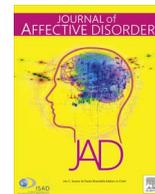




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Research paper

Moderators of age effects on attention bias toward threat and its association with anxiety

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ABSTRACT

Objective: The current study used a research domain criteria (RDoC) approach to assess age differences in multiple indicators of attention bias and its ties to anxiety, examining stimulus domain and cognitive control as moderators of older adults' oft-cited positivity effect (bias towards positive and away from negative stimuli, when compared to younger adults).

Method: 38 Younger adults and 38 older adults were administered a battery of cognitive control and trait and state anxiety measures, and completed a dot-probe task to assess attention bias, during which reaction time and fixation duration (using eye-tracking) were recorded for negative and neutral social (a salient threat domain for younger adults) and physical (a salient threat domain for older adults) stimuli.

Results: Mixed-effects models demonstrated that older adults were faster to react to dot-probe trials when the probe appeared in the place of negative (vs. neutral) physical stimuli, but displayed no difference in reaction time for social stimuli. Also, older (vs. younger) adults with lower levels of cognitive control were less negatively biased in their visual fixation to social stimuli. A negative reaction time attention bias on the dot-probe task predicted greater trait anxiety among participants with low levels of cognitive control, with a more complex pattern predicting state anxiety.

Conclusion: Older adults do attend to social and physical stimuli differently. When stimuli concern a social threat, older adults do not preferentially attend to either neutral or negative stimuli. However, when stimuli concern physical threat, older adults preferentially attend to negative stimuli. Threat biases are associated with anxiety at all ages for those with low cognitive control.

It is well documented that when people are anxious, they show an attention bias for threat, preferentially attending to threatening over neutral stimuli (Bar-Haim et al., 2007). This initial orienting toward and/or delayed disengagement from threat is thought to be an automatic, rather than a controlled, process (Bar-Haim et al., 2007). Across the lifespan though, there appear to be important differences in how attention bias manifests. Research on younger adults tends to find a bias for negative stimuli, or a negativity effect, but many studies have demonstrated a reversal of this bias, or a *positivity effect* in older adults, meaning that they preferentially attend to positive (relative to negative) stimuli (Reed et al., 2014). For what types of stimuli might older adults show a positivity effect, and how does this attention bias relate to anxiety? The current study takes a research domain criteria (RDoC) approach to examine potential moderators of the positivity effect. We examine multiple behavioral indicators of attention bias to neutral and negative physical health- and social-related images in

younger and older adults, and test relationships between attention bias and state and trait anxiety, while examining cognitive control as a moderator. [Note, in line with other researchers (e.g. Reed and Carstensen, 2012), we use the term positivity effect here broadly so that it includes both a relative focus on more positive stimuli and/or on less negative stimuli; e.g., attention to neutral vs. negative cues in this case.]

1. Incorporating the RDoC framework

Given older adults tend to show subclinical levels of anxiety symptoms (Bryant et al., 2008; Grenier et al., 2011) and their symptoms often do not fit as well with DSM categorical diagnoses (Bryant et al., 2013), examining anxiety-linked attention biases in older adults may benefit from considering a dimensional approach, like RDoC. In particular, some strengths of the RDoC approach of

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characterizing behavior and biology in dimensional, rather than categorical, terms, are the consideration of risk, associated impairment, and chronicity for varying degrees of each dimension, and the acknowledgement of heterogeneity of disorder presentation. As such, the RDoC framework is particularly well-suited to studying anxiety in older adults.

The RDoC framework is also useful for studying constructs that are multi-faceted and complex, because the framework identifies mechanisms by using convergent, multi-method approaches that consider multiple levels of analysis. Using this framework in the current study to better understand the components of attention involved in the positivity effect, we focus on a traditional behavioral index of attention bias (reaction time bias on a dot-probe task), but also include secondary analyses with a measure that captures a slightly different attentional processes: gaze bias. (Note, only a subsample of the larger sample provided valid data on this latter metric, so these secondary analyses are included for comparative purposes and as intriguing preliminary data.) Both metrics fit into the attention construct of the cognitive systems domain of the RDoC matrix. By measuring both reaction time to targets appearing after emotional versus neutral pictures and tracking eye gaze duration for these pictures, we obtain two slightly different behavioral measures of attention – eye gaze as a more direct measure of participants' sustained visual attention, and reaction time as a measure of behavioral interference thought to result from attentional capture by the pictures. We examined how these different components of attention to negative versus neutral pictures were inter-related and varied as a function of age, stimuli domain, and cognitive control.

Given cognitive control affects a wide variety of psychological processes, including attention (e.g. [Gorlin and Teachman, 2015a](#)), and shows normative age-related changes ([Braver and Barch, 2002](#)), we measured three components of cognitive control (from the RDoC Cognitive Systems domain) to examine its role as a moderator of attention bias effects. First, task switching was assessed (using the Trailmaking subtests of the Delis-Kaplan Executive Function System; [Delis et al., 2001](#)) to reflect RDoC's goal selection, updating, representation, and maintenance component process of cognitive control. Second, inhibitory control was assessed (using a color-word Stroop task; [Stroop, 1935](#)) to reflect the RDoC component process of response selection, inhibition or suppression. Third, working memory, an additional RDoC component of cognitive control, was assessed (using the Operation Span task; [Turner and Engle, 1989](#)).

Finally, we integrated these different components of the RDoC matrix by examining how cognitive control moderates attention bias effects (focusing on our primary reaction time bias measure) on anxiety. Specifically, we tested how attention bias predicts self-report measures of both state and trait anxiety that fit within the acute threat ("fear") construct in the RDoC negative valence systems domain.

Taken together, the RDoC framework provided a good fit to the current study goal of examining anxiety-linked attention bias in older adults. However, to address the question of how attention bias would differ across age groups, it was also important to consider lifespan models of attention and goals.

2. The age-related positivity effect in older adults and its moderators

As we age, health worsens and loved ones pass away, yet negative affect often decreases ([Carstensen et al., 2000](#); [Charles et al., 2001](#)). Socioemotional selectivity theory sets out one explanation for this improvement in mood across the lifespan: goals and cognitive processes shift as time horizons shorten ([Carstensen, 2006](#)). When people perceive they have less time left, they prioritize emotion regulation goals over information gathering goals ([Carstensen, 2006](#)). One way that older adults may reveal these emotion regulation goals (see [Isaacowitz and Blanchard-Fields, 2012](#)) is by selectively attending to

and remembering positive rather than negative stimuli – the age-related positivity effect ([Isaacowitz and Noh, 2011](#); [Reed and Carstensen, 2012](#)). Although the age-related positivity effect has been noted in many studies (see [Reed et al., 2014](#), for a meta-analysis), several factors moderate the strength of the effect and indeed whether it is noted at all, including the type of stimuli presented and the degree of cognitive control.

2.1. Stimulus domain

The positivity effect may be weakened when stimuli are highly personally relevant. When shown images low in personal relevance, younger adults remembered more negative images and older adults remembered more positive images, but this Age by Valence interaction was not found with highly personally relevant images ([Tomaszczyk et al., 2008](#)). For older adults, health concerns may be particularly salient. The literature is mixed as to whether older adults show a different pattern of attention bias for health- and death-related stimuli than other stimuli. In one study, older adults looked at negative images related to melanoma less than younger adults, which could be interpreted as older adults having a diminished negativity effect for this specific category of health stimuli ([Isaacowitz and Choi, 2012](#)). However, other studies have found that older adults may attend more to negative health-related stimuli than to other negative stimuli. One such study found that older adults were slower to disengage from general threat- and death-related words than middle-aged adults, but there was no age difference for neutral words, indicating a relative negativity effect in attention for older adults with threat- and death-related stimuli ([De Raedt et al., 2013](#)). Similarly, older adults in poorer health showed a positivity effect in attention for non-health decisions, but not for health decisions ([English and Carstensen, 2015](#)). Although one of these studies showed a negativity effect for death-related stimuli and the other showed the absence of a positivity effect for health decisions, both found that older adults attended relatively more to health-threat than neutral stimuli, possibly due to increased personal relevance of health threats.

Social stimuli appear to elicit a positivity effect in older adults, in contrast to a negativity effect in younger adults. In one study, older adults exhibited less anxiety than younger adults after a task designed to provoke social anxiety, but there was no age difference after a task designed to provoke physical anxiety ([Teachman and Gordon, 2009](#)). In another study, after reading valenced scenarios that were either physical health or socially relevant, participants were asked to rate the likelihood of future valenced events occurring ([Steinman et al., 2013](#)). The positivity effect was stronger for social than physical scenarios, as older adults showed higher expectancy of positive events following socially relevant scenarios ([Steinman et al., 2013](#)). Given these findings of less negative reactions and greater positive expectations tied to social relative to physical stimuli for older adults, we examined attention bias for social versus physical stimuli in the present study, predicting that older adults would show more of a positivity effect for social than physical stimuli.

Notably, even though older adults may have a tendency to attend to social stimuli in a more positive way than younger adults, whether this effect is expressed may depend on available resources.

2.2. Cognitive control

The positivity effect is conceptualized to require cognitive resources, and thus should be diminished under conditions of decreased cognitive control ([Mather and Carstensen, 2005](#)). The effect of cognitive control on the positivity effect can be examined in two ways: by comparing the positivity effect in groups high and low in trait-like cognitive control abilities, and by comparing the positivity effect when cognitive resources are taxed. Previous research has found that cognitive control abilities moderate the positivity effect in memory in

older adults; for people high in cognitive control (as indexed by better performance on tasks of executive attention, efficiency of refreshing recently presented information, and simultaneously storing and processing information), older adults remember more positive versus negative stimuli compared to younger adults, whereas this Age by Valence interaction is not observed for adults low in cognitive control (Mather and Knight, 2005). When cognitive resources are taxed – for instance, by dividing attention between a visual attention task and an audio tone pattern recognition task – older adults are less likely to show the positivity effect in memory (Mather and Knight, 2005) and visual attention (as measure by tracking eye gaze; Knight et al., 2007), compared to when completing the task under conditions of full (not taxed) attention. It is possible, however, that the positivity effect may only require moderate cognitive control. With a less taxing distractor task than the audio tone recognition task used in the studies described above, the positivity effect was maintained for older adults under conditions of dual-load (Allard and Isaacowitz, 2008).

Some eye-tracking studies have found that the positivity effect in attention is only evident in later stages of processing, which supports the idea that this effect is at least partially strategic, as opposed to a fully automatic process. When a neutral and an emotional stimulus are shown concurrently, the first gaze fixation for both younger and older adults is on the emotional stimulus, indicating that attention is initially drawn to emotional stimuli for both groups (Knight et al., 2007). However, positive attention bias in gaze patterns only emerged in older adults 500 ms after stimulus presentation and increased linearly after that (Isaacowitz et al., 2009). Because the positivity effect is not evident immediately upon stimulus presentation and increases with time as individuals process emotional stimuli, it seems to involve some more strategic, cognitively controlled processing. These studies also point to the benefits of including multiple indices of the cognitive process (attention, in our case) to evaluate whether there is consistency across metrics, a critical question given frequent findings of desynchrony across measures of emotional processing and expression (e.g. Lang, 1985). For this reason, we have included multiple measures of attention, as well as several behavioral tasks assessing slightly different aspects of cognitive control (to obtain a more reliable and multi-faceted assessment of control), in the present study.

This literature provides a helpful basis for considering how cognitive control might influence the expression of attention bias, but there is less known about how these variables in turn interact to predict anxiety.

3. Cognitive control moderating attention bias and anxiety

Although anxious individuals often show an attention bias for threatening stimuli, research is only beginning to examine how cognitive control may moderate the relationship between attention bias and anxiety. In two studies of highly socially anxious individuals, Gorlin and Teachman, (2015a, 2015b) found that inhibitory control differentially moderated the relationships between attention bias and different measures of anxiety. For participants low in inhibitory control, *greater* attention bias (as measured by interference on an emotional Stroop task) was associated with greater state and trait social anxiety. In contrast, for those high in inhibitory control, *lower* attention bias was related to greater state and trait social anxiety. It is possible that inhibitory control facilitates avoidance of threat or later controlled processing. Interestingly, moderation by inhibitory control occurred in the opposite direction for a behavioral index of anxiety: among those with weaker inhibitory control, lower attention bias was related to higher observer-rated anxious behavior on a speech task. Inhibitory control did not moderate the relationship between attention bias and behavioral avoidance of a speech task. As these studies demonstrate, cognitive control may not moderate the effects of attention bias on anxiety in a simple way, but rather, may act differently on different aspects of anxiety. For this reason, we have included measures

of both state and trait anxiety in the current study.

4. Overview and hypotheses

The current study aims to better understand age differences in attentional processing, including the positivity effect. As noted, the positivity effect is a *relative* preference for positive over negative stimuli in older versus younger adults, which can be driven either by relatively more attention to positive stimuli or away from negative stimuli (Reed and Carstensen, 2012). In this study, the positivity effect refers to a decreased preference for negative (relative to neutral) images, given positive stimuli were not included. We examined moderators of the age-attention bias relationship, including stimulus type (social versus physical stimuli) and cognitive control. Further, we studied the extent to which attention bias predicts state and trait anxiety in younger and older adults, and whether cognitive control moderated this relationship. We hypothesized that older adults would show a positivity effect in attention for social, but not physical, images, and that cognitive control would moderate this effect, such that participants with stronger cognitive control would attend relatively more to positive images than participants with weaker cognitive control. As for the relationship between attention bias and anxiety, we hypothesized that a more negative attention bias would be related to greater state and trait anxiety. We also hypothesized that for those lower in cognitive control, a more negative attention bias would be associated with greater anxiety. Our hypotheses did not differ for the two attention bias metrics, reaction time and gaze bias, especially given the smaller samples for the latter metric (which meant those analyses were more preliminary).

5. Method

5.1. Participants

Thirty-eight younger adults (63% female, mean age =18.8 years, $SD=0.9$, range=18–21) and 38 older adults (82% female, mean age=71.7, $SD=8.2$, range =60–95 years) participated in the study. Race and ethnicity for the sample were reported as 77.6% White, 10.5% Asian or Pacific Islander, 9.2% Black, 1.3% Native American, 1.3% mixed race, and 6.6% Hispanic or Latino across all races. The younger adult sample was recruited from the participant pool of the university psychology department, and the older adult sample was recruited from the community using recruitment events at a local senior activity center. Participants were selected based on their age (individuals aged 18–30 qualified for the younger adult group, and individuals 60 years and above qualified for the older adult group). Given the eye-tracking component of the study, participants were excluded based on a phone or email screen if they wore bifocal or trifocal eyeglasses with a definite line or lines, wore hard contact lenses, had cataracts, had an eye implant, had glaucoma, or if either of the individual's pupils were permanently dilated (following suggestions from the Center for the study of Emotion and Attention, University of Florida, <http://csea.php.ufl.edu/index.html> to try to maximize the number of participants with good eye-tracking data). 8 older adult participants (17% of those screened) were disqualified from participating based on these criteria. Additionally, participants completed the Mini-Mental Status Exam (MMSE; Folstein et al., 1975) during the lab session to screen for dementia; no participant scored below 24, the recommended cutoff (following Tombaugh and McIntyre, 1992), so no one was excluded based on this criterion.

5.2. Materials

5.2.1. Attention bias

5.2.1.1. *Behavioral index (reaction time)*. A dot-probe paradigm was used to measure attention bias to neutral and threatening social and

physical stimuli (MacLeod et al., 1986). At the start of each trial, a fixation cross appeared for 1000 ms. After this fixation cross, participants were presented with two stimuli arranged vertically, one neutral and one threatening, for 2000 ms, maintaining a 1:2 ratio of fixation time to stimuli time (following (MacLeod et al., 2002). These stimuli were either faces (social stimuli) or scenes of activities involving physical activity or health situations (physical). Although typical trial times are shorter for studies assessing attention bias among participants with anxiety (Bar-Haim et al., 2007), time on the trials was increased in the current study for eye-tracking purposes, similar to the supraliminal time used by Isaacowitz et al. (2006a). The images then disappeared, and a probe stimulus (either the letter “E” or “F”) appeared in the location of one of the two earlier images. The participant was told to indicate which probe they saw by pressing the corresponding letter key on the keyboard. Latency was measured from the time the probe was presented until the time the participant pressed the correct letter key. This task is widely used to index attention bias tied to anxiety (see review in Bar-Haim et al., 2007) based on the idea that being slower to identify the probe that appears in the place of where a neutral (vs. threat) stimulus had been presented indicates that one's attention had been focused on the threat stimulus (so it took longer to disengage from the threat stimulus to attend to the neutral stimulus location than it took on trials that required disengaging from the neutral stimulus).

There were 96 trials (four blocks of 24 trials), with the probe appearing behind each of the different stimuli once. Social stimuli consisted of disgusted (threatening) or neutral faces, and physical stimuli consisted of scenes in which a person was experiencing physical pain or illness (threatening) or physical scenes (such as a person taking a walk) in which people appeared neither distressed nor pleased (neutral). For example, a negative physical stimulus might be a photo of a seriously injured person in a hospital bed, while a neutral physical image might be a photo of a person sitting peacefully on a park bench. The neutral images for the physical stimuli were chosen to match the image complexity of the threatening images, and were also rated as highly physically relevant during pilot testing. Social stimuli were selected from a standardized database (NIMSTIM; <http://www.macbrain.org/>) and physical stimuli were found using an Internet search for public domain images. All stimuli were pilot tested using an online Mechanical Turk sample ($N=70$) to match social stimuli on valence and ease of categorization. Specifically, 35 older (age 60–100) and 35 younger adults (age 18–30) rated the social and physical images on valence (on a scale from 1=very negative to 9=very positive), and how socially relevant and physically relevant they found each image (on scales from 1=extremely socially/physically irrelevant to 9=extremely socially/physically relevant). Images were selected so that the final set of negative physical and negative social images were rated as comparably negative (m physical =2.34, m social =2.49; t [68] =0.995, $p=0.341$, $d =0.241$) and each negative image had a mean rating below 3, and the final set of neutral physical and neutral social images were rated as comparably neutral (m physical =5.148, m social =5.263; t [68] =0.659, $p=0.524$, $d =0.160$) and each neutral image had a mean rating between 3 and 7. A final set of 48 social and 48 physical images were selected. Of these images, half of each domain consisted of older adult images and half of younger adult images. The stimuli pairs in the dot-probe task were always matched for age and gender (i.e., if a neutral, female social stimulus was on the bottom of the screen, then a negative, female social stimulus was on the top). Images were presented on a 19-in. LCD monitor with 1440×900 resolution, 60-Hz refresh rate, and 32-bit color.

5.2.1.2. Scoring and data reduction. Reaction time outliers were rescaled using the Winsorizing process outlined by Price et al. (2015) to maximize reliability on the dot-probe task. Latencies outside of the

“Tukey Hinges” (1.5 interquartile ranges from the 25th or 75th percentiles) of the full distribution of reaction time (RT) values were rescaled to the last valid value within that range. All accurate trials were included in RT analyses (because RTs were Winsorized), however 1.9% of trials were excluded from RT analyses because the incorrect letter was selected when probed. An overall measure of negative attention bias was calculated for each participant using the process outlined by Price et al. (2015), which has been shown to increase reliability when compared to various, older methods of scoring overall bias. This overall bias score was calculated by subtracting the mean RT of trials where the probe replaced a negative image from the mean RT of trials where the probe replaced a neutral image. Per Price et al.'s (2015) recommendation, only trials in which the probe replaced the bottom image were used because this has been found to increase stability and reliability of RT bias on the dot-probe task. Using this system, a score of zero indicates no bias towards neutral or negative images, and positive scores indicate a negativity bias and negative scores indicate a neutral bias.

The data from two younger adults and five older adults (9.2% of the whole sample) were excluded from the RT dot-probe analyses because of missing RT data (one older adult's data was accidentally overwritten, and the others were excluded due to the dot-probe program failing). Thus, the final sample for the reaction time analysis consisted of 36 younger adults and 33 older adults.

5.2.1.3. Visual gaze index (gaze fixation duration). During stimulus presentation on the dot-probe task, participants' X and Y gaze coordinates were measured using an ASL D6-HS Optics controlled by an ASL EYE-TRAC 6 series eye-tracking system.¹

5.2.1.4. Scoring and data reduction. To score the eye gaze data, a ratio score was computed for each trial using the formula (negative image – neutral image)/(negative image+neutral image) from the raw fixation data for each image from each trial, following Isaacowitz et al. (2006b). To minimize the impact of momentary equipment failures, percentage of fixation duration, rather than raw fixation duration time, was used to calculate this ratio. The percentage of fixation duration refers to the percentage of time during which the participant fixated on the stimulus of interest out of the time the participant was detectably fixated on any screen position.

Eight younger adults and 15 older adults (30.3% of the whole sample) had to be excluded from eye-tracking analyses of the dot-probe task because of pupil obfuscation, reflective eyewear, excessive eye moisture, or missing eye-tracking data. This number is somewhat larger than the 18.9% exclusion rate achieved for a similar study by Isaacowitz et al. (2006b), but not markedly so. After these removals, 28 younger adults and 18 older adults were included in the eye-tracking analyses. All participants who were trackable for at least 25% of their trials were included in the analyses following Isaacowitz et al. (2006b). For those participants included in the eye-tracking analyses, 9.4% of their trials had to be excluded because gaze could not be tracked during a trial or because a participant was not tracked as having looked at either stimuli during the trial.

¹ Pupil diameter was also assessed for each trial. However, given that a proper baseline was not established for each participant and given that pupil size may reflect an effortful cognitive process to avoid attending to stimuli (thus causing greater pupil diameter when looking away from an intense target), it was decided that analyses using these measures could not be reliably interpreted, so they are not reported here. For information regarding this measure and analyses, please contact the first author.

5.3. Anxiety measures

5.3.1. Trait anxiety

Three well-established questionnaire measures of trait anxiety symptoms that have good psychometric properties across a wide age range were administered. The Depression and Anxiety Stress Scales - Anxiety Subscale (DASS-A; Lovibond and Lovibond, 1995), a 7-item subscale that assesses several autonomic and subjective emotional aspects of anxiety (e.g. “I felt scared without any good reason”) was used to measure general anxiety. Cronbach's alpha was 0.74 among our younger adult sample and 0.43 among our older adult sample. The Anxiety Sensitivity Index (ASI; Reiss et al., 1986), a 16 item scale that assesses fear or concern about negative consequences associated with a range of anxiety symptoms, including physiological arousal (e.g., “It scares me when I become short of breath”), was used to measure physical anxiety sensitivity. Cronbach's alpha was 0.83 among our younger adult sample and 0.88 among our older adult sample. Finally, the Social Interaction Anxiety Scale (SIAS; Mattick and Clarke, 1998), a 20-item scale that assesses reactions to social situations (e.g., “I get nervous if I have to speak with someone in authority”), was used to measure social anxiety. Cronbach's alpha was 0.92 among our younger adult sample and 0.88 among our older adult sample. In our analyses of trait anxiety, *z*-scores were obtained for each of these three measures and averaged for each participant. This was done to obtain a reliable measure that reflected multiple aspects of trait anxiety, all of which are important in determining the effect of attention bias on participants' general anxious responding.

5.3.2. State anxiety

To examine state anxiety reactivity, participants completed two stressor tasks, one designed to trigger anxiety about physical threat and one to trigger social threat. Specifically, to induce physical sensations relevant to physical anxiety sensitivity, a candle-blowing task was used. In the task, participants were told to blow on their index finger repeatedly, as though their finger was a candle and they were trying to blow out the flame. Participants were asked to do this for 60 s to the beat of a metronome set to 100 beats per minute. The candle-blowing task is harmless, but does produce temporary physical sensations (e.g., numbness, dizziness, sweating, tingling). This task been used in previous studies of anxious reactions to physical stressors (e.g., Gordon and Teachman, 2008; Steinman and Teachman, 2010). Additionally, to induce anxiety about a social situation, participants were asked to give a two-minute speech about what they like or dislike about their hometown. Participants were given one minute to prepare before delivering the speech to a research assistant who maintained a neutral facial expression. This task has been used successfully to induce anxiety about social situations in previous studies (see Cody and Teachman, 2011; Gorlin and Teachman, 2015b).

State anxiety was measured using the 0–100 verbal analog Subjective Units of Distress Scale (SUDS; Wolpe, 1990). Ratings were given by participants at baseline, in anticipation of each of the two stressor tasks, and retrospectively concerning their peak distress after each task. In our analyses of state anxiety, difference scores were created for anticipatory anxiety minus baseline, and peak anxiety minus baseline, for the physical and the social stressor tasks. These four scores were then averaged to create a state anxiety composite that reflected multiple indices of responding to stressors. Part of the rationale for using this method was the possibility of cross-domain activation of anxiety. For example, while the candle-blowing task has been used by our and others' labs to induce physical anxiety, it also may have a social component (i.e., participants worrying about the experimenter seeing them look silly while producing the physical sensations). In fact, in our own sample, the correlations between the SIAS and self-reported anxiety during the candle-blowing task were small but significant (peak: $r=0.251$, $df=73$, $p=0.03$; anticipatory: $r=0.276$, $df=74$, $p=0.016$). Thus, an aggregate state anxiety score was used

rather than trying to parse out physical or social anxiety from tasks that may involve both. (SUDS ratings were also obtained after the cognitive control and attention bias tasks, and after the study was completed to assess the need for relaxation exercises).

5.4. Cognitive control

Three measures were administered to assess different components of cognitive control. The Trailmaking subtests of the Delis-Kaplan Executive Function System (TM; Delis et al., 2001) consisted of two parts: on Test A, participants drew a line to connect a series of number targets jumbled across a page in sequential order (e.g., 1–2–3...), and then on Test B, participants were asked to draw a line connecting letter and number targets in alternating sequential order (e.g., 1-A-2-B...). The time taken to complete Test A subtracted from the time taken to complete Test B is the participant's score, with lower scores indicating better task-switching ability. On the color-word Stroop task (Stroop; Stroop, 1935), participants were instructed to indicate the color of words presented on a computer screen. Congruent trials were those in which the word presented was the same as the color (e.g., the word “BLUE” in blue font) and incongruent trials were those in which the word presented was different from the color (e.g., the word “BLUE” in red font). The difference in mean response latency between incongruent and congruent trials was calculated within each participant to assess inhibitory control, with greater latency differences indicating increased interference from task-irrelevant features. Finally, during the Operation Span task (Turner and Engle, 1989), participants were shown a set of math equations and a word [e.g., $(2 \times 4) - 3 = 5$, BEACH]. Participants were asked to indicate if the equation presented was true or false, and then to say the word aloud. After presenting multiple trials of equations and words, varying in size from 3 to 7 trials, participants were asked to write down the words in the order in which they were shown. A partial OSPAN score reflecting working memory was calculated by summing the number of words recalled in the correct serial position, regardless of whether other words in the set were recalled in the correct serial position (e.g., a point was earned for correctly writing the fourth word in a set, even if the third word written was incorrect; following Friedman and Miyake (2005). Higher OSPAN scores indicate better working memory capacity.

The three *z*-scored cognitive control measures (*Z*-scores were created using the present full sample, with scores reversed for TM and Stroop so that lower scores reflect greater cognitive control) were then averaged to create a composite measure of cognitive control. This composite was used to provide a single measure that encompassed multiple aspects of cognitive control, all of which are believed to potentially play an important role in attention bias. A single composite measure was desired for simplicity, to increase reliability, and because we did not have different hypotheses for the different tasks.

The psychometric properties of the DASS, ASI, TM, Stroop, and OSPAN have all been validated in older adults (see Gloster et al., 2008; Mohlman and Zinbarg, 2000; Mitchell and Miller, 2008; Davidson et al., 2003; Bailey et al., 2009). While the SIAS has not been specifically tested in older adults to our knowledge, it showed a high level of reliability in our older adult sample ($\alpha=0.88$).

5.5. Procedure²

After signing an informed consent agreement, participants gave a baseline SUDS rating and then completed the three cognitive control tasks in random order. Following these tasks, participants again indicated their current distress using SUDS, and a relaxation exercise (diaphragmatic breathing) was administered if participants were more

² This study was part of a larger project that also included measures of memory and interpretation bias. For a full list of measures, please contact the first author.

than 10 points above their baseline score. After this, participants were seated in front of the computer used for eye-tracking and their gaze was calibrated to a sixteen point dot matrix. Next, participants completed the dot-probe task, during which their gaze was measured, followed by a SUDS rating. Participants then completed the candle-blowing and speech stressor tasks in random order, indicating their distress using SUDS in anticipation of each task (after hearing the task instructions but before beginning the task) and immediately after each task (noting their peak distress during the task). Between the stressor tasks, a diaphragmatic breathing relaxation exercise was administered to minimize anxious carry-over across tasks. Finally, participants completed the trait anxiety measures in random order and the MMSE. Following debriefing, participants gave a final SUDS rating and received additional diaphragmatic breathing if their score was elevated relative to their baseline. Older adult participants were compensated \$40 for sessions that averaged 2 h, and younger adult participants were compensated 1.5 h of course credit in a psychology participant pool for sessions that averaged 1.5 h.

5.5.1. Plan for analyses

Mixed-effects models were run to test for age differences (and the effect of domain, valence, and cognitive control moderators of the age effects) on the indicators of attention bias. Given the different scoring methods and samples sizes for the reaction time and eye gaze indicators, they were analyzed and interpreted in slightly different ways. In both cases, all main effects are reported but only those interactions involving age are reported, given the focus of this investigation.

5.5.2. Dot-probe reaction time (RT)

Mixed-effects models were run to assess the effects of age group (younger vs. older adults), domain (social vs. physical stimuli), valence (whether the probe appeared where the neutral stimulus had been vs. the negative), and cognitive control score (aggregate of the three cognitive control measures), and their 2, 3, and 4-way interactions as predictors of (Winsorized) dot-probe RT. Random intercepts were included in the model for each participant (to account for variations in individual mean reaction time) and for each stimuli pair (to account for variation in the quality of individual stimuli not attributable to domain or valence). Significant interactions were plotted and analyzed according to techniques described by Preacher et al. (2006). The traditional plots of intercepts, slopes, and regions of significance were converted to bar-plots with confidence intervals for ease of interpretation. Effect sizes are reported as standardized β estimates because readily interpretable R^2 statistics are not yielded by mixed-effects regression models (see Peugh, 2010). Note that standardized β estimates are usually smaller, more conservative estimates of r (see Ferguson, 2009). Mixed-effects models were run using the “lme4” package in R (R Development CoreTeam, 2013; Bates et al., 2014).

5.5.3. Dot-probe gaze duration ratio

Mixed-effects models were run to assess the effects of age group, domain, and cognitive control score, and their 2 and 3-way interactions as predictors of duration ratio during dot-probe trials. Valence is not included as a factor in these models because the ratio scores reflect the effect of negative relative to neutral stimuli. Random intercepts were included in the model for each participant and for each stimuli pair. As noted earlier, these analyses were included as supplementary tests given the large number of participants whose eye-tracking data were unusable, which meant the analyses are seriously underpowered to detect effects at the 0.05 alpha level. Therefore, these supplementary analyses are reported using the effect size (standardized β) to provide an indication of the magnitude of the effects. We interpret effects when $\beta \geq 0.1$ in line with Cohen's recommendations for a small effect size when using Pearson's r , of which standardized β is a conservative estimate. Interactions with a standardized $\beta \geq 0.1$ were plotted and

analyzed according to techniques described by Preacher et al. (2006), and presented here as bar graphs for ease of interpretation.

Next, mixed-effects models were run to assess the effects of age group, attention bias (based on our primary dot-probe RT bias measure, given we had more adequate power with these data), cognitive control, and bias domain (RT biases were calculated separately for social and physical stimuli) on the composite trait and state anxiety scores. Models were also run examining the 2, 3, and 4-way interactions among these predictors. We report significant interactions involving either RT bias and/or age for these models given the dual interests in attention bias and age (and their interaction) as predictors of anxiety. A random intercept for each bias domain was included in the models. This was done because the dependent variable was measured once for each participant, but an independent variable (RT bias) was nested within bias domain for each participant.

Next, a series of secondary analyses were conducted to check the robustness of any observed age effects, testing for changes in results when accounting for education level, age of the people depicted in the stimuli, or possible older adult fatigue.

6. Results

Table 1 lists the descriptive statistics for the attention bias, cognitive control, and state and trait anxiety measures separated by age group.

6.1. Age and moderator effects on dot-probe reaction time (RT)

Table 2 lists all main effects and the significant interactions in the model (for a table listing all terms in the model, please contact the first author). There were significant main effects for age group ($\beta=1.00$, $p < 0.001$) and domain ($\beta=-0.09$, $p=0.023$), such that younger adults were faster than older adults to respond to the probe, as expected, and the full sample was faster to respond to social than physical stimuli. Additionally, a significant age group \times domain \times valence interaction was

Table 1

Descriptive statistics for attention bias, cognitive control, and anxiety measures.

Measure	Younger Adults		Older Adults	
	<i>m</i>	<i>sd</i>	<i>m</i>	<i>sd</i>
Physical Reaction Time Bias	0.233	42.189	22.242	69.983
Social Reaction Time Bias	-1.430	83.969	-2.547	70.167
Average Physical Fixation Duration	0.009	0.118	0.008	0.102
Ratio				
Average Social Fixation Duration Ratio	-0.008	0.101	-0.026	0.096
Trait Anxiety**	0.265	0.868	-0.240	0.601
DASS A***	10.632	3.132	8.921	1.880
ASI	34.053	7.969	33.105	9.759
SIAS*	37.684	13.611	30.184	10.019
State Anxiety	0.169	0.912	-0.188	0.664
Candle Anticipatory SUDS	4.079	18.105	-2.553	14.297
Reactivity				
Candle Peak SUDS Reactivity	14.459	16.077	11.026	16.930
Speech Anticipatory SUDS	11.711	15.820	4.605	14.176
Reactivity				
Speech Peak SUDS Reactivity	25.421	20.236	13.132	17.211
Cognitive Control**	0.307	0.684	-0.290	0.609
OSPAN**	24.474	6.446	20.711	5.467
TM (s)***	25.229	11.220	50.211	25.654
Stroop Latency (ms)	187.786	136.255	222.028	131.057

Note. DASS A: Depression and Anxiety Stress Scales, Anxiety Subscale, ASI: Anxiety Sensitivity Index, SIAS: Social Interaction Anxiety Scale, SUDS: Subjective Units of Distress Scale, OSPAN: Operation Span Task, TM: Trailmaking subtests of the Delis-Kaplan Executive Function System.

*** $p < 0.001$.

** $p < 0.01$.

* $p < 0.05$.

Table 2
Age and moderator effects on dot-probe reaction time.

Predictor	Variance	Standardized β	SE	t	p
<i>Random Effects</i>					
Subject Intercept	0.225				
Stimuli Intercept	0.029				
Residual	0.465				
<i>Fixed Effect</i>					
Age Group (Young to Old) ^{***}		1.019	0.205	7.843	< 0.001
Domain (Physical to Social) [*]		-0.090	0.039	-2.308	0.023
Valence (Negative to Neutral)		0.009	0.039	0.232	0.817
Cognitive Control Score		-0.056	0.093	-0.604	0.548
Age Group×Domain×Valence [*]		-0.152	0.068	-2.242	0.025
Cognitive Control×Domain×Valence [*]		0.110	0.048	2.270	0.023

** $p < 0.01$.

*** $p < 0.001$.

* $p < 0.05$.

found ($\beta = -0.15$, $p = 0.025$; presented as a bar-plot in Fig. 1 for ease of interpretation). (There was also a significant cognitive control×domain×valence interaction, but this is not detailed here given our focus on interactions with age).

To examine the age group×domain×valence interaction, follow-up mixed-effects models testing domain×valence interactions were conducted within each age group. Among younger adults, there was a significant effect of domain corresponding to the main effect of faster responding to social than physical stimuli ($\beta = -0.085$, $p = 0.039$), but no significant effect of valence or the domain×valence interaction (all $p > .05$). This indicates that younger adults showed neither a positivity nor negativity RT bias in either the social or physical domain. However, for older adults, the expected domain×valence effect was significant ($\beta = -0.15$, $p = 0.040$). Follow-up tests comparing social and physical domain within a given valence indicated that older adults responded significantly faster to probes following neutral social stimuli than neutral physical stimuli ($\beta = -0.159$, $p = 0.007$), but did not differ for negative physical and negative social stimuli ($\beta = -0.030$, $p = 0.659$). Finally, follow-up tests comparing neutral and negative stimuli within a given domain indicated that older adults were significantly faster when the probe appeared following negative relative to neutral physical stimuli ($\beta = -0.079$, $p = 0.050$), but showed no effect for negative relative to neutral social stimuli ($\beta = -0.048$, $p = 0.468$), in line with the expected older adult preferential processing of threatening physical stimuli and reduced preferential processing of social threatening stimuli.

6.2. Age and moderator effects on dot-probe gaze duration ratio

Table 3 lists all main effects and the interactions with a standardized $\beta \geq 0.10$ in the eye-tracking models for duration ratio (for a table listing all terms in the models, please contact the first author). No main effects achieved a standardized β of greater than 0.1, but a small age×domain×cognitive control interaction effect was found (standardized $\beta = 0.10$). This interaction is shown in Fig. 2 using bar graphs to more easily demonstrate group differences. To determine the source of the interaction, follow-up mixed-effects models were conducted testing within each age group, within each domain, and among those high vs. low in cognitive control (determined using a median split) to check for the simple effects that led to the interaction. We note those simple effects with standardized β of greater than 0.08, suggesting they may be contributing to the interaction effect. Among older and younger adults with low levels of cognitive control, older adults showed less negative bias than younger adults for social stimuli in terms of duration ratio (standardized $\beta = -0.082$). This finding is in line with our expectation of a reduced social threat bias for older adults relative to younger adults; however, emergence of the effect for those low (vs. high) in cognitive control was unexpected.

6.3. Relationships among indicators of attention bias

Correlations between the two indices of attention bias (reaction

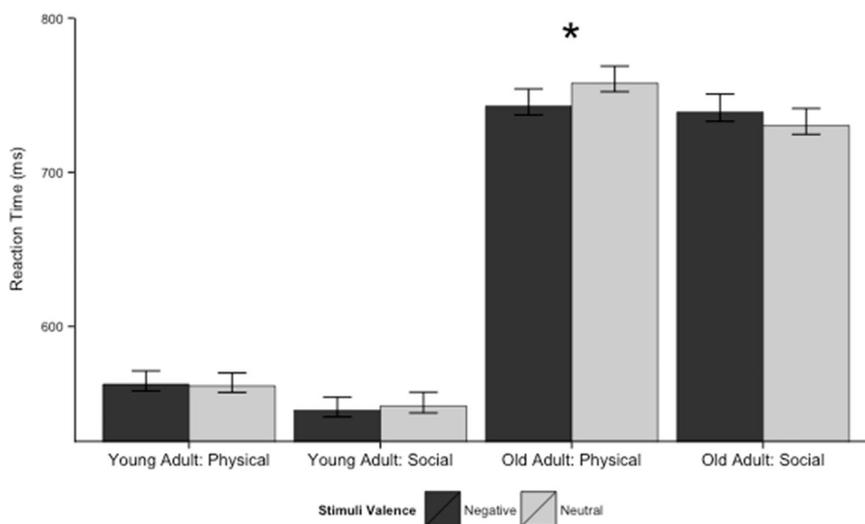


Fig. 1. Reaction time in milliseconds on the dot-probe task as a function of age group, domain, and stimulus valence. Note that shorter reaction times are thought to represent increased attention towards a stimulus on the dot-probe task.

Table 3
Age and moderator effects on dot-probe fixation duration ratio.

Predictor	Variance	Standardized β	SE	t	p
Random Effects					
Subject Intercept	0.006				
Stimuli Intercept	0.028				
Residual	0.966				
Fixed Effect					
Age Group (Young to Old)		0.011	0.046	0.241	0.811
Domain (Physical to Social)		-0.024	0.046	-0.529	0.598
Cognitive Control Score		0.028	0.032	0.895	0.375
Age Group×Domain×Cognitive Control		0.100	0.110	0.912	0.362

time and fixation duration ratio within the social and physical stimuli domains) were examined. As evident in Table 4, there was a moderate relationship between the physical and social fixation duration ratios, but otherwise associations between bias measures were weak. While the lack of significant interrelationships likely partly reflects the small sample size for the duration ratio scores, as well as the often low reliability of data from dot-probe paradigms (Price et al., 2015), the results also likely suggest the different measures of attention bias represent different components of this complex construct.

6.4. Attention bias and age as predictors of trait and state anxiety

Table 5 lists all main effects and the significant interactions in the trait anxiety model (for a table listing all terms in the model, please contact the first author). There was a main effect for age group, such that younger adults displayed more trait anxiety than older adults (standardized $\beta=0.460$, $p=0.001$), but no main effect for RT bias (standardized $\beta=0.050$, $p=0.428$), domain (standardized $\beta=0.009$, $p=0.941$) or cognitive control (standardized $\beta=0.086$, $p=0.380$). There was a significant RT bias×cognitive control interaction (standardized $\beta=-0.278$, $p=0.014$). No other interactions reached significance.

Follow up mixed-effects models testing the relationship between RT bias and trait anxiety separately for those high vs. low in cognitive control showed that, among participants with high levels of cognitive control, there was no effect of RT bias on trait anxiety (standardized $\beta=-0.051$, $p=0.6326$). Among participants with low levels of cognitive control, there was a marginal trend for RT bias as a predictor of trait anxiety (standardized $\beta=0.144$, $p=0.056$), such that higher levels of RT bias corresponded with higher levels of trait anxiety. As predicted,

Table 4
Correlations between within-subject means of attention bias measures.

	2.	3.	4. Social Reaction Time
1. Physical Duration Ratio	$r=0.42^{**}$	$r=0.05$	$r=0.19$
2. Social Duration Ratio		$r=-0.04$	$r=0.14$
3. Physical Reaction Time			$r=0.06$

*** $p < 0.001$, * $p < 0.05$.
** $p < 0.01$.

Table 5
Age, reaction time bias, and moderator effects on trait anxiety.

Predictor	Variance	Std. β	SE	t	p
Random Effects					
Bias Domain Intercept	< 0.001				
Residual	0.547				
Fixed Effect					
Age Group (Young to Old)**		0.460	0.114	3.311	0.001
Reaction Time Bias		0.050	0.063	0.795	0.428
Bias Domain		0.009	0.126	0.75	0.941
Cognitive Control		0.086	0.098	0.881	0.380
Reaction Time Bias×Cognitive Control*		-0.278	0.112	-2.487	0.014

*** $p < 0.001$.
** $p < 0.01$.
* $p < 0.05$.

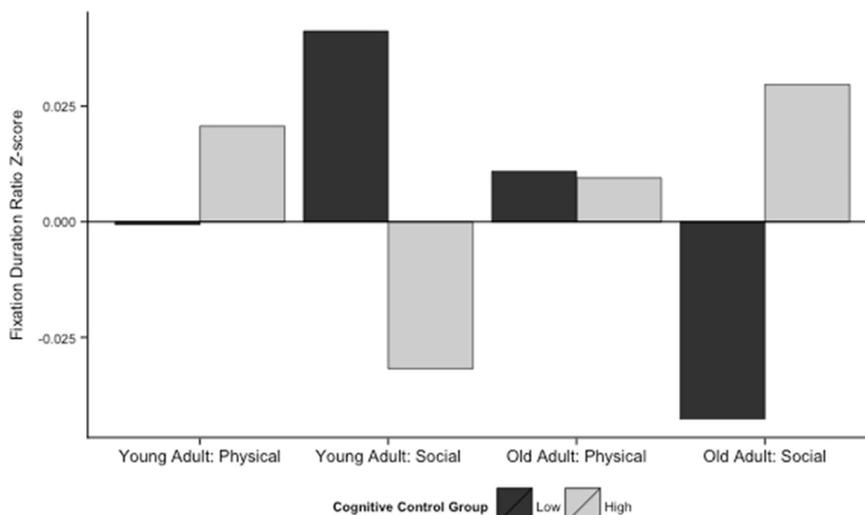


Fig. 2. Fixation duration ratio (converted to z-scores) as a function of age group, domain, and cognitive control (displayed as high vs. low based on a median-split for ease of visual interpretation but original mixed-effects models were conducted with the continuous measure). Note that greater duration ratio scores indicate longer fixation on negative relative to neutral stimuli.

Table 6
Age, reaction time bias, and moderator effects on state anxiety.

Predictor	Variance	Std. β	SE	t	p
Random Effects					
Bias Domain Intercept	< 0.001				
Residual	0.613				
Fixed Effect					
Age Group (Young to Old)**		0.466	0.148	3.115	0.002
Reaction Time Bias		-0.044	0.067	-0.064	0.949
Bias Domain		-0.008	0.134	-0.006	0.995
Cognitive Control		-0.185	0.104	-1.772	0.079
Reaction Time bias×Cognitive Control*		-0.252	0.121	-2.082	0.039
Age Group×Reaction Time		1.221	0.515	2.371	0.019
Bias×Bias Domain×Cognitive Control*					

***= $p < 0.001$.

** $p < 0.01$.

* $p < 0.05$.

greater negative attention bias was associated with higher trait anxiety among individuals with lower levels of cognitive control. Notably, this relationship did not interact with age.

Table 6 lists all main effects and significant interactions in the state anxiety model (for a table listing all terms in the model, please contact the first author). There was a main effect for age group indicating that younger adults displayed more state anxiety than older adults (standardized $\beta=0.466$, $p=0.002$), but no main effect for RT bias (standardized $\beta=-0.044$, $p=0.949$), bias domain (standardized $\beta=-0.008$, $p=0.995$), or cognitive control (standardized $\beta=-0.185$, $p=0.079$). The age group×RT bias×bias domain×cognitive control interaction was significant (standardized $\beta=1.221$, $p=0.019$; as was the RT bias×cognitive control 2-way interaction subsumed within it).

Follow up mixed-effects models indicated that there was no RT bias×bias domain×cognitive control interaction for older adults (standardized $\beta=-0.025$, $p=0.917$), but that this interaction was significant for younger adults (standardized $\beta=1.196$, $p=0.015$). This interaction was explored using simple linear regressions within each bias domain using cognitive control and RT bias as predictors (note that a mixed-effects model is not needed, since bias domain was the only within subject factor in the previous models). For young adults, social RT bias did not interact with cognitive control in predicting state anxiety (standardized $\beta=-0.302$, $p=0.368$); however, physical RT bias did (standardized $\beta=-0.894$, $p=0.025$). Although the effect of physical RT bias was not significant for younger adults with high or low cognitive control (determined using a median split), the effect of physical RT bias was much stronger in the high than low cognitive control group (high cognitive control: standardized $\beta=-0.581$, $p=0.074$; low cognitive control: standardized $\beta=0.198$, $p=0.668$). For younger adults with higher levels of cognitive control, there was a surprising pattern suggesting that greater physical RT bias predicted less state anxiety.

Note, we also examined simple linear regressions within the older adults to check whether there were other conditions, separated by domain and cognitive control level, where RT bias predicted state anxiety. Interestingly, there was some indication, though it did not reach significance, that among older adults with low cognitive control, greater physical RT bias predicted higher state anxiety, in line with predictions (standardized $\beta=0.262$, $p=0.152$).

6.5. Secondary analyses to check robustness of age effects

Education level differed significantly between the two age groups ($\chi^2=48.5$, $df =6$, $p < 0.001$), so all models were re-run including education as a first level covariate to check that education differences did not account for the age effects of interest. Education was not itself a

significant predictor of RT, nor did it reach an effect size of $\beta > 0.1$ as a predictor of gaze duration ratio. It also did not affect whether any interaction variables were significant in the RT model or whether any interaction variables met a $\beta > 0.1$ in the gaze duration model.

Additionally, to increase confidence that effects were being driven by the aging-relevance of the stimuli domain (physical vs. social), rather than simply the ability to relate to the people pictured in the stimuli (because they were either older or younger adults), the models were run including the age of the people depicted in the stimuli (dichotomously entered as older vs. younger adult) and all interactions with the age of the people depicted in the stimuli. The age of the people depicted in the stimuli was not a significant predictor of RT, nor a variable with $\beta > 0.1$ in the gaze duration model. Also, no interactions with the age of the people depicted in the stimuli reached significance in the RT model, or had β weights > 0.1 in the gaze duration model.

Finally, to test whether different levels of fatigue may have affected reaction times between the two age groups, we examined whether time to complete the dot-probe task differed significantly as a result of age group. Older adults took significantly longer to finish the dot-probe task (YA =516642.6 vs OA =582990.0, $t=4.5015$, $df =51.474$, $p < 0.001$). There was a main effect of task progress (indexed by which trial the participant was on) on reaction time, such that participants generally were faster on later trials ($\beta=-0.002$, $p < 0.001$). There was also a significant age group×Trial interaction predicting reaction time ($\beta=-0.001$, $p < 0.001$). Specifically, while younger adults did not differ in reaction time based on task progress ($\beta=-0.0006$, $p=0.37$), older adults become faster at responding as the task progresses ($\beta=-0.002$, $p=0.011$). Contrary to what might be expected, older adults became faster as the task progressed, performing more like younger adults as time passed.

Together, these results suggest that education, age of person depicted in the stimuli, and fatigue effects for older adults do not likely account for the observed age effects.

7. Discussion

The current study used an RDoC approach to examine age differences in attention bias to determine moderators of the oft-cited older adult positivity effect. Both reaction time (RT) and eye gaze fixation duration were examined to neutral and negative physical- and social-related images in younger and older adults, and relationships between attention bias and state and trait anxiety were assessed, while examining cognitive control as a moderator. Findings, although somewhat mixed, were mostly consistent with the idea that older adults show a positivity effect for social stimuli, relative to younger adults (on eye-tracking measure in participants with low levels of cognitive control), but preferentially attend to negative over neutral stimuli if the stimuli are related to physical threat (as indexed by RT bias). Moreover, negative attention bias was associated with anxiety, especially for individuals low in cognitive control. The current study contributes to our understanding of age-related differences in attention towards emotionally relevant stimuli. Both age-linked content domain and cognitive control effects on attention bias were found, which help to explain the conditions under which older adults will preferentially attend to negative or neutral stimuli, and when these preferences will contrast with those of younger adults. They suggest that broad claims about older adult positivity effects need to be contextualized to reflect the nuanced conditions under which they are expressed, and that older adults are still vulnerable to threat biases.

7.1. Age differences in attention bias

Our findings that older adults more rapidly attend to negative (vs. neutral) physical stimuli, and neutral social vs. neutral physical stimuli, are in line with previously observed negative attention biases when older adults attend to physical stimuli (see De Raedt et al., 2013;

English and Carstensen, 2015). Note, although Isaacowitz and Choi (2012) found that older adults looked less at negative physical stimuli than younger adults, seemingly counter to the current results, they used video clips tied to melanoma, so the very different medium and content focus may partly explain why their results differed. Using a broad range of physical stimuli and directly assessing personal relevance of these physical stimuli to each participant in future research will be useful to determine what makes negative physical stimuli more attention grabbing. Clearly, our results also highlight the importance of considering content domain when assessing age effects in attention bias because we would have missed evidence for older adults' negative attention bias if we had only used social stimuli, even when using images of older adults' faces. Future studies should also examine whether social stimuli that are particularly relevant to older adults will elicit similar negative attention biases as seen for physical stimuli. If our hypothesis is true, that increased personal or in-group relevance is driving the biases, then older-adult relevant stimuli in the social domain should provoke the same reaction. For example, social stimuli that reflect a loss of autonomy or increased dependency on others may be more personally relevant to older adults than the angry or disgusted faces usually used in attention bias research, and as such, may elicit more of a negative attention bias in older adults.³

The current findings also complement past eye-tracking research suggesting less negative bias among older (vs. younger) adults to social stimuli (see Isaacowitz et al., 2006b; Isaacowitz et al., 2008). However, our finding that this effect occurred for individuals with low levels of cognitive control appears at odds with the proposal that preferential disengagement from negative social stimuli is a more controlled process that occurs late in the attentional cycle (Isaacowitz et al., 2009), though aligns with work by Foster et al. (2013). Foster and colleagues proposed a dual-route model to explain the relatively less negative attentional focus in older adults; namely, older adults with low levels of cognitive control will show an early, uncontrolled preference away from negative stimuli, while older adults with strong levels of cognitive control will initially respond similarly to younger adults but then apply their effortful processes to disengage more quickly from negative stimuli (Foster et al., 2013). This might explain why we observed differences on fixation duration in the lower cognitive control group. The dual-route model suggests that because older adults with low cognitive control have difficulty simultaneously processing negative stimuli and maintaining a desirable emotional state, they experience an early, forced shift away from negative stimuli, akin to an uncontrolled reflex away from something painful (Foster et al., 2013). However, more fine-grained temporal analyses, which will require a larger sample, will be necessary to test this proposal. It will also be helpful in future research to recruit a sample that varies more systematically in cognitive control, given our sample is likely fairly highly cognitive functioning given they elected to participate in a community research study. This would also make it possible to test the role cognitive control plays in moderating age effects on other cognitive biases, such as interpretation and memory bias, to better understand how executive function alters the development and maintenance of cognitive biases over the lifespan.

7.2. Attention bias predicting trait and state anxiety

In the current study, participants with low levels of cognitive control, regardless of age, exhibited higher levels of trait anxiety if they attended more rapidly to negative relative to neutral images. The domain of the images did not moderate this effect, nor did age (though the observed main effect of age, that older adults are less anxious than younger adults, is consistent with epidemiological data indicating lower rates of anxiety disorders among older adults; (Wolitzky-Taylor et al.,

2010). The cognitive control finding is in line with results reported by Gorlin and Teachman (2015a) and fit expectations that threat biases are especially problematic for individuals low in cognitive control for whom the biases likely mean people are stuck processing negative material for extended periods, likely contributing to more pervasive anxiety. The lack of an interaction with age suggests the combination of threat bias and low cognitive control is problematic across the lifespan, and points to the importance of carefully assessing threat biases in older adults and not simply assuming a protective positivity effect. This is especially important given older adults are more likely, on average, than younger adults to be low in cognitive control (e.g. Braver and Barch, 2002).

The pattern for attention bias predicting state anxiety was quite different, pointing to the value of assessing multiple indicators of negative valence in the RDoC matrix. A complex interaction emerged indicating that among younger adults with high levels of cognitive control, high levels of negative attention bias for physical stimuli surprisingly predicted less state anxious reactivity to the stressor tasks. This younger adult effect was not predicted and definitely should be interpreted with caution, but is not entirely inconsistent with observed effects in Gorlin and Teachman (2015a) that young adult participants high in cognitive control showed diminished anxiety as negative attention bias increased, perhaps because they were electing to process the negative cues (given their high cognitive control), so the typical pernicious effects of uncontrollable threat processing were not evident. In contrast, although it did not reach significance, among older adults with low levels of cognitive control, higher levels of negative attention bias for physical stimuli predicted higher levels of state anxious reactivity, as expected. While we are reticent to over-interpret these small effects, the older adult result is consistent with the hypothesis that low cognitive control may serve as a risk factor that magnifies the relationship between negative attention bias and anxiety. Once again, the state anxiety results complement the trait anxiety results in pointing to the importance of not ignoring the potential negative clinical effects of threat biases in older adults, an area strongly in need of further research with older adult clinical samples (see Green et al., in press).

An important reason to understand attention bias and anxiety even in undiagnosed samples of older adults is that attention bias may provide a target for the treatment of subclinical levels of anxiety, which is very common among older adults (Grenier et al., 2011). There is growing evidence that attention bias towards threat plays an important role in promotion and maintenance of anxious mood (Cisler and Koster, 2010). Further, techniques that target negative attention bias have shown some effectiveness in reducing anxiety symptoms and can be administered simply using computer programs (see Clarke et al., 2014, p. for a review of these findings). These sorts of treatment modalities may prove particularly appealing to older adults who might not seek or qualify for regular treatment outlets because their anxiety does not reach a diagnosable level. However, simple programs targeting attention bias, catered to individuals using age-appropriate, personally relevant threatening stimuli, might alleviate some of the suffering many older adults face.

7.3. Multi-modal assessment of attention bias

Using the RDoC matrix as a guide, the current study measured multiple constructs within Cognitive Systems (Attention and Cognitive Control) and used multiple indices of each construct. In particular, attention was measured using two recommended behavioral elements (RT and fixation duration) from the RDoC framework. It is notable that the two measures were not significantly correlated, pointing to the unique aspects of attention each capture (and likely also to measurement error in both), but the observed effects across the measures yielded a fairly complementary, theoretically-consistent pattern. The RT index revealed how older adults attend to negative physical stimuli

³ Thank you to an anonymous reviewer for this suggestion.

relatively more than they attend to neutral physical stimuli, which is different than the pattern they display for social stimuli (and the pattern younger adults display for either physical or social stimuli). However, only the fixation duration index showed that older adults with low levels of cognitive control attend to social stimuli in a less negatively biased manner than younger adults with low levels of cognitive control.

Though some of the different results across the RT and gaze fixation measures may be due to reliability issues with the dot-probe task as a behavioral index (see Price et al., 2015) and the small eye-tracking sample, split-half reliability for the RT data were reasonable in our data (Physical bias: 0.872, Social bias: 0.628) and there is reason to believe the differences may also be driven by the complexity of the attentional process. Previous studies have shown that preferential attention effects play out differently over time (Isaacowitz et al., 2009), the full details of which cannot be captured using a single time-point behavioral measure. By incorporating multiple indices to measure the same construct within the RDoc matrix, we were able to more comprehensively assess age differences in attention bias. It will be helpful in future research to include further indicators, such as physiological and other biomarkers of attention bias and paradigms beyond the dot-probe task, to determine whether the pattern remains complementary across metrics. Moreover, we suspect that an idiographic profile of different attention bias measures may be most useful for predicting anxiety reactions because it may be that sustained visual attention has especially negative effects for one person but rapid orienting to a threat stimulus may be more problematic for another person. The promise of the RDoc matrix for classification requires using a range of metrics that will be sensitive to multifinality; the many different paths that can lead an individual to psychopathology.

7.4. Limitations and conclusion

The current results need to be interpreted in light of the study's limitations, especially the cross sectional nature of the design. Although the older and younger adult samples did not differ in terms of gender, race, or ethnicity, we cannot draw direct conclusions about aging, a dynamic process, given the possibility of cohort effects. Small sample size, especially the sample that had useable eye-tracking data, is also a significant limitation of the current study and replication with a larger sample will be important. Additionally, our use of a healthy, instead of diagnosed anxious, sample may limit our ability to translate findings to a clinical context. The use of an older adult sample that was recruited from a local senior activity center may also limit the generalizability of our findings, given that this sample may be more healthy and active on average than the general older adult population. A final sample concern is the different internal consistencies of the DASS-A between the older ($\alpha=0.43$) and younger ($\alpha=0.43$) adults in our sample. However, given that the ASI and SIAS were highly internally consistent in both the older and younger adult samples (all $\alpha > 0.8$), the use of the averaged z-scores of all three measures for our trait anxiety score should have helped offset some of this difference in internal consistency.

There were also some limitations concerning the stimuli used in the dot-probe task. No positive stimuli were included in the dot-probe task so positivity was operationalized here as decreased negativity. This method of examining the positivity effect has been used with images of faces in prior older adult literature (Lee and Knight, 2009), but means we cannot differentiate between approach towards positive stimuli and a repulsion from negative stimuli. Also, the split-half reliability of the reaction time bias index was different for social (0.628) and physical (0.872) stimuli. However, while different, the reliability of the index for both stimuli categories is reasonably high.

Another limitation is that the fixed task administration order may have influenced our results. For instance, the cognitive ability tests were administered prior to assessing attention bias, and then anxiety

was assessed, so depletion effects may have occurred on the later measures. Additionally, it was not possible to test bi-directional links between attention bias and anxiety. Future work may find interesting results by examining the effects of priming anxious mood before bias assessment. Another possible effect of task administration order is the chance of carry-over anxiety from one stressor task to the next, though this possibility was minimized given diaphragmatic breathing was administered after each stressor task and anxiety was assessed (using the SUDs) to help ensure that state anxiety had been reduced to baseline levels.

Despite these limitations, the current study is the first to our knowledge to provide a multimodal assessment of age differences in attention bias that compared bias across threat domains and examined moderation by cognitive control and ties to anxiety. The evidence that older adults' positivity effect varies by both content domain and cognitive control illustrates the nuanced nature of these effects, and older adults' preserved vulnerability to physically-relevant threat biases and the effects of these biases on anxiety if they are low in cognitive control.

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References

- Allard, E.S., Isaacowitz, D.M., 2008. Are preferences in emotional processing affected by distraction? Examining the age-related positivity effect in visual fixation within a dual-task paradigm. *Neuropsychol. Dev. Cogn. B Aging Neuropsychol. Cogn.* 15 (6), 725–743. <http://dx.doi.org/10.1080/13825580802348562>.
- Bailey, H., Dunlosky, J., Hertzog, C., 2009. Does differential strategy use account for age-related deficits in working-memory performance? *Psychol. Aging* 24 (1), 82–92. <http://dx.doi.org/10.1037/a0014078>.
- Bar-Haim, Y., Lamy, D., Pergamin, L., Bakermans-Kranenburg, M.J., van Ijzendoorn, M.H., 2007. Threat-related attentional bias in anxious and nonanxious individuals: a meta-analytic study. *Psychol. Bull.* 133 (1), 1–24. <http://dx.doi.org/10.1037/0033-2909.133.1.1>.
- Bates, D., Maechler, M., Bolker, B., Walker, S., 2014. *lme4: Linear mixed-effects models using eigen and s4*. R package version 1.0–6. Retrieved from (<http://CRAN.R-project.org/package=lme4>)
- Braver, T.S., Barch, D.M., 2002. A theory of cognitive control, aging cognition, and neuromodulation. *Neurosci. Biobehav. Rev.* 26 (7), 809–817.
- Bryant, C., Jackson, H., Ames, D., 2008. The prevalence of anxiety in older adults: methodological issues and a review of the literature. *J. Affect. Disord.* 109 (3), 233–250. <http://dx.doi.org/10.1016/j.jad.2007.11.008>.
- Bryant, C., Mohlman, J., Gum, A., Stanley, M., Beekman, A.T., Wetherell, J.L., Lenze, E.J., 2013. Anxiety disorders in older adults: looking to DSM5 and beyond.... *Am. J. Geriatr. Psychiatry* 21 (9), 872–876. <http://dx.doi.org/10.1016/j.jagp.2013.01.011>.
- Carstensen, L.L., 2006. The influence of a sense of time on human development. *Science* 312 (5782), 1913–1915. <http://dx.doi.org/10.1126/science.1127488>.
- Carstensen, L.L., Pasupathi, M., Mayr, U., Nesselroade, J.R., 2000. Emotional experience in everyday life across the adult life span. *J. Pers. Soc. Psychol.* 79 (4), 644–655.
- Charles, S.T., Reynolds, C.A., Gatz, M., 2001. Age-related differences and change in positive and negative affect over 23 years. *J. Pers. Soc. Psychol.* 80 (1), 136–151.
- Cisler, J.M., Koster, E.H.W., 2010. Mechanisms of attentional biases towards threat in the anxiety disorders: an integrative review. *Clin. Psychol. Rev.* 30 (2), 203–216. <http://dx.doi.org/10.1016/j.cpr.2009.11.003>.
- Clarke, P.J., Notebaert, L., MacLeod, C., 2014. Absence of evidence or evidence of Absence: reflecting on therapeutic implementations of attentional bias modification. *BMC Psychiatry* 14 (8). <http://dx.doi.org/10.1186/1471-244X-14-8>.
- Cody, M.W., Teachman, B.A., 2011. Global and local evaluations of public speaking performance in social anxiety. *Behav. Ther.* 42 (4), 601–611. <http://dx.doi.org/10.1016/j.beth.2011.01.004>.
- Davidson, D.J., Zacks, R.T., Williams, C.C., 2003. Stroop interference, practice, and aging. *Neuropsychol. Dev. Cogn. B Aging Neuropsychol. Cogn.* 10 (2), 85–98. <http://dx.doi.org/10.1076/ane.10.2.85.14463>.

- De Raedt, R., Koster, E.H., Ryckewaert, R., 2013. Aging and attentional bias for death related and general threat-related information: less avoidance in older as compared with middle-aged adults. *J. Gerontol. B Psychol. Sci. Soc. Sci.* 68 (1), 41–48. <http://dx.doi.org/10.1093/geronb/gbs047>.
- Delis, D.C., Kaplan, E., Kramer, J., 2001. *Delis Kaplan Executive Function System*. Psychological Corporation, San Antonio, TX.
- English, T., Carstensen, L.L., 2015. Does positivity operate when the stakes are high? Health status and decision making among older adults. *Psychol. Aging* 30 (2), 348–355. <http://dx.doi.org/10.1037/a0039121>.
- Ferguson, C.J., 2009. Effect size primer: a guide for clinicians and researchers. *Prof. Psychol.: Res. Pract.* 40 (5), 532–538.
- Folstein, M.F., Folstein, S.E., McHugh, P.R., 1975. Mini-mental state: a practical method for grading the cognitive state of patients for the clinician. *J. Psychiatr. Res.* 12 (3), 189–198. [http://dx.doi.org/10.1016/0022-3956\(75\)90026-6](http://dx.doi.org/10.1016/0022-3956(75)90026-6).
- Foster, S.M., Davis, H.P., Kiskey, M.A., 2013. Brain responses to emotional images related to cognitive ability in older adults. *Psychol. Aging* 28 (1), 179–190. <http://dx.doi.org/10.1037/a0030928>.
- Friedman, N.P., Miyake, A., 2005. Comparison of four scoring methods for the reading span test. *Behav. Res. Methods* 37 (4), 581–590.
- Gloster, A.T., Rhoades, H.M., Novy, D., Klotsche, J., Senior, A., Kunik, M., Stanley, M.A., 2008. Psychometric properties of the depression anxiety and stress scale-21 in older primary care patients. *J. Affect Disord.* 110 (3), 248–259. <http://dx.doi.org/10.1016/j.jad.2008.01.023>.
- Gordon, T.L., Teachman, B.A., 2008. Ethnic group differences in affective, behavioral, and cognitive markers of anxiety. *J. Cross-Cult. Psychol.* 39 (4), 424–446. <http://dx.doi.org/10.1177/0022022108318224>.
- Gorlin, E.I., Teachman, B.A., 2015a. Inhibitory control as a moderator of threat-related interference biases in social anxiety. *Cogn. Emot.* 29 (4), 723–735. <http://dx.doi.org/10.1080/02699931.2014.931275>.
- Gorlin, E.I., Teachman, B.A., 2015b. Threat interference biases predict socially anxious behavior: the role of inhibitory control and stressor duration. *Behav. Ther.* 46 (4), 493–509. <http://dx.doi.org/10.1016/j.beth.2015.03.001>.
- Green, J.S., Magee, J.C., Steiner, A.R.W., Teachman, B.A., 2016. When the golden years turn blue using the healthy aging literature to elucidate anxious and depressive disorders in older adulthood. *Int. J. Behav. Dev.* (in press) doi: <http://dx.doi.org/10.1177/016502541561385>
- Grenier, S., Preville, M., Boyer, R., O'Connor, K., Béland, S., Potvin, O., Study, S.C. o.t.E., 2011. The impact of dsm-iv symptom and clinical significant criteria on the prevalence estimates of subthreshold and threshold anxiety in the older adult population. *Am. J. Geriatr. Psychiatry* 17, 769–781. <http://dx.doi.org/10.1097/JGP.0b013e3181ff416c>.
- Isaacowitz, D., Wadlinger, H., Goren, D., Wilson, H., 2006a. Is there an age-related positivity effect in visual attention? A comparison of two methodologies. *Emotion* 6 (3), 511–516.
- Isaacowitz, D.M., Allard, E.S., Murphy, N.A., Schlangel, M., 2009. The time course of age-related preferences toward positive and negative stimuli. *J. Gerontol. B Psychol. Sci. Soc. Sci.* 64 (2), 188–192. <http://dx.doi.org/10.1093/geronb/gbn036>.
- Isaacowitz, D.M., Blanchard-Fields, F., 2012. Linking process and outcome in the study of emotion and aging. *Perspect. Psychol. Sci.* 7 (1), 3–17. <http://dx.doi.org/10.1177/1745691611424750>.
- Isaacowitz, D.M., Choi, Y., 2012. Looking, feeling, and doing: are there age differences in attention, mood, and behavioral responses to skin cancer information? *Health Psychol.* 31 (5), 650–659. <http://dx.doi.org/10.1037/a0026666>.
- Isaacowitz, D.M., Toner, K., Goren, D., Wilson, H.R., 2008. Looking while unhappy: mood-congruent gaze in young adults, positive gaze in older adults. *Psychol. Sci.* 19 (9), 848–853. <http://dx.doi.org/10.1111/j.1467-9280.2008.02167.x>.
- Isaacowitz, D.M., Wadlinger, H.A., Goren, D., Wilson, H.R., 2006b. Selective preference in visual fixation away from negative images in old age? An eye-tracking study. *Psychol. Aging* 21 (1), 40–48. <http://dx.doi.org/10.1037/0882-7974.21.1.40>.
- Isaacowitz, D.M., Noh, S.R., 2011. Does looking at the positive mean feeling good? Age and individual differences matter. *Soc. Personal. Psychol. Compass.* 5 (8), 505–517. <http://dx.doi.org/10.1111/j.1751-9004.2011.00374.x>.
- Knight, M., Seymour, T.L., Gaunt, J.T., Baker, C., Nesmith, K., Mather, M., 2007. Aging and goal-directed emotional attention: distraction reverses emotional biases. *Emotion* 7 (4), 705–714. <http://dx.doi.org/10.1037/1528-3542.7.4.705>.
- Lang, P.J., 1985. The cognitive psychophysiology of emotion: fear and anxiety. In: Maser, J., Tuma, A.H. (Eds.), *Anxiety and the Anxiety Disorders*. Lawrence Erlbaum Associates, Hillsdale, NJ, 131–170.
- Lee, L.O., Knight, B.G., 2009. Attentional bias for threat in older adults: moderation of the positivity bias by trait anxiety and stimulus modality. *Psychol. Aging* 24 (3), 741–747. <http://dx.doi.org/10.1037/a0016409>.
- Lovibond, S.H., Lovibond, P.F., 1995. *Manual for the depression anxiety stress scales 2nd ed.* Psychology Foundation, Sydney.
- MacLeod, C., Mathews, A., Tata, P., 1986. Attentional bias in emotional disorders. *J. Abnorm. Psychol.* 95 (1), 15–20. <http://dx.doi.org/10.1037/0021-843X.95.1.15>.
- MacLeod, C., Rutherford, E., Campbell, L., Ebsworthy, G., Holker, L., 2002. Selective attention and emotional vulnerability: assessing the causal basis of their association through the experimental manipulation of attentional bias. *J. Abnorm. Psychol.* 111 (1), 107–123. <http://dx.doi.org/10.1037/0021-843X.111.1.107>.
- Mather, M., Carstensen, L.L., 2005. Aging and motivated cognition: the positivity effect in attention and memory. *Trends Cogn. Sci.* 9 (10), 496–502. <http://dx.doi.org/10.1016/j.tics.2005.08.005>.
- Mather, M., Knight, M., 2005. Goal-directed memory: the role of cognitive control in older adults' emotional memory. *Psychol. Aging* 20 (4), 554–570. <http://dx.doi.org/10.1037/0882-7974.20.4.554>.
- Mattick, R.P., Clarke, J.C., 1998. Development and validation of measures of social phobia scrutiny fear and social interaction anxiety. *Behav. Res. Ther.* 36 (4), 455–470. [http://dx.doi.org/10.1016/S0005-7967\(97\)10031-6](http://dx.doi.org/10.1016/S0005-7967(97)10031-6).
- Mitchell, M., Miller, L., 2008. Prediction of functional status in older adults: the ecological validity of four Delis-Kaplan Executive Function System tests. *J. Clin. Exp. Neuropsychol.* 30 (6), 683–690. <http://dx.doi.org/10.1080/13803390701679893>.
- Mohlman, J., Zinbarg, R., 2000. The structure and correlates of anxiety sensitivity in older adults. *Psychol. Assess.* 12 (4), 440–446.
- Peugh, J.L., 2010. A practical guide to multilevel modeling. *J. Sch. Psychol.* 48, 85–112.
- Preacher, K.J., Curran, P.J., Bauer, D.J., 2006. Computational tools for probing interactions in multiple linear regression, multilevel modeling, and latent curve analysis. *J. Educ. Behav. Stat.* 31 (4), 437–448.
- Price, R.B., Kukertzm, J.M., Siegle, G.J., Ladouceur, C.D., Silk, J.S., Ryan, N.D., Amir, N., 2015. Empirical recommendations for improving the stability of the dot-probe task in clinical research. *Psychol. Assess.* 27 (2), 365–376. (doi: 1040-3590/15/\$12.00).
- Reed, A.E., Carstensen, L.L., 2012. The theory behind the age-related positivity effect. *Front. Psychol.* 3, 339. <http://dx.doi.org/10.3389/fpsyg.2012.00339>.
- Reed, A.E., Chan, L., Mikels, J.A., 2014. Meta-analysis of the age-related positivity effect: age differences in preferences for positive over negative information. *Psychol. Aging* 29 (1), 1–15. <http://dx.doi.org/10.1037/a0035194>.
- Reiss, S., Peterson, R.A., Gursky, D.M., McNally, R.J., 1986. Anxiety sensitivity, anxiety frequency and the prediction of fearfulness. *Behav. Res. Ther.* 24 (1), 1–8. [http://dx.doi.org/10.1016/0005-7967\(86\)90143-9](http://dx.doi.org/10.1016/0005-7967(86)90143-9).
- R Core Team, 2013. *R: A language and environment for statistical computing*: R Foundation for Statistical Computing, Vienna, Austria. (<http://www.R-project.org>)
- Steinman, S.A., Smyth, F.L., Bucks, R.S., MacLeod, C., Teachman, B.A., 2013. Anxiety-linked expectancy bias across the adult lifespan. *Cogn. Emot.* 27 (2), 345–355. <http://dx.doi.org/10.1080/02699931.2012.711743>.
- Steinman, S.A., Teachman, B.A., 2010. Modifying interpretations among individuals high in anxiety sensitivity. *J. Anxiety Disord.* 24 (1), 71–78. <http://dx.doi.org/10.1016/j.janxdis.2009.08.008>.
- Stroop, J.R., 1935. *Studies of interference in serial verbal reactions*. Georg. Peabody Coll. Teach.
- Teachman, B.A., Gordon, T., 2009. Age differences in anxious responding: older and calmer, unless the trigger is physical. *Psychol. Aging* 24 (3), 703–714. <http://dx.doi.org/10.1037/a0016813>.
- Tomaszczyk, J.C., Fernandes, M.A., MacLeod, C.M., 2008. Personal relevance modulates the positivity bias in recall of emotional pictures in older adults. *Psychon. Bull. Rev.* 15 (1), 191–196.
- Tombaugh, T.N., McIntyre, N.J., 1992. The mini-mental state examination: a comprehensive review. *J. Am. Geriatr. Soc.* 40 (922–935).
- Turner, M.L., Engle, R.W., 1989. Is working memory capacity task dependent? *J. Mem. Lang.* 28, 127–154.
- Wolitzky-Taylor, K.B., Castriotta, N., Lenze, E.J., Stanley, M.A., Craske, M.G., 2010. Anxiety disorders in older adults: a comprehensive review. *Depress Anxiety* 27 (2), 190–211. <http://dx.doi.org/10.1002/da.20653>.
- Wolpe, J., 1990. *The Practice of Behavior Therapy 4th ed.* Pergamon Press, New York.