by Duffy (1932) and Freeman(1948)), it nonetheless provided the basis for many such studies. Basically, the evolved Yerkes-Dodson Law (YDL) has two components: the inverted U-shape, which indicates that there is a level of optimal arousal for the performance of any task: too little or too much arousal, and task performance suffers. Further, there is a task difficulty aspect, which indicates that the more difficult a task, the lower the level of optimal arousal. This means that for a very easy task, the level of arousal needs to be high for optimal performance, whereas for a very difficult task, arousal should be relatively low for optimal performance. Subsequent research has supported aspects of the YDL, for example, Watters, Martin, and Schreter (1997) found support for the inverted U shape for performance on a cognitive task: participants received varying levels of caffeine, thus inducing 6 different levels of arousal, and

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performed 4 different cognitive tasks at two levels of difficulty. The optimal performance was found at level 4 for all tasks, supporting the inverted U-shape but providing no evidence for the task difficulty hypothesis. As early as 1932, Duffy argued that individual differences in arousability might have a genetic component, and that there are two factors to arousability: intensity and direction. She provided evidence for stability of arousability across situations, and also suggested that individual differences in arousability might interact with situations to produce certain avoidant or approach reactions and to influence performance. Stennett (1957) also found support for the inverted U-shape in an auditory tracking task, where 31 participants performed better on average at moderate levels of arousal than at low or high levels of arousal. Furthermore, Easterbook (1959) provided evidence for the mechanism by which performance suffers (at least at the high-arousal end of the continuum): according to the cue utilization theory, high levels of arousal restrict the range of perceived clues, thus impairing performance especially for complex tasks. In addition, he makes the case that "the range of cue utilization can be regarded of cerebral competence, and the generalization then asserts that cerebral competence is reduced in emotion" (p. 198).

Although approach and avoid constructs have been related to arousability previously (see Duffy, 1932), there are still insights and improvements waiting to be applied to the nomological net. For example, there exists some literature on sensitivity to stimuli (e.g., Aron & Aron, 1997) and arousability (Dawson, Schell, & Filion, 2000) that has not yet been integrated into the temperament literature. This represents a gap in the literature that deserves to be filled, because sensitivity to stimuli is likely to be conceptually related to temperaments. For example, a person with an avoid temperament might be very sensitive to incoming stimuli, to the point where too much noise, light, or activity is uncomfortable and causes withdrawal. Avoiding new situations with many new stimuli may become a habitual way to reduce the uncomfortable arousal for that person. At the same time, a person with an approach temperament might be very low on sensitivity, and therefore need a lot of stimulation in the form or activity or noise in order to experience excitement. Over time, this person would establish an approach behavior pattern. One extension of this argument would be that the point of optimal arousal is determined by a person-situation interaction: a person's inherent sensitivity to stimuli provides an upper and lower limit to the point of optimal arousal. The complexity of the task at hand is the second determinant; for a very complex task the optimal arousal would be very near the lower limit set by that person's sensitivity to stimuli, whereas a very simple task might a point of optimal arousal close to the person's upper limit.

The arousability construct is a little less well researched than the approach and avoid temperaments. It is often mentioned together with anxiety, but the two are not synonymous. Anxiety is a subtype of arousability that has a negative component to it; that is, if someone is experiencing anxiety, that person is aroused, but because of fear of something bad happening. Arousability, by contrast, is more broad and general in nature – it simply describes the strength of stimulus needed and the person's speed to change from a state of relative calm to a state of arousal, which includes negative arousal, such as anxiety or fear, but also positive arousal, such as happiness or excitement. This construct is one of the psychological constructs that has been measured by self-reports as well as physiologically. For the present study, arousability will be measured by self-report only.

The self-report measure that is closest to a measure of arousability is Aron and Aron's (1997) measure of *sensory processing sensitivity* (SPS). Briefly stated, SPS reflects a sensitivity to large amounts of external or internal input, such as: loud noises, caffeine, hunger, pain, change, overstimulation, strong sensory input, other's moods, violence in the media, and being observed. Their 27-item scale attempts to measure SPS and includes items such as "Do you startle easily," "Do you get rattled when you have a lot to do in a short amount of time," "Do you make a point to avoid violent movies and TV shows," and "Do you become unpleasantly aroused when a lot is going on around you." The measure taps arousal through external physical stimuli (noise, light) as well as through internal psychological and physical stimuli (hunger, stress), and has demonstrated an alpha reliability of .85.

About 15-20% of the population displays a very high sensory processing sensitivity (Kagan, Reznick, & Snidman, 1994). This sensitivity can lead to feelings of being overwhelmed, being uncomfortable in social situations, and withdrawing. However, SPS is different from social introversion and emotionality, as extroverts can also show high SPS, although at a much lower percentage than introverts (Aron & Aron, 1997). The reported correlations with other related constructs are -.29 ($p < .01$) with the Extraversion/Introversion scale of Eysenck's Personality Inventory, which includes many items that assess arousability, and .12 (*ns*) with the Extraversion scale of the Big Five Inventory (John, 1990). The SPS is also correlated .41 ($p < .05$) with the Big Five Neuroticism scale (Aron & Aron, 1997), again providing some evidence for its sensitivity to anxiety/arousability.

Knowing about arousability is important for the study of work performance, because this individual difference construct has the potential to increase prediction of work performance over and above cognitive ability, and allows for a broader (and hopefully better) understanding of the individual. This study develops theory relating arousability to the approach and avoid temperaments, as well as to performance in a multiple-task situation as described below.

External Variables: Motivation and Goal Orientation

Goal orientation and motivation were measured because they are known to have a relationship with performance. For the current study, they serve as external variables intended to provide some convergent and/or divergent validity, but they are not central to the model.

Elliot and Thrash (2002) examined the relationship between temperaments and goal orientation, and declared that "temperaments are viewed as energizers or instigators of valenced propensities, whereas goals are viewed as specific, cognitive forms of regulation that give focus and direction to these general propensities" (p.806). Achievement goal orientation has three possible manifestations: mastery, performance-approach and performance-avoid (not to be confused with approach and avoid temperament). Briefly, an individual with mastery goal orientation would complete a task because he or she enjoys learning, would like to further his or her skills, or thinks the task is somehow valuable. By contrast, a performance-approach oriented person would perform a task because he or she likes to show others how well he or she is doing and is looking for recognition and confirmation of being "the best". A performance-avoid oriented person would perform a task in order to not be embarrassed, or would not want

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to perform "worse than everyone else". Goal orientation in this study was measured using Elliot and Harackiewicz's (1996) 18-item self-report measure. Using a five-point scale, participants rate the extent to which they agree with statements such as "In school, it is important for me to do better than others" (performance-approach), "I want to learn as much as possible in my classes" (mastery), or "One goal in my classes is to avoid doing poorly" (performance-avoid). The instructions are specifically designed to be non-competitive and the emphasis is always on the relationships on the within-individual measures rather than the between-individual measures. Goal Orientation was measured because it can also influence performance, and was important for this study to develop a clean picture of the effect of approach and avoid temperaments by ruling out other possible contributors. For the path analyses, performance-approach, mastery, and performance avoid were treated as indicators for a latent goal orientation factor.

Motivation is often confused with goal orientation, such that some researchers speak of mastery, performance-approach and performance-avoid motivation (e.g. Dieffendorf & Mehta, 2007). Others argued that arousal is a part of motivation (see Humphreys & Revelle, 1984), and that motivation consists of arousal and effort. However, more recent theory suggests that motivation is more accurately delineated by effort, intensity, and persistence (Campbell, 1990; Sackett, Gruys, & Ellingson, 1998). I would argue that the difference between arousal and motivation is a levels issue. Arousal somewhat closer to the biological/neurological level and happens outside of the individual's conscious control. Motivation, on the other hand, is a conscious, focused process by which the individual decides to devote resources to the task at hand. Higher arousal might in some cases allow the individual to pay more attention to the task, but it might also have negative effects, as in too much arousal that interferes with performance. Therefore, I included motivation by asking individuals about their intrinsic motivation for this study, using a 3-item measure of task enjoyment before, during and after the task.

Current Study

Synthesizing the above information, I arrive at the following model that organizes and relates the constructs discussed (see Figure 5): There are two separate, latent temperaments, approach and avoid. They are not opposites of a continuum, but rather distinct constructs, and individuals can be high on both, low on both, or any combination in-between. In order to tease apart the relationships between the predictor constructs and the temperaments it was necessary to focus on each temperament and its relationship to multitasking ability separately for study purposes. Throughout the course of the study I will be referring to "individuals high [or low] in avoid [or approach] temperament." I would like to note, however, that the temperaments tend to operate independently and concurrently outside the experimental lab situation, and that individuals can possess varying degrees of approach and avoid temperament at the same time.

Each of the temperaments is the underlying basis for the expression of several personality traits: approach temperament underlies extraversion, sensation seeking, and dominant BAS. The approach temperament influences multitasking performance directly.

The avoid temperament is the basis for high arousability, SPS, dominant BIS, and anxiety. It is also related to multitasking performance, but I propose that this relationship might be moderated by cognitive ability. Specifically, individuals who are higher in *g* may have more cognitive resources to devote to self-control and may therefore not be quite as affected by their high arousal and anxiety. Darke (1988) has demonstrated that performance on a working memory task is lower for highly anxious individuals than for less anxious individuals, and working memory is highly correlated with cognitive ability (Kyllonen & Christal, 1990; Stauffer, Ree, & Caretta, 1996).

Study Overview

The outcome measure of interest is performance on a multitasking paradigm. This study uses a computerized task that comprises four activities to be carried out at once: mental arithmetic, memory, auditory signal detection, and visual monitoring. Participants performed all four tasks at once. Because two of the main characteristics of multitasking are task switching and time pressure (Delbridge, 2000), participants completed two versions of the task: a slow version, in which the tasks could be completed almost sequentially and with minimal interruptions, and a fast version, in which tasks needed to be attended to almost simultaneously. This allowed me to compare performance of the same tasks in a relatively low-anxiety situation with performance on the tasks in a high-anxiety situation. Furthermore, approach and avoid temperament were expected to have an impact on performance: the slow version should be relatively boring for individuals with a dominant approach temperament, and they might perform better in the fast version, where they experience the stimulation they crave. On the other hand, individuals with a dominant avoid temperament might do well in the slow version because they will sustain their attention, but they might be too overwhelmed by the fast version and perform poorly.

Multitasking ability will be considered a latent variable, and will have four indicators: the number of points achieved in each of the four tasks: memory, math, visual monitoring and auditory signal detection. Furthermore, participants will fill out self-report measures of all the constructs listed above in addition to a measure of cognitive ability. The relationships between the variables will be modeled separately for the slow and the fast version.

Method

Participants. Participants were recruited from the university psychology subject pool. There were 227 participants, 144 women, 82 men, and one person did not report his or her gender. The sample size was determined by a power analysis to detect a medium effect for the most sensitive analysis, in this case the moderated multiple regression. Stone-Romero and Anderson (1994) demonstrate that the sample size for moderated multiple regression needs to be at least 120 for a medium effect size in order to correctly reject the null hypothesis 91% of the time (see also Aguinis, 1995). 77.1% of the participants were Caucasian, 10.6% were African-American, and 6.6% were Asian or Pacific Islander. The mean age was 19.48, with a minimum of 18 and a maximum of 48 years.

Measures. Multitasking performance was assessed via a computerized task called SynWork (Elsmore, 1994). In this task, the screen is divided into quadrants. Each quadrant has a different task to be completed, and to do so effectively all four tasks need to be attended to with relatively quick and prioritized task switching – less so for the slow version, but especially for the fast version. Task one is a *memory task*; participants view a list of up to 6 letters for 5 seconds before it disappears. They are then prompted with one letter at a time, which may or may not be from the list. By clicking "yes" or "no" on the screen, participants indicate whether they think that letter was from the original list. A correct answer adds 10 points to the score, and an incorrect answer (or no answer after a pre-set time limit) results in subtraction of 10 points from the score.

The second task is an *arithmetic task.* Participants are presented with two 3-digit numbers they have to add. Rather than typing the correct answer with a keypad, they use a mouse to input the answer by changing the default value of 0000 in the answer field to the correct answer using plus and minus buttons on the screen. A correct answer adds 20 points to the score, and an incorrect answer subtracts 10. This task does not have a time limit; the participants can pace themselves and submit the answer when finished. However, this task has the highest payoff of all the tasks (20 points vs. 10 points), which is designed to be an incentive not to ignore this task.

The third task is a *visual monitoring task*, which consists of a fuel gauge with a pointer that moves at a pre-set speed from full to empty. Participants receive points for "refilling" the tank by clicking on the fuel gauge. The closer the pointer is to the empty mark when the gauge is clicked, the more points they obtain (from 1 for the pointer close to full to 10 for the pointer close to empty). However, for each second that the pointer actually rests on zero before being reset, the participant loses 10 points.

The last task is an *auditory discrimination* task. Participants hear one of two tones played. The interval between tones is 15 seconds in the slow version and 5 seconds in the fast version. One of the tones is high and one is low. The task is to click on a red "Alert" button whenever the high tone is played. A correct response adds 10 points to the score, and an incorrect response (clicking to the low tone or not clicking after the high tone within a certain time limit) results in subtraction of 10 points.

The outcome measure of interest for this study is the performance on the multitasking paradigm described above. Performance is operationalized as the number of points obtained in both the slow and the fast versions, and is computed by adding the number of points obtained in each of the four tasks.

Consistent with the literature review above, the following self-report measures were administered: to assess approach behavioral temperament, the BAS items from Carver and White's BAS scale were administered. There are 13 items such as "When I go after something I use a 'no holds barred' approach" or "I will often do things for no other reason than that they might be fun." These are rated on a five-point Likert scale, ranging from 'strongly agree' to 'strongly disagree', and showed a reliability of alpha = .88 in this sample. Furthermore, consistent with Elliot and Thrash's (2002) conceptualization, the Big Five facet of extraversion was assessed using the International Personality Item Pool (IPIP, Goldberg, Johnson, Eber et al., 2006) Extraversion scale with an alpha of .95 in this sample. This scale contains 20 items that are rated on a five-point Likert scale ranging from 'very inaccurate about me' to' very accurate about me.' The sensation seeking construct was assessed with 15 items from the IPIP excitement seeking scale, (Goldberg et al., 2006) which has been shown to have a reliability of .78, and in this sample had a reliability of .89. It includes items such as "I love excitement," "I enjoy being part of a loud crowd," and "I act wild and crazy."

In order to assess the components of the avoid temperament, the following scales were administered: Carver and White's (1994) BIS scale. This scale consists of the seven BIS items from the BIS/BAS scale (See Appendix) and has been shown to have an alpha reliability of .74, and in this sample had an alpha of .85. Items include statements such as "Criticism or scolding hurts me quite a bit," or "I worry about making mistakes," which are rated on a five-point Likert scale ranging from 'strongly agree' to 'strongly disagree.' Furthermore, 20 anxiety items from the IPIP scales (Goldberg et al., 2006) were administered. In this sample the reliability for the trait anxiety scale was .93, and included items such as "I worry about things," "I get stressed out easily," or "I am relaxed" (reverse-scored).

Arousability was measured by self-report. I used Aron and Aron's (1997) Sensory Processing Sensitivity measure, which has 27 items such as "Are you particularly sensitive to the effects of caffeine" or "Are you made uncomfortable by loud noise?" Items are rated on a five point scale ranging from 'very much like me' to 'not at all like me'. For this sample, the scale was shortened to 14 items in order to include only items that are relevant to this particular study (see Appendix for the original and shortened scale). The reliability for the 14 items was alpha =.87.

To assess goal orientation, participants completed Elliott & Harackiewicz's (1996) self-report measure of performance-approach, performance-avoid and mastery goal orientation. Questions were geared towards students and included items such as "In school, it is important for me to do better than others" (performance-approach), "I mainly want to avoid doing poorly in class" (performance-avoid), or "I want to learn as much as possible in my classes" (mastery). The scale had 18 items that were rated on a 7-point scale anchored by "very much like me" to "not at all like me". There were 5 performance-approach items (alpha = .90), 5 performance-avoid items (alpha = .71), and 8 mastery items (alpha = .83).

Motivation was assessed with a short 3-item intrinsic motivation questionnaire, which asked about their enjoyment of the task, for example: "I think the SynWork task is fun" (alpha = .86).

Cognitive ability was assessed using paper-and-pencil series completion tests: A test of crystallized intelligence (*Gc*) similar to the Vocabulary subtest in the WAIS III

(Psychological Corporation, 1997) that consisted of 18 items, which include one stimulus word and 5 response options. The participant had to indicate which response option is most similar to the stimulus word (alpha = .93). The second test was a series completion task designed to assess fluid intelligence (*Gf*) (Carroll, 1993). Participants were given a sequence of letters, numbers, syllables or words, and had to add the last item in the series (alpha = .89).

Procedure. Upon arrival in the lab, participants were greeted and seated at one of the workstations. Once all participants have arrived, the administrator passed out informed consent forms, read it to the participants, answered any questions, and explained that they were free to leave if they wished. Then the administrator collected the signed informed consent sheets and began the study. The total duration of each session was approximately one and a half hours. For the first 45 minutes, participants were completing the individual difference measures (BAS/BIS, sensation seeking, extraversion, anxiety, cognitive ability, and SPS) as well as demographic questions on the computer. They were then allowed to take a five-minute break. Upon return from the break, they performed the SynWork task, which took approximately a half hour. After the administrator explained the task to the participants, they were allowed to complete a 5-minute training session to familiarize themselves with the nature of the tasks. Each of the four tasks was practiced by itself for one minute, plus one minute with all four tasks. After the training, participants began the performance blocks where all four tasks occur simultaneously. The first version was calibrated to be slow enough that participants could complete each task before the next requires attention. After half of the allotted time had passed (ten minutes), the task sped up, so that participants were no longer be able to work on all four tasks comfortably, as indicated by data from previous studies using the same computer program. This also took ten minutes. The order of tasks was counterbalanced, such that approximately half of the participants completed the slow version first and then the fast version, and the other half completed the fast version first and then the slow version. Once the SynWork task was finished, participants were thanked, debriefed and were free to leave.

Hypotheses

H1. Sensation seeking, dominant BAS, and extraversion all share common variance and will load positively on the approach temperament factor (i.e., positive and statistically significant factor loadings).

H2. Sensory processing sensitivity, dominant BIS, and neuroticism all share common variance and will load positively on the avoid temperament factor (i.e., positive and statistically significant factor loadings).

H3. The approach factor and the avoid factor are relatively independent factors, with an absolute magnitude of correlation significantly less than -1.0.

Elliot and Thrash (2002) have found their approach and avoid temperaments to be independent of each other in a very similar conceptualization to this study; they evaluated the loadings of the subconstructs of extraversion, positive emotionality, and BAS onto approach temperament and the subconstructs of neuroticism, negative emotionality, and BIS onto avoid temperament. Their two-factor model had a good fit, with chi-square (8, $N = 167$) = 16.67, $p < .05$, IFI = .98, Tucker–Lewis index (TLI) = .96, comparative fit index (CFI) = .98, root-mean-square error of approximation (RMSEA) = .08, and all latent variable variances and factor loadings highly significant. Their reported correlation between approach and avoid temperaments was -.34.

H4. Cognitive ability will be positively related to performance in both versions of the task.

H5: In the fast version of the multitasking test, the path loading from approach temperament to multitasking performance is positive and statistically significant (Figure 2).

Individuals with a dominant approach temperament are expected to thrive on the stimulation that the fast task provides. I propose that those with a strongly developed approach temperament might perform best in this task.

H6: In the fast version of the multitasking test, the path loading from avoid temperament to multitasking performance will be negative and statistically significant (Figure 2).

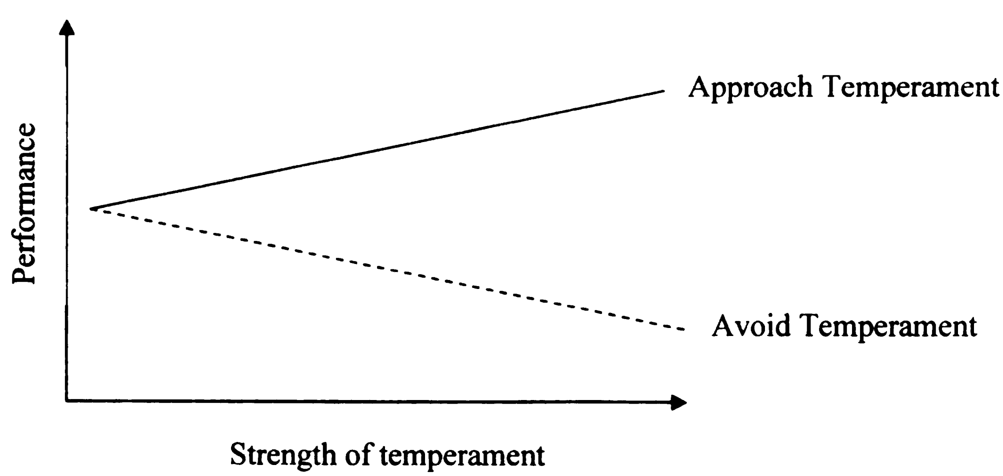
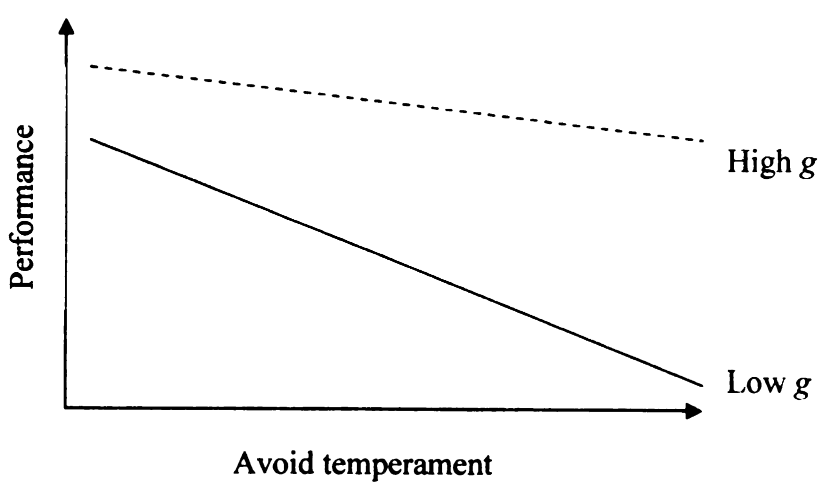


Figure 2. Proposed Relationship between Temperaments and Performance during Fast Version.

H7: In the slow version of the multitasking test, the path loading from avoid temperament to multitasking performance will be negative, but less strong than the same path in the fast version.

The slow version of the task has much less time pressure than the fast version, fewer interruptions, and is in general less stressful. It should produce very little anxiety and arousal, and therefore not impede performance for individuals more sensitive to either anxiety or arousal. On the other hand, the fast version has considerable time pressure, interruptions and stress, and was designed to elicit a lot of anxiety and arousal. It should therefore produce a steep decline in performance for individuals with a dominant avoid temperament.

H8: For individuals with a dominant avoid temperament, multitasking performance is moderated by cognitive ability, such that individuals high in cognitive ability will experience less of a performance decline than those low in cognitive ability (Figure 3).



Note: the split into 'High *g*' and 'Low *g*' is for illustration purposes only; the interaction will be tested without splitting groups, using moderated multiple regression.

Figure 3. Cognitive Ability as a Moderator between Avoid Temperament and Performance.

Results

H1 and H2 were supported. A confirmatory factor analysis in SPSS 15.0 (SPSS, Inc., 2006) using maximum likelihood extraction supported BIS, neuroticism and sensory processing sensitivity loading on one factor, with an eigenvalue of 2.48, and explaining 41% of the variance. Sensation seeking, extraversion, and BAS loaded on the second factor, with an eigenvalue of 1.75 and explaining 29% of the variance. The chi-square for the goodness-of-fit test was 18.45 ($df = 4$, $p < .01$).

H3 was also supported. The correlation between the two factors was -.20; although it is statistically significant at the $p < .01$ level, it is still low enough to conclude independence of the factors (i.e., the upper bound on the confidence interval has an absolute value much less than 1.0).

H4 was supported. Two components of cognitive ability were assessed, crystallized and fluid intelligence ability. The two components were correlated at $r = .20$, $p < .01$. Crystallized intelligence was related to the slow version $r = .21$, $p < .01$, and to the fast version $r =.15$, $p < .05$. Fluid intelligence was related to the slow version $r = .37$, $p < .01$, and to the fast version $r = .37$, $p < .01$. In a simple regression, the combination of crystallized and fluid intelligence explained 15.1% of the variance in multitasking performance in the slow version ($F(2,219) = 19.30$, $p < .01$), and 14.0% of the variance in the fast version ($F(2,219) = 17.73$, $p < .01$).

The correlations between cognitive ability and the slow and fast versions are statistically identical, raising the question whether cognitive ability matters when the task speeds up. Comparing the correlations between cognitive ability and the four sub-tasks, it becomes apparent that there are some stronger and some weaker correlations, which are masked in the overall correlation. In the slow version, cognitive ability is most strongly correlated with the math task ($r = .31, p < .01$) and the memory task ($r = .28, p < .01$). The correlations with the visual task and auditory task are not significant ($r = .07$, ns, and $r = .10$, *ns*, respectively). On the other hand, the correlations for the fast version present a different picture: the strongest correlation is with the verbal task ($r = .27, p < .01$), followed by the visual task ($r = .26, p < .01$), the math task ($r = .19, p < .01$), and the auditory task ($r = .17, p < .05$).

Even closer examination reveals that the correlations in the fast version are almost entirely driven by fluid intelligence. All correlations between the subtasks and fluid intelligence are significant at $p < .01$ and between $r = .22$ (math task) and $r = .29$ (visual task). However, for crystallized intelligence, only the correlation with memory is significant ($r = .19, p < .01$), all others are less than $r = .11$, *ns*.

One potential explanation is that the role of cognitive ability for the prediction of multitasking might to be a matter of the speed at which tasks or stimuli are presented: if the speed is relatively slow, cognitive ability (both crystallized and fluid) seem to be good predictors of tasks that require memory and mathematical ability. As the task speeds up, it might to be more a matter of fluid intelligence only, and how fast an individual can perceive and react to stimuli. An interesting question for future research might be the topic of older workers, and to determine whether there is a decline in multitasking ability with age.

Hypothesis 5 was not supported. The correlation between approach temperament and the score in the fast version was not significant, $r = 0.09$. Neither was the path loading (standardized path estimate = 0.11, *ns*.). Individuals high in approach temperament (> 1

SD above the mean) were not the best performers in this task (M = 1522 points), but were second best after the low avoid temperament group (> 1 *SD* below the mean) with M = 1830 points).

Hypothesis 6 was partially supported. The stimulation and stress of the fast task might be too much for those with a strong avoid temperament, and they were therefore expected to experience the largest performance decrement. The correlation between avoid temperament and performance on the fast version was negative and significant, $r = -.16$, $p < .05$, indicating that those with a stronger avoid temperament indeed tended to have lower scores on the fast version of the task. A multiple regression analysis indicated that avoid temperament added incremental variance explained over and above cognitive ability, ($\Delta R^2 = 0.06$, $p < .01$). Cognitive ability explained 14.0% of the variance ($F(2,219) = 17.73$, $p < .01$). Cognitive ability plus avoid temperament explained 20.5% of the variance ($R^2 = .21$, $F(5,219) = 11.03$, $p < .01$). However, in a path model with avoid temperament and approach temperament as predictors of multitasking performance, the path from avoid temperament to multitasking performance was negative but not statistically significant (standardized path estimate = -0.10, *ns*.).

Although the relationship between approach temperament and performance on the fast version was not supported as it was laid out in Figure 2, it is still informative to take a look at the same figure plotted with the actual data (Figure 4). The most striking feature is the large decline in performance in the fast version for avoid temperament. Individuals low in avoid temperament are the best performers in the fast version, but as avoid temperament scores rise, performance in the fast version plummets.

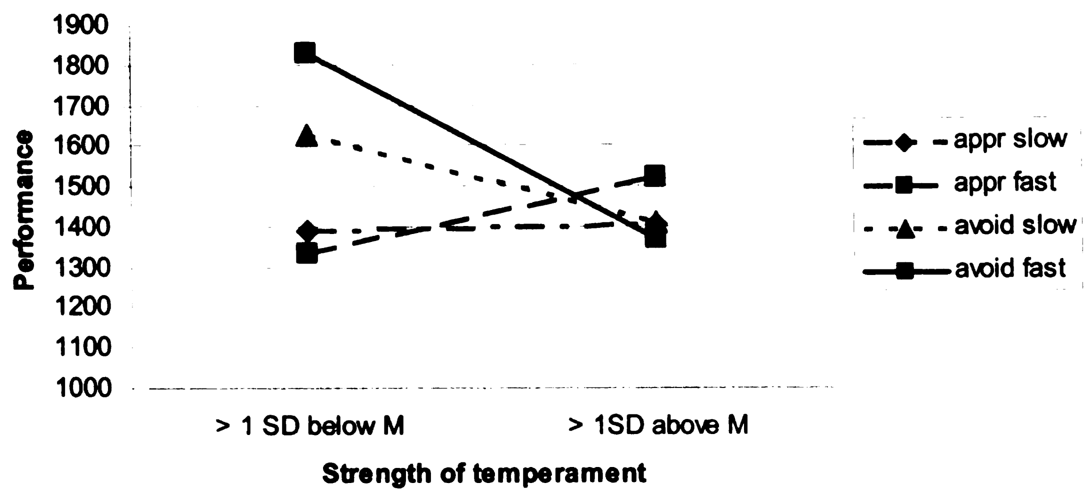


Figure 4. Actual Relationship between Temperaments and Performance during Slow and Fast Version.

H7 was not supported. Avoidant temperament and performance on the fast version correlate $r = -.16, p < .05$, and the correlation between avoidant temperament and performance on the slow version is virtually the same with $r = -.17, p < .05$. In the slow version, the standardized path estimate from avoid temperament to multitasking performance is negative and statistically significant (standardized path estimate = -0.22, $p < .05$). In the fast version, the standardized path estimate from avoid temperament to multitasking performance is negative but not statistically significant (standardized path estimate = -0.14, *ns*). These results are opposite to those expected, and seem to indicate that avoid temperament has a stronger negative effect on performance in the slow version than in the fast version. One possible interpretation could be that because the slow version is very low in pressure, individual differences in avoid temperament are much more salient, whereas the fast version is so difficult situational constraints overpower the effects of any individual differences in avoid temperament. One might expect an opposite effect for the approach temperament, such that the slow condition is boring for everyone and thus individual differences are less apparent than in the fast condition, where approach temperament could really shine. However, this was not supported by the data; both the slow and fast versions had non-significant correlations ($r = .01$ and $r = .09$, respectively) and standardized path loadings (.08, *ns*, and .04, *ns*, respectively). See Table 3 for a comparison of path loadings in the full model.

Hypothesis 8 was not supported. For the slow version of the task, the interaction term in the moderated multiple regression was not significant ($p = .74$, *ns*). For the fast version of the task, the interaction term was not significant, either ($p = .98$, *ns*).

Overall, a structural model (Figure 5) was also produced to assess overall fit of the proposed model (without the cognitive ability moderator). Two dependent models were produced, one for the fast and one for the slow version, and the latent correlations between the variables are reported in Table 2).

The full model for the slow version showed a moderate fit as indicated by typical indices of model fit (Bentler (1990), Hu & Bentler (1999), Jöreskog, & Sörbom (1999), and McDonald & Ho (2002)), with RMSEA = 0.07, SRMR = 0.07, CFI = 0.90, NNFI = 0.88, and χ^2 (94) = 187.15, $p < .01$. The full model for the fast version showed a moderate fit, with RMSEA = 0.06, SRMR = 0.07, CFI = 0.92, NNFI = 0.89, and χ^2 (94) = 177.81, $p < .01$.

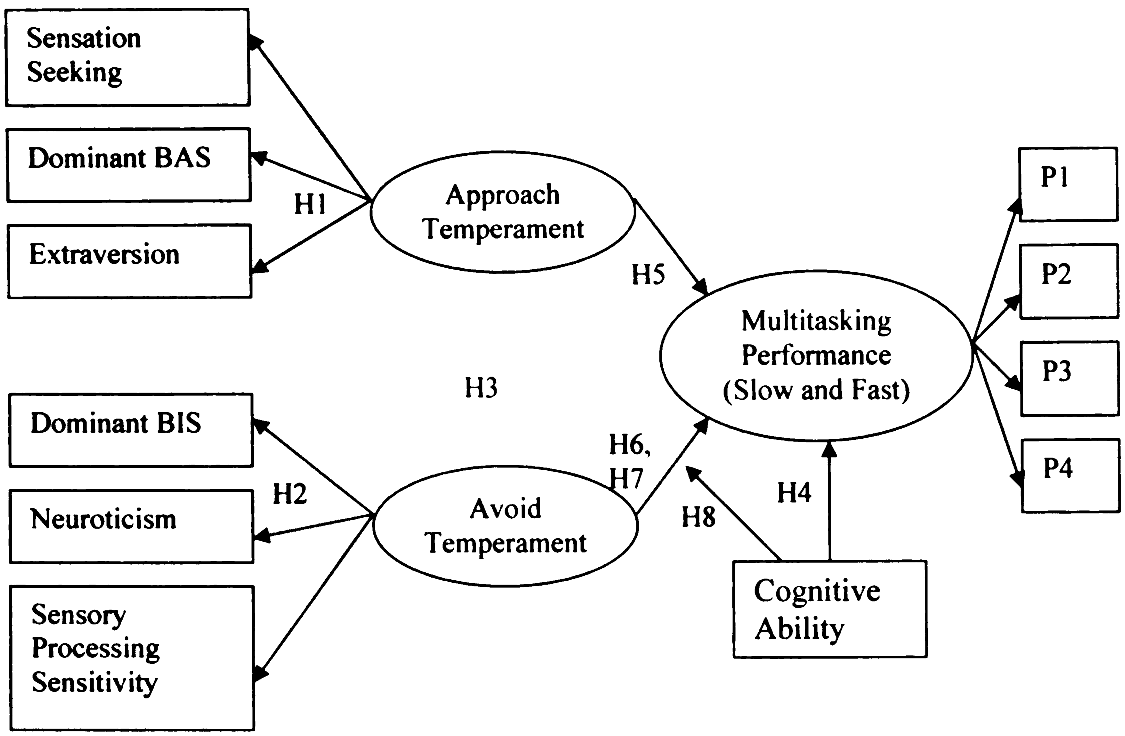


Figure 5. Model of Relationships and Hypotheses for Slow and Fast Version

Although goal orientation and motivation are not part of my focal hypotheses, they were also measured in order to rule out possible confounding factors that might seriously distort or qualify results in my model. The latent correlation between goal orientation and performance in the slow version was found to be $r = -.28$, and $r = .14$ in the fast version. The latent correlation between motivation and performance was found to be $r = .08$ in the slow version, and $r = .28$ in the fast version. Given these non-trivial correlations, and the large differences in the magnitude of the correlations between versions, there seem to be relationships that could be incorporated into further studies that examine a wider variety of task settings and difficulties. In a path model of the slow version, neither goal orientation nor motivation had significant paths to multitasking performance. In the path model of the fast version, motivation had a significant positive loading on performance (standardized path loading = .23, $p < .05$). This indicates that especially in difficult tasks, motivation might play a role. However, a post-hoc regression analysis revealed that motivation does not explain any variance over and above cognitive ability ($\Delta R^2 = 0.01$, *ns*.). Avoidant temperament, on the other hand, does explain additional variance over and above cognitive ability, and its predictive ability for performance is worth investigating more. The correlations between the subconstructs (BIS, SPS, neuroticism, BAS, sensation seeking, extraversion) and goal orientation and motivations are small to moderate, and in the expected direction to support the current conceptualization of the nomological net: for example, BIS and avoid goal orientation ($r = .36$, $p < .01$), BIS and motivation ($r = -.19$, $p < .01$), neuroticism and avoid goal orientation (r - .32, $p < .01$), and SPS and avoid goal orientation ($r = .31$, $p < .01$). These correlations are to be expected given the theoretical relationships between these constructs, and yet they are small enough to argue that goal orientation and motivation are truly separate from temperaments.

The counterbalancing of the slow and fast version produced significant order effects in the average scores (see Table 4). Individuals who started with the slow task had a lower score on the slow task (M = 1310.96 points, vs. M = 1569.01 points for those who started with the fast version), but a higher score in the fast version (M = 1867.61 points vs. M = 1218.65 points for those who started fast). These differences were significant at $p < .01$. This indicates that those in the slow-then-fast condition had time to practice the task, which resulted in a much higher score in the fast version, whereas those in the fast-then-slow condition did very poorly in the fast task but then showed a better performance in the slow task because that now seemed extremely easy. All hypotheses were re-analyzed by condition to determine whether the order effect could have influenced the outcome. The results are presented in Table 5. It appears that the overall pattern of results remains the same regardless of condition. The slow-then-fast condition does show path estimates and correlations that are slightly more in the expected direction, but not enough to change the results.

Discussion

The main goal of this paper was to show that approach and avoid temperaments are broad factors that can help in the prediction of multitasking performance. The results were mixed but provide some illuminating findings and point to avenues for future investigation. The proposed factor structure was supported, strengthening the claim that there is underlying shared variance in BIS, SPS, and neuroticism that can be explained by an avoid temperament factor, and that there is underlying shared variance in BAS, extroversion and sensation seeking that can be explained by an underlying approach temperament factor. Furthermore, the assertion that both factors are relatively independent was also supported. The approach temperament did not seem to have any predictive power for multitasking performance. None of the results seemed to show any relationship to performance at all. This is not completely unsurprising given previous non-findings of relationships between extraversion and performance; this may be a dead end. The avoid temperament on the other hand does hold some promise for interesting results and furthering our ability to predict multitasking ability. The most interesting question would be, "just what exactly do individuals with high scores do differently from individuals with low scores?" In other words, are there different strategies that are adopted, and are there individual differences in who adopts which strategy? The current data selection was not set up specifically for strategy detection, but a few interesting post-hoc analyses are possible.

A further examination of the data revealed a large standard deviation in performance scores in the fast version (*SD* = 951.93), more than twice as large as in the slow version (*SD* = 426.33). Histograms for both versions show a distribution that approaches the normal curve for the slow version, and a slightly negatively skewed distribution with outliers for the fast version (see Figure 6).

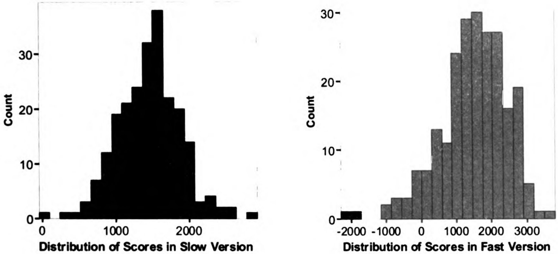
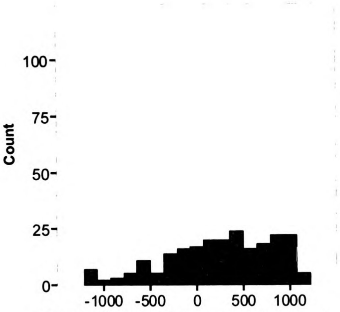
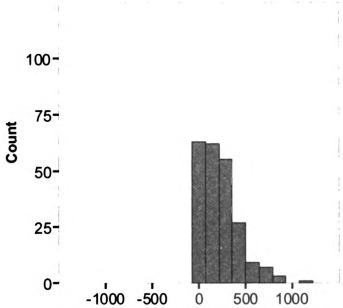


Figure 6: Histograms for Performance in Slow and Fast Version

Even more interesting is the decomposition of the score on the fast version into its four parts: memory score, math score, visual score and auditory score (Figure 7a-d).

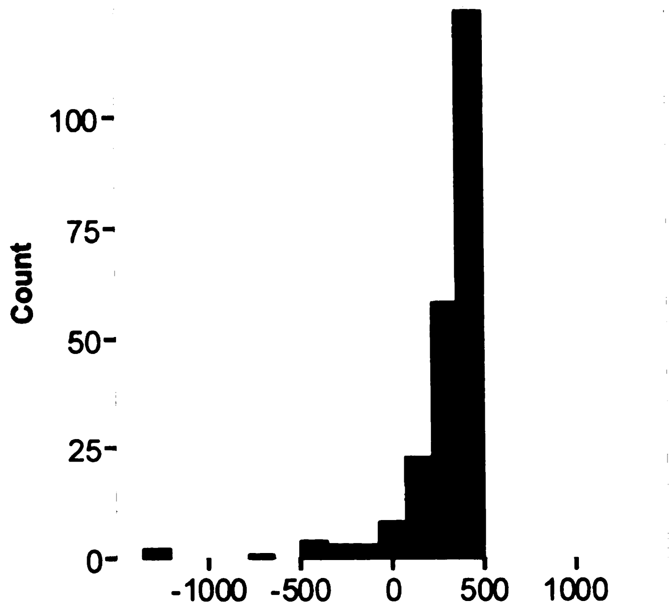


7a. Distribution of Scores on Memory - Fast

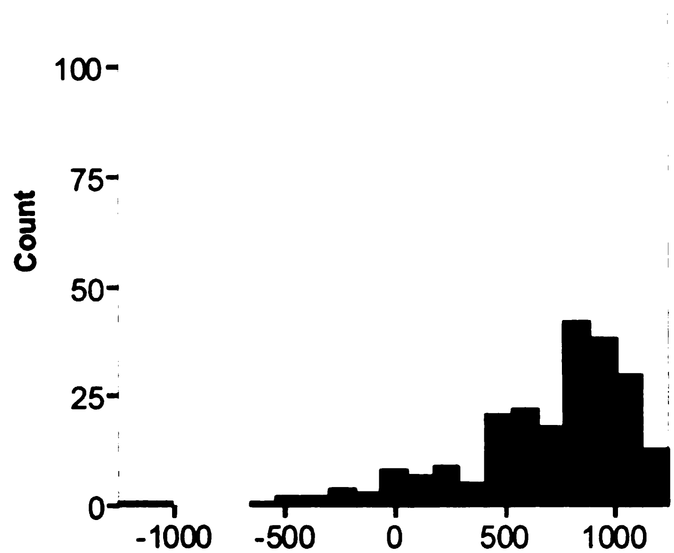


7b. Distribution of Scores on Math - Fast

Figure 7: Distribution of Scores on Each of the Tasks in the Fast Version



7c. Distribution of Scores on Visual - Fast



7d. Distribution of Scores on Auditory - Fast

Figure 7 - continued

These histograms seem to show that for each task, different strategies were adopted. For the memory task, individuals were punished both for entering an incorrect response and for not entering a response at all. The histogram indicates that most participants at least made an effort to keep up with this task, because the majority of the scores are above zero. Still, a significant number of scores is in the negative range, indicating that individuals either chose to ignore the task or entered incorrect responses.

The math task was self-paced and did not punish individuals if they ignored it. This is reflected in the score distribution, the large majority of scores are near zero, meaning that individuals chose to ignore the task.

The visual attention task shows an interesting distribution. A very large majority had scores in the positive range, which means that they understood that if they ignored this task, they would lose points at the rate of 10 points per second, and they paid attention to this task. A few people seemed to have ignored it or forgotten about it temporarily, and thus received negative scores.

The auditory task also showed most of the scores in the positive range, with a few scores in the negative range where individuals either provided and incorrect response or no response within the given time frame.

It could be argued that if individuals ignore one or more task(s), they are no longer working on a multitasking paradigm. That is a valid point, and one that needs to be considered. However, it also shows another parallel between this task and the real world: At work, individuals may choose to ignore any number of tasks that they are presented with. Some, as is the case with the math task, don't have a penalty if they are not completed, thus they are not high priority. Other tasks do carry a penalty if not completed, which is also the case in the workplace – for example, a report that the supervisor needs by 5 pm and it is now 4:30pm.

I would argue that this computerized simulation does capture multitasking performance, exactly because it seems to capture the individuals' ability to prioritize tasks and to shift their attention where it is most needed. Even if some individuals ignore some of the tasks – at least in this data set there was no one who had negative scores across the board. Some individuals performed badly at one or two tasks at the most, but that is a result of their inadequate strategy. And inadequate strategy is something that is encountered all too frequently in the workplace as well.

My initial suspicion that the visual task was the "culprit" of the large variance in scores in the fast version – because if it was ignored, individuals would lose points so rapidly – was not confirmed. The visual, memory and auditory tasks are all significantly correlated at $r = .32$ to $r = .36$. The one task that is not correlated with any other task is the math task. One possible explanation could be that individuals ignore the math task, knowing they will not be punished if they do so, and instead focus on the other three tasks. However, there are some individuals who do not ignore the math task. A quick comparison of the 19 lowest scorers (-30 to 0 points) and the 19 highest scorers on the math task reveals that the low scorers had an average multitasking performance score of 1559.63 (SD = 1238.77), and the high scorers (520 to 1150 points) had an average score of 2025.68 (SD = 1023.99). Incidentally, the high math scorers also had a mean cognitive ability score of .77 (z-Score units), whereas the low math scorers had a mean cognitive ability score of .05 (z-Score units).

Although this was a very quick post-hoc analysis with the available data, it does indicate that the strategy individuals use has an impact on the score, and that strategy use may also be related to cognitive ability.

With regards to the approach and avoid temperaments, I examined whether there were differences in strategy between individuals high and low in approach or avoid temperament (more than 1 *SD* above or below the mean) in the fast version of the task (Table 6). To do this, I compared the score for each subtask, plus the number of attempts (where possible), or the percentage of errors of commission (providing the wrong response) and errors of omission (providing no response). The one group that stands out is the low avoid individuals. They have the highest scores in all of the subtasks except for the visual task, in addition to having by far the most attempts at the math task and the lowest rate of errors of commission in the auditory task. It is difficult to know why they reacted the way they did without asking the individuals directly, but one speculation could be that reporting to be very low in avoid temperament means not being rattled by rapid stimuli and being able to prioritize and think quickly despite the high pressure. This could be addressed in future research, possibly by using voice protocol while individuals complete these tasks.

The high approach group had the highest rate of errors of commission in the memory task and the auditory task, which would be expected according to theory, since they are characterized by acting quickly and not thinking things all the way through. This group also had the highest error rate in the math task, possibly because they pushed the "done" button without re-checking their work, which would be typical of individuals high in approach temperament. Further research could look at strategy change over time, not just overall scores. It might be possible that some individuals start poorly but in the end recover and gain a lot of points. This would not be evident when looking only at the overall score, because the initial loss and the gains at the end would cancel out.

In 2000, Delbridge had found that extraversion and neuroticism did not predict multitasking performance, but that avoidant behavior did. In 2007, Oswald et al. found that neuroticism did have some predictive power for multitasking ability. These two findings are not as contradictory as it would seem at first glance, if we take a look at the composition of the avoidant temperament. Using the subconstructs of avoidant temperament (neuroticism, SPS, and BIS) helps to decipher why sometimes neuroticism seems to impede performance and sometimes not. In the slow version of this multitasking study, all three components were almost equally strong predictors of multitasking performance as indicated in a simple regression (SPS standardized coefficient = -0.18, $p < .05$; BIS standardized coefficient = 0.19, $p < .05$, and neuroticism standardized coefficient = -0.21, $p < .05$). However, in the fast version, SPS was the strongest predictor of multitasking performance in a simple regression. The standardized regression coefficient was -0.28 ($p < .01$), followed by BIS (0.22, $p < .05$), and neuroticism was not significant (-0.14, *ns*). A similar pattern is shown in the correlations, where in the slow version, neuroticism, BIS and SPS correlate with performance $r = -.18, p < .01$; $r = -.04$, *ns*, and $r = -.21, p < .01$, respectively. In the fast version, the correlations are $r = -.14, p < .05$ (neuroticism); -.01, *ns*, (BIS), and $r = -.26, p < .01$ (SPS). Neuroticism, therefore, does not seem to be a reliable predictor of performance, especially since it is non-significant in the faster version, where we would expect it to be a strong negative predictor. On the other hand, SPS shows exactly the pattern we would have predicted and that makes this construct useful for future research: in the slow version, it is a weak to moderate negative predictor of multitasking performance, and as the speed of the task increases, the predictor becomes stronger. It is possible that the previous contradictory results were obtained for several reasons: some measures of neuroticism might tap into the SPS construct and therefore show a negative relationship with performance, whereas other measures may tap a slightly different angle of neuroticism and thus may not show a relationship with performance. The relationship could also be more complicated than just linear, and neuroticism might be the best predictor at a low-to-moderate level of task intensity but not at very fast or intense tasks.

Interestingly, BIS has a positive coefficient for both the slow and the fast version, indicating that the stronger a person's behavioral inhibition system, higher the score. A potential explanation for this could be that individuals high in BIS are better able to suppress incorrect responses, and therefore make fewer errors of commission. A post-hoc analysis did not confirm this idea; the correlations between BIS and errors of commission in the memory task were near zero ($r = .03$, *ns*, in the slow version, and $r = .06$, *ns*, in the fast version).However, avoid temperament as a whole did correlate $r = .17$, $p < .05$ in the slow version and $r = .14$, $p < .05$ in the fast version with errors of omission (but not with errors of commission), indicating that those with a stronger avoid temperament tend to not respond at all rather than responding and risking a mistake.

Not surprisingly, cognitive ability was confirmed as a good predictor of multitasking performance, in both the slow version and the fast version, explaining 15.1% and 14.0% of the variance in performance, respectively. However, the suggestion in H8 that cognitive ability might moderate a decline in performance for individuals high in avoidant temperament was not supported. While the decline in performance for individuals with a dominant avoidant temperament was supported, cognitive ability did not seem to have any influence on that.

In addition, the path estimate for avoidant temperament to multitasking performance was stronger (-.22, $p < .05$) in the slow version than in the fast version (-.14, *ns*). Upon closer examination it seems that this effect is driven by neuroticism, which, as mentioned above, is not a strong predictor of multitasking performance in the fast version. If we remove it from the path model, the standardized estimate for avoid temperament and multitasking performance in the slow version is -.19, $p < .05$, and in the fast version it is -.15, *ns*.

Overall, the avoid temperament, and especially the SPS subconstruct, do seem to hold promise for more research on the prediction of multitasking ability.

Limitations

As with any laboratory study, the question of generalizability is raised. How can a four-task computer simulation be in any way predictive of real-world performance? On the surface level, the similarities between a computerized task and the real world might not be apparent. In the beginning of this paper, I listed the characteristics of the tasks that make up the multitasking situation. Two levels were presented: the situation level, which described the characteristics of the multitasking situation: a situation in which a person must switch his or her attention between several tasks; there are interruptions, time pressure, and environmental uncertainty (Delbridge, 2000; Oswald, Hambrick, & Jones, 2007). Second, the task level describes each component of the situation: characteristics of the tasks (are they visual or auditory, unknown to the individual or familiar, simple or complex); the structure of the tasks (are there two to three tasks or eight to ten, are they independent or interdependent, are they equally important); the timing of the tasks (are they predictable, is someone else dictating the timing, is there a specific order they need to follow); the control over the tasks (can they be rearranged, does the participant have control over aspects of the execution), and finally, the outcomes of the tasks (do they have feedback or rewards, does one carry more weight than another).

If we now compare the computerized multitasking simulation and the real-world tasks that we wish to generalize to, we can see that there are a number of parallels along these characteristics in both levels. The computer simulation requires a person to switch attention, it provides interruptions and time pressure, and the participant does not know when the next stimulus will appear or what it will be. This is analogous to many jobs requiring multitasking that requires responding to multiple demands, such as workers who must monitor several displays, must answer phones, emails, and are interrupted by other workers. They must respond quickly do not know where the next problem might occur, and must prioritize the multiple demands that are imposed in real time.

The same comparison can be made at the task level; the tasks and stimuli that employees are faced with can be auditory, visual or even tactile, and have a set of rules and regulations that governs how to respond to certain signals but not others, thus evidencing task characteristics, structure, timing, control, and outcome.

By comparing the lab study and the work environment at this level, it is apparent that this study does have the potential to generalize beyond the lab, and that conclusions can indeed be drawn that are valid for the workplace. Take, for example, the "timing" characteristic of multitasking in this study and in the workplace. I have shown above that for individuals high in avoid temperament, there is a performance decline in the fast version. This can easily be translated into selection considerations, where personality tests might help match high- or low avoid temperament individuals with low- or high stress positions. A person high in avoidant temperament might be exceptionally well suited to a job that requires monitoring displays with relatively little activity for a long time (e. g. night watch at a factory), but that same person would not be successful during a particularly hectic time of the day when a lot is going on at once. By the same token, a person high in approach temperament would be extremely bored on the night watch and might miss important cues, but would be in his or her element during the busy day shift. At a task level, an organization might try to identify common causes of profit loss, and determine whether it was the employees' failure to do something (omission) that caused more loss, or employees' doing the wrong thing (commission). With further research it might be determined that individuals higher in avoid temperament tend to make more errors of omission, and the organization could use this knowledge for their selection process.

Further research might address the issue of strategy development and performance over time: there is a possibility that both temperament and the pace of the multitasking task can influence what strategies individuals develop in order to perform best? As the pace of the task accelerates, various strategies have been observed in previous studies: some individuals increase muscle activation and key strike force, putting themselves at risk for repetitive stress injuries (Hughes, Babski-Reeves, & Smith-Jackson, 2007). Other individuals stop trying, while yet others focus even more of their attention on the task (Smillie, Yeo, Furnham, & Jackson, 2007). Whichever strategy is employed by the individual, organizations will benefit from identifying these patterns and strategies and either adjusting to or working with them.

APPENDICES

APPENDIX A

Tables

Table 1

Means, Standard Deviations, and Correlations for all Measured Variables

	M	*SD*	1	2	3	4	5	6	7	8
1. Approach Factor	15.53	2.17	*(.81)*							
2. Avoid Factor	12.23	2.52	-.20**	*(.73)*						
3. GO-Perf	5.06	1.19	.19**	.10	*(.90)*					
4. GO-Avoid	3.00	1.03	-.06	-.39**	-.28**	*(.71)*				
5. GO-Mastery	4.92	0.92	.16*	.11	.42**	-.19**	*(.83)*			
6. Motivation	2.61	0.72	-.05	.20**	-.02	.00	-.19**	*(.90)*		
7. Cognitive Ability	0.005	1.54	-.10	-.03	.11	.08	-.08	-.03	*(.87)*	
8. MT Slow	1456.47	426.33	.01	-.17*	.09	.13*	-.07	-.10	.37**	*(na)*
9. MT Fast	1501.67	951.93	.09	-.16*	.12	-.01	.03	-.20**	.33**	.52**

Note: * = $p < .05$, ** = $p < .01$. Values in parentheses are alpha reliabilities. GO-Perf = Performance goal orientation, GO-Mastery = Mastery goal orientation, GO-Avoid = Avoid goal orientation, CogAbSer = Cognitive ability series completion, CogAbVoc = Cognitive ability vocabulary, MTSlow = performance on the slow version, MTFast = performance on the fast version. Cognitive Ability was computed by z-transforming the *Gf* and *Gc* series completion scores and adding them.

Table 2

Correlations between Latent Constructs

	MT Slow/Fast	AvoidTemp	ApprTemp	GoalOrienta
MTSlow				
Avoid Temp	-0.17/ -0.15			
Approach Temp	-0.01/ 0.13	-0.20		
Goal Orientation	-0.28/ 0.14	0.30	0.32	
Motivation	-0.08/ 0.28	0.20	-0.07	-0.14

Note: MTSlow = performance on the slow version, MTFast = performance on the fast version

Table 3

Path Loadings for the Full Model Slow and Fast Version

Indicator to factor loadings	AvoidTemp	ApprTemp	GoalO	Motiv
BIS	0.77**			
Neuroticism	0.87**			
SPS	0.65**			
BAS		0.69**		
Sensation Seeking		0.66**		
Extraverion		0.76**		
Goal Orientation Perfor			0.60**	
Goal Orientation Master			0.59**	
Goal Orientation Avoid			-0.48**	
Pre-test Motivation				0.78**
During-test Motivation				0.89**
Post-test Motivation				0.80**
Factor to DV loadings				
Slow version perform	-0.03	0.08	-0.31	-0.11
Fast version perform	-0.14	0.04	0.14	-0.23*

Note: * = $p < .05$, ** = $p < .01$.

Table 4

Descriptive Statistics for Comparison between Conditions

	All participants (N = 227)	Slow-then-fast (N = 99)	Fast-then-Slow (N = 128)
Slow Mean Score	1465.47	1310.96	1569.01
Slow SD	426.33	392.09	418.98
Fast Mean Score	1501.67	1867.61	1218.65
Fast SD	951.93	810.62	959.37

Note: All differences between conditions are significant at $p < .01$

Table 5

Re-Analysis by Conditions

Hypotheses	All Participants	Slow then fast	Fast then slow
H1: approach factor loadings	Supported	Supported	Supported
H2: avoid factor loadings	Supported	Supported	Supported
H3: independence of factors	r = -.20	r = -.12	r = -.25
H4: How much variance in performance does cognitive ability explain?	Slow: 15.1% Fast: 14.0%	Slow: 19.6% Fast: 19.5%	Slow: 15.2% Fast: 13.5%
H5: Path loading from approach to MT perf is positive in fast version	Not supported (0.11, *ns*)	Not supprted (0.16, *ns*)	Not supported (0.04, *ns*)
H6: Path loading from avoid to MT perf is negative in fast version	Not supported (-.14, *ns*)	Not supported (-.21, *ns*)	Not supported (0.02, *ns*)
H7: Path loading from avoid to MT in slow version is negative but weaker than in fast version	Not supported. Slow = -.22, $p < .05$ Fast = -.14, *ns*	Not supported Slow = -.37, *ns* Fast = -.21, *ns*	Not supported Slow = -.16, *ns* Fast = 0.02, *ns*
H8: MT performance is moderated by cognitive ability	Not supported	Not supported	Not supported
Overall full model fit	Slow: moderate fit RMSEA = .07, CFI = 0.90 Fast: moderate fit RMSEA = .06, CFI = 0.92	Slow: good fit RMSEA = .05 CFI = .94 Fast: moderate fit RMSEA = .06, CFI = .92	Slow: moderate fit RMSEA = .07, CFI = .88 Fast: moderate fit RMSEA = .07, CFI = 0.88

Table 6

Approach and Avoid Temperaments and Strategies for each Task

	Low Approach	High Approach	Low Avoid	High Avoid
Memory Task				
Score	167.06	374.55	444.67	199.14
Correct Attempts	61.66%	67.92%	70.88%	62.28%
Errors of Comission	12.22%	13.04%	10.15%	10.35%
Errors of Omission	26.12%	19.05%	18.97%	27.36%
Math Task				
Score	187.65	166.36	305.33	166.29
Number of Attempts	15.47	14.54	21.57	14.31
Correct Responses	73.46%	65.93%	77.31%	68.99%
Incorrect Responses	26.54%	34.07%	22.69%	31.00%
Visual Task				
Score	258.5	289.36	298.83	309.11
Number of Resets	56.09	52.06	50.40	54.00
Number of Lapses	3.03	4.88	4.23	3.71
Auditory Task				
Score	615.00	597.88	731.00	437.77
Correct Responses	86.87%	85.76%	89.33	86.94
Errors of Commission	2.38%	3.79%	1.69%	1.81%
Errors of Omission	10.75%	10.45%	8.98%	11.24%

APPENDIX B

Personality Measures

BIS/BAS Scale (Carver & White, 1994)

1. If I think something unpleasant is going to happen I usually get pretty "worked up". (BIS)
2. I worry about making mistakes. (BIS)
3. Criticism or scolding hurts me quite a bit. (BIS)
4. I feel pretty worried or upset when I think or know somebody is angry at me. (BIS)
5. Even if something bad is about to happen to me, I rarely experience fear or nervousness. (BIS) (Reversed)
6. I feel worried when I think I have done poorly at something. (BIS)
7. I have very view fears compared to my friends. (BIS) (Reversed)
8. When I get something I want, I feel excited and energized. (BAS-Drive)
9. When I'm doing well at something, I love to keep at it. (BAS-Drive)
10. When good things happen to me, it affects me strongly. (BAS-Reward)
11. It would excite me to win a contest. (BAS-Reward)
12. When I see an opportunity for something I like, I get excited right away. (BAS-Reward)
13. When I want something, I usually go all-out to get it. (BAS-Drive)
14. I go out of my way to get things I want. (BAS-Drive)
15. If I see a chance to get something I want, I move on it right away. (BAS-Drive)
16. When I go after something I use a "no holds barred" approach. (BAS-Drive)
17. I will often do things for no other reason than that they might be fun. (BAS-Fun)
18. I crave excitement and new sensations. (BAS-Fun)
19. I'm always willing to try something new if I think it will be fun. (BAS-Fun)
20. I often act on the spur of the moment. (BAS-Fun)

IPIP Anxiety (Goldberg et al., 2006)

1. Feel uneasy about the task at hand.
2. Am anxious about what is to come.
3. Fear for the worst.
4. Get stressed out easily.
5. Get caught up in my problems.
6. Am not easily bothered by things. (R)
7. Am relaxed. (R)
8. Am not easily disturbed by events. (R)
9. Am not worried about things that have already happened. (R)
10. Get upset easily.
11. Am afraid that I will do the wrong thing.
12. Feel threatened.
13. Am easily hurt.
14. Feel guilty when I say "no."
15. Feel crushed by setbacks.
16. Often worry about things that turn out to be unimportant.
17. Get upset by unpleasant thoughts that come into my mind.
18. Panic easily.
19. Am not worried.(R)
20. Remain calm under pressure. (R)

IPIP Sensation Seeking (Goldberg et al., 2006)

1. Love excitement.
2. Seek adventure.
3. Love action.
4. Enjoy being part of a loud crowd.
5. Enjoy being reckless.
6. Act wild and crazy.
7. Willing to try anything once.
8. Seek danger.
9. Would never go hang gliding or bungee jumping. (R)
10. Dislike loud music. (R)
11. Take risks. (R)
12. Know how to get around the rules.
13. Would never make a high risk investment. (R)
14. Stick to the rules. (R)
15. Avoid dangerous situations. (R)

IPIP Extraversion (Goldberg et al., 2006)

1. Feel comfortable around people.
2. Make friends easily.
3. Am skilled in handling social situations.
4. Am the life of the party.
5. Know how to captivate people.
6. Start conversations.
7. Warm up quickly to others.
8. Talk to a lot of different people at parties.
9. Don't mind being the center of attention.
10. Cheer people up.
11. Have little to say. (R)
12. Keep in the background. (R)
13. Would describe my experiences as somewhat dull. (R)
14. Don't like to draw attention to myself. (R)
15. Don't talk a lot. (R)
16. Avoid contacts with others. (R)
17. Am hard to get to know. (R)
18. Retreat from others. (R)
19. Find it difficult to approach others. (R)
20. Keep others at a distance. (R)

Sensory Processing Sensitivity Scale (Aron & Aron, 1997)

1. Are you easily overwhelmed by strong sensory input?
2. Do you seem to be aware of subtleties in your environment? (not used)
3. Do other people's moods affect you? (not used)
4. Do you tend to be more sensitive to pain? (not used)
5. Do you find yourself needing to withdraw during busy days into bed or into a darkened room or any place where you can have some privacy and relief from stimulation? (not used)
6. Are you particularly sensitive to the effects of caffeine?
7. Are you easily overwhelmed by things like bright lights, strong smells, coarse fabrics, or sirens close by?
8. Do you have a rich, complex inner life? (not used)
9. Are you made uncomfortable by loud noise?
10. Are you deeply moved by the arts or music? (not used)
11. Does your nervous system sometimes feel so frazzled that you just have to go off by yourself? (not used)
12. Are you conscientious? (not used)
13. Do you startle easily?
14. Do you get rattled when you have a lot to do in a short amount of time?
15. When people are uncomfortable in a physical environment do you tend to know what needs to be done to make it more comfortable (like changing the lighting or the seating)? (not used)
16. Are you annoyed when people try to get you to do too many things at once?
17. Do you try hard to avoid making mistakes or forgetting things? (not used)
18. Do you make a point to avoid violent movies and TV shows?
19. Do you become unpleasantly aroused when a lot is going on around you?
20. Does being very hungry create a strong reaction in you, disrupting your concentration or mood?
21. Do changes in your life shake you up? (not used)
22. Do you notice and enjoy delicate or fine scents, tastes, sounds, works of art? (not used)
23. Do you find it unpleasant to have a lot going on at once?
24. Do you make it a high priority to arrange your life to avoid upsetting or overwhelming situations?
25. Are you bothered by intense stimuli, like loud noises or chaotic scenes?
26. When you must compete or be observed while performing a task, do you become so nervous or shaky that you do much worse than you would otherwise?
27. When you were a child, did parents or teachers seem to see you as sensitive or shy? (not used)

Goal Orientation (short) (Elliot & Harackiewicz, 1996)

1. In school, it is important for me to do better than other students.
2. In most of my classes, I worry about not learning everything that I could learn.
3. I want to learn as much as possible in my classes.
4. I mainly want to avoid doing poorly in my classes.
5. It is important for me to do well compared with others in my classes.
6. Sometimes I worry that I may not understand the content in my classes as thoroughly as I would like.
7. It is important for me to understand the content of my classes as thoroughly as possible.
8. One goal in my classes is to avoid doing poorly.
9. In my classes, I want to try and get a better grade than most of the other students.
10. I get concerned that I did not learn everything that I could have learned in my classes.
11. I want to completely master the material presented in my classes.
12. My fear of performing poorly in my classes is often what motivates me.
13. I like school work that I'll learn from, even if I make a lot of mistakes.
14. I want to show my teachers that I'm smarter than my classmates.
15. One reason I do my class homework and projects is so that others won't think I'm dumb.
16. An important reason why I do my school work is because I like to learn new things.
17. I want to do better than other students in my classes.
18. I study for classes and do my homework because I don't want to embarrass myself.

Intrinsic Motivation

1. I enjoy doing the SynWork task.
2. I think doing the SynWork task is boring (Reversed).
3. The SynWork task is fun.

Cognitive Ability Series Completion (*Gf*)

1. 1 2 3 4 5 ___
2. white-black short-long down-___ ___
3. AB BC CD D___
4. Z Y X W V U ___
5. 12321 23432 34543 456___ ___
6. NE/SW SE/NW E/W N/___
7. escape scape cape ___ ___ ___
8. oh-ho rat-tar mood-___ ___ ___ ___
9. A Z B Y C X D ___
10. tot-tot bard-drab 537-___ ___ ___
11. mist-is wasp-as pint-in tone-___ ___
12. 57326 73265 32657 26573 ___ ___ ___ ___ ___
13. knit-in spud-up both-to stay-___ ___
14. Scotland landscape scapegoat ___ ___ ___ ___ee
15. surgeon-1234567 snore-17635 rogue-___ ___ ___ ___ ___
16. tam-tan rib-rid rat-raw hip-___ ___ ___
17. tar-pitch-throw saloon-bar-rod fee-tip-end plank-___ ___-meals
18. 3124 82 73 154 46 13___
19. lag-leg pen-pin big-bog rob-___ ___ ___
20. two-w four-r one-o three-___

Cognitive Ability Series Completion (*Gc*)

1.	RENOWN	A) length	B) head	C) fame	D) loyalty
2.	SMIRCHED	A) stolen	B) pointed	C) remade	D) soiled
3.	HILARITY	A) laughter	B) speed	C) grace	D) malice
4.	SQUANDER	A) tease	B) belittle	C) cut	D) waste
5.	FACILITATE	A) help	B) turn	C) strip	D) bewilder
6.	RUE	A) eat	B) lament	C) dominate	D) cure
7.	AMULET	A) charm	B) orphan	C) dingo	D) pond
8.	SERRATED	A) dried	B) notched	C) armed	D) blunt
9.	LISSOME	A) moldy	B) loose	C) supple	D) convex
10.	APPRISE	A) reduce	B) strew	C) inform	D) delight
11.	PLAGIARIZE	A) appropriate	B) intend	C) revoke	D) maintain
12.	ORIFICE	A) brush	B) hole	C) building	D) lute
13.	PARIAH	A) outcast	B) priest	C) lentil	D) locker
14.	TEMERITY	A) rashness	B) timidity	C) desire	D) kindness
15.	CAPTION	A) arrest	B) ballast	C) heading	D) ape

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