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# The role of worry and attentional control in mental imagery

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**Abstract**
Models of Generalized Anxiety Disorder postulate that attentional biases for threat-related information and avoidance are key maintenance factors of worry. Such models suggest that worry is primarily a verbal-linguistic, as opposed to an imagery-based process; however, findings regarding the role of imagery, worry, and attentional control (AC) have been inconsistent. The current study aimed to investigate the impact of worry and AC during mental imagery. The sample was comprised of ($N = 93$) college-age students who self-reported current levels of worry and AC. Participants engaged in either worry or relaxation prior to an imagery task, during which they were asked to rate valence and arousal of each image. Heart rate, heart rate variability (HRV), and respiratory sinus arrhythmia (RSA) were recorded throughout the task. Results suggest that overall, individuals reported more difficulties engaging in mental imagery following the worry manipulation. Moreover, individuals with high worry found it more difficult to engage in mental imagery, particularly after engaging in relaxation. Additionally, results revealed no differences in physiological arousal between groups. Results provide support for the avoidance function of worry such that individuals high in worry found it more difficult to engage in mental imagery. Furthermore, results may suggest that those high in worry find it more beneficial to maintain negative affect as demonstrated by findings that individuals with anxiety found it more difficult to engage in mental imagery following relaxation. This study provides important information regarding the mechanisms of worry and AC by documenting the role of avoidance and mental imagery.

**Keywords** Generalized anxiety · Worry · Attentional control · Mental imagery

## Introduction

Worry is defined as the central feature of Generalized Anxiety Disorder (GAD) and is characterized by excessive and uncontrollable apprehension regarding uncertain future events. Chronic worry is characterized by negative verbal-linguistic thoughts, biased attentional processing, and use of cognitive avoidance strategies (Borkovec et al., 2004; American Psychiatric Association, 2013). Based on this disposition, verbal-linguistic worry is often viewed as a tool to avoid aversive experiences evoked by negative imagery, such as increased somatic responses, further reinforcing worry as an effective cognitive avoidance strategy (Borkovec et al., 2004). In addition, individuals with anxiety focus their attention on threat-related information, consuming attentional resources to a current task and decreasing overall cognitive abilities (Eysenck & Derakshan, 2011). Although researchers have studied the role of verbal-linguistic thought and cognitive avoidance in worry, the extent to which these processes affect the ability to engage in mental imagery and subsequent physiological arousal has not been well studied. Given the growing support for the importance of attentional control on cognitive processes, the aim of the current study is to document how individual trait worry and levels of attentional control differentially impact engagement in mental imagery and physiological arousal.

### Models of Worry

Due to the central role of negative cognitions in worry, researchers have described it as the primary maintenance factor of GAD, emphasizing that attentional biases may be a result of worry. The Attentional Control Theory (ACT; Eysenck et al., 2007; Eysenck & Derakshan, 2011) postulates that worry impairs central executive function by consuming cognitive resources, reducing the ability to focus on current tasks. When an individual with anxiety perceives a

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potential threat, attention turns to detecting its source and deciding the necessary response (Power & Dalgleish, 1997). Due to this hypervigilance for aversive stimuli, individuals with anxiety often display reduced task efficiency (i.e., increased reaction times) and greater difficulties disengaging from threat-related stimuli (Eysenck et al., 2007). Although considerable support has been found for this model, these processes may be moderated by trait level of attentional control. For example, previous studies suggest that individuals with worry who display low levels of attentional control may experience a greater sense of uncontrollability with regard to their worry-related thoughts (Mills et al., 2016). Because of the strong reciprocal relationship between worry and attentional control, it is critical to examine additional processes that may be impacted, such as mental imagery.

Consistent with this hypothesis, the Avoidance Model of Worry (AMW; Borkovec, 1994; Borkovec et al., 2004) suggests that worry may reduce attentional resources directed towards mental imagery, thereby suppressing physiological arousal. For example, when negative or threatening mental images reach awareness, an individual may engage in verbal worry in order to decrease somatic arousal and reduce the intensity of distressing imagery (Vrana et al., 1986). When utilizing verbal-linguistic avoidance strategies (i.e., worry), mental imagery and its associated somatic and emotional arousal is inhibited, further reinforcing the use of worry (Foa & Kozak, 1986). In addition to the avoidance function of worry, researchers have asserted that worry serves to avoid negative contrasts, or sharp changes in emotional state (Newman & Llera, 2011). Due to this coping strategy, individuals high in worry may find it more beneficial to maintain a negative affective state using verbal-based mentation, rather than to shift between strong emotions that may accompany negative mental imagery. Therefore, in order to further our understanding of the impact of mental imagery on emotion processing and physiological arousal, it may be important to evaluate both the extent that someone engages in worry as well as their level of attentional control.

Indeed, inconsistencies in the literature point towards the importance of attentional control during mental imagery. Borkovec and Inz (1990) suggest that while engaging in relaxation, non-anxious individuals primarily engaged in imagery-based thought, whereas anxious individuals engaged in equal amounts of verbal-linguistic and imagery-based thoughts. Additionally, anxious individuals displayed increased verbal-linguistic processing compared to non-anxious individuals when engaged in worry (Borkovec et al., 2004). Collectively, these and more recent research support the hypothesis that thought patterns among individuals high in worry are primarily verbal-linguistic in nature compared to individuals low in worry (Williams et al., 2014). Interestingly, Stokes and Hirsch (2010) documented that individuals high in worry experienced increased cognitive intrusions when engaging in verbal-linguistic processing as compared to those engaging in imagery-based processing. Similarly, Hayes et al. (2010) found when individuals with high worry were instructed to engage in mental imagery rather than typical verbal worry, fewer negative intrusions were reported while trying to shift attention. These findings suggest a potential consequence of engaging in verbal worry is increased negative intrusions, leading to decreased ability to direct attention elsewhere. Although such findings have been consistently documented (Butler et al., 1995; Ruscio & Borkovec, 2004; Leigh & Hirsch, 2011), the mechanisms for this process have not.

## Physiological Processes

Given theoretical conceptualizations of worry, researchers have attempted to document modulations in physiological arousal during worry and related processes. Measures such as overall heart rate, heart rate variability (HRV) and respiratory sinus arrhythmia (RSA) are thought to be markers of overall emotion regulation, defensive activation, and parasympathetic activation involved with physiological arousal, respectively (Appelhans & Luecken, 2006; Porges, 2007; Thayer & Lane, 2009). A central assumption within models of anxiety is that worry may be used to avoid further changes in physiological arousal. Investigations have demonstrated reduced levels of resting HRV for GAD individuals compared to controls; however, these differences did not appear during worry manipulations or imagery tasks (Fisher & Newman, 2013; Thayer et al., 1996; Lyonfields et al., 1995; Borkovec & Hu, 1990). In contrast, Levine et al. (2016) examined HRV among individuals with and without GAD during a variety of laboratory tasks, including a relaxation and worry imagery task. Results suggested similar levels of HRV at baseline; however, GAD individuals displayed reduced HRV during the worry imagery period. A 2014 meta-analysis found moderate effect sizes demonstrating lower HRV among GAD individuals when worrying, suggesting that when individuals with anxiety engage in worry, cognitive avoidance strategies may not only serve to reduce negative cognitions, but also distressing somatic responses associated with worry (Chalmers et al., 2014). Additionally, research has demonstrated that high attentional control is associated with increased autonomic flexibility, suggesting that assessing attentional control may further our understanding of the ability to regulate somatic responses (Taylor et al., 2020). Previous research has provided inconsistent results related to physiological arousal during worry and mental imagery, therefore it remains critical to further examine such relationships.

### Current Study

Taken together, theoretical models suggest that worry is a strategy used to avoid physiological arousal associated with negative mental imagery. Moreover, engagement in worry also may lead to attentional impairments and decreased ability to engage in tasks. Although significant support exists for both the Avoidance Model of Worry and Attentional Control Theory, the role of mental imagery and its impact on physiological arousal among worriers remains unclear (e.g., Borkovec et al., 2004). The current study aimed to evaluate whether trait worry impacts self-reported measures of arousal and ability to engage in mental imagery, and if this relationship is influenced by worry inductions and attentional control. Based on current cognitive models, it was hypothesized that those high in trait worry would find it more difficult to engage in mental imagery, particularly for those who engaged in a worry induction. Similarly, it was expected that after engaging in worry, individuals high in trait worry would report negative mental imagery as being more arousing and distressing (i.e., more negative valence) than those low in worry or those who engaged in a neutral mentation period. We further expected that attentional control would moderate these processes, such that individuals low in attentional control would report more difficulty, more arousal, and more distress engaging in mental imagery. Lastly, it is expected that individuals high in worry would display reduced HRV and RSA than low worriers, and that this relationship may be largest for those low in attentional control following the worry induction as compared to relaxation.

## Methods

### Participants

Participants ($N = 93$) were recruited through an online participation pool from a large Midwestern university and received course credit. The sample was on average 19.34 ($SD = 2.06$, Range 18–34) years old. Participants primarily identified as female (65.6%) and reported being White (68.8%), African-American (9.7%), Latinx (9.7%) Asian (3.2%), and Middle Eastern (1.1%), and Other (7.5%). Items from the 8-item abbreviated version of the Penn State Worry Questionnaire (PSWQ-A; Hopko et al., 2003) were summed and a cut-off score of 23 was used to create Low Worry (LW; i.e., $\leq 23$) and High Worry (HW; i.e., $> 23$) groups. This cut-off score has been demonstrated to sensitively distinguish clinical from non-clinical samples (Stanley et al., 2011; Wuthrich et al., 2014). This approach resulted in an LW group comprising 40 participants, and an HW group comprising 53 participants. A median-split (Median = 1.00) of the Attentional Control Scale (ACS; Derryberry & Reed, 2002) was used to form high ($N = 43$) and low ($N = 50$) Attentional Control (AC) groups. A median split was utilized for ease of interpretation as previous work suggests its utility (Iacobucci et al., 2015).

### Materials

**Demographics** Participants completed a demographics questionnaire assessing a number of items such as age, sex, and ethnicity.

**Penn State Worry Questionnaire – Abbreviated Version (PSWQ-A; Hopko et al., 2003)** The PSWQ-A is an 8-item self-report measure that captures predispositions to worry, as well as the frequency, intensity, and interference of worry (e.g., "my worries overwhelm me" or "many situations make me worry"). The PSWQ-A is rated on a 5-point Likert-type scale ranging from 1 (*not at all typical*) to 5 (*very typical*). Total scores range from 8 to 40, with higher scores indicating increased worry. The PSWQ-A has demonstrated good internal consistency ($\alpha = 0.89$) and displays comparable convergent and discriminant validity to the full PSWQ (Hopko et al., 2003; Kertz et al., 2014).

**Attentional Control Scale (ACS; Derryberry & Reed, 2002)** The ACS is a 20-item measure of attentional control that captures individual differences in abilities to focus and shift attention (e.g., "it's very hard for me to concentrate on a difficult task when there are noises around" or "I can quickly switch from one task to another"). The ACS is rated on a 4-point Likert-type scale ranging from 1 (*almost never*) to 4 (*always*). This questionnaire has demonstrated good internal consistency ($\alpha = .88$) and has been shown to be a valid measure of attention regulation in samples of individuals who worry (Spada et al., 2010; Judah et al., 2014) and also is predictive of behavioral indicators of attention (Derryberry & Reed, 2002; Judah et al., 2014).

### Relaxation and Worry-Induction Manipulation

Relaxation and Worry-Induction manipulations described below were adapted from Nolen-Hoeksema and Morrow (1993), Hinrichsen and Clark (2003), and Mills et al. (2014). All participants were instructed that they would engage in an anxiety provoking social interaction later in the study. Participants were then randomly assigned to engage in worry or relaxation regarding the upcoming event. Those who were assigned to the Worry-Induction group were instructed to worry about the upcoming event and saw prompts on the computer screen to facilitate worry. Prompts presented to those assigned to the Worry-Induction condition included: Think about (1) a previous social situation that you felt did

not go well, where you felt uncomfortable or felt that others formed an unfavorable impression of you; (2) how you appeared in that situation; (3) how you are going to appear during the upcoming social situation; (4) what could go wrong during the social interaction; (5) the worst thing that could happen during the social interaction; (6) what you would have to do if you made a fool of yourself. Those who were assigned to the Relaxation-Induction group instructed to distract themselves from the upcoming event and saw prompts on the computer screen to facilitate relaxation. Prompts presented to those assigned to the Relaxation condition included to think about: (1) a boat slowly crossing the Atlantic; (2) the layout of a typical classroom; (3) the shape of a large black umbrella; (4) the movement of an electric fan on a warm day; (5) raindrops sliding down a window pane; (6) clouds forming in the sky. Each prompt was presented for 60 s.

## Mental Imagery Task

After the manipulation, participants completed a mental imagery task based on MacNamara (2018), during which they were instructed to listen to audio recordings of 28 negative (e.g., "Everyone is staring at you, waiting for your presentation. You've misplaced all of your notes, graphics, everything is lost. What will you say? They see you shaking, sweating, mumbling stupidly.") and 28 neutral scenes (e.g., "You turn on the tap and feel the water run over your hands. You wash your hands thoroughly with soap before placing them under the hand dryer.") and imagine themselves in those scenarios as vividly as possible (see Fig. 1). The order of the recordings was randomized across subjects and participants completed each of the negative and neutral scene recordings. After listening to each recording (~10,000 ms), and imaging themselves in the scenario (10,000 ms), participants rated the valence (i.e., "How positive/negative is the image?") and arousal of the mental images (i.e., "How arousing was the previous image") on a Likert-type scale ranging from 1 (*not at all)* to 9 (*Extremely/All the time*).

## Physiological and Heart Rate Recordings

Electrocardiographic (ECG) data were recorded using the MP150 Biopac System, recorded using AcqKnowledge software. Data were sampled at 1000 Hz using two disposable Ag/AgCl electrodes, connected to the right collarbone and left ribcage (Andreassi, 2007). ECG data were imported into and cleaned using QRStool to quantity the QRS complex. R-wave peaks were visually inspected and mean heart rate and RSA were computed (Allen et al., 2007). ECG data were collected during a baseline period before the task and during the worry manipulation.

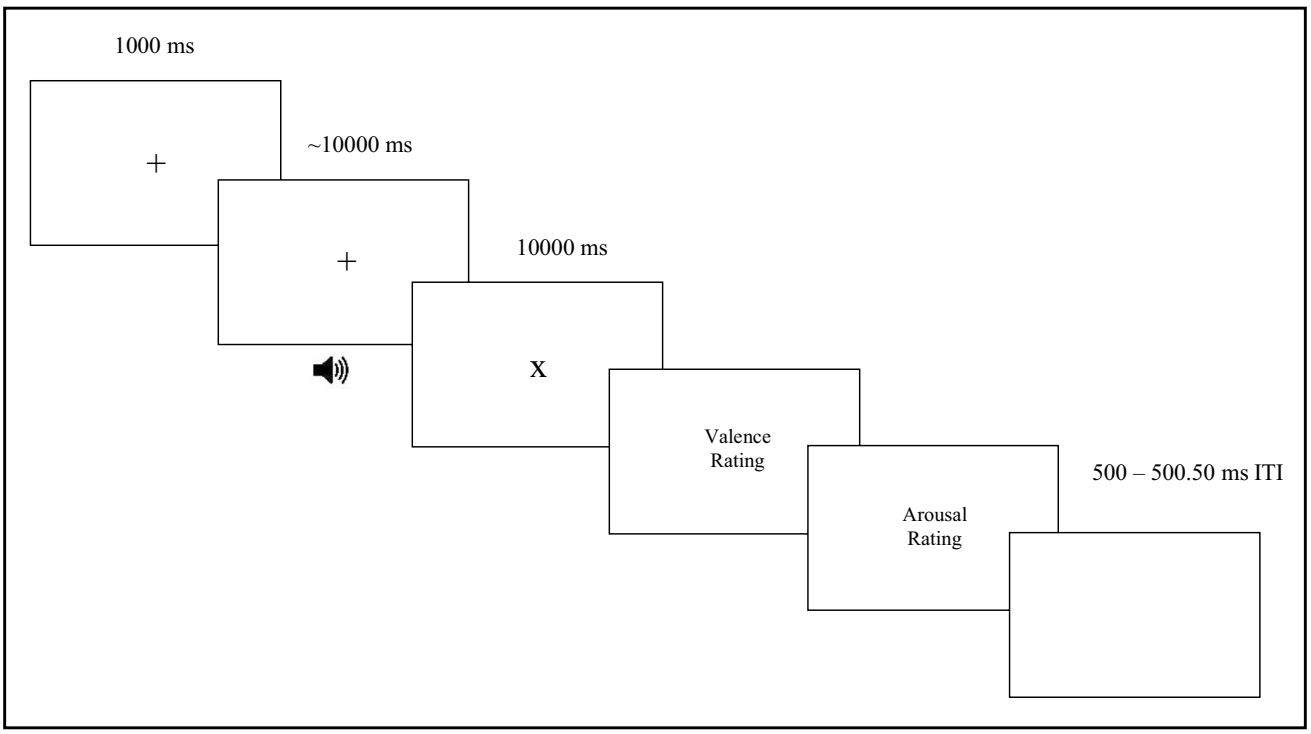


**Fig. 1** Example of one trial within the mental imagery task

## Procedure

All procedures were approved by the Institutional Review Board of the university at which the study was conducted and participants provided informed consent. All measures and manipulations were conducted as part of a larger electrophysiological study documenting attentional biases and self-imagery in those with anxiety concerns (Kraft et al., 2021). Participants were seated in front of a computer monitor, provided with headphones, and connected to ECG electrodes. Following completion of demographics and self-report measures, participants were randomly assigned to engage in either a Relaxation ($N=46$) or Worry-Induction ($N=47$), described above, followed by a mental imagery task. Participants completed a series of manipulation checks throughout the task. Upon study completion, participants were disconnected from the ECG, debriefed and provided with course credit as compensation.

## Analytic Strategy

A series of 2 (PSWQ-A: High, Low) by 2 (ACS: Low, High) by 2 (Manipulation: Worry, Relaxation) mixed model ANOVAs were used to assess the 2 difficulty questions. A series of 2 (Image: Threatening, Neutral) by 2 (PSWQ-A: High, Low) by 2 (ACS: Low, High) by 2 (Manipulation: Worry, Relaxation) mixed model ANOVAs were used to assess the mental images arousal and valence. To evaluate the changes in HR, HRV, and RSA from baseline to manipulation, a series of 2 (Time: baseline, manipulation) by 2 (Manipulation: Worry, Relaxation) by 2 (PSWQ-A: High, Low) by 2 (ACS: Low, High) mixed model ANOVAs. Pairwise comparisons were used to probe significant interactions. Bonferroni adjustments were used if/when necessary.

## Dependent Variables

To evaluate the participants level of state anxiety through the task, participants completed manipulation checks at baseline, post-Relaxation/Worry-Induction Manipulation, and post-Mental Imagery Task. Participants were asked (1) How difficult was it to imagine the scenarios and (2) How difficult was it to keep their mind focused on the mental images at the end of the task. Each of these items was rated on a Likert-type scale ranging from 1 (*not at all)* to 9 (*extremely*). Physiology examining HR, RSA, and HRV were also analyzed based on manipulation, worry level, and attentional control.

# Results

**How Difficult was it to Engage in the Mental Imagery Scenarios?** Results revealed a main effect of manipulation, ($F[1,85]=9.26$, $p=.003$, $\eta_p^2=.10$), such that those who engaged in worry ($M=4.21$, $SE=.30$) had more difficulty imaging the mental images compared to those who engaged in relaxation ($M=2.90$, $SE=.31$). A main effect of PSWQ-A also was observed, ($F[1,85]=5.34$, $p=.023$, $\eta_p^2=.06$), such that those with higher PSWQ-A ($M=4.05$, $SE=.29$) had more difficulty when imaging the mental images compared to those with lower PSWQ-A ($M=3.06$, $SE=.32$). Additionally, those with lower attentional control ($M=3.99$, $SE=.30$) had more difficulty when imaging the mental images compared to those with higher attentional control ($M=3.11$, $SE=.31$) as indicated by a main effect of ACS ($F[1,85]=4.22$, $p=.043$, $\eta_p^2=.05$). Finally, results revealed a PSWQ-A and manipulation interaction ($F[1,85]=8.03$, $p=.006$, $\eta_p^2=.09$), such that within those who engaged in relaxation, those with higher PSWQ-A ($M=4.01$, $SE=.38$) had more difficulty imaging the mental images compared to those with lower PSWQ-A ($M=1.79$, $SE=.49$, $p=.001$), whereas no differences were shown within those who engaged in the worry manipulation.[1]

**How Difficult was it to Keep your Mind Focused on the Mental Images?** Results revealed a main effect of ACS ($F[1,85]=8.17$, $p=.005$, $\eta_p^2=.09$), such that those with lower attentional control ($M=5.60$, $SE=.34$) had more difficulty keeping their minds focused on the mental images compared to those with higher attentional control ($M=4.24$, $SE=.34$).[2]

**Arousal Ratings** Results revealed a 4-way interaction between Image, Manipulation, PSWQ-A, and ACS ($F[1,85]=7.56$, $p=.007$, $\eta_p^2=.08$; Fig. 2). Evaluation of pairwise comparisons indicated a significant difference between those with high attentional control ($M=2.24$, $SE=.32$) and low attentional control ($M=3.32$, $SE=.38$) in the anxious arousal rating of the neutral mental image. This effect was observed within the low PSWQ-A group for those who engaged in worry. In other words, among those with low PSWQ-A in the worry condition, those with high attentional control rated the neutral images as less anxious arousing than those with low attention control. There was a main effect of Image ($F[1,85]=698.94$, $p<.001$, $\eta_p^2=.89$), such that the threatening mental images ($M=7.12$, $SE=.11$) were reported as more anxious arousing than the neutral mental images ($M=2.95$, $SE=.13$). Additionally, those with

[1] Supplemental analyses using ANCOVA assessed PSWQ-A and ACS as continuous variables for all dependent variables. Results reveal a similar main effect of manipulation, $F(1, 93) = 10.41$, $p = 0.002$ and PSWQ-A by manipulation interaction, $F(1, 93) = 6.16$, $p = 0.015$. The main effect of PSWQ-A is marginally significant, $p = 0.061$.

[2] After examining ACS as a continuous variable, this effect is marginally significant, $p = 0.054$.

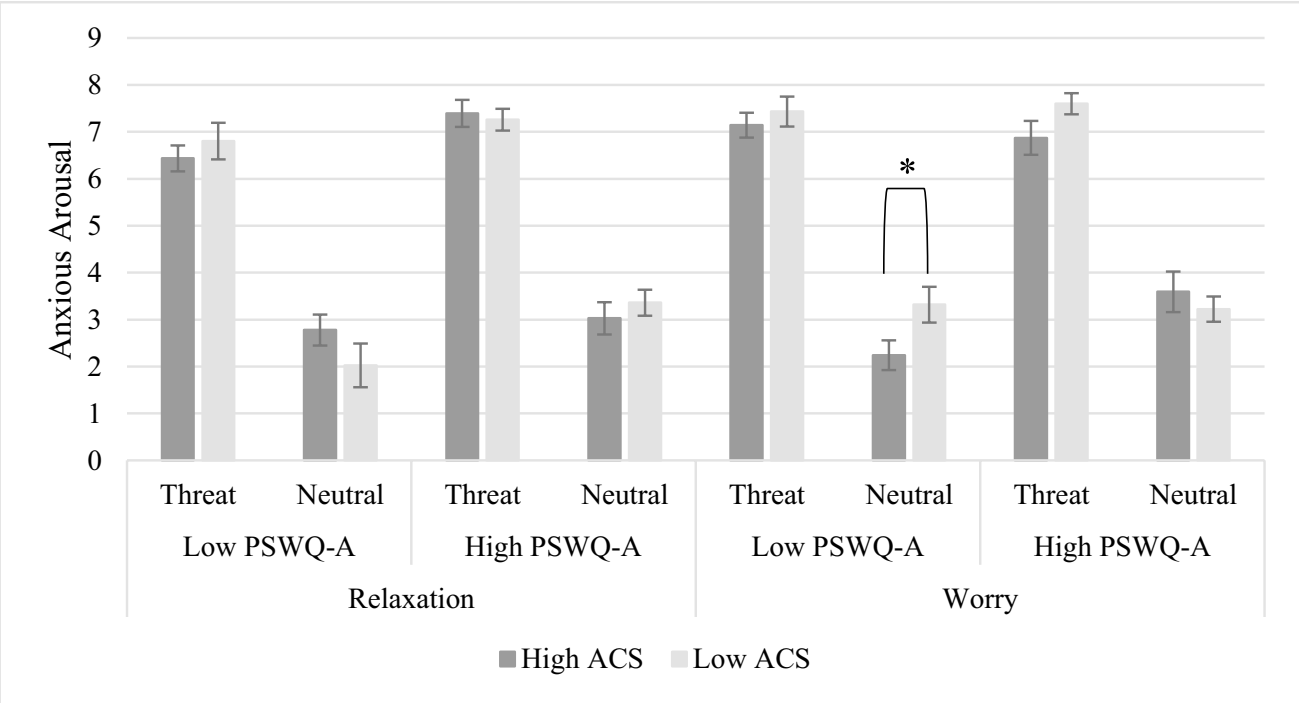


**Fig. 2** Mean anxious arousal ratings for those by ACS, Manipulation, PSWQ-A, and Image Conditions. *Note. * = significant ($p < .05$) difference, PSWQ-A = Penn State Worry Questionnaire- Abbreviated Version, ACS = Attentional Control Scale

high PSWQ-A ($M = 5.29$, $SE = .11$) rated all mental images as more arousing than those with low PSWQ-A (M = 4.77, $SE = .13$, $F[1,85] = 9.09$, $p = .003$, $\eta_p^2 = .09$).[3]

**Valence Ratings** Results indicated a main effect of Image ($F[1,85] = 619.44$, $p < .001$, $\eta_p^2 = .88$), such that the threatening mental images ($M = 3.12$, $SE = .13$) had a more negative valence than the neutral mental images ($M = 7.41$, $SE = .09$).

**Physiology** Results indicated no significant main effects or interactions for HR, RSA, or HRV.

## Discussion

The current study aimed to investigate the impact of worry and attentional control on mental imagery after worry and relaxation inductions. Additionally, physiological measures of arousal were examined to determine how worry and attentional control modulate physiological arousal during the manipulation. Results provide partial support for our hypotheses, suggesting that worry and attentional control may lead to subjective difficulties engaging in mental imagery; however, physiological data suggested no differences between groups. Primary results indicated that, overall, individuals high in worry found it more difficult to imagine the stated scenarios, particularly when asked to engage in relaxation. Results also demonstrate a four-way interaction between trait worry, attentional control, arousal ratings, and worry manipulation such that when engaging in a worry induction, individuals low in trait worry, rated the arousal of neutral images differently based on level of attentional control. When asked to rate the arousal of each image, individuals high in worry subjectively rated all image types as more arousing, regardless of image valence. This is interesting as results for physiological arousal (e.g., HR, HRV, RSA) were not significant.

Overall, threat-related images were rated as more negative than neutral images, suggesting task images indeed were perceived accurately.

These findings reveal important information regarding the impact of worry and attentional control on the mental imagery process. First, results extend upon previous literature on how worry is primarily a verbal-linguistic process and often leads to cognitive avoidance. Although research has provided significant support for the avoidance function of worry, it remained unclear how this function may manifest within mental imagery. Results suggest that

[3] A main effect of image is still observed on arousal rating, $F(1, 85) = 7.93$, $p = 0.006$; however, there is no longer a significant 4-way interaction, $p = 0.074$.

individuals high in worry found it more difficult to engage in mental imagery overall. Based on the Attentional Control Theory, it is possible that when engaging in mental imagery, individuals high in worry experienced a greater disruption in top-down processing leading to greater overall difficulties engaging in the task. Additionally, individuals found it more difficult to engage in mental imagery after engaging in a worry manipulation as compared to relaxation manipulation, regardless of trait worry levels. These findings suggest that even state worry consumes cognitive resources, leading to overall reductions in task performance. Interestingly, following engagement in the relaxation manipulation, individuals high in trait worry experienced more difficulties engaging in mental imagery as compared to individuals low in trait worry, whereas no differences were shown within those who engaged in the worry manipulation. Results suggest that individuals high in trait worry may perform better when asked to maintain an anxious state versus when asked to engage in relaxation. Research has posited that individuals with anxiety have a tendency to avoid sharp changes or contrasts in emotions, and therefore choose to worry to maintain negative affect (Newman & Llera, 2011). Due to this tendency, individuals high in worry may find it more difficult to engage in relaxation versus to remain in a worry state.

Results also indicated that trait worry, attentional control, arousal ratings, and the worry manipulation collectively influenced self-reported arousal ratings, such that in the worry manipulation, individuals low in worry with different levels of attentional control differed only in their arousal ratings of neutral images. More specifically, results demonstrated that low worriers with high attentional control reported less subjective arousal as compared to those with low attentional control after engaging in worry. This provides interesting information regarding the role of attentional control and worry in emotion processing such that even among those low in worry, attentional control appears to moderate subjective ability to maintain physiological arousal. Research regarding internal controlled attention has found that individuals low in worry, but high attentional control display a greater ability to disengage from emotional stimuli, therefore decreasing subjective ratings of arousal (Johnson, 2009). These results suggest that individuals with low levels of anxiety can still be influenced by engaging in worry, particularly if they are low in attentional control.

Differences in attentional control were found within both self-reported measures of difficulty imaging the scenario as well as ability to keep mind focused on the mental images. In line with Eysenck et al. (2007), individuals low in attentional control reported more difficulties imagining the scenarios, as well as found it more difficult to keep their mind focused on mental images. Results support previous research suggesting increased difficulties in task completion among individuals with low attentional control (Derryberry & Reed, 2002). These findings build upon previous literature regarding the impact of attentional control on overall task performance.

Contrary to stated hypotheses, no significant differences in physiological arousal were observed, as indexed by heart rate, HRV, and RSA. Although in contrast to the original hypotheses, some research has found that imagery tasks may not elicit strong changes in objective physiological arousal among individuals with worry despite changes in self-reported arousal, as compared to verbal- worry tasks (Hayes et al., 2010). These results are consistent with research indicating that although an individual may report subjective increases in levels of arousal, cognitive avoidance strategies (as indicated by significant differences in task engagement) may lead to no changes in physiological responding, providing further support that worry reduces somatic responses (Borkovec & Hu, 1990; Fisher & Newman, 2013; Llera & Newman, 2014). Furthermore, these results are consistent with Borkovec's (1994) theory of cognitive avoidance, such that when faced with imagery, individuals with anxiety may engage in verbal worry as a means to reduce negative emotionality and physiological arousal. Findings provide support for the use of verbal-linguistic processing to reduce somatic arousal as compared to mental imagery (Foa & Kozak, 1986).

The current study was limited by a number of variables including use of self-report measures, group cutoffs, and imagery type. Analyzing levels of worry and attentional control using the provided cut-off method may has been justly criticized. Although these methods are useful for ease of interpretability and analytic approaches, a major limitation is the assumption that scores near the cut-offs are likely not meaningfully different. Future research should utilize diagnostic interviews in order to determine clinical levels of worry and GAD. It also may be important to implement additional measures of attentional control, such as electroencephalogram (EEG), to obtain objective measures of overall engagement and attentional processing. Additionally, the current study utilized only negative and neutral imagery, and it may be important to incorporate a wider range of imagery valences. Previous research suggests that not only do individuals with anxiety display a hypervigilance for threat, but also for disgust and sad images and stimuli (Dennis & Chen, 2007). Therefore, future studies should make use of these additional image types. Furthermore, it is possible that the mental imagery manipulation used in the current was strong enough to target specific features of worry, such as worry about the future and uncertain events. Future research may consider additional manipulations to target general worry beyond social situations, including common worrisome situations such as finances, work/school, and general world affairs.

This study documents novel evidence regarding the mechanisms of worry, specifically by evaluating the role of mental imagery in worry and attentional control. Most importantly, these results support the avoidance function of worry such that individuals with anxiety displayed greater difficulty engaging in mental-imagery. Furthermore, these results support the importance of evaluating level of attentional control in order the impact of mental imagery among individuals who engage in chronic worry. Additionally, findings that those high in trait worry found it more difficult to engage mental imagery following relaxation supports a contrast avoidance function, suggesting that those high in worry find it more beneficial to remain in a negative affective state rather than undergo a sharp contrast to relaxation. Results of this study extends upon the growing literature that evaluates the functions and mechanisms of worry and attentional control.

**Data Availability** Not applicable.

**Code Availability** Not applicable.

## Declarations

**Conflicts of Interest/Competing Interests** The authors have no conflicts of interest to disclose.

**Ethics Approval** The Institutional Review Board at Oklahoma State University approved the present study and the study was in line with the ethical standards as described in the 1964 Declaration of Helsinki and its later amendments.

**Consent to Participate** Informed consent was obtained from all participants in the study.

**Consent for Publication** Informed consent regarding publication of data was obtained from all participants in the study.

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