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Neuroticism Negatively Affects Multitasking Performance through State Anxiety

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14. ABSTRACT

Multitasking is on the rise, both at work and at home. As such, researchers have begun to focus attention on understanding and predicting multitasking performance. Though past research has demonstrated that cognitive predictors correlate positively with multitasking performance, there is reason to believe that non-cognitive factors are likely to predict such performance as well. This study tested for relationships between extraversion, neuroticism, Type A Behavior Pattern, polychronicity, and multitasking performance. Results supported the hypothesis that neuroticism, but not the other personality characteristics measured, significantly predicts performance at multitasking, and that this relationship is mediated by state anxiety experienced during multitasking. Implications for the impact of personality and anxiety on multitasking performance are discussed.

15. SUBJECT TERMS

Performance, multitasking, personality, anxiety, neuroticism, extraversion, Type A Behavior Pattern, polychronicity

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Foreword

Though selection and classification in the U.S. Navy has traditionally been driven by the recruitment interview and scores from the ASVAB, important facets of performance within Navy jobs may be better understood and predicted by a broader range of predictors. Whole Person Assessment (WPA) is an effort on the part of Navy Personnel Research, Studies, and Technology (NPRST/BUPERS-1) to improve the selection and classification of Sailors within the U.S. Navy by developing tools to assess a broader range of characteristics in order to reflect this reality.

Within this context, this study discusses a particular facet of Sailor performance that may not be predicted well by traditional selection instruments, yet is on the rise due to the increasing complexity of the work environment: multitasking. Multitasking is characterized by the switching of attention between multiple tasks rather than the completion of a single task at a time. Though past research has established that cognitive ability is related to multitasking, the present study sought to investigate whether non-cognitive (e.g., personality) characteristics were related to performance in a multitasking simulation.

This study investigated multitasking performance in a sample of university students who engaged in a computerized multitasking simulation. Results of this study indicated that neuroticism, a personality characteristic associated with the enduring tendency to experience negative emotional states, was negatively associated with performance at multitasking. Further, results indicated that this relationship was mediated by state anxiety experienced during the multitasking simulation. As state anxiety increased, multitasking performance decreased. These findings indicate that neuroticism may be a useful predictor of performance at multitasking because of its relationship with anxiety experienced during multitasking. Though preliminary in nature, these results may also provide some evidence for the utility of non-cognitive predictors of multitasking performance. This study is a product of the overarching SYRUS project, which has generated a series of both lab and field studies informing Sailor multitasking performance.

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David L. Alderton, Ph.D.
Director

Summary

Multitasking is on the rise, both at work and at home. As such, researchers have begun to focus attention on understanding and predicting multitasking performance. Though past research has demonstrated that cognitive predictors correlate positively with multitasking performance, there is reason to believe that non-cognitive factors are likely to predict such performance as well. This study tested for relationships between extraversion, neuroticism, Type A Behavior Pattern, polychronicity, and multitasking performance. Results supported the hypothesis that neuroticism, but not the other personality characteristics measured, significantly predicts performance at multitasking, and that this relationship is mediated by state anxiety experienced during multitasking. Implications for the impact of personality and anxiety on multitasking performance are discussed.

Contents

Neuroticism Negatively Affects Multitasking Performance through State Anxiety

> "We live in a moment of history where change is so speeded up that we begin to see the present only when it is already disappearing." R. D. Laing

In today's world of instant communication, technological innovation, and information overload, the pace of life is rapidly increasing. The pressure to do more in less time, often with frequent interruptions, is greater than ever. As a result, multitasking has become a necessity in both home and work life for many individuals (e.g., Bühner, König, Pick, & Krumm, 2006; Delbridge, 2000). Multitasking has been defined as "performance on multiple tasks, with shifts in attention…over a short time span" where both the nature of the tasks and time span are considered from both subjective and objective perspectives (Oswald, Hambrick, & Jones, 2007, p. 80–81). Although multitasking has received much interest in popular culture and the media, it has not been well studied in the psychological and organizational literatures. One topic relevant to multitasking has received some research attention; however, and that is the prediction of multitasking performance.

The prediction of multitasking performance is distinct from the prediction of task performance because of the unique pressures placed on an individual in a multitasking situation. Multiple tasks place interrelated as well as unique demands on an individual's knowledge, skills, and cognitive resources, and the activity of interleaving or coordinating these tasks places additional demands on the performer (e.g., Ackerman, Schneider, & Wickens, 1984. Thus, the coordination and time management strategies required in the multitasking environment place demands on the performer that go beyond the additive demands required by the tasks taken individually. These task coordination efforts require executive processes such as goal shifting and rule activation (Rubinstein, Meyer, & Evans, 2001), and as a result it is perhaps unsurprising that cognitive ability has been shown to predict performance at multitasking (Salthouse, Hambrick, Lukas, & Dell, 1996).

In addition to cognitive demands, however, the balancing act of managing task switches and interruptions may lead a multitasker to have a wide range of affective reactions such as stress, anxiety, excitement, or some combination of these (Delbridge, 2001). Although some people may find the relative chaos of a multitasking situation to be stimulating and motivating, others may find it overwhelming and stressful (Oswald, Hambrick, & Jones, 2007). As a result, there is reason to believe that non-cognitive variables may take on an important role in the prediction of multitasking performance as well. The notion that cognitive factors are necessary, but not sufficient, when predicting complex task performance is not new. In 1965, Guion and Gottier noted that information on both can-do factors (intelligence) and will-do factors (motivational or personality characteristics) is essential in order to gain a more complete understanding of performance. More recently, Murphy (1996) reiterated this point, stating that although cognitive ability may be the most parsimonious way to predict performance, to understand performance fully we must consider other factors such as personality and

motivational influences. As such, researchers have begun to explore non-cognitive predictors of multitasking performance as well. Though research to-date in the area has been relatively limited, the most commonly researched non-cognitive predictors of multitasking have been extraversion, neuroticism, Type A Behavior Pattern, and polychronicity.

Extraversion and Neuroticism

Extraversion is a personality characteristic reflecting gregariousness, assertiveness, and excitement-seeking; neuroticism is a personality characteristic reflecting an individual's tendency to experience negative emotions such as anxiety and depression (McCrae & Costa, 1985). Both high levels of extraversion and low levels of neuroticism are associated with lower baseline levels of arousal and a higher need for stimulation (Eysenck, 1967; Eysenck & Eysenck, 1985). As such, individuals high in extraversion or low in neuroticism tend to perform better in situations where they are highly stimulated (König, Bühner, & Mürling, 2005). Conversely, individuals low in extraversion or high in neuroticism tend to do poorly in situations where they are highly stimulated, due to the fact that they are above the optimal arousal or stimulation threshold for performance (e.g., Eysenck, 1982; Humphreys & Revelle, 1984). As was noted above, multitasking is generally viewed as being a highly stimulating activity due to the demands of the tasks themselves and the activity of coordinating them. Therefore, individuals high in extraversion or low in neuroticism are generally predicted to perform better at multitasking than individuals low in extraversion or high in neuroticism (Lieberman & Rosenthal, 2001; Szymura & Necka, 1998).

König, Bühner, and Mürling (2005) examined extraversion as a predictor of multitasking ability. The multitasking scenario used was the Simultaneous Capacity/Multi-Tasking (SIMKAP) program. Following a training session, participants performed the simulation which consisted of three main tasks that were performed together, along with a fourth task that periodically interrupted the other three. The three main tasks consisted of simple operations such as crossing off numbers or doing word puzzles, and the fourth was made to resemble interruptions that might occur via such technology as email (e.g., a message stating "You are invited to a party on Friday – can you attend?" would pop up along with a date book containing the answer). The researchers performed hierarchical regression analyses to test the predictive validity of the cognitive measures and the incremental validity of the non-cognitive measures, finding that though cognitive variables predicted multitasking performance, personality variables (extraversion and polychronicity) did not provide additional prediction over and above the cognitive variables.

Lieberman and Rosenthal (2001) focused on introversion in the context of interpersonal communication, which is viewed as a type of multitasking due to the need for listening, decoding nonverbal cues, and thinking of what to say in a conversation. Their prediction was that introverts would have less capacity for multitasking as a result of their already high arousal levels, and they would therefore be less successful at decoding nonverbal cues during interpersonal interaction. The authors conducted three studies in which they assessed nonverbal decoding skill using various interpersonal situations. Overall, the authors concluded that introversion was related to poorer

nonverbal decoding due to deficits in multitasking ability—but only when the nonverbal decoding task was secondary to other tasks (i.e., there was no difference when the decoding task was primary). The authors posited that this was due to the fact that introverts were focusing on only the primary task and ignoring the secondary task in order to lower their levels of arousal.

Szymura and Necka (1998) and Szymura and Wodnieka (2003) examined both extraversion and neuroticism in relation to multitasking performance. The multitasking simulation used in this research involved a signal detection task in which participants had to identify a probe letter from a field of distractors. In the first group of studies, the authors found evidence that extraverts tend to perform better at multitasking due to low baseline arousal and a desire for highly stimulating activity. In addition, they found that high levels of neuroticism generally resulted in performance deficits. In the second group of experiments, the authors were able to replicate some of the relationships found in the first group of experiments; however results were much more mixed.

In a dissertation, Delbridge (2000) also measured extraversion and neuroticism in an attempt to predict multitasking performance. Her hypotheses were based on a model of multitasking that focused on the stressful nature of a multitasking situation and the likelihood that personality variables would predict multitasking performance through the use of coping behaviors. Specifically, characteristics such as neuroticism were predicted to increase perceptions of stress and, as a result, increase coping behaviors. Delbridge hypothesized that increased coping would result in withdrawal and lowered performance. Significant effects were not found for either extraversion or neuroticism. However, the author implicated a methodological issue in this study that will be addressed later for the lack of significant findings.

In short, some studies empirically support the notion that extraversion may be a valid predictor of multitasking ability, though across the studies reviewed these findings are far from conclusive.

Type A Behavior Pattern

Type A *behavior pattern* (TABP) is a multidimensional construct consisting of time urgency, achievement strivings, and impatience/irritability (Conte, Schwenneker, Dew, & Romano, 2001; Ishizaka, Marshall, & Conte, 2001). The theoretical relationship between TABP and multitasking performance is somewhat similar to that of extraversion and neuroticism; that is, individuals high in TABP are hypothesized to be overstimulated during multitasking due to their already high baseline levels of arousal. Studies examining TABP and its resulting attentional strategies in relation to multitasking performance have been somewhat successful in finding the hypothesized relationships.

De la Casa, Gordillo, Mejias, Rengel, and Romero (1998) examined the attentional strategies of Type A individuals in two types of situations. In the first situation, one task was labeled as important and one as unimportant, supposedly making the prioritization of tasks clear. In the second situation, one task was labeled as important and the second was presented without an importance label, making prioritization unclear. The primary task was to cross off probe symbols on a screen, and the secondary task was to

remember words that would periodically appear on the screen. Their first experiment found support for the idea that Type As relied on a hypervigilance strategy (i.e., to focus intensely on all stimuli presented, even irrelevant ones) and thereby performed better than Type Bs on the secondary tasks. In their second experiment they found that Type As selected a hypervigilance strategy only in the ambiguous condition. In the dual-task condition, Type As focused intensely on only the main task. In both situations in the second experiment (ambiguous versus dual-task), the attentional strategies selected by Type A individuals resulted in decrements in overall performance as compared with Type Bs.

Ishizaka, Marshall, and Conte (2001) did not find a significant relationship between an overall measure of TABP and multitasking performance. In this study, multitasking performance was operationalized as performance at three simultaneous tasks, two of which were visual (a gauge monitoring and an arithmetic task) and one of which was auditory (listening to and remembering spoken words). However, they did find some support for a relationship between facets of TABP and performance on certain tasks in specific situations. The significant relationships, however, were extremely variable and taken together would indicate that overall, TABP and its subcomponents were not predictive of multitasking performance. The authors noted that a major weakness of their design was the relative ease with which participants completed the tasks. The low difficulty of the tasks probably reduced both the stressful nature of the task and the variability of the data.

Though Kirmeyer (1988) did not focus directly on the effect of TABP on performance in a multitasking situation, she did examine the relationship between TABP and perceptions of stress in a multitasking environment (police dispatchers). She found that Type A individuals perceived both high workload and interruption as more stressful than their Type B counterparts. Although there was no measure of actual performance in this study, the results coincide nicely with the majority of research in this area. Taken together, results for Type A Behavior Pattern have been somewhat supportive of the notion that it has potential as a predictor of multitasking performance.

Polychronicity

Polychronicity is defined as an individual's preference for performing multiple tasks at once (Slocombe & Bluedorn, 1999). Individuals higher in polychronicity are therefore more likely to prefer and engage in multitasking activities. Research exploring polychronicity as a predictor of multitasking performance, however, has not provided strong empirical support. The König, Bühner, and Mürling (2005); Delbridge (2000); and Ishizaka, Marshall, and Conte (2001) studies described earlier also included polychronicity as a predictor, but in these studies a significant relationship was not found between polychronicity and multitasking performance. One study, however, did find a significant relationship between polychronicity and performance on a dual-task (Zhang, 2005). Though individuals low in polychronicity performed better on the central task, it was found that individuals high in polychronicity performed better on both the central task and a secondary task. As a whole, studies investigating the role of polychronicity in the prediction of multitasking performance do not provide strong evidence that it plays a significant role.

Critique of Past Research on Non-cognitive Predictors of Multitasking

To summarize, empirical research exploring the relationships between non-cognitive predictors and multitasking performance has been somewhat mixed, but largely unsuccessful in finding the hypothesized relationships. This paper will argue that these lackluster findings are not due to the fact that non-cognitive variables are not related to performance at multitasking, but rather that past researchers have failed to pay attention to an important factor that has prevented them from finding these relationships. Conceptually, the hypothesized relationships between non-cognitive variables and multitasking depend on arousal or anxiety, yet most research has been flawed in this respect in three ways. First, the multitasking operationalizations used by researchers have either not been evaluated with respect to how arousing they are, or they have actually been found to be much less arousing than the researchers had expected, often due to their simplicity or lack of realism (e.g., Ishizaka, Marshall, & Conte, 2001). Second, anxiety and arousal have not been formally hypothesized or tested as mediators of the relationship between non-cognitive predictors and multitasking performance. Third, no distinction has been made between the two concepts of anxiety and arousal, although there is reason to believe that differences may exist between the two concepts (Lundqvist, 2006).

Researchers not evaluating how arousing or engaging their multitasking situations are perceived leave open the possibility that participants simply are not experiencing the higher levels of arousal or anxiety that are necessary for the relationship between non-cognitive variables and multitasking to become evident. Most researchers have not provided evidence from past research or from their own research that the simulations they used were arousing to participants (e.g., by way of a manipulation check and/or comparison to some sort of baseline or control group). Because there is no way of knowing whether the participants were experiencing the arousal that was hypothesized, conclusions about the relationship between non-cognitive predictors and multitasking performance are tentative at best. When researchers have evaluated how arousing or anxiety producing the tasks they have used are, they have found disappointing results. Delbridge (2000) evaluated how arousing the multitasking paradigm used in her study was and found that although participants did engage in multitasking, the design included frequent breaks that greatly reduced stress levels and thereby potentially attenuated the relationships between the personality variables, stress perceptions, and multitasking performance. Ishizaka, Marshall, and Conte (2001) also pointed out that a weakness of their design was the relative ease with which participants completed the tasks. The low difficulty of the tasks and/or the ease of coordinating them probably reduced both the stressful nature of the task and the variability of the data due to ceiling effects. This study will address this issue by a multitasking simulation that allows the experimenter to manipulate task parameters in the simulation to produce arousal in participants (e.g., task pace, task complexity). In addition, the study will also measure state arousal during the multitasking simulation in order to verify that heightened arousal was in fact experienced by participants.

Next, although often mentioned in previous research, the intervening causal variables (whether dubbed arousal or anxiety) were not measured or included in the analysis as mediators in any of the above described studies. The present study will

remediate this by both measuring and formally testing anxiety as a mediator of the relationships between non-cognitive variables and multitasking performance. Finally, past researchers have used the terms arousal and anxiety almost interchangeably. Although the two are closely related and it is quite plausible to suggest that a person engaging in multitasking might be experiencing both, there is a meaningful difference between the two in the performance context. Whereas arousal reflects a generalized state of activation or readiness, anxiety reflects a type of unpleasant arousal experienced as a reaction to actual or imagined stressors (Lundqvist, 2006). As such this study will differentiate arousal during multitasking into two components: anxiety (bad or unpleasant arousal) and excitement (good or activated arousal). Thus state anxiety, as one of the most commonly accepted causes of performance deficits (Humphreys & Revelle, 1984) is expected to mediate the relationship between non-cognitive traits and multitasking performance.

Hypotheses

Direction of the Relationships

As with past research, it is expected that the high levels of baseline arousal experienced by individuals high in neuroticism, low in extraversion, or high in TABP will result in overstimulation and anxiety during multitasking, thus resulting in performance decrements. Therefore, neuroticism and TABP are expected to be negatively related to performance and positively related to anxiety. Extraversion is expected to be positively related to performance and negatively related to anxiety. With respect to polychronicity, it is expected that individuals low in polychronicity will experience greater amounts of anxiety during multitasking as a result of the fact that they would prefer not to multitask. Thus, it is predicted that polychronicity will be positively related to multitasking performance and negatively related to state anxiety. The hypotheses will be presented once in a generalized form, then tested separately. Following Baron and Kenny's (1986) steps for testing mediation, the following are hypothesized:

- H1a: Non-cognitive predictors will be significantly related to multitasking performance.
- H1b: Non-cognitive predictors will be significantly related to anxiety during multitasking.
- H1c: State anxiety will be negatively related to multitasking performance.
- H1d: Controlling for state anxiety, the relationship between non-cognitive predictors and multitasking performance will become nonsignificant. In other words, relationships between non-cognitive predictors and multitasking performance will be completely mediated by state anxiety.

Methods

One hundred fifty-two students at a large Midwestern University participated in the experiment in exchange for extra credit in their Psychology courses. Ninety-two percent of participants were aged 18–20, 60 percent were female, and 71 percent were Caucasian. All participants completed the experiment in a laboratory environment in groups of 3–8.

Measures

Participants first completed a measure of demographic characteristics that were assessed as potential control variables. Participants then completed a 20-item measure of extraversion and neuroticism from the International Personality Item Pool (IPIP; Goldberg, 1999). Each item contained a statement such as "I'm the life of the party" or "I often feel blue," to which participants indicated how well the item described them using a 5-point scale. Participants then completed a measure of Type A Behavior Pattern used in previous multitasking research. The 21-item version of the Jenkins Activity Survey (student version; Glass, 1977, Jenkins, Zyzanski, & Rosenman, 1971) was used. This measure consisted of a number of questions such as "How often are you late for appointments," to which the participant indicated his or her answer from a list of potential choices. Finally, participants completed the Inventory of Polychronic Values, a 10-item measure of polychronicity consisting of a number of statements such as "I like to juggle several activities at the same time," to which participants indicated their level of agreement on a 5-point scale (Bluedorn, Kalliath, Strube, & Martin, 1999).

Participants then completed the computerized multitasking simulation. The multitasking simulation used was SynWin, a synthetic work task which contains four component tasks that are presented simultaneously (Elsmore, 1994; see Figure 1). The tasks are memory search, arithmetic, visual monitoring, and auditory monitoring. In the memory search task, a set of letters is presented for a short time and then covered. Subsequently a letter is presented and participants identify whether the letter was a part of the previously shown set. Participants may click the area where the list appeared to reveal the letter set again, but doing so carries a point penalty. In the arithmetic task, participants add 2- or 3-digit numbers. This task is performed at the participant's own pace. In the visual monitoring task, a needle moves from right to left across a fuel-like gauge. Participants must click on the gauge to reset the needle before it reaches zero. More points are given for the needle being as close to zero as possible and points are lost proportional to the length of time the needle stays at zero. In the auditory monitoring task, participants must respond to a higher-pitch target tone and to ignore a lower-pitch distracter tone. Participants were given training on the simulation and allowed to practice for 9 minutes, after which their performance was recorded during the 2 10-minute performance blocks.

Finally, following the multitasking simulation participants completed the state anxiety measure, for which they indicated the extent to which they felt certain emotional states (e.g., anxious, tense) during the multitasking simulation. The participants were then thanked, debriefed, and excused.

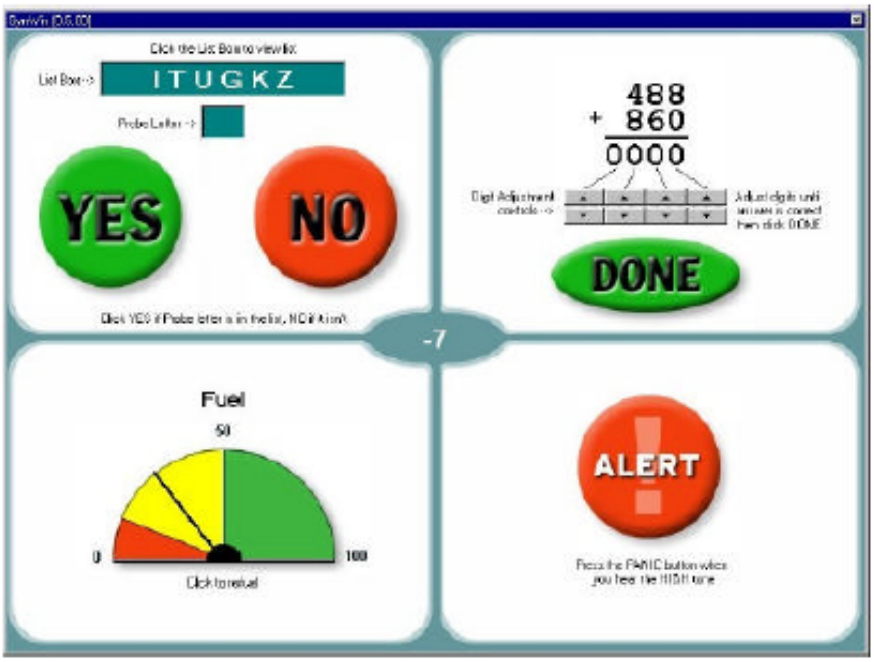

Figure 1. SynWin Screenshot.

Results

Scale means, standard deviations, intercorrelations and alpha reliabilities for all measures are reported in Table 1. The measure of TABP is not included in this table because contrary to the satisfactory reliabilities found for the Type A Behavior Pattern measure in past research, this study found a very low alpha reliability ($\alpha = .57$) and extremely low or negative item-total correlations. A variety of scoring methods (e.g., continuous, dichotomous) and the dropping of many combinations of items were attempted in an exploratory fashion order to improve the psychometric qualities of the measure, but none of these efforts resulted in substantial improvements. Thus, the measure was dropped from further analyses. By contrast, alpha reliabilities for all other measures were acceptably high. As was expected, performance scores for the two multitasking performance blocks were highly correlated ($r = .69$, $p < .05$), and thus they were averaged to form one score for multitasking performance. Also as was expected, state anxiety was approximately normally distributed and showed an acceptable amount of variability (see Figure 2).

Table 1
Scale Means, SDs, Reliabilities, and Intercorrelations

	Scale	N	M	SD	1	2	3	4
1	Extraversion	152	35.28	6.05	**(.88)**			
2	Neuroticism	150	26.58	6.39	**-.25**	**(.88)**		
3	Polychronicity	151	29.42	6.12	.08	-.15	**(.89)**	
4	State Anxiety	149	23.93	6.60	-.01	**.24**	**-.22**	**(.87)**
5	Multitasking Perf.	152	1464.08	349.68	.08	**-.23**	.07	**-.27**

Note. Scale alpha reliabilities are presented in parentheses. Bolded correlations are significant.

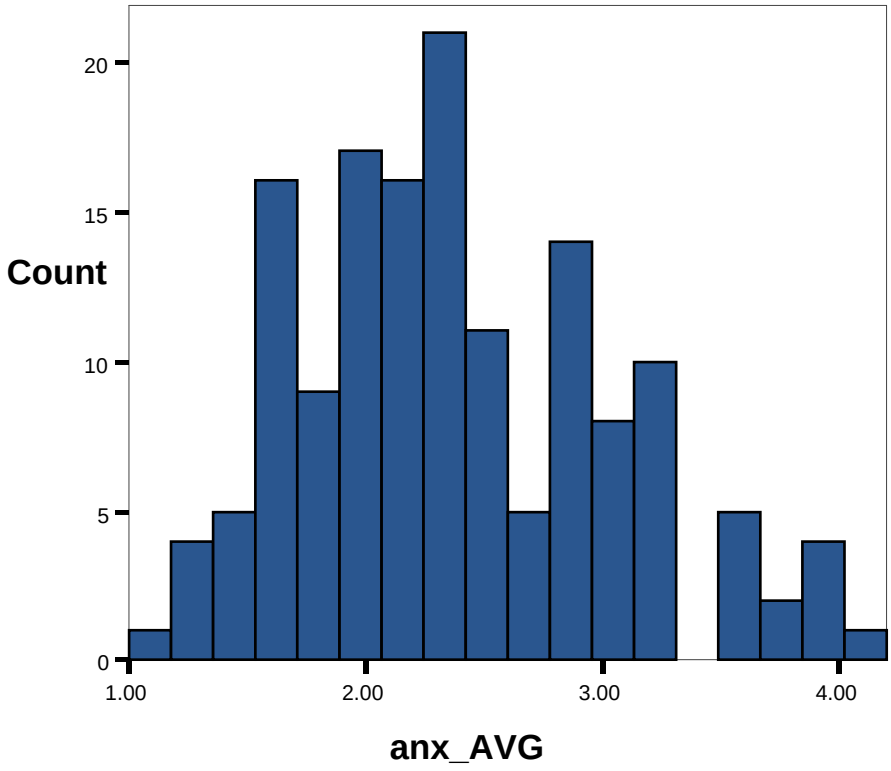

Figure 2. Histogram of average anxiety scores.

Extraversion

To test H1a, a simple linear regression was performed with multitasking performance as the criterion and extraversion as the predictor. Results did not support the notion that extraversion was a significant predictor of multitasking performance, $\beta = .08$, $F(1,151) = .87$, $p = .35$, $R2 = .01$. As such, Step 1 of Baron and Kenny's (1986) steps for testing mediation was not met, and further analyses were not performed for

extraversion. Though there has been some debate as of late as to the necessity of testing for this first relationship, it has been recommended that only researchers expecting the mediating variable to act as a suppressor or the predictor and criterion to be weakly related skip this step (Shrout & Bolger, 2002). Because neither of these conditions was met, it was decided to take the lack of support for H1a as evidence that there was no relationship to be mediated.

Neuroticism

To test H1a, a simple linear regression was performed with multitasking performance as the criterion and neuroticism as the predictor. In support of H1a neuroticism was found to be a significant predictor of multitasking performance, $\beta = -.23$, $F(1,149) = 8.18$, $p = .01$, $R2 = .05$, in that higher levels of neuroticism were found to relate to lower levels of multitasking performance. In support of H1b, neuroticism was found to be a significant predictor of state anxiety, $\beta = .24$, $F(1,146) = 9.11$, $p = .00$, $R2 = .06$ in that higher levels of neuroticism were associated with higher levels of state anxiety during the multitasking simulation. In support of H1c, state anxiety was found to be a significant predictor of multitasking performance, $\beta = -.27$, $F(1,148) = 11.68$, $p = .00$, $R2 = .07$, in that higher levels of state anxiety were related to lower levels of multitasking performance. To test H1d (and whether the mediation was partial or complete), a hierarchical regression was performed with multitasking performance as the criterion, anxiety entered in Step 1, and neuroticism in Step 2. After controlling for anxiety, neuroticism was a reduced but still significant predictor of multitasking performance, indicating partial mediation $\beta = -.18$, $F(2,146) = 8.57$, $p = .00$, $R2 = .11$ for the full model, R2 change = .03 for Step 2, $p = .03$. The indirect effect of neuroticism on multitasking performance was tested using Preacher & Hayes' (in press) bootstrapping macro for SPSS, and it was found that the 95 percent confidence interval (-7.88 to -.80) did not include zero, indicating that neuroticism had a significant indirect effect on multitasking performance.

Polychronicity

To test H1a, a simple linear regression was performed with multitasking performance as the criterion and polychronicity as the predictor. Results indicated that polychronicity was not a significant predictor of multitasking performance, $\beta = .07$, $F(1,150) = .66$, $p = .42$, $R2 = .00$. As such, no further analyses were performed for polychronicity.

Discussion

Though extraversion and polychronicity were not found to relate to multitasking performance, this study does provide two relevant findings with respect to the prediction of multitasking performance. First and foremost, the simulation was shown to have produced various degrees of anxiety in participants, and the anxiety they experienced during the multitasking simulation was a significant predictor of

multitasking performance. This is an important finding because past researchers have often discussed the potential role of anxiety in reducing performance, but have not directly measured anxiety. Second is the finding that neuroticism is a significant predictor of multitasking performance (partially mediated by anxiety). Though past researchers (Szymura & Necka, 1998; Szymura & Wodnieka, 2003) found some preliminary evidence that neuroticism predicted multitasking performance, their results were mixed and somewhat inconclusive. Thus, the present study is the first to find a clear relationship between neuroticism and multitasking performance.

This finding provides evidence to suggest that perhaps researchers should continue to investigate non-cognitive predictors of multitasking performance. Because of the relative failure of researchers to link non-cognitive predictors with multitasking performance, some researchers (e.g., Bühner, König, Pick, & Krumm, 2006) have suggested that perhaps multitasking researchers should abandon non-cognitive predictors. The present results, however, would suggest that doing so might be premature.

Limitations and Future Directions

The present study possessed some important limitations that should be addressed by future research. First, the sample used in the present study was restricted to college undergraduates, a sample whose generalizability to the population at large is questionable. With respect to the generalizability of the sample, the present sample of college undergraduates possesses two main important differences from other samples. First is the likely motivation of the participants. Though motivation was not measured, it is probably safe to assume that participants on the whole were not highly motivated to perform the task to the best of their ability because it had no bearing on any future outcome for them. Study participants were aware that their performance on the SynWin task would have no impact on the amount of credit they would receive, and therefore their motivation to perform might have been low despite encouragement from the experimenters to try hard and get the highest score possible. However, low motivation is not particularly problematic in that, if anything, it may have resulted in lowered performance scores overall and as such, reduced variance. This would actually result in the present study being a conservative estimate of the magnitude of these relationships.

The second limitation of the present sample is the age of the participants. Research has shown that multitasking ability decreases with age (e.g., Salthouse, Hambrick, Lukas, & Dell, 1996), and as such the results of multitasking studies performed with participants of college age are likely not to generalize well to older populations. Though the present sample was reasonable for this study due to the basic nature of the research questions and the availability of the sample, future studies should attempt to replicate the reliability and validity findings of this study and to address its weaknesses by using a more diverse sample, particularly in terms of age, motivation, and work experience.

In addition to sampling limitations, the present study also possessed limitations with respect to the multitasking simulation utilized. Though the simulation does provide many benefits that were discussed earlier in the paper (e.g., the manipulability of task

characteristics), the task possesses limitations relevant to both the external and internal validity of the study. First, the simulation possesses limited generalizability to real-world multitasking situations. The tasks within the multitasking simulation are designed so that they require no previous knowledge (e.g., reading ability) and so that they are very easily learned. By contrast, many tasks that are performed in real workplaces require both general and task-specific knowledge. Having to access such knowledge while multitasking might alter the processes used or the level of challenge, and thus limit the applicability of these results to real multitasking situations.

The simulation also possesses limited external validity as a result of its general appearance. Though memorizing, performing arithmetic, and monitoring are perhaps similar to the types of tasks a person might perform in some roles (e.g., receptionist), the tasks all appear on the same computer screen, and the tasks appear more like a game than a workplace situation. Other multitasking simulations (e.g., SIMKAP, discussed earlier) appear much more similar to real-world tasks, and thus may be more generalizable than the SynWin simulation.

A final limitation of this study is its use of self-report measures for all variables except multitasking performance. This is a limitation for two main reasons. First, the relationships in the study may have been inflated due to common method variance. Participants filled out all the measures in the same format (an online survey) with very similar response scales for all measures. This problem is compounded by the fact that the relationships of interest are likely to be small in magnitude, and as such even a small degree of common method variance might result in conclusions that are not merited. Second is the fact that a key measure, anxiety, may not be most appropriately measured using a self-report, perceptual measure as it was in this study. Participants may not be aware of their actual level of anxiety, or may misattribute excitement or other types of arousal to anxiety because they are in a performance context. To address this issue, future research may benefit from the use of physiological measures of anxiety or arousal (e.g., cortisol levels or heart rate) during multitasking.

Though the present study was small in size and scope, the results provide evidence that future researchers should more carefully consider the role of anxiety, and should not be too quick to dismiss non-cognitive variables as predictors of multitasking performance.

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