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The Mediating Effefcts of Cortisol on the Relationship between Conscientiousness and Judgments of Learning

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THE MEDIATING EFFECTS OF CORTISOL ON THE RELATIONSHIP BETWEEN CONSCIENTIOUSNESS AND JUDGMENTS OF LEARNING

A Masters Thesis

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Master of Science, Psychology

By

Katherine Danielle Miller

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ABSTRACT

Cortisol assists in facilitating stress response. A peak in cortisol levels can be seen between 20 and 40 minutes after exposure to the stressful event. Judgments of learning (JOLs) are within the field of metacognition and are judgments individuals make about how well they feel they have acquired the target information. Many factors influence the accuracy of these judgments, including whether they are immediate or delayed. Conscientiousness is a characteristic of personality that is associated with responsibility and organization. Individuals high in conscientiousness are more likely to have positive health related outcomes. A relationship between conscientiousness and the appraisal of stressors exists, and this study sought to extend that relationship to cortisol and the ways in which conscientiousness may influence salivary cortisol levels. Since conscientiousness is associated with more approach-based methods to handle stress, as well as more organization and responsible behaviors, this study also predicted a correlation between higher conscientiousness scores and increased JOL accuracy. Finally, the mediating effects of cortisol on the relationship between conscientiousness and JOLs was evaluated. The results support previous JOL research, in addition to supporting the relationship between conscientiousness and cortisol. The relationship between conscientiousness and JOLs, as well as the mediated relationship, were found to be nonsignificant.

KEYWORDS: conscientiousness, judgments of learning, cortisol, mediation, metacognition

This abstract is approved as to form and content

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INTRODUCTION

Judgments of Learning (JOLs), conscientiousness, and cortisol have importance in academia both individually and collectively. Crucially, we must understand each of these concepts to conceptualize the ways in which they are related and the ways in which they impact academic outcomes. The present study attempts to merge these three concepts to evaluate the mediating effect of cortisol on the relationship between conscientiousness and judgments of learning.

LITERATURE REVIEW

Judgments of Learning

Judgments of Learning are metacognitive judgments that occur either during or after the acquisition of new information about how well a person feels they have learned the target material (Metcalfe & Dunlosky, 2008). Put more simply, it is the ability to think about one's thinking. JOLs are often measured by showing participants word pairs, often associatively related, and asking them to make either immediate or delayed judgments. These judgments ask the participants, on a scale from 0-100 percent, how confident they are that they would be able to recall the second word (target) when shown the first word (cue) in the pair (Dunlosky & Nelson, 1994). For example, if shown *block-fish*, participants would estimate how likely they would be to remember *fish* if cued with *block*. Immediate judgments occur directly after the word-pair is shown, while delayed judgments occur later in the experiment. Multiple factors have been identified that

influence the accuracy of JOLs, including when the judgments occur, as well as the perceived retention interval and type of response elicitation (i.e. participants are shown the cue and asked to remember the target during the testing phase.

We can determine JOL accuracy by using a gamma correlation between JOLs and memory recall. Delayed, cue-only judgments appear to be the most accurate of the judgments that people can make, with a gamma correlation of +0.90. Immediate judgments of learning, however, are far less accurate with a gamma correlation of +0.30 (Metcalfe & Dunlosky, 2008). This facet of judgments is often called the sensitivity, or the slope of the relationship between judgments and accuracy (Maki, 2007). Another measure of accuracy would be the general bias in judgments, as we are often over or underconfident in our guesses for memory scores. First-trial judgments that are made immediately after acquisition are overconfident, while those made on a second trial are underconfident (Metcalfe, 2009). These overestimations in future recall are referred to as illusions of competence (Koriat & Bjork, 2005). During these JOL studies, the cue and the target both appear simultaneously, and participants make JOLs of their ability to recall the target in the presence of the target, which creates bias. To make more accurate judgments, the participant must shift their mindset to that of an examinee rather than that of a learner. Failure to make this shift in mindset leads to an overestimation of the knowledge they possess, leading to overconfidence in JOLs (Koriat & Bjork, 2005).

Additional JOL research indicates that there is a discrepancy between a participant's level of successful recall and their estimated recall when considering a retention interval. When asked to make metacognitive judgments, individuals seem to be unaware of the impact a retention interval will have on their ability to recall information

at a later time (Koriat, Bjork, Sheffer, & Bar, 2004). As the retention interval increases, recall often decreases, without a corresponding reflection in JOLs (Koriat et al., 2004). One potential explanation for the indifference of JOLs to retention interval is the dual-basis view of metacognitive judgments. This view of metacognition suggests that metacognitive judgments are based on one or both subjective experience and domain-specific knowledge. JOLs that are based on subjective experience are associated with the ease in which information is processed, which does not take into account the conditions of retrieval. Theory based judgments take into consideration the participant's knowledge of their own competence and metacognition to form an educated guess (Koriat et al., 2004). An additional explanation for the indifference of JOLs to retention interval is the forgetting-notion hypothesis. Individuals are oblivious to the effects of forgetting, and it may be necessary to encourage people to apply their knowledge of the effects of forgetting to JOLs, because once this information is considered, they are more able to take into consideration the specified retention interval when making a judgment (Koriat et al., 2004).

The possible explanations for the stark contrast in accuracy of these judgments can be attributed to theories of the delayed JOL effect. The first theory is that of the monitoring dual memories hypothesis. Nelson and Dunlosky (1991) suggest that, when making a JOL, information from both the short term memory (STM) and long term memory (LTM) are retrieved. The information in STM adds "nondiagnostic information" to the judgment, which makes immediate judgments less accurate. In terms of delayed judgments, this hypothesis purports that people gather judgment information from LTM, which is more accurate in terms of predicting test performance (Metcalfe & Dunlosky,

2008). The second theory of the delayed judgment of learning effect is the transfer-appropriate monitoring hypothesis. Transfer appropriate monitoring suggests that delayed JOLs accuracy may be due to the contextual differences between the judgment of learning conditions; the more similar the JOL situation is to the testing situation, the more accurate the judgment. Retrieval attempts show greater similarity between a delayed test and a delayed JOL than a delayed test and an immediate JOL (Metcalfe & Dunlosky, 2008).

The self-fulfilling prophecy hypothesis attributes the increase in accuracy in delayed JOLs to the process of making of the judgment. When an individual is judging their learning, they are also attempting retrieval. Individuals use the presented stimulus as a cue to attempt retrieval of the target word and then base their judgment on whether or not that retrieval attempt was successful (Spellman & Bjork, 1992). If retrieval for that particular pair is achieved, they will give the pair a higher JOL. Since retrieval was already successfully accomplished, and successful recall is the basis for predicting subsequent recall performance, the JOLs will be more accurate (Spellman & Bjork, 1992).

The fourth explanation is the stochastic drift model. This model breaks memory strength for an item down into exponential functions, with slow and fast components. In immediate judgments, this drift is much larger, resulting in less accuracy. However, drift is smaller in delayed judgments of learning, which gives rise to more predictable and accurate JOLs (Metcalfe & Dunlosky, 2008). Taking into consideration all four of these theories of explanation regarding the delayed judgment of learning effect, it is important to note that there is not one single theory that can be relied upon to explain this effect.

Research has suggested that the most reasonable explanation for this phenomenon is a combination of both the monitoring-dual-memories hypothesis and the self-fulfilling prophecy hypothesis (Metcalfe & Dunlosky, 2008).

JOLs are of significant importance, especially in terms of academic performance. Metcalfe (2009) suggests that if someone's metacognitive abilities are accurate, they can have a greater amount of control over their academic performance. Specifically, if one is able to make accurate JOLs, they will make more optimal study choices. If a person can accurately assess what they know and what they have yet to learn, they will make better judgments in terms of allocating the appropriate amount of study time to items with various levels of mastery and difficulty. Metcalfe and Finn (2008) conducted three experiments that collectively demonstrated that one's metacognitions (JOLs) are directly related to their decisions in studying. For example, word pairs were shown to participants a variable number of times per study session with subsequent JOLs ratings. The pairs were either repeated once in trial one and three times in trial two (1-3), or three times in trial one and once in trial two (3-1). In the second trial, they were asked which pairs they would like to study again and participants predominantly selected the pairs shown only once. To ensure that it was indeed the JOLs that determined their study choices, Metcalfe and Finn added a between subjects component, looking at whether their JOLs were made immediately or at a delay. Biased judgements continued in the immediate judgment condition, which lead to biased study choices on which words to restudy.

Cortisol

Cortisol has been often researched as a biochemical marker of stress and is more informally known as the stress hormone. This hormone is classified as a glucocorticoid, which is a family of hormones that reduces inflammation in the body. It is produced by the hypothalamic-adrenocortical system (HPA), whose levels rise in situations in which one would feel threatened or a lack of control (Bruce, Davis, & Gunnar, 2002). In addition to facilitating stress responses, the HPA is critical in terms of energy and metabolism, as it mobilizes energy to fuel the body. Additionally, the HPA may inhibit certain aspects of immune system functioning and act as the body's natural anti-inflammatory (Dickerson & Kemeny, 2004). This hormone follows a circadian rhythm, and peaking between 30 and 60 minutes of waking, and continues to taper throughout the day. This peak upon waking is referred to as the cortisol awakening responses (CAR), which is considered to be a good indicator of chronic stress. The diurnal rhythm is characterized by an increase in cortisol approximately 30 minutes after awakening, with a diurnal decline at around midnight. Higher levels of cortisol in a CAR peak have been related to greater individual peak response and secretion of cortisol in an acute stress period (Wetherell, Lovell, & Smith, 2015). In addition to following a circadian rhythm, maximum cortisol responses can be measured between 20 and 40 minutes after exposure to the stressful event (Gonzalez-Cabrera, Fernandez-Prada, Iribar-Ibabe, & Peinado, 2014).

Both physical and psychological stressors are capable of activating the HPA. However, there is significant heterogeneity in cortisol research findings, which leads researchers to conclude that stress-inducing situations do not lead to uniform changes in cortisol. Research suggests various physical and psychological stressors cause changes in

the HPA in animals, however, little is known about the potential impacts of psychological stressors on the HPA in humans (Dickerson & Kemeny, 2004). In general, research surrounding the release and effects of acute cortisol responses are focused around lab simulated settings, which might explain the variability in research findings. Some researchers have determined that cortisol levels increase during an examination, while other researchers have found just the opposite (Gonzalez-Cabrera et al., 2014). Chronic stress, however, has commonly been researched in "real-life" situations. Salivary cortisol is a commonly used measure in stress research, as it is easily obtained across a multitude of situations.

While cortisol is essential to survival and may even provide some benefits; prolonged, chronic exposure to increased levels has an adverse effect on immune functioning, memory, and attention (Bruce et al., 2002). Chronic elevations in the stress hormone may also increase activation in the areas of the brain responsible for fear, as well as leading to the development of pathological anxiety. This finding demonstrates that, while HPA system functioning is necessary for survival, cortisol must be well regulated to prevent the potential negative consequences of chronic cortisol elevation (Bruce et al., 2002). Cortisol is said to have a modulatory effect of memory, and that effect is largely dependent on the stage of memory consolidation (Ackermann, Hartmann, Papassotiropoulos, de Quervain, Rasch, 2013). An increase in cortisol has been found to assist in the event of memory consolidation, especially for those events that are more emotionally arousing. However, cortisol is said to impair the act of retrieving memories from the long-term memory, again, for emotionally arousing events (Ackerman et al.,

2013). The brain may be in "learning mode," during high levels of cortisol, thus, impairing its ability to retrieve the information (Kromann, Jensen, & Ringsted, 2011).

Conscientiousness

Conscientiousness is characterized by a tendency to follow social norms, make plans, and being goal oriented. Research in conscientiousness has found a promising positive relationship between conscientiousness and longevity. Higher level of conscientiousness are associated with a lower risk of dying in any given year, because high conscientiousness individuals are typically associated with better health statuses, including a lower risk of obesity (Gartland, O'Connor, & Lawton, 2012). Additionally, conscientiousness is also associated with coping and healthy behaviors (Bartley & Roesch, 2011). People who are high in conscientiousness can be described as organized, goal-oriented, reliable, diligent, as well as showing high levels of self-regulation and impulse control. The personality trait of conscientiousness has also been shown to have negative relationships with depression and perceived stress, implying that as conscientious increases, the instances of depressive symptoms and perceived stress decreases (Bartley & Roesch, 2011).

Research is now focusing in on whether conscientiousness levels are related to the ways in which people experience stress. Previous research discusses the negative impacts of stress on health and well-being, as well as the emerging establishment of the potential health benefits of positive affect. Additionally, there is emerging evidence of a positive relationship between conscientiousness and positive affect (Gartland et al., 2012). Conscientiousness is important in the ways in which individuals perceive and respond to

stressful situations. Conscientiousness plays a large role in stress management, tolerance, and avoidance. These results may be attributed to the fact that individuals higher in conscientiousness have more approach based coping strategies, rather than avoidance based strategies, which result in more positive affective experiences (Bartley & Roesch, 2011). A link between both stress and conscientiousness already exists as researchers have attempted to explain both the direct and indirect pathways between them. The link between conscientiousness and daily stressors is a new avenue of research, as well as the way in which levels of conscientiousness may affect the ways in which these stressors are perceived (Gartland et al., 2012).

When it comes to appraising daily stressors, there are both primary and secondary appraisals, according to the transactional model of stress (Gartland et al., 2012). Primary appraisals are the stake someone feels they have in the situation, and secondary appraisals are whether or not they feel that anything can be done to change the outcome. To have a higher score on the primary appraisal indicates that the stressor is perceived as more stressful, and to have a higher score on the secondary appraisal indicates a higher perceived ability to cope with said stressor. The individuals' level of conscientiousness was negatively correlated with the primary appraisal, but was positively correlated with the secondary appraisal (Gartland et al., 2012). This result would imply that those who are higher in conscientiousness rate the level of stress as lower and feel that they can do more about the stressor. Those lower in conscientiousness, however, perceive it as more stressful, and have a lower perceived ability to cope (Gartland et al., 2012). This connection between conscientiousness and stress levels could potentially lead to negative health outcomes, thus indicating the connection between conscientiousness and health.

Shifting the focus of personality on stressors from major life events to smaller scale hassles, in a naturalistic setting, may present the opportunity to understand how people perceive and handle their everyday worries, and to see how that may carry over into the academic realm.

While the relationship between conscientiousness and stress has been established in terms of the way individuals appraise stressful situations, the relationship between cortisol and conscientiousness is one to still be explored (Nater, Hoppmann, & Klumb, 2010). The relationship between the stress hormone and neuroticism, another facet of personality has been investigated, and has provided mixed results. Some research indicates that there is a positive correlation between neuroticism and increased levels of cortisol throughout the day, while other research determined the relationship to be inconclusive, or even negative (Nater et al., 2010). Based on the research attempting to relate personality to HPA axis activity, it is hypothesized that those who are higher in their level of conscientiousness will show lower cortisol levels throughout the day (Nater et al., 2010). In their study, Nater et al. did not determine there to be a relationship between conscientiousness and daily cortisol. However, it was found that there was a significant interaction between conscientiousness, positive affect, and basal cortisol levels. This indicates that individuals with higher conscientiousness displayed decreasing daily cortisol levels when associated with positive affect (Nater et al., 2010).

The Current Study

While the relationship between cortisol and other personality characteristics, such as neuroticism has been previously explored, the relationship between cortisol and

conscientiousness has yet to be established. This study will look at the relationship between conscientiousness and stress, as measured through questionnaires and saliva samples, to determine if those that are higher in this particular personality trait are more effective at appraising the daily academic stressors involved in learning and recalling new information. Since there is an already established relationship between personality and cortisol, the intent of this study is to evaluate and extend this research to the relationship between conscientiousness and cortisol, as well as conscientiousness and JOLs, in addition to the mediating effect stress (cortisol) may have on the relationship between conscientiousness and their judgments of learning. Full hypotheses are listed below.

METHODS

Participants

This study was approved by the IRB, study number FY2017-425, and all researchers are CITI trained. 51 participants were involved in this study. These participants were gathered from different statistics courses at Missouri State University. The participants were granted class credit for their participation in this study. A power analysis performed with G*Power determined that the minimum number of participants needed for a medium effect size of $d = 0.50$ with 80% power is 37 (Cohen, 1992). Additionally, a medium effect size was chosen due to the JOL literature showing medium correlations (Nelson & Dunlosky, 1991). To account for a smaller effect, a sample of at least 68 participants would be necessary.

Materials

The International Personality Item Pool (IPIP) is a public domain personality questionnaire that will be used to measure the participants' level of conscientiousness (Appendix A). This measure was developed in 1996 and has grown widely popular for a number of reasons; it is free, the items can be accesses instantaneously, IPIP has over 2000 items, scoring keys are provided, and the items do not have to be presented in any particular order (Goldberg et al., 2006). The vast flexibility and availability makes the IPIP widely appealing to personality researchers, since using the internet to collect and score the responses makes the questionnaire much more efficient. The reliability of each item is calculated through a standard reliability analysis, and any item whose addition to

the scale lowers alpha is excluded (Goldberg et al., 2006). In addition to the IPIP, there were other personality questionnaires used to gather data. The Self-Regulation Questionnaire (SRQ) is typically used to assess the participants' levels of self-regulatory behaviors. The Depression, Anxiety, and Stress Scale (DASS) is used to further evaluate anxious tendencies and behaviors. A modified version of the SEMLI-S was also administered. Typically, the questions are asked within the scope of a scientific environment, so the questions specifically tailored to learning in the field of science were omitted, and they were asked instead to keep in mind the class they were earning credit for. While each of these questionnaires may contribute valuable information to the study overall, their use was strategic in the sense of timing. Since cortisol has a diurnal rhythm, it was essential that at least 15 minutes lapsed between the second and third saliva samples. These questionnaires added enough time to the study to allow for the necessary amount of time to pass.

In order to assess the participants' cortisol levels, the Salimetrics Salivary Cortisol kits was used to collect saliva samples. This kit is a SalivaBio passive drool method, which is a method for collecting whole saliva that ensures the purest saliva samples. The cortisol kit also comes equipped with a saliva collection aid, which makes the collection process more efficient. They were labeled by participant, as each participant receives a number upon entering the study, but not with any identifying information. The samples were stored at the appropriate temperature of -23 degrees Fahrenheit until they were sent to the Salimetrics Lab to be analyzed. Salimetrics took approximately five weeks to assay and return to us the cortisol levels of the participants.

The words used in the memory task were modeled similarly to that of Nelson and

Dunlosky (1991). The task consisted of 66 unrelated word pairs, such as *ocean-tree*. All pairs were concrete nouns (Dunlosky & Nelson, 1994). Word-pairs were considered unrelated if they were not explicitly paired in the USF Free Association Norms (Nelson, McEvoy, & Schrieber, 2004), semantic word pair norms (Buchanan, Holmes, Teasley, & Hutchison, 2013) or in the latent semantic analysis norms (Maki, 2007).

Procedure

At the start of the study, saliva samples were collected to help establish a baseline cortisol level. Prior to receiving the materials to be learned, participants were told they would receive extra credit if they more successfully recalled the word pairs, in order to encourage them to make a stronger effort in learning the presented material. However, each participant was granted the extra credit regardless of how they performed. Nelson and Dunlosky (1991) showed the participants 66 pairs of unrelated concrete nouns and told them to study every pair so they could later be able to recall the second word (target) when shown the first word (cue). Using similar methodology, participants were shown 60 unrelated word pairs to recall later in the experiment. After studying the word pairs, they were asked to give a judgment of learning; "How well do you think you will be able to recall the presented target words when given the cues?" Their responses are on a scale from 0-100, 0 indicating a 0% chance they would successfully recall the target, and 100 indicating a 100% chance they would recall. See Appendix B.

Once judgments had been made for all of the word pairs, participants were given a distractor task of alphabetically sorting the names of U.S. states for two minutes to clear short-term memory. Then participants were given a test to actually determine how well

they can recall the target words. The test included the cue word of each pair, and participants were asked to type their guess of the target word presented from earlier in the experiment. Another saliva sample was collected following recall portion. At this time, several questionnaires were administered to measure their level of conscientiousness (IPIP), self-regulation (SRQ), metacognitive awareness (SEMLI-S), and anxiety (C-DASS); to allow an adequate amount of time for the levels of cortisol to peak, as it normally peaks in about a 15-minute interval after a stressful event (Kromann et al.). A third and final saliva sample was collected at the conclusion of the study, and the change in cortisol levels across the first and third samples will be compared.

Hypotheses

My first hypothesis was that JOLs will be positively correlated with recall accuracy, in the same ranges as previous research on immediate judgment JOLs. Because each participant was measured on multiple items, a logistic multilevel model was used to control for the correlated structure of the data, as well as the dichotomous scoring of recall. My second hypothesis used each person's JOL-recall correlation as the dependent variable, and we expect that as the individual's level of conscientiousness increases, so will the accuracy of their JOLs, as people who are more conscientious should also be more aware of their learning. This hypothesis was assessed with a correlation between JOL-recall accuracy and conscientiousness score. To confirm previous findings for conscientiousness and cortisol, we then hypothesized to find that higher levels of conscientiousness are related to decreasing levels of cortisol. Using a multilevel model and moderation analyses, we will predict cortisol levels using time, conscientiousness,

and their interaction to determine if increasing conscientiousness scores predict decreasing cortisol over time. If the interaction of time and conscientiousness is significant, we will examine time simple slopes (-1SD and +1SD for conscientiousness) to elucidate the pattern of effects. Since those who are higher in conscientiousness are better able to appraise and cope with stressors, it is hypothesized that those who have a higher conscientiousness score will not experience a significant stress response (i.e. decreasing slopes). However, those with lower levels of conscientiousness will not be able to regulate their stress levels, and will experience a more significant stress response (i.e. increasing slopes). My fourth hypothesis is that we expect cortisol to mediate the relationship between conscientiousness and the JOL-recall correlation. Several types of analyses are possible for this hypothesis. First, we would consider programming a latent curve model using cortisol's three time points as the slope and intercept factor. This analysis would allow us to control for random intercepts (i.e. different start points for each participant for cortisol) and, potentially, random slopes (i.e. each participants slopes vary a bit). As part of mediation models, we first will establish the relationship between conscientiousness and JOL-recall (Hypothesis 2). Next, we will establish the relationship between conscientiousness and cortisol (Hypothesis 3). Given these two relationships, in this hypothesis, we will use conscientiousness to predict the slope in the latent curve model, which will then predict the JOL-recall correlation. A direct path between conscientiousness and JOL-recall will be included, and this procedure matches the traditional mediation steps of Baron and Kenny (1986). However, if these models will not converge, we potentially will try multilevel regression. Additionally, moderation analyses may be considered given the results from Hypothesis 3. These elevated cortisol levels are

hypothesized to negatively correlate with JOL accuracy; those who experience a more significant cortisol response will be less accurate in predicting their memory performance.

RESULTS

A total of 51 participants were involved in this study. A different statistical analysis was used for each of the four hypotheses. Each participant provided three saliva samples, and the standardized slope was calculated (see hypothesis 3, below). The participants' average salivary cortisol levels were $M = 0.21$µg/dL, $SD = 0.14$µg/dL. When compared to the Salimetrics lab ranges for average salivary cortisol levels, the participants are within range. Adult females have an average AM range of 0.27-1.35 µg/dL, and a PM range of 0-0.36µg/dL. Adult males have an average AM range of 0.11-0.74µg/dL, and a PM range of 0-0.31µg/dL (Salimetrics, 2016).Participants also completed the IPIP as a measure of personality, and we focused specifically on their responses to items related to conscientiousness ($M = 78.67$, $SD = 12.72$). Participants, on average, predicted that they would be more successful in recalling the target when shown the cue (JOL $M = 29.29$, $SD = 24.68$) than they were actually able to recall (Recall $M = 19.28$, $SD = 39.46$).

Hypothesis 1

Prior to analysis, all data were screened for accuracy, missing data, and outliers. It was determined that all data were satisfactory in terms of both accuracy and outliers. Some missing data was found, and they were imputed using the *mice* package (van

Buuren & Groothuis-Oudshoorn, 2011) for participants with less than 5% of missing data (Tabachnick & Fidell, 2013).

For hypothesis one, a direct binary logistic regression analysis was conducted to evaluate recall accuracy using the participants' judgments of learning (JOLs) and their recall scores. Using recall scores as the dependent variable, this analysis was used to determine whether or not their JOLs predicted their recall scores. There were 51 participants included in this analysis. This model as analyzed as a multilevel model because each participant rated and answered multiple items. First, a random intercept by participant only model was coded, as a comparison point for a model with predictors. The addition of JOL as a predictor was a significant increase in model fit over the random intercepts model, $X^2(3) = 93.08$, $p < 0.001$, $R^2 = 0.07$. We hypothesized that the relationship found would be representative of previous research in the field. The first hypothesis was in fact supported, as the correlation between their predicted recall and their actual recall fell within the parameters of previous research, $b = 0.23$, $Z = 9.58$, $p < 0.001$. Overall, 82.71% of the participants were correctly classified, with better classification in the incorrect recall group (97.37%) over the correct recall group (21.36%), as shown in Fig. 1. The percent correctly classified was much greater in the incorrect recall group due to the fact that the recall task was difficult, and a majority of the participants did not have a high percentage of correct recall in the memory task.

Hypothesis 2

To evaluate the relationship between conscientiousness and judgment accuracy, a correlation between JOL (predicted recall) and actual recall was calculated for each

participant. Data were screened for accuracy and additivity. The data were concluded to be accurate, and no problems with additivity were found. First, the correlation between their predicted recall and their actual recall was calculated. This correlation is the judgment accuracy. Participant conscientiousness scores, based on their responses on the IPIP, were then totaled. Finally, a correlation between their total conscientiousness scores and recall accuracy was calculated. Two participants were excluded from this analysis due to their lack of successful recall of the target word when shown the cue; thus, no correlation could be calculated due to no variance in recall. The correlation was not found to be significant $r = .04$ $t(47) = 0.24$, $p = .81$, and therefore, this hypothesis was not supported.

Hypothesis 3

A multilevel model was used to look at the relationship between conscientiousness and cortisol. We predicted an interaction of cortisol slopes and conscientiousness, such that higher conscientiousness scores would be associated with a decrease in cortisol throughout the study. The data were screened for assumptions. Although four outliers were found, they were left in for the analysis for more statistical power. The data were screened for multivariate assumptions and additivity, normality, linearity, and homoscedasticity were met, while some issues were noted with homogeneity. All 51 participants were used in this analysis.

First, an intercept only model was analyzed as a comparison point for subsequent models (Field, Miles, & Field, 2014). The addition of time measurement and conscientiousness as main effects was significant, $X^2(2) = 6.78$, $p = .03$, $R^2 = .01$.

Overall, time of measurement indicated that cortisol levels decreased over the course of the study, $b = -0.02$, $t(101) = -2.61$, $p = .01$, but that conscientiousness was not a significant main effect predictor of overall cortisol levels, $b < -0.001$, $t(49) = -0.17$, $p = 0.86$. The addition of the interaction of time of measurement and conscientiousness was significant, $X^2(1) = 5.73$, $p = .02$, $R^2 = .02$ At low levels of conscientiousness, no change in cortisol over time of measurement was found, $b = -0.001$, $t(100) = 6.89$, $p = .85$. However, increasing levels of conscientiousness showed an increasing negative change over the course of the study, wherein average conscientiousness (see above) and high levels of conscientiousness, $b = -0.03$, $t(100) = -3.59$, $p < .001$, showed negative slopes over time. This hypothesis was therefore supported.

Hypothesis 4

Finally, we hypothesized that cortisol would mediate the relationship between judgments of learning and conscientiousness. Since participants gave three saliva samples over the course of the study, the standardized slopes (i.e., correlation between time of measurement and cortisol level) for their salivary cortisol levels were determined. Additionally, the correlation between judgments of learning and recall from Hypothesis Two were used as judgment accuracy; and therefore, two participants were excluded from these analyses. Traditional (Baron & Kenny, 1986) and newer approaches (Hayes, 2013) to mediation were used to analyze this data.

First, the model of conscientiousness predicting cortisol levels was nonsignificant, $b = -0.01$, $t(49) = -1.36$, $p = .18$, $R^2 = .04$. Second, the *a* path was examined using conscientiousness to predict judgment accuracy, $b < 0.001$, $t(49) < 0.01$, $p = .82$, $R^2 < .01$.

Last, the *b* and *c'* paths were examined using both conscientiousness and judgment accuracy to predict cortisol slopes. This model was not significant overall, $F(2, 46) = 0.88$, $p = .42$, $R^2 = .04$. Individually, judgment accuracy, $b = 0.82$, $t(46) = 1.21$, $p = .23$, and conscientiousness, $b = -0.006$, $t(46) < 0.01$, $p = .53$, did not predict changes in cortisol over the course of the study. Because none of these models were significant, the Sobel test and bootstrapped mediation effects were not calculated.

DISCUSSION

Applications

Taking the previous research investigating the relationship between conscientiousness and stress responses (Gartland et al., 2012) and applying it in an academic setting allows researchers to investigate how students might appraise the stressors involved in everyday life and in learning and remembering new information. The results in the first hypothesis further support the previous research surrounding the accuracy of one's judgments of learning. The correlations between the participants' predicted recall and actual recall were consistent with those found in immediate judgments (Nelson & Dunlosky, 1991). It was determined in the second set of analyses that there is not a significant correlation between someone's conscientiousness score and their ability to accurately judge their learning. These results might indicate that there may not be a significant relationship between conscientiousness and judgments of learning. While conscientiousness is beneficial in the appraising of and dealing with daily stressors, it was not found to be beneficial in accurately judging how well they feel they have learned new information (Gartland et al., 2012).

The results from the multilevel model in the third hypothesis indicate that the relationship between the participants' conscientiousness score and their cortisol level throughout the experiment was significant. It was found that those with higher conscientiousness scores had decreasing salivary cortisol levels over the course of the study. This implies that those who are higher in conscientious are better at evaluating stressors and coping with them, which is consistent with previous research (Gartland et

al., 2012). Finally, the mediation relationship in the fourth and final hypothesis was found to be nonsignificant.

The results do suggest a relationship between conscientiousness scores and cortisol levels. While it was hypothesized that those who are higher in conscientiousness would be at a benefit due to the positive habits, affect, and health outcomes, the results did not support the relationship between higher conscientiousness and more accurate JOLs. Thus, one might infer that being a conscientious individual does not put you at an advantage when it comes to accurately predicting your learning. Additionally, it may be concluded that the level of salivary cortisol is indeed affected by conscientiousness. It was hypothesized in previous research that individuals higher in conscientiousness would have decreasing cortisol levels throughout the day, and that was found to be the case only in participants where an interaction between higher levels of conscientiousness and positive affect occurred (Nater et al., 2010). In the current study, that hypothesis was also supported within the timeframe of the study, as the participants' higher conscientiousness scores were associated with lower salivary cortisol levels. Possessing the traits that come along with conscientiousness, such as organization and responsibility, may help an individual with the appraisal of a stressor and the way they respond to it, in addition having an effect on the decreasing of cortisol levels. Looking at this relationship through the scope of an academic setting, it may lead to implications for more positive learning outcomes for those with higher conscientiousness levels. While it did not benefit the accuracy of their JOLs, having a decrease in cortisol levels over time may point to more approach based coping strategies when it comes to academic stressors. Those who are higher in conscientiousness have been found to feel as if they have more power in coping

with the stressor, and appraise things to be less stressful, while those who are lower in conscientiousness feel as if they have less power in stressful situations (Gartland et al., 2012). Additionally, individuals higher in conscientiousness have more approach based coping strategies when dealing with stressors (Bartley & Roesch, 2011).

Limitations

These results should be considered in light of a few limitations. First, a small sample size. Small sample size limits the types of analyses that can be used. Additionally, it was a convenience sample that was comprised entirely of university students. The timing of the cortisol samples could also pose as a limitation. The participants' salivary cortisol levels could have been reflective of other factors that would have caused them to either increase or decrease, such as final examinations. Also, there are several factors that may impact an individual's salivary cortisol level that were not controlled for, such as food, caffeine, alcohol, and hormonal birth control. If participants in this study were using something that could impact their salivary cortisol levels, the results might not have been entirely accurate. Another limitation could be that of the word pairs themselves. Due to the low percentage of successful recall of the target when down the cue, it might be inferred that the memory task was too difficult. This low percentage of successful recall was found in previous research, regarding immediate judgments in which the participants were told to study the pair through rote rehearsal. That proportion of correct recall was .22, which is consistent with the present study (Dunlosky & Nelson, 1994). However, reevaluating which word pairs were used may have a positive effect on successful recall of the target word, and be beneficial to further statistical analyses.

It could be beneficial to continue researching the relationship between conscientiousness and JOLs, in addition to the relationship between conscientiousness and cortisol. Seeing how the different levels of conscientiousness interacts with different accuracies in judging what information has been learned can lead to implications regarding how to facilitate more conscientious behaviors in students. Additionally, if it is found that there is a relationship between cortisol and conscientiousness, it may give rise to implications regarding stress management. Finally, if it is found that cortisol mediates the relationship between conscientiousness and judgment accuracy, conclusions may be drawn about conscientious, stress, and academic outcomes.

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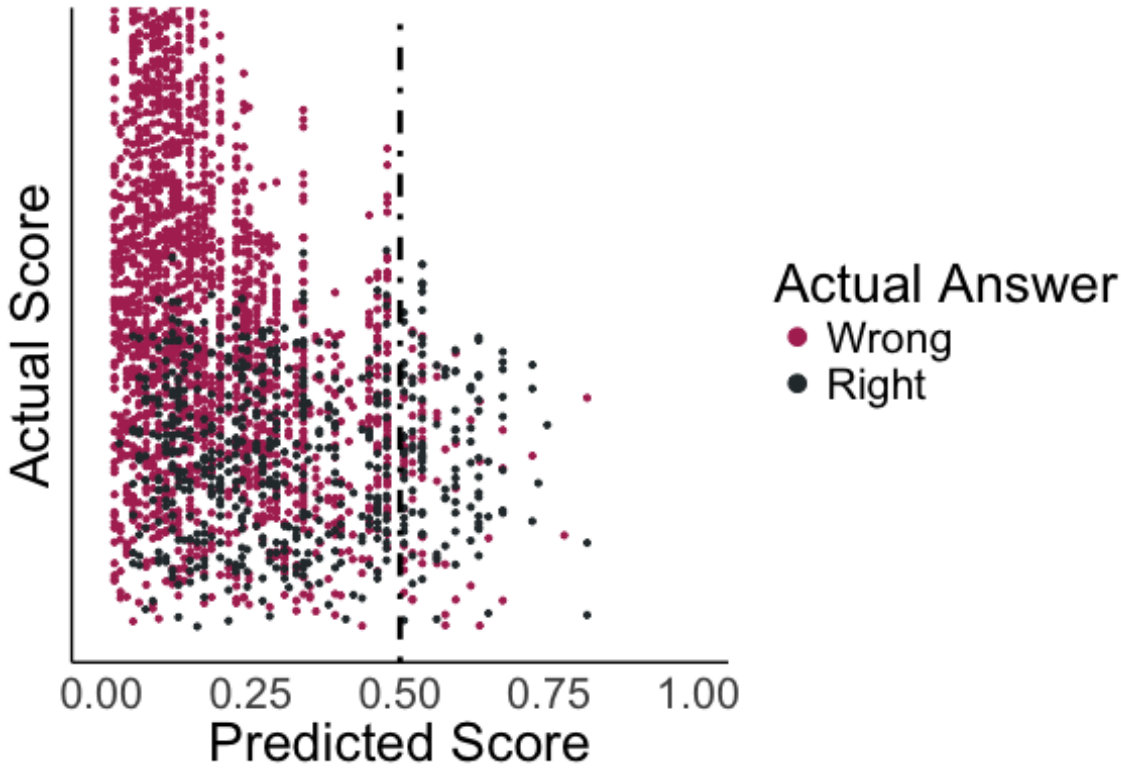

Figure 1. The percent correct when predicting the accuracy of participants recall of the target word when shown the cue.

APPENDICES

Appendix A.

The Items in Each of the Preliminary IPIP Scales
Measuring Constructs Similar to Those in the 5 NEO-PI-R Broad Domains

Neuroticism
10-item scale (Alpha = .86)
+ keyed Often feel blue.
Dislike myself.
Am often down in the dumps.
Have frequent mood swings.
Panic easily.

– keyed Rarely get irritated.
Seldom feel blue.
Feel comfortable with myself.
Am not easily bothered by things.
Am very pleased with myself.

20-item scale (Alpha = .91)
+ keyed Often feel blue.
Dislike myself.
Am often down in the dumps.
Have frequent mood swings.
Panic easily.
Am filled with doubts about things.
Feel threatened easily.
Get stressed out easily.
Fear for the worst.
Worry about things.

– keyed Seldom feel blue.
Feel comfortable with myself.
Rarely get irritated.
Am not easily bothered by things.
Am very pleased with myself.
Am relaxed most of the time.
Seldom get mad.
Am not easily frustrated.
Remain calm under pressure.
Rarely lose my composure.

Extraversion
10-item scale (Alpha = .86)

+ keyed Feel comfortable around people.
Make friends easily.
Am skilled in handling social situations.
Am the life of the party.
Know how to captivate people.

– keyed Have little to say.
Keep in the background.
Would describe my experiences as somewhat dull.
Don't like to draw attention to myself.
Don't talk a lot.

20-item scale (Alpha = .91)
+ keyed Feel comfortable around people.
Make friends easily.
Am skilled in handling social situations.
Am the life of the party.
Know how to captivate people.
Start conversations.
Warm up quickly to others.
Talk to a lot of different people at parties.
Don't mind being the center of attention.
Cheer people up.

– keyed Have little to say.
Keep in the background.
Would describe my experiences as somewhat dull.
Don't like to draw attention to myself.
Don't talk a lot.
Avoid contacts with others.
Am hard to get to know.
Retreat from others.
Find it difficult to approach others.
Keep others at a distance.

Openness to Experience
10-item scale (Alpha = .82)
+ keyed Believe in the importance of art.
Have a vivid imagination.
Tend to vote for liberal political candidates.
Carry the conversation to a higher level.
Enjoy hearing new ideas.

– keyed Am not interested in abstract ideas.
Do not like art.
Avoid philosophical discussions.

Do not enjoy going to art museums.
Tend to vote for conservative political candidates.

20-item scale (Alpha = .89)
+ keyed Believe in the importance of art.
Have a vivid imagination.
Tend to vote for liberal political candidates.
Carry the conversation to a higher level.
Enjoy hearing new ideas.
Enjoy thinking about things.
Can say things beautifully.
Enjoy wild flights of fantasy.
Get excited by new ideas.
Have a rich vocabulary.

– keyed Am not interested in abstract ideas.
Do not like art.
Avoid philosophical discussions.
Do not enjoy going to art museums.
Tend to vote for conservative political candidates.
Do not like poetry.
Rarely look for a deeper meaning in things.
Believe that too much tax money goes to support artists.
Am not interested in theoretical discussions.
Have difficulty understanding abstract ideas.

Agreeableness
10-item scale (Alpha = .77)
+ keyed Have a good word for everyone.
Believe that others have good intentions.
Respect others.
Accept people as they are.
Make people feel at ease.

– keyed Have a sharp tongue.
Cut others to pieces.
Suspect hidden motives in others.
Get back at others.
Insult people.

20-item scale (Alpha = .85)
+ keyed Have a good word for everyone.
Believe that others have good intentions.
Respect others.
Accept people as they are.
Make people feel at ease.

Am concerned about others.
Trust what people say.
Sympathize with others' feelings.
Am easy to satisfy.
Treat all people equally.

– keyed Have a sharp tongue.
Cut others to pieces.
Suspect hidden motives in others.
Get back at others.
Insult people.
Believe that I am better than others.
Contradict others.
Make demands on others.
Hold a grudge.
Am out for my own personal gain.

Conscientiousness
10-item scale (Alpha = .81)
+ keyed Am always prepared.
Pay attention to details.
Get chores done right away.
Carry out my plans.
Make plans and stick to them.

– keyed Waste my time.
Find it difficult to get down to work.
Do just enough work to get by.
Don't see things through.
Shirk my duties.

20-item scale (Alpha = .90)
+ keyed Am always prepared.
Pay attention to details.
Get chores done right away.
Carry out my plans.
Make plans and stick to them.
Complete tasks successfully.
Do things according to a plan.
Am exacting in my work.
Finish what I start.
Follow through with my plans.

– keyed Waste my time.
Find it difficult to get down to work.
Do just enough work to get by.

Don't see things through.
Shirk my duties.
Mess things up.
Leave things unfinished.
Don't put my mind on the task at hand.
Make a mess of things.
Need a push to get started.

Converting IPIP Item Responses to Scale Scores

Here is how to score IPIP scales:

For + keyed items, the response "Very Inaccurate" is assigned a value of 1, "Moderately Inaccurate" a value of 2, "Neither Inaccurate nor Accurate" a 3, "Moderately Accurate" a 4, and "Very Accurate" a value of 5.

For - keyed items, the response "Very Inaccurate" is assigned a value of 5, "Moderately Inaccurate" a value of 4, "Neither Inaccurate nor Accurate" a 3, "Moderately Accurate" a 2, and "Very Accurate" a value of 1.

Once numbers are assigned for all of the items in the scale, just sum all the values to obtain a total scale score.

Appendix B.

The following is an example of the unrelated word pairs as they appear in Qualtrics

Each pair is presented as a CUE and TARGET. If you are shown FISH-SPOON, then FISH is the CUE and SPOON is the TARGET.

For each pair, how likely are you to remember the TARGET word if you are only shown the CUE word?

	0-10	11-20	21-30	31-40	41-50	51-60	61-70	71-80	81-90	91-100
Shrimp-Look	○	○	○	○	○	○	○	○	○	○
Comment-Purse	○	○	○	○	○	○	○	○	○	○
Pier-Writer	○	○	○	○	○	○	○	○	○	○
City-High	○	○	○	○	○	○	○	○	○	○
Tear-Blush	○	○	○	○	○	○	○	○	○	○
Tiger-Nut	○	○	○	○	○	○	○	○	○	○
Washer-Cabin	○	○	○	○	○	○	○	○	○	○
Farm-Door	○	○	○	○	○	○	○	○	○	○
Record-Apple	○	○	○	○	○	○	○	○	○	○
Sauce-Ocean	○	○	○	○	○	○	○	○	○	○