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Components of Mindfulness Training: Impacts on Attention and Affect

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Components of Mindfulness Training: Impacts on Attention and Affect

A thesis submitted in partial fulfillment
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by

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Abstract

The literature on mindfulness supports a distinction between two components of non-judgmental acceptance and directed attention. The present research analyzed whether there are distinct differences in attentional capabilities or affect between mindfulness inductions which differed in either including only directed attention or directed attention and non-judgmental acceptance. I hypothesized that the acceptance component of mindfulness would increase participants sustained attentional capabilities relative to a control condition; furthermore, I hypothesized that the non-judgmental acceptance component of mindfulness would lead to significant increases in positive affect and decreases in negative affect relative to control. Lastly, I hypothesized that an individual difference measure of need for cognitive closure would moderate this effect between non-judgmental acceptance and affect, such that individuals low in need for cognitive closure would see a significantly smaller benefits of the acceptance component relative to the directed attention condition. Results showed a significant increase in sustained attentional capabilities across time for the acceptance-based mindfulness condition, contrary to the literature.

Furthermore, consistent with my hypothesis, NFC significantly moderated the relationship the negative affect felt by individuals in the acceptance condition such that participants low in NFC felt significantly more negative affect compared to the attention and control conditions.

Therefore, the hypotheses were at least partially supported suggesting that individual differences and length of mindfulness training program should be taken into consideration.

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Components of Mindfulness Training: Impacts on Attention and Affect

Introduction

Our cognitions have a fundamental impact on our affective well-being. For example, someone might feel stress as a product of their family member's deteriorating health, which can lead to intrusive or unwanted thoughts. These intrusive thoughts impact people's everyday functioning, such that intrusive thoughts occupy cognitive resources which could be utilized in more efficient ways (Smeekens & Kane, 2016). Intrusive thoughts may sometimes be caused by something as serious as a family member's health, but they can also result from worrying about your tire pressure (didn't that tire look low today?) or if having eaten that burger for lunch completely ruined your weight loss plan. Intrusive thoughts need not always be detrimental or negative, but thoughts that cross people's mind throughout the day do have effects on available cognitive resources (Posner & Petersen, 1990). Cognitive interventions have been created to help people better manage their cognitive resources (Cullen, 2011).

A variety of interventions are geared towards helping people cope with stress and negative affect in a way that will allow them to function despite stressors. One such strategy is mindfulness-based interventions (MBI's). Current research on mindfulness often over-indulges itself in suggesting that the practice of mindfulness as a whole is beneficial, regardless of how mindfulness is defined in each particular study (Van Dam, et al., 2017). Mindfulness is often billed as a robust behavioral intervention which was originally derived from Buddhist meditation practices (Lee, 2017). The research being proposed in this study is a replication with extension of Rahl, Lindsay, Pacilio, Brown, & Creswell (2017), with the intention of using a current operationalization of mindfulness which differentiates between two components of mindfulness:

present moment awareness and nonjudgmental acceptance. Mindfulness as a practice has been called into question, primarily regarding the loose definitions and operationalizations and the variety of reported effects in research (Van Dam et al., 2017). Many studies on mindfulness are conducted via self-report measures of mindfulness, correlations with trait mindfulness, or interventions that claim to foster mindfulness and all of its components, but the methodologies vary greatly from one study to the next (Coffey et al., 2010; Van Dam et al., 2017). Research on mindfulness should look at the specific components contained within, and should not overgeneralize the effects of mindfulness as a whole (Van Dam et al., 2017). The proposed research in this study will look to properly define specific components of mindfulness and the effectiveness of these components, with the intention of determining the differing mechanisms subsumed within mindfulness and the downstream impacts on attention and affect.

I will decompose mindfulness based interventions into their varying components of altering people's attentional systems (namely directing / focusing attention) and increasing acceptance of unwanted/intrusive thoughts. Mindfulness will lead to decreases in negative affect or increases in sustained attention by fostering an acceptance of unwanted thoughts. Furthermore, I will suggest that a person's need for cognitive closure moderates the increases in positive affect stemming from the acceptance of unwanted thoughts such that people high in need for cognitive closure may see greater positive benefits from the acceptance component of mindfulness. Individuals high in cognitive closure are motivated to come to quick conclusions, avoiding alternatives and intrusive thoughts (Ask & Granhag, 2005).

H1a: Mindfulness training, primarily the acceptance component, will lead to decreases in negative affect.

H1b: Mindfulness training, primarily the attention component, will lead to increases in positive affect.

H2: The effect of the acceptance component of mindfulness on negative affect will be moderated by need for cognitive closure, such that high need for cognitive closure will predict greater decreases in negative affect.

H3: The acceptance component of mindfulness will lead to increases in sustained attention measured via the Sustained Attention to Response Task.

H4: NFC will have a positive relationship with negative affect, such that higher NFC will predict greater levels of negative affect in the control and attention conditions.

Statement of Problem.

Mindfulness as a concept and practice has been called into question, with the results of studies being inconsistent and the operationalization of mindfulness varying greatly from one study to the next (Van Dam et al., 2017). The components of mindfulness should be tested to determine impacts on sustained attention and affect. The study tested components of mindfulness by utilizing the materials created by Rahl et al. (2017), who created an attention only mindfulness manipulation as well as an attention-plus-acceptance manipulation. These manipulations test the distinction between attention only and attention-with-acceptance mindfulness practices (Rahl et al., 2017). The study further tested an individual difference measure of people's tolerance for ambiguity, need for cognitive closure. NFC was included to measure people's specific cognitive processes as they pertain to the tolerance, attention, and possible acceptance of off-task or intrusive thoughts.

Mindfulness.

Mindfulness has been shown in certain studies to be an effective strategy for mitigating negative affect from intrusive thoughts, benefiting sustained attention, and increasing positive affect (Blanke, Riediger, & Brose, 2017; Jha, Krompinger, & Baime, 2007; Rahl et al., 2017; Shipherd & Salters-Pedneault, 2017). Mindfulness as a concept describes the act of focusing attention with a purpose in mind, maintaining thoughts in the present moment and at the same time fostering a non-judgmental acceptance of these thoughts (Kabat-Zinn, 1994). Mindfulness was initially derived from present moment Buddhist meditation practices (Lee, 2017). Although mindfulness was initially conceptualized by Kabat-Zinn as Mindfulness Based Stress Reduction (MBSR), it has since become a robust cognitive practice implemented for emotion regulation, stress management, and a host of other implementations (Hanley, Garland, & Tedeschi, 2016; Lee, 2017). Mindfulness can be broken down into an attentional and an acceptance component (Lee, 2017). The attentional component refers to people intentionally regulating their attention by observing their thoughts, physical sensations, and other stimuli that occur in the present moment (Coffey, Hartman, & Fredrickson, 2010). The acceptance component of mindfulness describes the act of maintaining a mindset of openness to the aforementioned experiences rather than judging or ignoring them, in particular any off-task thoughts should be met with this non-judgmental acceptance (Coffey et al., 2010).

Mindfulness practices consist of a variety of components and are often utilized to help people deal with stress, negative affect, or ruminative thoughts. The nature of these practices, namely the orienting of one's attention and non-judgmental acceptance of unwanted thoughts, was subsumed into current conceptualizations of mindfulness based interventions (Cullen, 2011). Mindfulness can be used as a general strategy throughout people's daily experience to focus in

on the present moment and disentangle themselves from ruminative thoughts. Furthermore, mindfulness based practices are often implemented by clinicians with their clients. In a more concrete sense, mindfulness has been implemented in a variety of mindfulness based interventions such as Mindfulness Based Stress Reduction (MBSR: Cullen, 2011; Jha et al., 2007; Kabat-Zinn, 1994). MBSR consists of mindful movement (yoga or mindful awareness of the body), body scan (directed attention towards body sensations), and sitting meditation (Cullen, 2011). Mindfulness based interventions help people to cope with negative affect, stress, and intrusive thoughts (Brown & Ryan, 2003; Coffey et al., 2010). Previous research showed that negative psychological well-being (neuroticism, anxiety, depression) was negatively correlated with mindfulness; positive well-being (competence, life satisfaction, pleasant affect) was positively correlated with mindfulness (Brown & Ryan, 2003). Research into mindfulness suggests a variety of positive outcomes. Experience sampling research has further shown that the acceptance component of mindfulness leads to decreases in negative affect, allowing people to cope with or accept negative thoughts (Blanke et al., 2017).

Mindfulness is consistently conceptualized as having the components of directed attention and acceptance of one's thoughts/sensations (Rahl et al., 2017; Teper & Inzlicht, 2013). In mindfulness meditation, people are asked to direct their attention to present moment sensations such as their breathing or the various details of their environment (Kabat-Zinn, 1994). This practice of directing one's attention to specific sensations or details is the attention component of mindfulness. Mindful attention has been shown to lead to increases in positive affect (Blanke et al., 2017). The research showed that increases in mindful attention led to increases in positive affectivity. These increases in mindful attention would help someone appreciate their present moment experience or "enjoy the little things in life." On the flip side,

the acceptance component of mindfulness leads to greater decreases in negative affect, allowing people to cope with or accept unwanted / off-task thoughts (Blanke et al., 2017). The functions of mindful awareness and how it works in conjunction to attentional systems will be further discussed.

Attention.

Our attentional systems play an integral role in how we see the world around us. An individual's attentional systems inform cognitive processes as to what information is attended to and processed (Posner & Petersen, 1990). Attention has been broken down into: orienting to sensory stimuli, signaling important information for conscious processing, and maintaining attention or vigilance to the task at hand (Eriksen & Yeh, 1985; Kahneman, 1973). Orienting to sensory stimuli refers to the general allocation of attentional resources towards the perception of stimuli. Our attentional system then signals which of these stimuli is most pertinent, interesting, or relevant. Once stimuli are flagged as being pertinent the attentional system then must sustain vigilance towards those stimuli (Posner & Petersen, 1990). Our conscious attention functions in a variety of ways. Namely, people can focus their attention on one specific stimulus or broaden their attention to a variety of stimuli within their environment. More concretely, one could focus their attention to a leaf in front of them, or the entire forest. This broadening or narrowing of attention is an intrinsic component of mindfulness-based interventions in that mindfulness trains people to focus their attention on the present moment (Kabat-Zinn, 1994). Not only does mindfulness instruct people to orient their attention but it also necessitates that people maintain their attention to the task at hand. Mindfulness interventions have been shown to increase people's sustained attention capabilities (Jha et al., 2007).

Specifically, mindfulness based interventions have been shown to improve people's abilities to orient their attention and monitor conflict (Jha et al., 2017). Conflict monitoring refers to people's ability to direct their attention in the face of irrelevant or distracting stimuli, tested via the flanker test (Jha et al., 2017). The flanker task requires people to determine which direction an arrow (or some such stimuli) is facing in the presence of distractor stimuli on either side called flankers. People placed in the mindfulness training condition were significantly better at directing and orienting their attention to the task at hand, compared to the control condition at time one, which allowed them to ignore the distracting stimuli. These attentional subsystems are related to people's voluntary attentional direction, which suggests that mindfulness based practices improve people's ability to direct their attention to stimuli they deem as being more important in the moment (Jha et al., 2017; Teper & Inzlicht, 2013). This attentional focus is particularly important because it allows people to focus their cognitive resources to the task at hand, blocking out some of the distracting stimuli which may hinder them (Jackson & Balota, 2012). Furthermore, the narrowing of attention also allows people to focus their attention on the stimuli which they find most interesting or even most pleasing.

Narrowing of attention leads to increases positive or neutral affect and narrowing one's attention in the face of distractors in an intrinsic component of mindfulness-based strategies (Blanke et al., 2017). Increases in positive or neutral affect are a product of people being able to direct their attention to their positive experience while blocking out or ignoring some of the other negative affectively laden stimuli present in their environment (Brown & Ryan, 2003). For example, directed attention could be as simple as enjoying your coffee at the café and being present in the moment, giving focal attention to the positively laden stimuli around. Our attentional systems determine what stimuli are feeding into our current cognitions, so training

directed attention can change the content of subsequent cognitions (Teper, Segal, & Inzlicht, 2012).

Attention, specifically the ability to direct attention, narrows under stress and mindful attention can help direct people's attention in the face of narrowed attentional resources (Hancock, 1989). Constrained attentional resources are more easily taken up, as a product of there being fewer attentional resources to spare. Stress particularly effects people's ability to maintain attention when the task at hand leads to negative mood states (Wang, Xu, Zhuang, & Liu, 2017). The negative mood induced by a task compounded with the need to complete the task leads to increased stress, which leads to people reporting that their attentional resources are strained (Hancock, 1989). For example, the stress of needing to complete an assignment compounded with the negative mood that arises from working on the assignment compound to tax attentional resources greater than if stress was not in the equation. The narrowing of attention, or the increased rate that people's attentional resources deplete under stress, suggests that a strategy such as mindful attention may mitigate the negative impact of stress (Blanke et al., 2017).

The positive benefits of mindfulness on reducing negative affect are further tied to the second component of mindfulness: non-judgmental acceptance. The acceptance component of mindfulness will be discussed regarding how it functions as well as the benefits that it affords.

Non-Judgmental Acceptance.

Non-judgmental acceptance as a component of mindfulness is essential in decreasing negative affect in that it fosters an openness and acceptance towards unwanted thoughts, and thereby helps people avoid rumination (Coffey et al., 2010). That is, the acceptance component of mindfulness entails the nonjudgmental acceptance of thoughts. Mindfulness, or more

specifically the non-judgmental acceptance of thoughts, reduces people's reactivity to their internal cognitive states, which in the case of negative or ruminative thoughts, leads to decreases in negative affect (Brown & Ryan, 2003). Greater trait mindfulness is correlated with decreases in depression and self-reported anxiety (Brown & Ryan, 2003). For example, someone may acknowledge that their negative thoughts are normal and fleeting. This allows someone to move on from these thoughts, avoid rumination, and in general decrease the negative affective impact. Research has shown that a mindfulness program that specifically included acceptance led to greater increases in sustained attention and decreases in negative affect compared to a mindfulness program that only included an attention component (Rahl et al., 2017). Increases in sustained attention suggest that people are able to maintain their attention in the face of any intrusive thoughts that occur.

By accepting negative thoughts people can further disengage themselves from those thoughts, leading to decreases in intrusive thoughts and subsequent decreases in mind wandering associated with those thoughts (Brown & Ryan, 2003; Schonert-Reichl & Lawlor, 2010). The mechanism of disengagement from negative thoughts is that people can mitigate the negative affect felt by the intrusive or unwanted thought, which leads to one being able to forget or move on from this thought more quickly. These intrusive or unwanted thoughts can cause decreases in sustained attention; therefore, mindful acceptance leads to increased sustained attention and suggests that people are better able to mitigate the attentional impact of intrusive thoughts (Rahl et al., 2017).

Negative affect often results from intrusive thoughts and mindfulness has been shown to decrease this negative affect. Furthermore, the relationship of mindfulness and negative affect is mediated by mind wandering (Mrazek, Smallwood, & Schooler, 2012; Wang et al., 2017). If

people have higher levels of mind wandering they will see a greater effectiveness in mindfulness decreasing negative affect. Mind wandering is often measured via self-report as the content of people's thoughts can not be measured directly. Self-report measures of mind wandering during an attention task show a decrease in mind wandering for participants in an acceptance mindfulness condition (Mrazek et al., 2012).

Mind wandering does not always produce negative affect, but it does tend to lead to rumination, which produces negative affect (Teper & Inzlicht., 2013). Negative affect can occur from mind wandering because thoughts are often emotionally laden. Experienced mindful meditators have been shown to have reduced emotional responses to thoughts as measured through activations of the amygdala (Teper & Inzlicht., 2013). In this same vein, individual differences in levels of acceptance in mindfulness mitigate the effects of posttraumatic stress disorders, such that greater individual levels of nonjudgmental acceptance led to better coping with posttraumatic stress (Shipherd & Salters, 2017). Mindfulness does not only help mitigate the effects of unwanted thoughts, but also more generally increases emotion regulation and executive control.

Mindful acceptance has been analyzed in regards to how it functions at the neurological level and how it has been shown to lead to greater effectiveness in executive control, namely decreases in error-related negativity for those individuals who practiced mindfulness meditation (Teper et al., 2013; Teper & Inzlicht, 2013). Error-related negativity describes the neurological response that occurs roughly at 100 msec after an error in cognition occurs. Mindfulness meditators were shown to have greater executive control, more positive affect, and a greater error-related negativity (Teper & Inzlicht, 2013). In other words, the meditators had a greater ability to notice their errors but then overcome them to continue completing the task at hand. It

appears that mindfulness, and in particular the acceptance component, allows people to more effectively notice an unwanted thought and then redirect their attention to on-task thoughts. Off-task thoughts still occur, but having acceptance of these thoughts allows people to mitigate the negative effects that these thoughts may have on cognition.

Having discussed the two components of mindfulness, it's worth noting that nonjudgmental acceptance is theorized in this paper to be moderated by need for cognitive closure. Acceptance as a component of mindfulness allows people to reduce the impact that unwanted thoughts have on their cognition, in particular people who are high in need for cognitive closure. It is theorized in this paper that people's need for cognitive closure moderates the effectiveness of nonjudgmental acceptance, because the need for cognitive closure describes people's propensity to settle on their initial thoughts and judgments to avoid ambiguity. This relationship between need for cognitive closure and mindful acceptance will be discussed.

Need for Cognitive Closure.

A person's need for cognitive closure refers to the need for stable and secure knowledge as opposed to ambiguity (Kruglanski & Webster, 1996). This need for cognitive closure has been operationalized in the form of a validated scale, which measures stable individual differences in people's acceptance of ambiguity and general tendency towards wanting closure or certainty in their cognition. The need for cognitive closure has been shown to play a crucial role in social cognition, informing an individual's judgments in situations such as: stereotypic judgments, construct accessibility when interpreting ambiguous situations or stimuli, and social comparisons among similar as well as dissimilar others (Ask & Granhag, 2005; de Dreu, Koole, & Oldersma, 1999; Webster & Kruglanski, 1994). These social constructs, such as stereotypic judgments and construct accessibility, are impacted by need for cognitive closure such that people high in need

for cognitive closure are biased towards primacy effects in their judgements. For example, participants asked to negotiate in a business setting who were higher in need for cognitive closure made fewer concessions to the other party and relied more on initial stereotypic impressions (de Dreu et al., 1999). Or in a mock criminal case, people high need for cognitive closure showed greater adherence to the initial impression of the guilty perpetrator, even in the face of alternatives (Ask & Granhag, 2005). In other words, need for closure in cognition leads to people settling on their initial judgment of a situation. This initial judgment can be rife with stereotypic judgments, but it will alleviate any feelings of ambiguity thus satisfying need for cognitive closure.

In relation to mindfulness, it may be that as need for cognitive closure increases so too will people seize upon stressful thoughts that occur to them or fixate on a thought pattern even if it is not stressful or negative. For example, a person may have an intrusive thought cross their mind about how their boss purposefully scheduled them for a shift on Friday night and that this must be because the boss was not happy with them. Another person, who is lower in need for cognitive closure, may not be motivated to come to an initial judgment on the situation and as such would not be cemented in this conception that the boss was unhappy with them. This person may consider a variety of other possibilities as to why their boss may have scheduled them on Friday night, and furthermore they may be content with the ambiguity of not knowing what the reason is that they were made to work on Friday night. It is worth noting that people high in need for cognitive closure will not always freeze upon a negative thought of a situation, but even freezing upon a positive thought and then fixating upon it should have an impact on cognitive resources (Coffey et al., 2010). Cognitive resources being taxed suggests that a cognitive intervention which frees up these cognitive resources would be beneficial.

People's need for cognitive closure may therefore inform how they interpret and react to emotionally laden or stressful stimuli. By learning to accept unwanted thoughts, people high in need for closure may see less of a negative affective impact on their cognition from this unwanted or intrusive thought. For example, the aforementioned disgruntled employee may think that their boss is scheduling them for work because they have done something wrong, but that this thought is normal and is not necessarily indicative of the situation at hand. By accepting the thought and not becoming fixated or frozen on this conceptualization of the situation people may be able to lessen the negative thoughts impact on their attention or affect. I theorize that people high in need for cognitive closure will freeze upon negative or intrusive thoughts more than people low in need for closure, and therefore by learning to accept these thoughts people high in need for cognitive closure should see less of a negative impact on affectivity and sustained attention. Furthermore, only a non-judgmental acceptance based mindfulness practice will produce this learning. The acceptance of unwanted thoughts will lead to increases in sustained attention and decreases in negative affect. Negative affect felt from a positively valenced thought would stem from a person freezing upon a thought and that thought taking up cognitive resources they would have wanted to devote to the task at hand.

However, the opposite direction of effect is also plausible. People low in need for cognitive closure are prone to having a greater quantity of off-task thoughts or mind wandering. These people therefore do not settle on an initial judgment but are instead bombarded by a multitude of possibilities as intrusive thoughts; therefore, the acceptance component of mindfulness would benefit them changing their mindset towards their multitude of thoughts. I theorize that need for cognitive closure moderates the effectiveness of acceptance on negative

affect and to a lesser extent positive affect, but the direction of this moderation can be rationalized in both ways.

Overview and Hypotheses.

This study was conducted to further understand the relationship and function of attention and non-judgmental acceptance in mindfulness based practices on sustained attention, positive affect, and negative affect. This study is an important and distinct contribution to the research literature because it expands on the methodology of Rahl et al. (2017) while also including the moderating factor of need for cognitive closure. Need for cognitive closure was measured as it is theorized to moderate the relationship between the mindfulness components and the outcome variables of sustained attention and negative affect. Need for cognitive closure describes an individual's tolerance of ambiguity and general concreteness in their thinking, NFC was measured via a validated individual difference measure. Mindfulness training is expected to lead to increases in sustained attention, increases in positive affect through the attention component, and decreases in negative affect through the acceptance component. The decrease in negative affect is theorized to be moderated by need for cognitive closure. This study will look to uncover the benefits of narrowed attention through the attention component of mindfulness, and how this may impact a person's ability to sustain attention on an attentional task. Furthermore, this research will seek to illuminate the importance of the acceptance component of mindfulness and how it will decrease the negative impact of intrusive or unwanted thoughts. It is theorized that by training and fostering nonjudgmental acceptance one will be able to reduce the negative affect felt from intrusive thoughts, and return to on-task cognitions more quickly. Furthermore, it is theorized that this relationship between nonjudgmental acceptance and decreases in negative

affectivity will be moderated by need for cognitive closure such that higher levels of need for cognitive closure will see greater decreases in negative affectivity.

Participants were asked to take part in two lab based mindfulness training sessions as well as being asked to utilize these practices in between the two sessions. Furthermore, an individual difference measure of need for cognitive closure was obtained with the intention of showing that NFC moderates the effects of mindful acceptance on cognitive functioning. Two hypotheses will be tested.

The first is a conceptual replication hypothesis, in which it is hypothesized that the acceptance and attention mindfulness practice will lead to greater increases in sustained attention and positive affect compared to an attention-only mindfulness practice (Blanke et al., 2017; Rahl et al., 2017; Teper & Inzlicht, 2013). In conjunction, it is hypothesized that the effects of mindfulness training on negative affect, namely the acceptance component, are moderated by need for cognitive closure such that people high in need for cognitive closure will see greater decreases in negative affectivity and increases sustained attention compared to those low in need for cognitive closure. High need for cognitive closure leads to people seizing upon initial judgments that may be negatively valenced or stressful or just take up cognitive resources that should be devoted to being on task, therefore the acceptance component of mindfulness will allow people to see decreases in the negative affectivity felt from these thoughts. The increases in sustained attention will be a product of the unwanted thought being accepted, and the person not feeling negative affect from not being able to move on from the thought.

This study was conducted using participants from the University of Arkansas general psychology pool. Rahl et al. (2017) placed participants into a attention mindfulness, attention + acceptance mindfulness, or control condition. Each of these conditions had participants come in

four days for 20 mins each. Participants were measured on their sustained attention via the Sustained Attention to Response Task [SART], as well as their positive and negative affect. This study will utilize a similar methodology to that of Rahl et al. (2017), but it will expand on this methodology by asking participants to utilize the mindfulness practices that they were taught in-between lab sessions. Furthermore, this research will include a measure of participant's levels of need for cognitive closure that will be measured before any manipulation is presented. The measurement of need for cognitive closure expands on the research done on mindfulness based interventions by attempting to explain which individual difference factors may influence the effectiveness of these mindfulness practices. More specifically, by measuring an individual difference of need for cognitive closure I may be able to make conclusions on how cognitive intervention practices influence people differentially.

Need for cognitive closure was measured and a median split was conducted, placing participants into high or low need for cognitive closure. Analyses were conducted to determine if the high NFC significantly differed from low NFC on all dependent variables in relation with any of the mindfulness training types.

Method

Participants.

Participants for this study consisted of 244 students recruited from the pool of general psychology students at the University of Arkansas who completed session 1, these students received credit towards a research requirement in their general Psychology class. Final participants (as in participants who have a score on the attention measure at session 2) had a mean age of 19.3. The sample was 64.6 % female. Furthermore, the sample identified as 80.3% white, 8.5% black, 7.9% Hispanic, and any remaining ethnicity / race identification was split

between a variety of responses. 244 participants took part in session 1 of this study, 202 completed the study through the end of session 2 (as indicated by a score on the attention measure at session 2). This attrition was the result of participants not showing up for their second scheduled session. Further attrition in analyses is the result of computer / software malfunctions or participants not completing or filling out measures.

Furthermore, dropout analyses were conducted via Chi-Square to determine whether there was a significant difference in participants demographics or NFC who completed or dropped out from the research study. There was a significant X^2 of gender, such that $X^2 (2) = 34.10, p < .05$. This chi-square result is driven by the fact that significantly more women dropped out from the study than men, but there were significantly more women in the study overall. There was a further significant X^2 of ethnicity, such that $X^2 (24) = 54.55, p < .05$. This chi-square was not unpacked as the participants could enter their own ethnicities therefore producing too wide a variety with too small of numbers within categories to draw any relevant conclusions. Most importantly, NFC showed a non-significant $X^2 (2) = .05, p = .82$. This value indicates that there was not a significant difference in high or low NFC individual's in regards to whether or not they finished the research study or dropped out.

Materials and Procedure.

The study was conducted in two in-lab sessions and included online survey responses in between the two lab sessions. During the first in-lab session participants were asked to complete the Need for Cognitive Closure scale (Webster & Kruglanski, 1994; $\alpha = .84$) [see Appendix for sample items]. The NFC scale in this study had a $\alpha = .80$, which is sufficiently reliable.

Participants were randomly assigned to one of three conditions: attention focused mindfulness training, attention & acceptance focused mindfulness training, and a control

condition that consisted of a neutral news article. Each participant took part in two in-lab training programs that were held one week apart from one another.

The lab procedure utilized both a paper packet with measures, as well as computer for the SART and the audio files with instructions for the mindfulness or control inductions. Upon entering the lab for the first session all participants completed a brief demographics questionnaire assessing their gender identity, race/ethnicity, and age. Next, participants completed the Need for Cognitive Closure Scale (Webster & Kruglanski, 1994) and after completing these scales the participants then filled out the SPANE to assess baseline affect. The SPANE was utilized because it picks up on both hot and cold emotions in a succinct manner. The positive affect SPANE in this study had a Cronbach's Alpha ranging from .81 – .92, which is sufficiently reliable. The negative affect SPANE in this study had a Cronbach's Alpha ranging from .81 - .86, which is sufficiently reliable. Having completed the aforementioned scales and demographics participants were then instructed to put on the provided (or self-owned) headphones and follow all instructions of the audio induction. These audio inductions took roughly 14 minutes to complete. During the audio induction participants were periodically flagged to answer a brief intrusive thoughts questionnaire. After completing these audio inductions participants were once again asked to complete the SPANE. Upon completion of this second administering of the SPANE participants were then instructed to follow all instructions and complete the sustained attention to response task (SART; Robertson et al., 1997) [see Appendix for sample items]. This task consisted of the numbers 1-9. Participants were presented a number every 1.15 seconds. Participants were then asked to press a key as quickly as possible for every number except 3. Therefore it is a go-no-go task with the number 3 being the only no-go prompt. The SART took participants roughly 10 minutes. Upon completion of the

SART participants filled out one more SPANE questionnaire assessing affect before they were debriefed. Participants were reminded by the research assistant to utilize the strategies they learned in the lab throughout the week when they encountered stressful situations, these instructions were also printed on a handout which was given to each participant as they left the lab.

During the week in between the two lab sessions participants were texted and emailed a daily stress inventory and few added questions determining the extent to which they have utilized the strategies they learned in the lab. These emails / texts were sent out daily at 8:00 PM. Further questions in this daily inventory were used to assess whether or not participants had utilized the strategies that were presented to them in the lab in their everyday life. This was primarily included as a manipulation check of sorts, to see if the participants were engaged with the research outside of the lab as they were asked to do so. To this end, the questions about whether they had utilized the strategies taught to them in the lab simply asked if they had done so this week rather than that day. I was primarily interested in tapping into whether they had put any effort into utilizing these strategies rather than determining whether they did so daily.

Session two which occurred exactly seven days after session one follow all the same procedures and protocols as session one with the exception of participants not needing to fill out a demographics or the Need for Cognitive Closure scale.

Data Analytic Plan.

Analysis of variance (ANOVA) were used to test the effects of condition, session, and NFC on the outcome variables of positive affect, negative affect, and SART discrimination. These ANOVA's were used to be able to test the differential impacts of each of these variables on the outcome variables, but also the moderating impact of NFC.

Separate regression analyses were run regressing NFC on each of the outcome variables. NFC was input as a continuous variable in this case as opposed to the median split used in the ANOVA's. These separate and individual regression analyses were intended to determine if NFC is significantly related with changes in any of the outcome variables. These analyses were conducted separately to attempt to pick up on the moderation of NFC on negative affect that was hypothesized. A symptom of creating a median split NFC variable is that linearity was lost. NFC was therefore regressed on each condition separately for each outcome variable to determine whether there is a different relationship between discrimination and NFC in any of the conditions.

Data Scoring.

NFC was computed and a median split was created for the purposes of the ANOVA's. This sectioned off participants into either high or low NFC participants. The SART gave outputs of reaction time and errors committed. In line with previous research the SART scores were computed as discrimination (total trials – errors). The SPANE was broken down into separate measures of positive and negative affect and computed as such.

Results

The online questionnaire portion of this study was analyzed to determine study engagement. For the reading control condition this mainly served as a measure of following through with study instructions. The intention was to determine how much of the sample engaged with the research outside of the lab. 65% of the sample completed the online questionnaire, this is a sufficient number to state that on average the sample was engaged outside of the lab sessions. This engagement of 65% was greater than the *a priori* proposal of 60% engagement.

Furthermore, need for cognitive closure scores were computed by scoring or reverse scoring the necessary items on the scale and averaging them resulting in a total score for each participant (Kruglanski & Webster, 1996). A median split of high and low NFC was used as one of two independent variables in an ANOVA on the outcomes of positive affect, negative affect and sustained attention (errors committed). The median split was conducted as to not lose any participant data.

A 3 (Attention, attention + acceptance, reading control) X 2 (high NFC, low NFC) X 2 (session) X 2 (time of measurement) mixed-model ANOVA was conducted separately on positive and negative affect.

Both positive and negative affect were analyzed at time point two and three of each session, as including the first time point of each session produced spurious effects that were due to random differences at baseline. Baseline positive affect differed from $M = 14.30 - 9.90$, which resulted in spurious effects. Therefore, the time one measurement of positive and negative affect was eliminated.

Hypothesis: Acceptance Will Lead to Decreases in Negative Affect.

For negative affect results showed non-significant main effects for NFC and for condition. These non-significant main effects were qualified by a significant NFC*condition interaction, $F(2,164) = 6.01, p = .003, \eta_p^2 = .07$. This interaction is visualized in Figure 1. All F -values are reported in Tables 4 and 5. Post-hoc analyses were conducted by running a one-way ANOVA on a six-level IV encapsulating all three conditions and high or low NFC, further Tukey HSD post hoc tests were run on these ANOVA results. The ANOVA revealed a significant difference between groups at the second [$F(6,242) = 2.50, p = .02$] and third [$F(6,242) = 2.34, p = .03$] measurement of negative affect during session 1. Further Tukey post hoc tests reveal a

difference between the low NFC attention group ($M = 2.65$, $SD = 1.80$) in comparison to the low NFC control group ($M = 4.61$, $SD = 3.14$) and high NFC control group ($M = 4.50$, $SD = 3.20$) at the first measurement of negative affect [$p = .02$, $p = .03$ respectively]. These post-hoc analyses support the claim that there was a significant difference in the amount of negative affect felt at session 2 compared to session 1. The acceptance (referring to attention + acceptance and referred to as acceptance from here on out) condition was interestingly the only condition to show an opposite pattern of effects compared to the other two conditions, with low NFC experiencing significantly more negative affect. In the other two conditions (attention and control) high NFC showed greater negative affect relative to low NFC. This finding is interesting, as I hypothesized that the acceptance component of mindfulness would lead to decreases in negative affect. Instead, this effect appears to be opposite for low NFC participants.

Hypothesis: Attention Will Lead to Increases in Positive Affect.

Positive affect results showed non-significant main effects for NFC and condition. The interaction of NFC*Condition was also non-significant $F(2,164) = .90$, $p = .41$, $\eta_p^2 = .01$. All F-values and inferential statistics are reported in Tables 2 and 3. These results on positive affect are surprising and in opposition to the literature, which suggest that the directed attention component of mindfulness should lead to increases in positive affect (Blanke et al., 2017; Rahl et al., 2016).

Hypothesis: Acceptance Will Lead to Increases in Sustained Attention / Effect of Acceptance Component of Mindfulness Will Be Moderated by NFC.

A 3 (attention, acceptance, control) X 2 (high NFC, low NFC) X 2 (session) mixed-model ANOVA was conducted on sustained attention (total trials - errors committed).

Sustained attention was measured as discrimination (trials – errors) on the SART.

Sustained attention results showed non-significant main effects for NFC and condition. A non-

significant main effect of session. A non-significant interaction of NFC*condition. These results are qualified by an interesting within-subjects interaction of session*condition, $F(2,188) = 4.35$, $p = .02$, $\eta_p^2 = .05$. This significant interaction is represented by Figure 2. All F-values are reported in Tables 6 and 7. The acceptance condition had significantly different direction of effect, $M = 295.1$ at time 1 to $M = 297.6$ at time 2 compared to attention which had, $M = 298$ at time 1 and $M = 295.5$ at time 2. This was the driving difference of the interaction. This interaction is further qualified by a significant one-way ANOVA conducted on the difference score of SART discrimination scores (session 2 – session 1) of each condition, $F(2,194) = 3.50$, $p = .03$. This significant ANOVA is further qualified by a Tukey's HSD post hoc test revealing a significant difference between the attention ($M = 2.20$, $SD = 8.77$) and acceptance ($M = -1.93$, $SD = 9.70$) conditions. The attention and acceptance conditions had a significant mean difference of 4.13 with $p = .03$. The results of this significant interaction reveal that participants in the acceptance condition committed the greatest number of errors at session one and the attention condition performed the fewest errors at session one. Surprisingly, the acceptance condition is was the only condition to perform fewer errors from session one to session two. This finding was surprising, because I hypothesized that the attention component would have led to increases in sustained attention as measured by the SART. These findings support that hypothesis at session one, but at session two the acceptance condition committed the fewest errors and was the only condition to reduce errors from session one to session two.

Hypothesis: NFC Will Have Positive Relationship with Negative Affect.

Within each condition, need for cognitive closure was regressed on each measure. The R^2 and β are reported in Table 1. For the acceptance condition there was a non-significant relationship of regressing NFC on positive affect, negative affect, and errors committed. In the

acceptance condition positive affect was the only outcome variable to show a positive R^2 . For the attention condition there was a non-significant relationship of regressing NFC on positive, negative affect, and errors committed. Finally, in the control condition there was a non-significant relationship of regressing NFC on positive, negative affect, and errors committed. Overall, these results show non-significant effects of regressing NFC on the outcome variables. It was hypothesized that NFC would have a positive relationship with negative affect, such that individuals who were high in NFC would have significantly more negative affect. This hypothesis was not supported.

Discussion

The purpose of this research was to test the differential aspects of mindfulness components: directed attention and nonjudgmental acceptance, particularly impacts on sustained attention and affect. This distinction between directed attention and nonjudgmental acceptance is oft seen in the literature (Coffey et al., 2010), but the proposed downstream effects of mindfulness training / interventions are often far-reaching and the particular operationalization and implementations differ greatly (Van Dam et al., 2017). Therefore, this research speaks to the mechanisms of mindfulness through its specific components.

Four primary hypotheses were tested in this research. First, the acceptance component of mindfulness was theorized to decrease negative affect. Secondly, the attention component of mindfulness was theorized to increase positive affect. The acceptance component of mindfulness was further hypothesized to increase people's attentional capabilities as measured by the SART, this finding is in line with previous literature (Rahl et al., 2017). Finally, NFC was hypothesized to moderate the effect of the components of mindfulness training on negative affect.

Sustained Attention.

Mindfulness interventions were shown to increase individual's attentional capabilities as measured by the sustained attention to response task (SART), such that the acceptance based mindfulness condition committed significantly fewer errors at time two. Not only that, but the acceptance condition was the only condition to see a reduction in errors committed from session one to session two. This shows that instructing individuals on how to direct their attention has an appreciable change on their downstream behavior. The current study therefore supports previous findings in the literature, helping to elucidate the overall effects of mindfulness interventions (Chambers & Allen, 2008). Surprisingly the acceptance based mindfulness condition committed the most errors at time one relative to the other conditions. While this finding was not statistically significant, it is still interesting when one considers that the acceptance based intervention led to significantly fewer errors committed at time two. It seems as if mindfulness inductions help to increase people's orienting capabilities, allowing them to more quickly switch towards off-task thoughts and then back to the task at hand. The non-judgmental acceptance component seems to add complexity which takes people more time to get used to (hence the decrease in errors from session one to two), but once people were comfortable with this non-judgmental acceptance it was the most effective mindfulness induction as measured by the SART. Furthermore, this finding that the acceptance condition was the only one to decrease errors does not support the initial hypothesis that the attention component would lead to greatest appreciable benefits in sustained attention.

Need for Cognitive Closure.

Cognitive processing style, as measured by need for cognitive closure, was included as a moderating variable. NFC speaks to the effects of individual differences in cognition and how

that may affect cognitive interventions like mindfulness inductions. This research showed that people who are low in need for cognitive closure felt significantly more negative affect when placed into the nonjudgmental acceptance mindfulness condition, compared to the other two conditions. Furthermore, the acceptance based mindfulness condition was the only group to experience higher negative affect for the low NFC people relative to the high NFC. These findings reveal an interesting interaction between the acceptance component of mindfulness and NFC. This interaction of negative affect and NFC was not demonstrated in the separate regression analyses. People who are low in need for cognitive closure have a high tolerance for ambiguity or uncertainty in their thoughts; therefore, when they are told to accept off-task thoughts, perhaps negative affect results as these people are used to having multiple thoughts or uncertainty as to what the overall outcome of their thoughts will be.

Positive affect did not differ based on condition. This is surprising as previous literature has suggested that mindfulness inductions should increase positive affect (Brown & Ryan, 2003). The present research did not support this finding as the two mindfulness conditions did not significantly differ from the control condition. This lack of a finding is somewhat surprising, but may have occurred because the tasks participants were asked to complete primarily fostered negative rather than positive affect. As such, only negative affect was able to be impacted. The SART was tedious and boring, and overall the rest of the procedures could have been interpreted as time-consuming at best. Often times the positive affect boosting nature of mindfulness inductions is theorized to result from people directing their attention to positive stimuli around them (Hanley et al., 2017), and there were not many positive stimuli to direct one's attention to in this particular study.

Studies on mindfulness interventions have shown variable and inconsistent results (Van Dam et al., 2017). The concept of mindfulness is ill defined and often times the operationalization of mindfulness varies greatly from one study to the next. The present study suggests that individual differences in cognitive processing, such as NFC, account for some of the variance and uncertainty surrounding mindfulness interventions. Perhaps varying effects are found from one study to the next because mindfulness interventions impact people variably as a product of individual differences. These differences on training effectiveness as a product of individual differences should inform our application of mindfulness inductions in all contexts. If we know that mindfulness inductions impact people differently based on individual differences, then interventions should be tailored to the individual to insure the greatest benefits. Currently, many mindfulness interventions are assumed to function the same for all individuals (Van Dam et al., 2017).

Limitations.

This research was not free of limitations. The EPRIME program used to measure sustained attention via the SART at times crashed, causing a loss of data. Participants were asked to complete the same affect measures three times during each session which may have caused them considerable annoyance or dissatisfaction. An intention of this study was to ask participants to partake in the strategies that they learned within the lab outside of the lab between the two sessions. As researchers we didn't have a particularly effective way of ascertaining whether the participants actually took part in this practice. The content of individuals' off-task thoughts was not measured. Individuals in the mindfulness induction conditions were told to either accept or return to on-task thoughts, but the content of their off-task thoughts may play a pivotal role in the attentional and affective influence of these off-task thoughts. For example, if a participant's off-

task thought was centered around what they were going to eat later this should have a differential impact compared to an off-task thought related to how someone just broke up with their significant other. Furthermore, the nature of the attentional measure (SART) was not particularly ecologically valid. The SART does encapsulate an individual's need to sustain attention in the face of distractors, but this task does not map very well onto real world experience (Posner & Petersen, 1990). Primarily, the SART is extremely unengaging compared to the things that people normally need to sustain attention to. Asking a participant to direct their attention towards a series of numbers is significantly more boring or tedious than listening to a lecture, working on a report, or driving a car. A more complex attentional measure, which is more ecologically valid, may boost the applications of this research. Lastly, the mindfulness inductions themselves can be interpreted as a limitation. Experienced mindfulness meditators exhibit the greatest positive benefits (Jha et al., 2007). The present research strived to foster as much experience in participants as possible, but this only amounted to two inductions interspersed by a week. More inductions and more training should lead to even greater effects on sustained attention and affect.

Application of Mindfulness Interventions.

Mindfulness interventions can be utilized in a variety of contexts. They have been shown to increase positive affect, reduce negative affect, and increase sustained attention capabilities, although this study only supports the general findings on sustained attention (Chambers, Lo, & Allen, 2017). Negative affect was significantly increased in the acceptance based condition and positive affect showed no significant effects. These previously stated outcomes would be sought after in a wide variety of situations, including individuals who work in attention taxing occupations (e.g. pilots, air traffic controllers, heavy machinery operators, etc.), but more research needs to be done on how these effects can be stably found as they are not necessarily

supported by this research. Therefore, by understanding how cognitive interventions impact individuals, including individual differences, we can have a greater understanding of how to increase efficiency for people in the workplace (Ask & Granhag, 2005). It is imperative that the operationalizations of mindfulness be clear and consistent, and that the components of present moment awareness and non-judgmental acceptance be considered in regard to the intended behavioral or affective outcome. It is very strange that the acceptance component of mindfulness is what led to increased sustained attention at session two, when this component of mindfulness was hypothesized to increase positive affect. It appears as if training people to foster and cultivate a non-judgmental acceptance of off-task thoughts increases their orienting capabilities as measured by errors committed on the SART. By training participants to accept off-task thoughts each off-task thought may have a diminished impact on their attentional resources, but it takes time to train oneself to engage in this activity as is evidenced by the effects being seen at session two but not session one. The research in this study elucidates the distinction between those components and brings forth substantiating evidence for the efficacy and also murkiness of mindfulness interventions. Further research needs to be conducted on the components of mindfulness, their interaction with individual differences (such as NFC), and the intended outcomes of mindfulness based on an agreed upon operationalization of the concept.

Future research should look to build upon the varying benefits or detriments of the components of mindfulness. The present research showed that present moment awareness leads to greater attentional benefits in the short term relative to nonjudgmental acceptance, but after session two these nonjudgmental acceptance condition participants committed fewer errors. The temporal effectiveness of mindfulness components should be further analyzed. Understanding the time table of how these mindfulness interventions impact individuals will inform the

implementation of mindfulness practices in any context. If the desired outcome is for short term improvements in attentional capabilities, then perhaps an attention only mindfulness induction will be the most effective.

Future research should consider the results presented in this paper, namely that need for cognitive closure moderates the effectiveness of the acceptance component of mindfulness on negative affect. The greatest take-away from this research is that individual differences have a profound impact on the effectiveness of interventions. For mindfulness interventions, and perhaps all interventions, relevant individual differences should be measured and considered to increase the effectiveness of the intervention. Research will need to be done on what individual differences may impact varying cognitive or behavioral interventions. Future research should therefore identify theoretically relevant individual differences and test what sorts of effects they have on mindfulness or other interventions. Finally, the present research presented findings in support of varying effects of the components of mindfulness training. Differing effects of mindfulness training components suggest that more care should be taken in the implementation of mindfulness interventions. For example, for shorter mindfulness implementations this research suggests that it should not include an acceptance component. The acceptance component was shown to increase negative affect in individuals who are high in NFC. Furthermore, the acceptance component was only able to perform better on the sustained attention task at session 2, further supporting the claim that this aspect of mindfulness is more effective in the long term rather than the short term.

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Appendix

Figures.

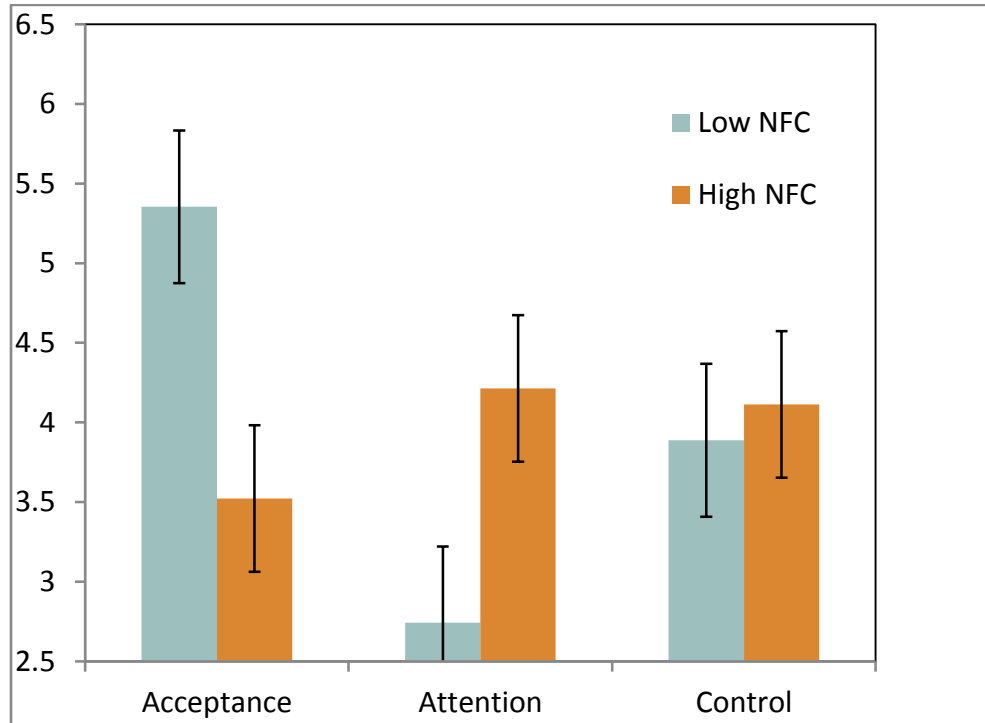


Figure 1. Negative affect by condition and NFC, error bars +/-1 SD.

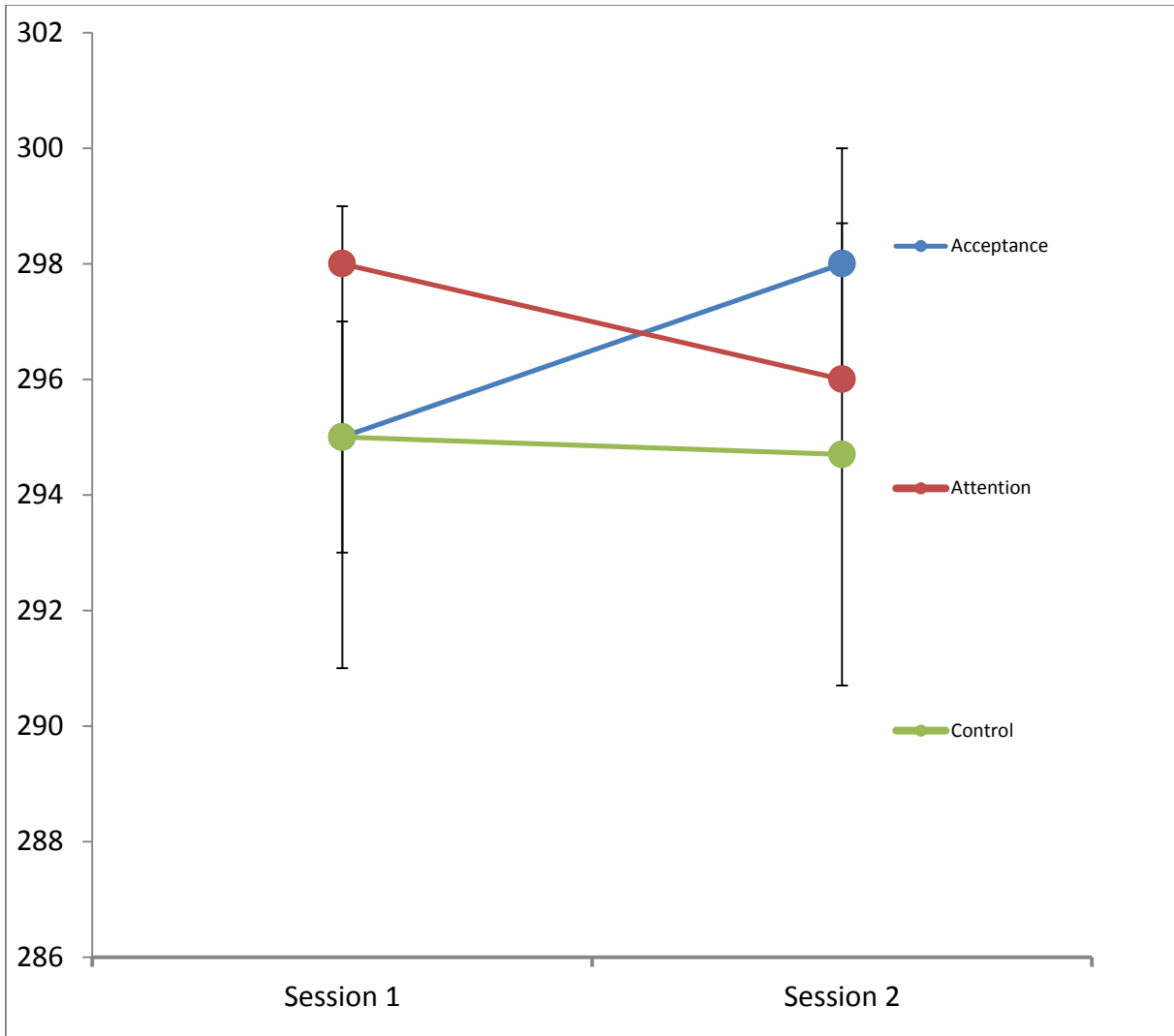


Figure 2. SART discrimination by session and condition, error bars +/-1 SD.

Tables.

Table 1

Separate linear regressions of each DV on NFC

Condition	DV	<i>B</i> (SE)	β	Model <i>F</i> , <i>R</i> ²
Acceptance	PA	-.06 (.04)	-.19	<i>F</i> (1,81) = 2.93, <i>p</i> = .09, <i>R</i> ² = .04
	NA	.007(.03)	.03	<i>F</i> (1,81) = .06, <i>p</i> = .80, <i>R</i> ² = .001
	Disc	-.05 (.07)	-.07	<i>F</i> (1,78) = .024, <i>p</i> = .51, <i>R</i> ² = .01
Attention	PA	.008(.05)	.02	<i>F</i> (1,75) = .024, <i>p</i> = .89, <i>R</i> ² = .00
	NA	.03 (.03)	.12	<i>F</i> (1,75) = .101, <i>p</i> = .32, <i>R</i> ² = .01
	Disc	.083 (.07)	.14	<i>F</i> (1,73) = 1.50, <i>p</i> = .22, <i>R</i> ² = .02
Control	PA	-.03 (.03)	-.10	<i>F</i> (1,77) = .85, <i>p</i> = .35, <i>R</i> ² = .01
	NA	.03 (.02)	.15	<i>F</i> (1,77) = 1.72, <i>p</i> = .19, <i>R</i> ² = .02
	Disc	-.01 (.06)	-.03	<i>F</i> (1,74) = .053, <i>p</i> = .81, <i>R</i> ² = .00

Note: NFC = Need for Cognitive Closure, PA = Positive Affect, NA = Negative Affect, Disc= Discrimination

Table 2
ANOVA Results – Positive Affect Between Subjects Effects

Predictor	<i>df</i>	MS	<i>F</i>	<i>p</i>	η_p^2
Intercept	1	68927.64	665.80	.00	.80
NFC	1	4.08	.04	.84	.00
Cond	2	230.14	2.22	.11	.03
NFC X Cond	2	92.10	.90	.41	.01

Note. NFC is the median high/low split of the continuous Need for Cognitive Closure variable. MS is Mean Square.

Table 3
ANOVA Results- Positive Affect Within Subjects Effects

Predictor	<i>df</i>	MS	<i>F</i>	<i>p</i>	η_p^2
Session	1	72.51	3.75	.06	.02
Session X NFC	1	8.43	.44	.51	.00
Session X Cond	2	8.23	.43	.66	.00
Session X NFC X Cond	2	39.30	2.03	.14	.02
Time	1	1767.97	116.71	.00	.42
Time X NFC	1	1.35	.09	.80	.00
Time X Cond	2	1.75	.12	.90	.00
Time X NFC X Cond	2	13.73	.12	.41	.01
Session X Time	1	55.10	6.90	.01*	.04
Session X Time X NFC	1	.13	.02	.90	.00
Session X Time X Cond	2	12.50	1.60	.21	.02
Session X Time X NFC X Cond	2	4.50	.56	.57	.00

Note. NFC is the median high/low split of the continuous Need for Cognitive Closure variable. MS is Mean Square.

* Indicates significance, $p < .05$.

Table 4
ANOVA Results – Negative Affect Between Subjects Effects

Predictor	<i>df</i>	MS	<i>F</i>	<i>p</i>	η_p^2
Intercept	1	10416.22	4.19	.00	.72
NFC	1	.33	.01	.91	.00
Cond	2	48.93	1.98	.14	.02
NFC X Cond	2	149.10	6.01	.00*	.07

Note. NFC is the median high/low split of the continuous Need for Cognitive Closure variable. MS is mean square.

* Indicates significance, $p < .05$.

Table 5
ANOVA Results- Negative Affect Within Subjects Effects

Predictor	<i>df</i>	MS	<i>F</i>	<i>p</i>	η_p^2
Session	1	168.02	19.60	.00	.11
Session X NFC	1	3.62	.42	.52	.00
Session X Cond	2	11.11	1.30	.28	.02
Session X NFC X Cond	2	10.69	1.25	.30	.02
Time	1	101.80	11.22	.00	.06
Time X NFC	1	1.03	.11	.74	.00
Time X Cond	2	4.67	.52	.60	.00
Time X NFC X Cond	2	17.34	1.91	.20	.02
Session X Time	1	8.71	1.76	.19	.01
Session X Time X NFC	1	.48	.10	.76	.00
Session X Time X Cond	2	14.10	2.85	.06	.03
Session X Time X NFC X Cond	2	7.10	1.43	.24	.02

Note. NFC is the median high/low split of the continuous Need for Cognitive Closure variable. MS is Mean Square.

Table 6
ANOVA Results – SART Discrimination Between Subjects Effects

Predictor	<i>df</i>	MS	<i>F</i>	<i>p</i>	η_p^2
Intercept	1	33107250.12	224409.17	.00	.99
NFC	1	155.53	1.05	.31	.00
Cond	2	87.04	.60	.56	.00
NFC X Cond	2	37.20	.25	.78	.00

Note. NFC is the median high/low split of the continuous Need for Cognitive Closure variable. MS is Mean Square.

Table 7
ANOVA Results – SART Discrimination Within Subjects Contrasts

Predictor	<i>df</i>	MS	<i>F</i>	<i>p</i>	η_p^2
Session	1	1.50	.04	.85	.00
Session X NFC	1	12.23	.30	.60	.00
Session X Cond	2	183.20	4.35	.01*	.04
Session X NFC X Cond	2	47.91	1.14	.32	.01

Note. NFC is the median high/low split of the continuous Need for Cognitive Closure variable. MS is Mean Square.

* Indicates significance, $p < .05$.

IRB Letter

To: Maximilian V Fey
BELL 4188

From: Douglas James Adams, Chair
IRB Committee

Date: 01/02/2018

Action: **Exemption Granted**

Action Date: 01/02/2018

Protocol #: 1711084165

Study Title: Attention and affect

The above-referenced protocol has been determined to be exempt.

If you wish to make any modifications in the approved protocol that may affect the level of risk to your participants, you must seek approval prior to implementing those changes. All modifications must provide sufficient detail to assess the impact of the change.

If you have any questions or need any assistance from the IRB, please contact the IRB Coordinator at 109 MLKG Building, 5-2208, or irb@uark.edu.

cc: Denise R Beike, Investigator

Questionnaire

Need for Cognitive Closure scale

1. I think that having clear rules and order at work is essential for success. (_____)
2. Even after I've made up my mind about something, I am always eager to consider a different opinion.(_____)
3. I don't like situations that are uncertain. (_____)
4. I dislike questions which could be answered in many different ways. (_____)
5. I like to have friends who are unpredictable. (_____)
6. I find that a well ordered life with regular hours suits my temperament. (_____)
7. I enjoy the uncertainty of going into a new situation without knowing what might happen. (_____)
8. When dining out, I like to go to places where I have been before so that I know what to expect. (_____)
9. I feel uncomfortable when I don't understand the reason why an event occurred in my life. (_____)
10. I feel irritated when one person disagrees with what everyone else in a group believes. (_____)
11. I hate to change my plans at the last minute. (_____)
12. I would describe myself as indecisive. (_____)
13. When I go shopping, I have difficulty deciding exactly what it is I want. (_____)
14. When faced with a problem I usually see the one best solution very quickly. (_____)
15. When I am confused about an important issue, I feel very upset. (_____)
16. I tend to put off making important decisions until the last possible moment. (_____)
17. I usually make important decisions quickly and confidently. (_____)
18. I have never been late for an appointment or work. (_____)
19. I think it is fun to change my plans at the last moment. (_____)
20. My personal space is usually messy and disorganized. (_____)
21. In most social conflicts, I can easily see which side is right and which is wrong. (_____)
22. I have never known someone I did not like. (_____)
23. I tend to struggle with most decisions. (_____)
24. I believe orderliness and organization are among the most important characteristics of a

good student. (_____)

25. When considering most conflict situations, I can usually see how both sides could be right.

26. I don't like to be with people who are capable of unexpected actions. (_____)

27. I prefer to socialize with familiar friends because I know what to expect from them. (_____)

28. I think that I would learn best in a class that lacks clearly stated objectives and requirements. (_____)

29. When thinking about a problem, I consider as many different opinions on the issue as possible. (_____)

30. I don't like to go into a situation without knowing what I can expect from it. (_____)

31. I like to know what people are thinking all the time. (_____)

32. I dislike it when a person's statement could mean many different things. (_____)

33. It's annoying to listen to someone who cannot seem to make up his or her mind. (_____)

34. I find that establishing a consistent routine enables me to enjoy life more. (_____)

35. I enjoy having a clear and structured mode of life. (_____)

36. I prefer interacting with people whose opinions are very different from my own. (_____)

37. I like to have a plan for everything and a place for everything. (_____)

38. I feel uncomfortable when someone's meaning or intention is unclear to me. (_____)

39. I believe that one should never engage in leisure activities. (_____)

40. When trying to solve a problem I often see so many possible options that it's confusing. (_____)

41. I always see many possible solutions to problems I face. (_____)

42. I'd rather know bad news than stay in a state of uncertainty. (_____)

43. I feel that there is no such thing as an honest mistake. (_____)

44. I do not usually consult many different options before forming my own view. (_____)

45. I dislike unpredictable situations. (_____)

46. I have never hurt another person's feelings. (_____)

47. I dislike the routine aspects of my work (studies). (_____)

Scale of Positive and Negative Affect Experience (SPANE)

Please think about what you have been doing and experiencing during the present moment. Then report how much you experienced each of the following feelings, using the scale below. For each item, select a number from 1 to 5, and indicate that number on your response sheet.

0	1	2	3	4
Absent	Mild	Moderate	Strong	Very Strong

_____ Positive

_____ Negative

_____ Good

_____ Bad

_____ Pleasant

_____ Unpleasant

_____ Happy

_____ Sad

_____ Afraid

_____ Joyful

_____ Angry

_____ Contented

Survey Questions

- 1) Have you utilized the practices presented to you in lab this week? (yes/no)
- 2) Have you encountered any stressful situations or intrusive thoughts this week? If so, how did you manage them? (Open ended)
- 3) Have you practiced mindfulness this week? (yes/no)

Daily Stress Inventory

Instructions: Below are listed a variety of events that may be viewed as stressful or unpleasant. Read each item carefully and decide whether or not that event occurred within the past 24 hours. If the event *did* occur place a **“YES”** next to the statement, if the event *did not* occur place a **“NO”** next to the statement. Please answer as honestly as you can so that we may obtain accurate information.

1.	Performed poorly at task
2.	Performed poorly due to others
3.	Thought about unfinished work
4.	Hurried to meet deadline
5.	Interrupted during task/activity
6.	Someone spoiled your completed task
7.	Did something you are unskilled at
8.	Unable to complete a task
9.	Was unorganized
10.	Criticized or verbally attacked
11.	Ignored by others
12.	Spoke or performed in public
13.	Dealt with rude waiter/waitress/salesperson
14.	Interrupted while talking
15.	Was forced to socialize
16.	Someone broke a promise/appointment
17.	Competed with someone
18.	Was stared at
19.	Did not hear from someone you expected to hear from
20.	Experienced unwanted physical contact (crowded, pushed)
21.	Was misunderstood
22.	Was embarrassed
23.	Had your sleep disturbed
24.	Forgot something
25.	Feared illness/pregnancy

26.	Experienced illness/physical discomfort
27.	Someone borrowed something without your permission
28.	Your property was damaged
29.	Had minor accident (broke something, tore clothing)
30.	Thought about the future
31.	Ran out of food/personal article
32.	Argued with spouse/boyfriend/girlfriend
33.	Argued with another person
34.	Waited longer than you wanted
35.	Interrupted while thinking/relaxing
36.	Someone "cut" ahead of you in a line
37.	Performed poorly at sport/game
38.	Did something that you did not want to do
39.	Unable to complete all plans for today
40.	Had car trouble
41.	Had difficulty in traffic
42.	Money problems
43.	Store lacked a desired item
44.	Misplaced something
45.	Bad weather
46.	Unexpected expenses (fines, traffic ticket, etc.)
47.	Had confrontation with an authority figure
48.	Heard some bad news
49.	Concerned over personal appearance
50.	Exposed to feared situation or object
51.	Exposed to upsetting TV show, movie book
52.	"Pet peeve" violated (someone fails to knock, etc.)
53.	Failed to understand something
54.	Worried about another's problems
55.	Experienced narrow escape from danger

56.	Stopped unwanted personal habit (overeating, smoking, nailbiting)
57.	Had problem with kid(s)
58.	Was late for work/appointment

To manage your feelings about the stressful event, to what extent have you:

Brooded or ruminated about what happened 0 = not at all
 1 = minimally
 2 = slightly
 3 = somewhat
 4 = moderately
 5 = very much
 6 = extremely

Tried accept your feelings 0 = not at all
 1 = minimally
 2 = slightly
 3 = somewhat
 4 = moderately
 5 = very much
 6 = extremely

Tried to direct attention to your body sensations 0 = not at all
 1 = minimally
 2 = slightly
 3 = somewhat
 4 = moderately
 5 = very much
 6 = extremely

Tried to accept your thoughts 0 = not at all
 1 = minimally
 2 = slightly
 3 = somewhat
 4 = moderately
 5 = very much
 6 = extremely

Tried to distract myself 0 = not at all
 1 = minimally
 2 = slightly
 3 = somewhat
 4 = moderately
 5 = very much
 6 = extremely

Tried to direct attention to a task 0 = not at all
 1 = minimally
 2 = slightly
 3 = somewhat
 4 = moderately
 5 = very much
 6 = extremely

Scripts.

Attention + Acceptance

DAY 1

Thank you for participating in this study. The primary intention of this study is to understand how training your attention can impact your well-being and performance. Attention training, such as that you will learn here, requires your full attention and effort, and it may be difficult for you at times, but stay with it-- all that I ask is that you give your best effort!

For the next several days, you will learn and practice how to monitor your moment-to-moment experience in a non-judgmental and accepting manner. Specifically, you have the opportunity to practice training your attention and attitude toward your experience. You may have had the experience of driving and having someone cut you off on the road—suddenly, you had a surge of anger and reactivity. This training will focus on helping you become more attentive and aware of your experiences, and less automatically reactive to your experiences. Developing an attitude of acceptance will remove obstacles that otherwise inhibit awareness, such as self-criticism and fear. The way you will develop this moment-to-moment awareness is through monitoring your breath. Your breath is always there, so it's a great anchor for training your moment-by-moment attention and awareness. In the coming days you will continue to train your attention to monitor your breath in a detached and non-reactive way, and then expand the training so that you are monitoring other aspects of your experience. This attention training will help you notice how you are responding during our performance tasks at the end of this study, and we believe it will make you a more effective problem-solver. If you put in the work and stay with it over the next couple of days, you will see your problem solving abilities improve.

At several points during your training today you will hear this sound [CHIME], at which time we ask that you indicate the degree to which your mind was attentive to this training. These chimes will occur at random intervals during your training today. Once you make a rating, you can then soften your eyes and resume the training.

What I want you to do is keep both feet flat on the ground when you're sitting in your chair. Let your sit bones and pelvis sink down into the chair as your spine lifts up. Keep your back straight and upright, but not too rigid. This upright position will help you stay alert and focused during the training session. Your hands can rest on your lap in a position that is comfortable for you. To train your attention, your goal is to fully follow my instructions.

[15 second silence]

And when you are comfortable with your body position, I want you keep your eyes open, but close them a little, look ahead, and then shift your gaze at a point that is 45 degrees down toward the ground. We'll call this "soft eyes", you are passively focusing on a point that is out in front of you and down toward the ground. This attention practice today is about noticing your breath, so there's no need to stare at anything, or attend to your visual experience in any way, but to focus all your attention on your breathing. Your soft eyes should be comfortable and not strained; make any adjustment you think is necessary, but it is important to keep them partially open-- this helps foster alertness. You must choose to remain awake and alert. Having given you the background on our plan for this training, let's begin. Today's attention training session will help you develop a moment to moment awareness of your breath and a non-judgmental attitude toward your experience. Your breathing is always there, it's happening in each moment, and you can tune into your experience of breathing.

Take a deep breath, hold it in for a couple of seconds and exhale slowly. Let's do this for the next few moments, on each in-breath you can say quietly "breathing in" and as you breathe out, you can say "breathing out" to yourself. Note each in breath and each out breath.

[15 second silence]

Watch your full in-breath; notice that point when the in-breath ends and the out-breath begins.

[15 second silence]

To help train your ability to monitor and accept your experience of breathing, let all things come and go with detachment, observing from a distance. If you notice that you are distracted, just let the thought go and come back to this breathing practice..... Breathing in, know that you are breathing in. Breathing out, know that you are breathing out.

[30 second silence]

Allow your experience to be what it is, gently accepting each new thought or sensation. Each sensation is momentary, here one moment, and gone the next. Sitting in awareness, in stillness, can teach you how to be right here, right now. Breathing in, breathing out.

CHIME [90 second silence]

There is no need to control your breathing, watch each breath without reacting to it. You might notice that your mind has drifted off into thoughts about a class assignment or dinner later—you can label this as “distracted”, accepting these distractions with kindness while continuing to breathe deeply. Training your attention is all about noticing and labeling when your mind wanders, then returning to your primary target of attention, your breathing,.

[30 second silence]

Breathing in, breathing out. When you notice that you are distracted or that your mind has wandered off away from watching your breathing, you can gently bring your attention back to your breath.

[30 second silence]

When you become comfortable with it, bring your full attention to the changing sensations of your breathing. These sensations may be occurring at your nostrils, that place where the air is moving into and out of your body. Begin to develop an open and curious attitude toward your experience-noticing when you react emotionally and coming back to a place of non-reactivity, of simple observation.

[15 second silence]

When you breathe in, gently notice and accept what is occurring at the nostrils, maybe it's a little cold and tingly, and when you breathe out, it's smooth, and warm.

CHIME [90 second silence]

You can continue to note the in-breath, and the out-breath. Spend the next few moments in silence noticing what is happening at the nostrils as you breathe in and breathe out. This attention training practice teaches you that each of our experienced sensations are momentary, they're fleeting, they're here one moment, and they're gone the next. You can choose to respond to each moment with openness and compassion. This flexible and objective state of mind that results from focusing on the breath is effective during times of stress.

[30 second silence]

Noticing that you are distracted and accepting these distractors in a calm and detached manner is one of the most important aspects of this attention training practice. It's okay; you're raising your awareness. When your mind has drifted away from your intended focus - your breath - you acknowledge that distractor and accept all feelings that occur. For instance you may be thinking of a conversation you had earlier, or internal feelings like hunger and may become frustrated with yourself. These are all distractors; what you do is acknowledge these experiences when they arise, and return to your breath. Most importantly, there is no need in this practice to judge yourself negatively, because becoming distracted is just part of the practice of training your attention.

Take a deep breath, relax, and then breathe normally, bringing your full attention to the changing sensations of the breath.

[30 second silence]

There's no need to feed judgmental thoughts, instead you can practice becoming detached. You can notice when you are being judgmental, this is a distractor as well. Then, return to focusing on your breathing, cultivating this practice of open acceptance.

CHIME [90 second silence]

Accept distractions as they arise and as you let them go, take a couple of deep breaths, relax, and start over.

[15 second silence]

If you find your mind to be too sleepy, look around, get readjusted, re-soften your eyes and start over. You have one intention—to be right here, right now, fully experiencing and accepting each breath, in each moment. Breathing in, breathing out. [30 second silence]

If you've drifted too far away, just gently bring yourself back and start over. You can start over hundreds of times in one sitting, its part of the training.

[15 second silence]

In the few moments that you have left, see if you can really tune into the present moment in a detached manner. Notice the full in-breath and the full out-breath.

[20 second silence]

Whenever you are ready, open your eyes and bring your attention back to the world around you, adjusting your body position.

[5 second silence]

[*Bell*] That will conclude today's session. Thank you for participating in this session.

Day 2

Welcome back, you'll be completing the performance task, but first we are going to give you the chance to practice your attention training one more time. During today's attention training session you will begin by focusing on your breath, then shift to body awareness, and end with monitoring your thoughts and emotions as they arise. Most importantly, your ability to accept your experience as it arises will help you manage how you react to everyday challenging events. This attention training will help you notice how you are responding during the upcoming performance tasks, and we believe it will make you a more effective problem-solver. Our hope is that you'll use the attention skills that you've gained to more effectively perform on the problem-solving tasks today.

At several points during your training today you will hear this sound [CHIME], at which time we ask that you indicate the degree to which your mind was distracted. Once you make a rating, you can then soften your eyes and resume the training.

Settle into your chair, feet flat on the ground, back upright. Your hands can rest on your lap in a position that is comfortable. Close your eyes part-way and shift your gaze at a point 45 degrees down toward the ground, we'll use these "soft eyes" during today's practice. Let's begin.

Take a few slow long deep breaths. Notice the full in breath and you breathe in... notice that point when you shift to breathing out, watching the full out breath as you breathe out. Invite each breath in with interest, receiving each breath with your full awareness. Extend your awareness and curiosity to the rest of your body. As you breathe in, expand outwards noticing your ribcage, your shoulders, and back. As you exhale, allow everything to relax around the core of the spine, while keeping the spine alert. After taking a couple of slow deep breaths, settle in and breathe naturally, there is no need to control your breath.

[15 second silence]

Scan through your body, starting at your toes and working all the way up through your body. Staying upright with your spine, setting your body at ease.... You might notice thoughts that arise as you slowly scan your body, acknowledge them as thoughts and bring your attention back to the body scan practice. Welcome in any thoughts with gentle objectivity, then let them go. Bringing your full attention to each body sensation, slowly scanning your body.

[15 second silence]

Go at your own pace, scanning each body part from your toes all the way to your head, then starting over again—slowly with awareness notice and accept all sensations.

CHIME [90 second silence]

If you notice yourself thinking, acknowledge that thinking is occurring with a gentle objectivity, then return to the body scan. [30 second silence]

Try not to argue or struggle with thoughts that arise, instead accepting them, there's no need to judge thoughts as good or bad—they are just thoughts, here one minute and gone the next. You can use the label “thinking” to help assert your gentle acknowledgement that the thought is there, and then return to your body scan.

[15 second silence]

You might also notice that thoughts can produce new body sensations, notice these thought related body sensations too. Then return to scanning your body. Go at your own pace, slowly scanning the body.

CHIME [90 second silence]

Emotions also might arise during this practice, producing new body sensations. For example, you might feel agitated and experience some tightness in your stomach or lower back. Or you might experience a sense of peace and relaxation in your body. Notice and invite in these emotion-related body sensations, label them “feeling” as though you were an objective outside observer and then return to your body scan practice.

[15 second silence]

One important feature of this practice is to notice feelings as they arise, moment-to-moment. You can carefully monitor with acceptance, watching them as they arise and then pass away. You might have a feeling like anger, which triggers thoughts and body sensations—you can use your new attention skills to invite in these thoughts and body sensations that are produced by this feeling, gently acknowledging each aspect of your experience with awareness. Sweep through the body and examine your feeling related experiences with acceptance.

[15 second silence]

Examine your whole body with curiosity and interest-- observe all sensations, thoughts, and feelings. Monitor and invite in all aspects of your experience, experiencing them as they arise and pass away.

[15 second silence]

For the last couple of minutes, bring your attention back to breathing, noting breathing in as you breathe in, and breathing out, as you breathe out. Monitor all that arises, whether it's thoughts, feelings, or body sensations. Acknowledge and appreciate each aspect of experience as it arises, then come back to your breathing. Breathing in, breathing out.

[15 second silence] Each moment is rich with things to notice, what do you notice in your experience right now? If you find your mind wandering from what is here right now, invite in the awareness that it has wandered, and return your attention to your breathing. Experience takes on a greater depth and clarity. Breathing in, breathing out.

CHIME [90 second silence]

Each time your mind wanders from breathing, you can notice where it has gone—into thoughts, into feelings, into body sensations—then return to monitoring breathing. No need to pass

any harsh judgment when the mind wanders, instead, acknowledge where it has gone and bring it back to monitoring breathing. Breathing in, breathing out.

[15 second silence]

In the time that we have left, let's start over together. Take a deep breath and see if you can really tune in to the changing sensations of the breath once again. Your ability to monitor and accept your experience is a tool you can use in any life circumstance. By more effectively knowing what you are experiencing and developing a more accepting mindset, you can more effectively respond to whatever life throws at you. You can use this skill of monitoring and accepting your experience during the upcoming performance activities—noticing and being more open to your experience without judging or criticizing yourself will help you optimize your performance. As we transition into today's performance activities, maintain this mindset of attending to all sensations occurring at the breath, in the body, and in the mind.

[30 second silence]

Whenever you are ready, open your eyes and bring your attention back to the world around you.

[15 second silence]

[*Bell*] That will conclude today's session. Thank you for participating in this session

Attention Only

Day 1

Thank you for participating in this study. The primary intention of this study is to understand how training your attention can impact your well-being and performance. Attention training, such as that you will learn here, requires your full attention and effort, and it may be difficult for you at times, but stay with it-- all that I ask is that you give your best effort!

For the next several days, you will learn and practice how to monitor your moment-to-moment experience. Specifically, you have the opportunity to practice training your attention and your ability to focus on your experience. You may have noticed that sometimes you find yourself zoning out, for example, you may have had the experience of eating a meal and later not remember the experience of eating, or of driving somewhere and not really remembering how you got to your destination—in short, it was like you were on full automatic pilot. This training will focus on helping you become more attentive and aware of your experiences. The way you will work to develop this moment-to-moment awareness is through training your ability to carefully monitor your breath. Your breath is always there, so it's a great anchor for training your moment-by-moment attention and awareness. In the coming days you will continue to train your attention to monitor your breathing, but then expand the training so that you are monitoring other aspects of your experience. This attention training will help you notice how you are responding during our performance tasks at the end of this study, and we believe it will make you a more effective problem-solver. If you put in the work and stay with it over the next couple of days, you will see your problem solving abilities improve.

At several points during your training today you will hear this sound [CHIME], at which time we ask that you indicate the degree to which your mind was attentive to this training. These chimes will occur at random intervals during your training today. Once you make a rating, you can then soften your eyes and resume the training.

What I want you to do is keep both feet flat on the ground when you're sitting in your chair. Let your body sink down into the chair as your spine lifts up. Keep your back straight and upright, but not too rigid. This upright position will help you stay alert and focused during the training

session. Your hands can rest on your lap in a position that is comfortable for you. To train your attention, your goal is to fully follow my instructions.

[15 second silence]

And when you are comfortable with your body position, I want you keep your eyes open, but close them a little, look ahead, and then shift your gaze at a point that is 45 degrees down toward the ground. This is called "soft eyes", you are passively focusing on a point that is out in front of you and down toward the ground. This attention practice today is about noticing your breath and where your mind wanders, so there's no need to stare at anything, or to attend to your visual experience in any way, but to focus all your attention on your breathing. Your soft eyes should be comfortable and not strained; make any adjustment you think is necessary, but it is important to keep them partially open - this helps foster alertness. You must choose to remain awake and alert.

Having given you the background on our plan for this training, let's begin. Today's attention training session will focus on learning how to carefully monitor your breathing, and to more clearly notice when you become distracted from your intention to carefully monitor your breathing.

Take a deep breath, hold it in for a couple of seconds and exhale slowly. There is no need to control your breath, simply notice the full in breath and out breath at your nostrils. Let's monitor the in-breath and out-breath where air is passing your nostrils, just breathe naturally for the next couple of moments.

[15 second silence]

Focus your attention on the sensations of breathing at your nostrils—noticing the cool sensations of air coming into your nostrils during the in-breath and warmer air leaving the nostrils as you breath out.

[15 second silence]

To help train your ability to monitor your experience of breathing, you can use mental labels. For example, as you breathe in, you can say quietly to yourself "breathing in." And when you breathe out, you can say quietly to yourself "breathing out."

[30 second silence]

You might find it easier to label your breathing by saying "In" during the in-breath and "Out" during the out-breath. The important thing is to clearly acknowledge with awareness when you are breathing in, and when you are breathing out. In, Out.

CHIME [1:30 second silence]

Relying on the breath as an anchor, you will begin to develop a deeper awareness of your experience. You might notice that you are no longer monitoring your breathing and instead your mind has drifted off into thoughts about a class assignment or dinner later—when you notice this occurring, you can label this as "distracted." Training your attention is all about noticing when your mind wanders, then returning to your primary target of attention, your breathing.

[30 second silence]

You can notice when your mind wanders off using the label "distracted", and then return to monitoring your breathing. Breathing in, breathing out.

[30 second silence] Watch your full in-breath, notice that point when the in-breath ends and the out-breath begins. And watch the full out-breath. Watch each in-breath and each out-breath at the nostrils. If you become distracted, acknowledge this with the label "distracted" and begin anew with watching your breathing. Know that you are breathing in as you breathe in; know that you are breathing out as you breathe out.

[15 second silence]

When you breathe in, you can try mentally noting what you notice occurring at the nostrils, maybe it's a little cold and tingly; and when you breathe out, maybe it's smooth, and warm.

CHIME [1:30 second silence]

Continue to label your breath, noting any sensations occurring as you breathe in and breathe out. You may notice other sounds in the room; if a sound distracts you from your breath, label this too as “distracted.” Then start again with watching your breathing. You are building a basic skill of maintaining your attention on the object of your breathing, moment-to-moment. This skill develops when you can clearly acknowledge your mind is distracted, so those moments of noticing and labeling your experience as “distracted” are also moments of training your attention.

[30 second silence]

Noticing that you are distracted is one of the most important aspects of this attention training practice. You are raising awareness of yourself and your environment.

When your mind has drifted away from your intended focus - your breath - you acknowledge the distractor for what it is: a distraction. For instance, you may be thinking of a conversation you had earlier; label these thoughts as “distracted” and return to labeling your breath.

Take a deep breath, relax, and then breathe normally, bringing your full attention to the changing sensations of the breath occurring at your nostrils as you sit here. Know that you are breathing in, as you breathe in. Know that you are breathing out, as you breathe out.

[15 second silence]

Just when you realize you’ve drifted away from the focus of your breath, bring yourself back, and start over.

[15 second silence]

Let’s spend the next few moments in silence trying to cultivate this practice, noticing the full in breath and out breath, acknowledging distractions as they arise, and returning your attention to the breath.

CHIME [1:30 second silence] Focus on one full in breath, one full out breath. If you find your mind to be too busy, remember that noticing and labeling your experience as “distracted” is training your attention.

[15 second silence]

Conversely, if you find your mind to be too sleepy, look around, get readjusted, re-soften your eyes and start over. The key is to balance a relaxed state, with an active state, to stay right in the middle.

You have one intention—to be right here, right now, fully experiencing each breath, in each moment. Breathing in, breathing out.

[30 second silence]

If you’ve drifted too far away, bring yourself back and start over.

[15 second silence]

In the few moments that we have left, see if you can really tune in to the present moment.

Notice the full in breath and the full out breath.

[20 second silence]

Whenever you are ready, open your eyes and bring your attention back to the world around you, adjusting your body position.

[5 second silence]

Bell That will conclude today’s session. Thank you for participating in this session.

Day 2

Welcome back, you’ll be completing the performance task, but first we are going to give you the chance to practice your attention training one more time. During today’s attention training session you will begin by focusing on your breath, then shift to body awareness, and end with monitoring thoughts and emotions that arise. This attention training will help you monitor how you are responding during the upcoming performance tasks, and we believe it will make you a more effective

problem-solver. Our hope is that you'll use the attention skills that you've gained to more effectively perform on the problem-solving tasks today.

At several points during your training today you will hear this sound [chime], at which time we ask that you indicate the degree to which your mind was distracted. Once you make a rating, you can then soften your eyes and resume the training.

Settle into your chair, feet flat on the ground, back upright. Your hands can rest on your lap in a position that is comfortable. Close your eyes part-way and shift your gaze at a point 45 degrees down toward the ground, we'll use these "soft eyes" during today's practice. Let's begin.

Take a few slow long deep breaths. Notice the full in breath and you breathe in... notice that point when you shift to breathing out, watching the full out breath as you breathe out. Extend your awareness to the rest of your body. As you breathe in, expand outwards noticing your ribcage, your shoulders, and back. As you exhale, allow everything to relax around the core of the spine, while keeping the spine alert. After taking a couple of slow deep breaths, settle in and breathe naturally, there is no need to control your breath. Continue to monitor your natural in breath and natural out breath, moment-by-moment.

[15 second silence]

Scan through your body, starting at your toes and working all the way up through your body. Staying upright with your spine, setting your body at ease.... You might notice thoughts that arise as you slowly scan your body, acknowledge them as thoughts and bring your attention back to the body scan practice. Watch these thoughts arise, and watch them go as you return your attention to your body. Bringing your full attention to each body sensation, slowly scanning your body.

[15 second silence]

Go at your own pace, scanning each body part from your toes all the way to your head, then starting over again—slowly with awareness notice all sensations.

CHIME [90 second silence]

If you notice yourself thinking, acknowledge that thinking is occurring, then return to the body scan.

[30 second silence] Thoughts naturally arise, when they do, you can label each thought as "thinking" and then return to your body scan. It may help to label the thought as 'thought about the future', 'thought about the past', or 'fantasy.' When a thought pops up in your mind, identify it for what it is, a thought, and let it go, returning to your body scan.

[15 second silence]

You might also notice that thoughts can produce new body sensations, notice these thought related body sensations too. Then return to scanning your body. Go at your own pace, slowly scanning the body.

CHIME [90 second silence]

Emotions also might arise during this practice, producing new body sensations. For example, you might feel agitated and experience some tightness in your stomach or lower back. Or you might experience a sense of peace and relaxation in your body. Notice these emotion-related body sensations, label them "feeling" and then return to your body scan practice. See if you can notice emotion related body sensations, slowly scanning the body and labeling each one as "feeling".

[15 second silence]

One important feature of this practice is to notice feelings as they arise, moment-to-moment. You can carefully monitor them as they arise and then pass away. You might have a feeling like anger, which triggers thoughts and body sensations—you can use your new attention skills to notice the thoughts and body sensations that are produced by this feeling, noting each aspect of your experience with awareness. Sweep through the body with your awareness and examine your feeling related experience.

[15 second silence]

Examine your whole body, all sensations, thoughts, and feelings present. All of these aspects of your experience arise and then pass away, they are temporary. You can monitor the rising and passing away of body sensations, thoughts, and feelings.

[15 second silence]

For the last couple of minutes, bring your attention back to breathing, noting breathing in as you breathe in, and breathing out, as you breathe out. Monitor all that arises, whether it be thoughts, feelings, or body sensations. Acknowledge each aspect of experience as it arises, then come back to monitoring your breathing. Breathing in, breathing out.

[15 second silence]

Each moment is rich with things to notice, what do you notice in your experience right now? If you find your mind wandering from what is here right now, note that it has wandered, and simply return your attention to your breathing. Experience takes on a greater depth and clarity. Breathing in, breathing out.

CHIME [90 second silence]

Each time your mind wanders from breathing, you can notice where it has gone—into thoughts, into feelings, into body sensations—then return to monitoring breathing. Notice where your mind has gone, then bring it back to monitoring breathing. Breathing in, breathing out.

[15 second silence]

In the time that we have left, let's start over together. Take a deep breath and see if you can really tune in to the changing sensations of the breath once again. Your ability to monitor your experience is a tool you can use in any life circumstance. By more effectively knowing what you are experiencing, you can more effectively respond to whatever life throws at you. You can use this skill of monitoring your experience during the upcoming performance activities—noticing how you are responding for optimizing your performance. As we transition into today's performance activities, maintain this mindset of attending to all sensations occurring at the breath, in the body, and in the mind.

[30 second silence]

Whenever you are ready, open your eyes and bring your attention back to the world around you.

[15 second silence]

Bell That will conclude today's session. Thank you for participating in this session

Control

Day 1

Thank you for participating in this study. The primary intention of this study is to understand how taking time each day to relax can impact your well-being and performance. Relaxation places your mind and body at ease for optimal performance. For the next several days, your imagination will be stimulated as you are transported around the world, hearing narratives that allow your mind to wander in a new place. In the coming days, you will set aside this time to relax and tune out all aspects of your experience that induce stress or anxiety. These sessions will help you relax during the performance tasks at the end of this study, and we believe this will make you a more effective problem solver. If you allow yourself to be absorbed by the narratives over the next couple of days, you will see your problem solving abilities improve.

What I want you to do is keep your eyes partially open, then shift your gaze at a point that is 45 degrees down toward the ground. This is called soft eyes; you are passively focusing on a point that is out in front of you and down toward the ground. It is important to keep your eyes partially open; this helps to prevent you from falling asleep. Please don't sleep during this session.

At several points during the narrative today, you will hear this sound [CHIME], at which time we ask that you indicate the degree to which your mind was attentive to the narrative. These chimes will occur at random intervals. Once you make a rating, you can then soften your eyes and continue listening.

Having given you the background on our plan for today, let's begin. Today's narrative is called "The Seas of Arabia" by Kennedy Warne.

The old fisherman sat on a scrap of carpet in a thatched shelter by the sea.

His face was like a walnut shell, and his eyes squinted with a lifetime of gazing into the white-hot glare of Arabia. The *shamal* was blowing off the sea in scorching gusts, making even the date palms droop. "It is the western wind," the man said in a raspy voice. "I feel its warmth."

Behind him, the village of Film, notched into the mountains of Oman's Musandam Peninsula, shimmered like a brazier. Goats panted in the shade cast by upturned boats and the walls of a mosque. Just breathing made me feel as if my nostrils might burst into flame. Sami Alhaj, my Yemeni dive partner, said: "Underwater, with the corals, we get a little piece of heaven. Above water, with this wind, we get a little piece of hell."

We soon fled the inferno and descended into paradise once more. Color marked our passage between worlds as vividly as temperature did. Where the colors of land were those of the spice suq—pepper, cinnamon, mustard, mace—the undersea world was drenched in the sumptuous hues of a sultan's palace. Long, waving indigo arms of soft corals mingled with pomegranate fronds of feather stars. Speckled-gray moray eels, whose gaping mouths reveal a startling burst of yellow, leered out of crevices, while butterflyfish flitted past in tangerine flashes.

Had the legendary Scheherazade known the richness of these seas, she would have had stories for another thousand and one Arabian nights. She might have piqued the king's curiosity with the riddle of the reefs of Dhofar, in southern Oman; they flourish as coral gardens in winter and seaweed forests in summer. The trigger for this ecological shift—found nowhere else—is the onset of the *khareef*, the southwesterly monsoon, which bathes the coast in an upwelling of cold, nutrient-rich water. Seaweed, dormant in the warm months, responds to the cooler conditions with a burst of luxuriant growth, carpeting the reefs with green, red, and golden fronds.

Or she might have told the story of the tribe of mudskippers that have their sheikdom on the shores of Kuwait Bay. Their name in Persian means "lazy ones," because they appear too lethargic to follow the falling tide. Instead, each goggle-eyed fish builds and patrols its own mud-rimmed swimming pool. Shining in slippery coats of mud, they wriggle through the slurry of their ponds, waddle along the walls on their broad pectoral fins, then fling themselves into the air, exuberant as porpoises.

Might she have mentioned the ghost crabs of Masira Island? They build perfect miniature Mount Fujis of sand every night, only to have them leveled by the winds the next day. Scheherazade would have had no shortage of material.

"I am the sea. In my depths all treasures dwell. Have they asked the divers about my pearls?" the Egyptian poet Muhammad Hafiz Ibrahim wrote a century ago. Few survive today of those champions of the sea, the pearl divers of generations past who sought the greatest treasure of all. Forty, fifty, a hundred times a day they dropped to the seafloor, as deep as 65 feet, without goggles and often wearing only a thin woven garment to protect against jellyfish stings. With other risks, they took their chances. Men died from stingray jabs, from poisonous stonefish spines, from shark bites. Clownfish—cruel joke—attacked their eyes. Their eardrums burst, and some went blind from constant exposure to the salty water.

Pearls were the diamonds of the ancient world. In Hafiz's time they were the Persian Gulf's most valuable resource, and 70,000 men were engaged in collecting them. But the divers saw little of the wealth they brought up. The oysters were thrown into a common pile, to be opened the next day, when dead. Even if a diver brought up a pearl of Steinbeckian magnificence, he would never know it. Debt drove them to dive. Debt inherited from their fathers and their father's fathers.

Yet pearling was equally a matter of deep cultural pride, part of a maritime tradition that is as Arabian as deserts and dates. [CHIME] Through the waters of the Persian Gulf, East met West, the wealth of Africa and India flowing to the empires of Europe. Until the 1930s, great Kuwaiti dhows, or booms, with names like *The Triumph of Righteousness* and *The Light of the Earth and Sea*, set their lateen sails to the billowing northeasterly wind that blew them to Zanzibar and Mangalore. Months later the khareef brought them home again. The seasonal fluctuations of the winds were the fuel of Arabian commerce. The winds were Allah's, and the winds were free.

Then came oil, and a seafaring way of life that had endured for millennia melted away at the breath of a new monetary lord. Oil was the genie that granted the wishes of modernization and affluence. Arabia was transformed—from camels to Cadillacs, mud houses to megamalls—as its citizens rode the magic carpet of petro-wealth.

Today human hands are reaching deep into Arabia's seas and taking more treasure than the seas can possibly replenish. Overfishing, pollution, seabed dredging, and massive coastal modification are crippling marine ecosystems by degrading water quality and exacerbating toxic algal blooms. In 2010 a group of marine scientists described the region's most strategic waterway, the Persian Gulf, as "a sea in decline," bedeviled by a storm of malign influences. "If current trends continue," they wrote, we will "lose a unique marine environment."

One of the groups at greatest risk are sharks. Of all the insults to Arabia's marine life, none is more grotesque than the mountains of shark carcasses that arrive every evening in the Deira Fish Market in Dubai, trucked from landing sites around Oman and the United Arab Emirates, from there to make their way east—a stinking tide of fins and flesh.

Rima Jabado, conspicuous in her yellow rubber boots and pink top, moves through the market counting and measuring hammerheads, threshers, bulls, silkies, and makos: the thoroughbreds of Arabia's seas, carted here to be hocked like horsemeat. Totemic animals that divers dream of encountering underwater are hauled out of the backs of trucks with meat hooks and lined up on the pavement, grimy and bloodied, row upon row of scowling mouths. An auctioneer works his way along the line, followed by a retinue of buyers calculating profit margins on their smart phones. In their wake a man expertly severs the fins and lays them out on plastic tarps for separate sale. A pickup truck pulls up, and the driver unloads a dozen sacks of dried fins. He plunges his hands into a sack and lifts out handfuls of small gray triangles, stiff as plywood. There must be several thousand fins in this one shipment.

"When I started working here, I thought, That's a lot of sharks," Jabado, a doctoral student at United Arab Emirates University, tells me. "But when you see it every day, you ask, How is this possible? How can this last?"

A muezzin gives the evening call to prayer from a mosque whose minarets make artful silhouettes against a golden sky. Across the parking lot, the fish market is crowded with Emirati housewives gliding down aisles of laden stalls, passing their purchases to Pakistani boys who wheel them in garden barrows to a rank of SUVs.

[CHIME]

The old name for this part of Arabia was the Pirate Coast. Trading ships carried companies of archers to repel thieves. But how to solve the plunder of the sea itself? Jabado travels the length of the U.A.E. coast, from Abu Dhabi to Ras al Khaimah, tallying sharks and interviewing fishermen. Everywhere it is the same story: Catches are down, and fishing intensity is up.

One of the questions Jabado asks the fishermen is whether they think sharks should be protected. Some say, No, why should we protect them? Sharks are a gift from God. He will replenish them. Others say that sharks should be protected but that it needs to happen across the region. If we protect them here, do you think the Iranians are going to stop taking them? they tell her. Why should I stop fishing for sharks and miss out on revenue if some other person keeps taking them?

Eight countries border the gulf. "They have the same kind of culture and heritage, mostly speak the same language, face the same problems, and share the same resources," Jabado says. "Why aren't they working together?"

Her concerns run deeper than fisheries management. The impact of an environmental disaster in so shallow and enclosed a waterway is appalling to contemplate. There are many hundreds of oil and gas platforms in the gulf, and tens of thousands of tanker movements annually through a narrow stretch of the Strait of Hormuz between the Musandam Peninsula and Iran. "What if there was a *Deepwater Horizon* event here?" she asks. "The average depth of the gulf is about 30 meters. One big spill could wipe out whole marine ecosystems."

There are inklings that the unified approach Jabado seeks may be starting to take shape. Several countries are considering following the lead of the United Arab Emirates in giving legal protection to a single species of shark: the whale shark, the biggest fish in the sea. The giant filter feeders have been turning up in unexpected places. In 2009 David Robinson, a Dubai-based whale shark researcher, was startled when a Google image search turned up a photograph of whale sharks swimming among the platforms of Al Shaheen, a major oil and gas field off the coast of Qatar.

"The photograph was on the Facebook page of a worker on a gas rig," Robinson said. "I sent him a message, he added me as a friend, and now we're getting a stream of pictures from him and others. In one photograph I counted 150 animals. I'd like to say we discovered the sharks through tirelessly scouring the oceans, but that would be a lie. It was through scouring the oceans of cyberspace! Science by Facebook—a bit embarrassing, really."

The discovery of whale sharks at Al Shaheen has led to other finds. Seasonal mass spawning of lobsters has been observed, with the lobsters rising to the surface at night and turning the sea into a vast crustacean soup. With fishing banned and boat traffic restricted in many oil and gas fields, these areas likely serve as de facto marine reserves. The platforms certainly act as giant fish-aggregating devices. **[CHIME]** At Al Shaheen, with a flare stack belching flame overhead, I watched a shoal of jacks circle the legs of the platform and spinner dolphins launch their lissome bodies into the air. A hammerhead cruised at the edge of visibility, finding sanctuary within the ring of fire.

A sense of marine guardianship seems to be growing across the region. In Kuwait hundreds of keen amateur divers have formed the ecological equivalent of SWAT teams, dedicated to repairing the environmental damage of war and waste. They lift sunken vessels from the seabed and remove tons of snared fishing nets from Kuwait's coral reefs.

Off the island of Qaruh, I helped cut away a net that was twined around the brittle stubs of staghorn coral—a nightmare of knotted nylon mesh that yielded reluctantly to our collection of chef's knives and garden shears. Our odd assortment of reef repairmen included a computer engineer, a television producer, and a former leader of Kuwait's Grand Mosque. On the return journey, crossing a smooth, tawny sea with a dust storm billowing on the horizon, two of the team found space among the scuba gear on deck to pray. Oblivious to the symphonic thunder of twin 200-horsepower outboards, they prostrated their bodies and uttered the ancient words of invocation and praise, giving voice to the hope that good might come to the world.

At the other end of the Persian Gulf, in Dubai, public-spirited beachgoers collect stranded turtles and take them to a rehabilitation facility in the luxury Burj al Arab hotel. In 2011, 350 juvenile turtles were brought in, many victims of "cold stunning"—inertia caused by the winter drop in sea temperature. "If they survive the first 24 hours, there's a 99 percent chance they'll recover," Warren Baverstock, the aquarium operations manager, said as we walked along a line of bubbling tanks. He reached in to scratch the backs of splashing turtles, which twisted their necks and flippers in pleasure at the attention. "They always know where the sea is," he said. "They swim up and down the wall nearest the sea, lifting their heads up, looking for it."

Mass releases of the rehabilitated turtles are staged at a nearby beach to publicize the work and reinforce the message that Arabia's marine life is valuable, vulnerable, and in need of protection.

Each turtle is implanted with a microchip for identification. In the seven years the project has been operating, no turtle has washed ashore twice.

The hotel's most famous patient was an adult green turtle called Dibba, which had arrived with a fractured skull. Baverstock and his team needed 18 months to rehabilitate the turtle, but Dibba, released with a satellite transmitter glued to its carapace, repaid its caregivers with a 259-day, 5,000-mile migratory journey, looping down the Arabian Sea, passing the Maldives, skirting Sri Lanka, and reaching as far as the Andaman Islands before the transmitter battery failed.

Dibba traced an ancient route imprinted not just on turtles but also on the cultural memory of Arabia's peoples. This way came the dhows laden with Basra dates and pearls. This way they returned, carrying camphor, silks, sandalwood, and cloves. Every Arabian family had its sea captains and sailors, its pearl divers and boat carpenters—a saltwater legacy written in its genes.

Modernity has dimmed that memory. "We have lost the thirst for the sea that can only be quenched by going to the sea," one Omani businessman told me with sadness in his eyes. Yet for others the thirst is returning. Increasing numbers of Arabs are going to the sea not to exploit it but to experience it as it is. They are renewing their bond with ancient shores and rediscovering the poet's truth: "In my depths all treasures dwell."

[CHIME] This concludes today's narrative. Thank you for participating in this study.

Day 2

Welcome back. You'll be completing the performance task, but first we're going to give you the chance to relax to a narrative one more time. During today's relaxation session, you will be transported across the world where your mind can wander in a new place. Relaxation places your mind and body at ease for optimal performance. These sessions will help you relax during the performance tasks at the end of this study, and we believe this will make you a more effective problem-solver.

At several points during the narrative today you will hear this sound [CHIME], at which time, we ask that you indicate the degree to which your mind was distracted. Once you make a rating, you can then soften your eyes and continue listening.

Close your eyes part way, and shift your gaze at a point that is 45 degrees down toward the ground, or close them all the way during today's session.

Let's begin. Today's narrative is called "Meso Amazing" by Kenneth Brower.

In the mangroves off the east coast of Central America, at the edge of the Mesoamerican Reef, the world is divided in two: the above and the below. As we killed the engines and poled the skiff from the hot April sun into the shade of the forest, Will Heyman, my marine biologist companion, and I gazed into the simplicity above. We saw the green crowns of one of the least diverse of all tropical forests, where there is often but a single species of tree, the red mangrove.

Salinity, storm waves, and oxygen-poor mud discourage understory growth in the mangroves, so there was little beneath the canopy for us to see. The occasional orchid. Rarely, a vine. A troop of fiddler crabs guarding holes in the mud. A big mangrove crab low on a trunk. Some insects. A tricolored heron perched on the stilt of a mangrove root.

I leaned over the gunwale to sample the mud around the roots, scooping up sherds of pottery. The mangroves of the Mesoamerican Reef were once at the fringe of the ancient Maya civilization. I contemplated slipping a souvenir into my pocket—with such a lode here, what possible harm? "Strictly catch-and-release," Heyman said. With a splashing of jettisoned sherds, we poled to another spot. There, in the still water, we witnessed the miracle of the below.

At the waterline the roots in this forest blossom downward, expanding all shaggy-bearded with mats of algae, and slender brittle stars, and boxy starfish, and the little translucent vases of the

filter feeders called tunicates—their “tunics” orange or purple or white—and soft corals and oysters and sponges in still more hues. Nothing here goes unadorned.

Mangroves are crucial nurseries. Schools of small fry shift away through the Moorish architecture of arched roots, each school a pale cloud of translucent fish. The palest clouds are hardly there at all, composed of hatchlings no bigger than the smallest mosquito wigglers. These living motes are too small to name. Are they destined for adulthood in a sea grass bed, or coral reef, or open ocean, or right here in the mangroves? Too soon to tell.

And so it goes on Central America’s reef system. Each component of this tripartite world of mangrove, sea grass, and coral reef is itself divided in two: the world above elementally simple, the one below bafflingly complex.

The Mesoamerican Reef system stretches more than 600 miles along the coasts of Mexico, Belize, Guatemala, and Honduras. Its Australian cousin, the Great Barrier Reef, is great indeed at 1,429 miles long—the biggest structure created by living things on this planet. Yet the Mesoamerican Reef, at less than half the length, is in its own way the more remarkable.

[CHIME]

The contours of the continental shelf here encouraged the development of an underwater reef platform that begins within a few hundred yards of shore in some places and as much as 20 miles offshore in others. This platform supports a variety of reef types and a profusion of corals unique in the Western Hemisphere. If the Mesoamerican Reef has any advantage over its massive Australian counterpart in the Pacific, it is in this proximity to land and the intimacy of its connection with inshore habitats. Here the provinces of mangrove, sea grass, and coral reef are bound so tightly together by currents, tides, and mutual need that it’s really not possible to tease them apart.

MANGROVES Mesoamerican mangroves form multiple lines of defense for the reef system. The first line is the tall mangrove forest along the coast and up the mouths of tidal rivers. The second line, and sometimes a third and fourth, occur offshore, in places where pointy mangrove seedlings have taken root atop a series of shallow marine ridges. Each clump slowly gathers the makings of an islet under itself. These islets grow into islands—mangrove cays—arranged in linear archipelagoes. The clusters of cays work as screens, benefiting the sea grass by moderating wave action and the coral reef by intercepting silt, fertilizers, and toxins in runoff from land.

The mangroves, in addition to defense, provide mulch. They can shed tons of leaves per acre every year. Fungi and bacteria break down this leaf litter and consume it, then are consumed by tiny worms and crustaceans, which in turn feed small fish, which feed larger fish and birds and crocodiles.

Life wells outward from the mangroves into the sea. At the same time, a living countercurrent flows back in: the eggs, larvae, and sometimes the gravid females of reef creatures that use the mangroves as a nursery. If any fish is emblematic of this life cycle—kindergarten in the mangroves, graduate school on the reef—it is the rainbow parrotfish.

The scientific name for this species is perfect, *Scarus guacamaia*, from the native Taino *huacamayo*, “macaw.” The resemblance is eerie: The fish has the parrot beak and the coloration of the blue-and-yellow macaw. The parrotfish starts small in the mangroves, as drab as a sparrow, and ends in full color on the reef, four feet long, the largest herbivorous fish in the Atlantic.

Mangroves are not just a convenience for *Scarus guacamaia*. They are a necessity. When mangroves are carved away, to make room for tourist venues, for example, the species tends to go locally extinct, with repercussions in all directions. Coevolution has brought the coral reef and its parrotfish into balance; when the horny-beaked herbivores are fished out or otherwise eliminated, the reef declines, its corals overgrown by carpets of the algae the parrotfish normally eat.

[CHIME]

John Muir told us what we can expect when humans with their habits begin to unravel a sound ecosystem. “When we try to pick out anything by itself, we find it hitched to everything else in

the universe,” he wrote. The parrotfish are a case in point. The Mesoamerican Reef is one section of the universe where the hitches are particularly tight.

SEA GRASS A sea grass bed begins with the sprouting of a pioneer species like shoal grass, with flat, thin leaves; or long and threadlike manatee grass. The pioneer grasses eventually give way to turtle grass, the climax species, which has flat, straplike blades up to two feet long. Of the various species of sea grass identified off Central America, turtle grass is commonest. Like the others, it is an angiosperm, a flowering plant, having solved the problem of pollination underwater—no bees—and having mastered submarine dispersal of fruit, which simply detaches and tumbles away on the current. Sexual reproduction is not a big preoccupation of the species. Most of the time, turtle grass is chaste. Maintenance and expansion of the bed are largely by vegetative reproduction—asexual sprouting from buried stems. The turtle-grass rhizomes, or underground stems, creep horizontally under the sand and are anchored by an extensive root system. Like the mangroves, they trap silt that might otherwise settle on corals.

This is a vital service. Reefbuilding corals require clear water. The basic unit of a coral colony, the tiny coral animal—the polyp—produces most of its food through photosynthesis by algae resident in its tissues. Sedimentation, which screens out sunlight and kills polyps, is one of the principal causes of coral-reef decline worldwide. De-sedimentation by sea grass is a reciprocal service. Turtle grass thrives in calm waters protected from surf and wind-driven currents by the barrier reef; its sequestering of sediments is merely a return of the favor. Just as the coral polyp lives in internal symbiosis with its resident algae, so the coral reef lives in external symbiosis with sea grass.

All in these waters is quid pro quo. The Mesoamerican Reef is an edifice built of mutualisms.

From a boat adrift above it, the turtle grass looks as monotonous as a field of corn or alfalfa. But snorkel the prairie at the level of the grass, your face mask parting the blades, and the detail and diversity jump out. Older, darker blades are encrusted with epiphytes, undersea “mosses” in hundreds of species. Films of algae and bacteria on the blades are food for tiny organisms, which in turn feed shrimp and small fish. Sea grass is a way station, a middle school, for many species hatched in the protection of the mangroves and bound for adulthood on the reef.

Bright schools of small fish hang over the undersea prairie as the current stirs in the grass. Occasionally you flush adult parrotfish and surgeonfish, come in from the reef to feed on the grass itself. Sometimes in the turtle grass, you meet one of those: a foraging green turtle, hawksbill, or loggerhead. Here and there the sea grass prairie is crossed by what appears to be a game trail. The big game here is blimp shaped, weighs a thousand pounds or more, and is distantly related to the elephant: These are the feeding swaths of manatees.

When foraging in turtle grass, a manatee really digs in. Sometimes it starts with a salad of grass-blades, steering those toward its mouth with wafting, gathering motions of its foreflippers. But often it goes straight for the starch in the stems beneath. Rooting these out, it churns up clouds of sediment. The big myopic head lifts from the muck; the huge upper lip, muscular and prehensile, makes a variety of indescribable chewing motions, the broken ends of plants sticking out past the whiskers; and then the manatee is obscured by the mud cloud it has made. A blizzard of detached turtle-grass leaves swirls above the cloud, like confetti on Armistice Day. Burying its face in the mud again, the manatee rejoins its own parade, plowing onward across the prairie.

[CHIME]

CORAL REEF From the deck of a skiff on the surface, the reef makes a lovely but minimalist seascape: the white line of surf breaking along the reef front, the turquoise of the reef flat, the royal blue of the open ocean beyond. But like the inshore habitats that it shelters, the rampart of the barrier reef is a world divided.

Adjust your mask, take a breath, and roll overboard. Now the real reef reveals itself: a concentration of life and a spectrum of colors unlike anything up in the world of air. The reef is a teeming city of

hard corals, soft corals, fire corals, lace corals, brain corals, staghorn corals, sea whips, sea fans, sea grapes, coralline algae, sponges. Taking refuge everywhere in the alleys of the coral city, or countersunk in holes drilled in the corals themselves, or perched atop the coral heads, are hosts of invertebrates—clams, crabs, shrimps, worms, sea cucumbers—of stunning diversity. Add to these the hundreds of new species scientists identify worldwide each year. Schooling above the reef are fish painted extravagantly in an array of electric colors we are missing in the upper world. There is an auto-luminescence to the palette here, as if each fish and feather worm came equipped with its own battery to power its stripes, bars, blazes, and dots.

The coral reef, like all reefs across the tropics, is threatened by ocean acidification and warming episodes caused by climate change. Overfishing, coastal development, and the accelerating pace of oil exploration are worrisome too.

But at dusk in springtime, when the moon is full, age-old magic still happens. Near the Silk Cays off southern Belize, thousands of cubera snappers, dog snappers, and mutton snappers come to spawn at a reef called Gladden Spit. They draw platoons of whale sharks, which feast on the eggs, and sometimes marine scientists as well. These sharks, the biggest fish in the sea, are plankton-eaters; Gladden Spit is the first place they have ever been observed eating spawn. The assembly here of snappers, the predators that eat them, and the colossal sharks that feed on the spawn is the most spectacular convocation I have ever witnessed in the ocean.

In scuba gear, 50 feet deep, Heyman and I swam toward a huge ball of spawning cubera snappers, a dark, slow-rotating, cyclonic tower that resolved itself, as we swam close, into thousands of particular fish. From the smooth rotation, tight groups flurried upward to spawn, releasing white clouds of eggs and milt. These coalesced into a great thunderhead, which billowed up to envelop us. For a time we were lost in a sperm-and-egg whiteout. Then a dim gray shape materialized, like *Titanic* in the fog, and out of the whiteness came the gigantic gape and spread pectoral fins of a feeding whale shark. Then more whale sharks arrived, and finally bottlenose dolphins and bull sharks.

We chased the party until we ran out of air. Surfacing, we inflated our vests and swam backward toward the skiff anchored under the newly risen moon. The full April moon had called snappers here, their spawning timed to catch the high spring tide that would carry their fertilized eggs into the mangroves. The whale sharks were guided in from afar by whatever mysterious cues they use in navigation. Tonight the shallow, tight-knit ecosystems of the Mesoamerican Reef had opened up. When you try to pick out anything by itself, you find it hitched to everything else in the solar system.

We paced ourselves, finning backward toward the bobbing skiff, under the moon that had brought us.

[CHIME] Thank you for participating.