



## 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

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