Healthy Interpretations with Healthy Aging

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Abstract

This study examined the moderating roles of threat-salience and physical health on the relationship between age and threat interpretations. During an online study, participants (N=1352, ages 18-91) rated the likelihood of neutral and negative explanations of ambiguous physical (older adult-relevant), social (younger adult-relevant) and general (age-neutral) scenarios. Results were consistent with the hypothesis; with increasing age, individuals interpreted the physical threat as relatively more negative and the social threat as relatively less negative. For healthy individuals (defined as individuals not on medication), a significant correlation was found between increasing age and making less negative general scenario interpretations. In contrast, for unhealthy adults (defined as individuals taking medication) there was a nonsignificant trend between increasing age and making more negative interpretations of the general scenario. Results are discussed in light of the importance of the relationship between interpretation biases and anxiety, as well as theories of optimized emotional processing with age.
Healthy Interpretations with Healthy Aging

In line with cognitive models of anxiety, research has found support for a potential causal link between threat-biased interpretations and anxiety (Wilson, MacLeod, Mathews, & Rutherford, 2006). In a non-anxious sample, manipulating interpretations of threatening scenarios has been shown to lead to decreased anxious responding (Wilson et al., 2006), and in an anxiety-sensitive sample, it has been shown to lead to decreased anxiety sensitivity along with less threatening interpretations of ambiguous scenarios (Steinman & Teachman, 2010). Although these findings bolster our understanding of anxiety models as they pertain to young adults, the role of threat interpretations across the lifespan has not yet been examined.

There is reason to believe that factors associated with aging may influence the expression of threat interpretive biases. Research on the differences in emotional processing between older and younger adults has the potential to contribute to our understanding of threat interpretations across the adult lifespan. Although with increasing age certain cognitive processes decline (e.g., memory, speed, and reasoning), others are spared (e.g., vocabulary; Salthouse, 2004) and potentially even optimized (e.g., emotional processing; Carstensen & Mikels, 2005). With age, emotion regulation becomes a salient goal (Socioemotional Selectivity Theory; Carstensen, Isaacowitz, & Charles, 1999); previous research suggests that with increasing age individuals exhibit greater control over their emotions, in addition to experiencing more positive and less negative emotion (Gross et al., 1997). In a 10-year longitudinal study of older adults, researchers found that up to the seventh decade, emotional well-being improves, while emotional experiences stabilize (i.e., decreased lability of emotional experience) and become more mixed (i.e., positive and negative emotions co-occur more frequently), with increasing age (Carstensen et al., 2011). Enhanced emotional well-being may have very real implications in older age.
Though causal conclusions cannot be drawn, Carstensen et al. (2011) found that across a 13-year period, individuals from mid- to late-adulthood who reported experiencing more positive compared to negative emotions had a decreased chance of mortality. These results emerged even when researchers controlled for ethnicity, sex, and age, and they suggest the potential protective benefits of experiencing positive emotions in older adulthood.

Emotional well-being has also been studied in the realm of cognitive processing biases. Research has found that older, compared to younger, adults preferentially process positive, as opposed to negative, emotional material; a phenomenon referred to as the positivity effect. Older adults demonstrate greater attention to and better memory for positive stimuli (Carstensen & Mikels, 2005; Isaacowitz, Wadlinger, Goren, & Wilson, 2006 a & b; Mather & Carstensen, 2003, though see Mather & Knight, 2005; Knight et al., 2007), though the effect has been shown to be greater in some paradigms than in others (e.g., Murphy & Isaacowitz, 2008).

The positivity effect has most often been researched in studies of attention and memory (for a review, see Murphy & Isaacowitz, 2008). In one of the earlier studies on the positivity effect, Mather and Carstensen (2003) found both attentional and memory biases when using dot-probe and memory tests. During the dot-probe portion of this study, participants looked at pairs of identical faces expressing different emotions (i.e., one neutral and one emotional face). Older adults more quickly identified a probe placed behind a positive face when the positive face was paired with a neutral face, and more quickly identified a probe placed behind a neutral face when the neutral face was paired with a negative face. In contrast, younger adults did not show a bias based on valence. Furthermore, results suggested that older adults have a better memory for faces encoded with a positive (rather than negative) expression. In addition, using eye-tracking technology, Isaacowitz, Wadlinger, Goren, and Wilson (2006 a & b), found that older adults
preferentially looked at positive synthetic faces (computer generated to eliminate potentially
distracting features), rather than at angry (Isaacowitz et al., 2006a) or sad (Isaacowitz et al.,
2006b) synthetic faces. This is in contrast to younger adults, who showed a bias towards looking
longer at afraid (as opposed to positive) faces (Isaacowitz et al., 2006a). These findings
regarding the positivity effect support the theory that emotional processing is optimized with age,
and that with increasing age, individuals are likely to have a positive (or less-negative) bias.

Carstensen and Mikels (2005) suggest Socioemotional Selectivity Theory (SST) can help account
for the positivity effect. One component of SST espouses that when individuals
perceive their remaining time as limited (e.g., as they age), their primary goal becomes emotion
regulation (Carstensen et al., 1999). The relationship between SST and the positivity effect is
supported by a study of gaze-patterns following a mood manipulation (Isaacowitz, Toner, Goren,
& Wilson, 2008). Older adults in a negative mood looked more towards positively-valanced
faces than did younger adults in a negative mood; these younger adults looked more at mood-
congruent faces. The authors suggest that because older adults look towards positive faces when
in a negative mood and not when in a positive or neutral mood, perhaps the attentional biases
seen in the positivity effect emerge as a result of age-related changes in the importance assigned
to emotion regulation (towards positive emotions). Additional support comes from studies
examining time remaining decoupled from age; when time is perceived as limited as a result of
chronic illness (Carstensen & Fredrickson, 1998) or impending graduation (Pruzan & Isaacowitz,
2006), emotion regulation goals become particularly salient. Thus, with decreased time
perceived as remaining along with increased age, individuals seem to prioritize emotion
regulation; perhaps these shifting goals also play a role in individuals’ interpretations of
ambiguous situations.
The current study’s purpose is to examine threat interpretation biases across the adult lifespan, given research to this point has been limited to young adult samples. The positivity effect provides a framework from which to form hypotheses. While research on the positivity effect has been limited to attention and memory paradigms, this cognitive process may also extend to interpretation biases. One of the only studies to investigate interpretations of ambiguous stimuli as a function of age examined younger and older adults’ perceptual judgments of facial emotions (Bucks, Garner, Tarrant, Bradley, & Mogg, 2008). Older and younger adults were asked to look at faces that had been morphed to display an ambiguous combination of angry and happy features. Older adults were less likely than younger adults to endorse anger in the ambiguous face blends, suggesting a bias away from potential threat that is in keeping with the positivity effect. While these findings of a perceptual judgment bias may be taken as an initial indication of a likely relationship between threat interpretation bias and aging, it is important to more explicitly examine threat interpretations across the adult lifespan. Additionally, because the positivity effect findings are mixed, investigating potential moderators of the effect may help to explain the differences among studies.

**The Role of Moderators**

In light of the positivity effect, one would hypothesize a general bias away from threatening stimuli that comes with age. However, some evidence suggests that different types of threatening stimuli are particularly salient for certain age groups. Teachman and Gordon (2009) investigated the effects of threat type on self-reported anxiety and threat interpretations. They hypothesized that older adults would have healthier interpretations of external anxiety triggers (particularly social situations) than would younger adults. Additionally, they hypothesized that older adults would exhibit less anxiety while making a speech (a social
stressor) than their younger counterparts, and would exhibit similar amounts of anxiety following physical stressors (e.g., straw breathing to elicit shortness of breath). The researchers’ hypotheses were based on previous research showing that the worries of young adults are often socially-based and related to a fear of negative evaluation (e.g., looking “unattractive to the opposite sex,” Ladouceur, Freeston, Fournier, Dugas, & Doucet, 2002, p. 432), whereas aging adults worry especially about their and their loved ones’ health (Ladouceur et al., 2002). Teachman and Gordon’s results suggested that there were no significant differences between older and younger adults for the social threat interpretations; however, older adults interpreted the physical scenarios as more threatening than their younger counterparts. Additionally, older adults and younger adults did not significantly differ on anxiety outcomes following the physically threatening tasks, even though older adults did report significantly less anxiety following the social stressor. The researchers suggest that this difference in anxiety outcomes across tasks is most likely a result of the age-relevance of the threat; physical threats are understandably more salient to older adults than to younger adults and social threats seem to be more anxiety-provoking to younger adults. Reports of the prevalence of social anxiety support this hypothesis; previous research has also found that social anxiety may be more prevalent in young adult samples than in older adult samples (Gretarsdottir, Woodruff-Borden, Meeks, & Depp, 2004), suggesting that perhaps social stressors are more salient to younger adults. Additionally, the age-relevance of threats may inhibit older adults’ usual ability to regulate negative emotions such as anxiety. In the present study, individuals’ interpretations of ambiguous, age-relevant (social and physical) scenarios and an age-neutral (general) scenario will be investigated, in order to examine the moderating role of age-relevance (or threat type) on interpretation biases across the adult lifespan.
In addition to age-relevance of the interpretation threat domain, a second predicted moderator of the expected age and threat interpretation bias relationship is physical health. While there is evidence to suggest that there are associations between health, anxiety, and interpretations, research has focused primarily on the relationship between specific health concerns and interpretation biases (Karsdorp, Kindt, Rietveld, Everaerd, & Mulder, 2008). For example, Karsdorp Kindt, Rietveld, Everaerd, and Mulder (2008) examined the relationship between state and trait anxiety, interpretation biases, and daily functioning in individuals with congenital heart disease. Their findings suggested that the relationship between state anxiety and daily functioning was mediated by interpretation biases of an ambiguous, heart-health-related scenario, and the anxiety-functioning relationship was stronger in those with a congenital heart disease than in healthy individuals. Additionally, state anxiety mediated the relationship between trait anxiety and interpretation biases, such that those who had the worst daily functioning experienced both high levels of trait and state anxiety and exhibited the most negative interpretation bias of the scenario. These findings show the importance of understanding the relationship between health and anxiety; quality of life and daily functioning are affected by this relationship.

The current study aims to investigate threat interpretation biases across the adult lifespan, and the moderating effects of threat type and physical health, using the positivity effect to guide predictions. First, as a result of preferential processing of non-negative information with age as described by the positivity effect, it is hypothesized that with increasing age, individuals will interpret ambiguous general threats as less threatening. Second, it is predicted that there will be an even stronger negative correlation between age and social interpretation bias (owing to the domain’s heightened age-relevance for younger adults). It is also predicted that with increasing
age, individuals will interpret ambiguous physical threats as increasingly threatening as a result of the age-relevance of the threat domain for older adults. Third, it is hypothesized that physical health will have a particularly influential impact on the relationship between age and physical threat interpretation bias, because physically threatening scenarios are especially older age-relevant, and older adults have been shown to have a more difficult time regulating anxiety when potentially threatening information is physically related (Teachman & Gordon, 2009). The present study will provide insight into understanding threat interpretations across the adult lifespan, in addition to a deeper understanding of the factors associated with this change, namely age-relevance of the threat and health. Additionally, the positivity effect provides a novel framework through which to examine these interpretations.

Methods

Participants

Participants were adults who volunteered to participate in an online study on the Project Implicit website (http://implicit.harvard.edu/). Volunteers were adults age 18 and older and were from the United States. While not a fully representative sample of the population, Project Implicit participants are more representative than typical college student samples. Once registered on the site, participants are randomly assigned to studies and are able to learn about implicit cognition generally, as well as their own biases.

Participants (N=1352, 67.20% women) reported being between the ages of 18 and 91 (M=43.00, SD=16.49). Race was reported as 74.2% White, 11.6% Black or African American, 4.7% biracial (other than Black/White), 1.4% biracial (Black/White), 1.6% East Asian, .9% American Indian/Alaskan Native, .8% South Asian, .4% Native Hawaiian or other Pacific Islander, 2.5% other or unknown, and 1.8% not reporting race. Ethnicities reported were 77.7%
Not Hispanic or Latino, 6.3% Hispanic or Latino, 8.3% unknown, and 7.7% not reporting ethnicity. Education levels were reported as 1.3% having some high school education, 4.6% were high school graduates, 28.5% had some college education, 7.5% had an associate’s degree, 16.2% had a bachelor’s degree, 12.0% had some graduate school education, 29.1% had a graduate degree, with 1.0% not reporting their education level.

Measures

Age.

Participants’ reported their chronological age in years (see Table 1).

Measure of threat interpretation bias.

*Brief Bodily Sensations Interpretation Questionnaire (BBSIQ; Clark et al., 1997).*

To measure participants’ bias toward making threatening (as opposed to neutral) interpretations, participants were asked to read three ambiguous scenarios selected from the BBSIQ (e.g., “You wake with a jolt in the middle of the night, thinking you heard a noise, but all is quiet. What woke you up?”). Each scenario was followed by three explanations, one that was threatening (e.g., “A burglar broke into your house”), and two that were neutral (e.g., “You were woken by a dream”). Participants rated the likelihood of each of the three explanations on a scale from 0 (not at all likely) to 8 (extremely likely). The scenarios reflected concerns from three threat domains hypothesized to vary in salience based on age: a social threat (younger adult-relevant), a physical threat (older adult-relevant), and a general threat scenario that was not hypothesized to be particularly age-relevant (see Appendix).

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1 These measures were collected as a part of a larger study. Only measures relevant to the current hypotheses are discussed here. Other measures included an age-related implicit association test, questions of feelings and behaviors associated with anxiety, mental health questions, and perceived memory functioning questions.
To ensure that the BBSIQ was a valid measure of the examined constructs, 22 raters who were blind to hypotheses provided physical, social, and age-relevance ratings of the three scenarios and rated the valence of the explanations. The results of two repeated measures analyses of variance (ANOVAs) revealed that, as intended, the physical scenario was rated as more physically relevant than either the general or social scenarios \(F(2, 20) = 58.68, p = .00\), and the social scenario was rated as more socially relevant than the general or physical scenarios, \(F(2, 20) = 70.18, p = .00\). To examine the explicit age-relevance of the scenarios, a repeated measures ANOVA was conducted with age-relevance ratings as the within-subjects factor. The age-relevance of the scenarios did not differ, \(p = .81\), which was appropriate for the purposes of the current study. In order to fairly examine interpretation biases across the adult lifespan, it was not intended for the scenarios to be read as explicitly targeted towards certain age groups. Finally, the valence ratings were examined to ensure that each of the explanations for the scenarios was rated as neutral or negative in the expected directions. The results of a repeated measures ANOVA for each scenario revealed that for all scenarios, as expected, the negative explanation was rated as significantly more negative than either of the two neutral situations (General: \(F(2,20) = 81.75, p = .00\); Physical: \(F(2, 20) = 15.80, p = .00\); Social: \(F(2, 20) = 79.88, p = .00\)).

To measure participants’ domain-specific threat interpretation biases and to operationalize interpretation bias, a bias score was created for each scenario (i.e., social, physical, or general threat) by subtracting the average of the likelihood ratings for the two neutral explanations from the likelihood rating for the threatening explanation (higher numbers are indicative of relatively stronger threatening interpretations). In turn, this method of scoring
creates a parallel to the positivity effect by examining relative endorsement of negative, as opposed to non-negative, explanations.

**Measures of physical health (adapted from Teachman & Gordon, 2009).**

Participants provided an objective and a subjective measure of their physical health. Objectively, they indicated the number of prescription medications they were currently taking for physical health difficulties. Additionally, participants provided a subjective rating of their physical health compared to their same-aged peers on a scale ranging from 0 (*poor*) to 3 (*excellent*).

**Procedure**

Following an informed consent page, participants completed an instructional manipulation check (IMC; Oppenheimer, Meyvis, & Davidenko, 2009). The IMC embeds unexpected instructions in a paragraph in order to verify that participants are thoroughly reading and following directions. Next, each participant completed the threat interpretation questions in a set order: socially relevant, physically relevant, and the general threat question. Afterwards, participants reported on their physical health by completing the objective then subjective health measures. Following these measures, participants were debriefed.

**Results**

**Age-Relevance as a Moderator of Threat Type Interpretations**

To examine the relationship between age and individuals’ interpretation biases across different threat types, a one-way repeated measures ANOVA was conducted with threat type as a within-subjects factor (general, physical, and social domains) and age as a continuous between-subjects predictor (see Table 2 for means and standard deviations). Results indicated that there was a significant main effect of threat type, $F(2, 1169) = 126.24, p = .00, \eta^2_p = .18$. Post hoc
pairwise comparisons indicated that individuals interpreted the general scenario as relatively less threatening than either the physical or social scenarios (both \( ps = .00 \)) and the physical situation as less threatening than the social situation (\( p = .00 \)). Also, as expected, there was a significant age by threat type interaction, \( F(2, 1169) = 22.80, p = .00, \eta^2_p = .04 \). To further understand the interaction, we examined the correlation between interpretation bias and age for each threat domain. As expected, a significant positive correlation was found between the physical interpretation bias and age, \( r = .19, p = .00 \), such that with increasing age, individuals interpreted the physical scenario as more threatening. Also as hypothesized, a significant (albeit very small) negative correlation emerged between the social interpretation bias and age, \( r = -.06, p = .05 \), such that with increasing age, individuals interpreted the social scenario as less threatening.\(^2\) No significant correlation was found between general interpretation bias and age, \( r = -.02, p = .59 \).

Therefore, age-relevance of the threat domain was a significant moderator of the age and interpretation bias relationship, in line with the second hypothesis. However, contrary to the first hypothesis, age was not significantly correlated with the general threat interpretation bias as would have been expected for a general positive effect.

**Health as a Moderator of the Age and Interpretation Type Relationship**

**Objective health.**

In order to examine whether physical health moderated the relationship between age and threat type bias, we categorized participants as healthy (\( n = 536 \)) or relatively less healthy (\( n = 515 \)) on the basis of whether they reported taking none or at least one prescription medication related to physical health difficulties, respectively. See Table 3. We then conducted a 3 (threat type: general, physical, social) \( \times \) 2 (objective health: medication, no medications) repeated

\(^2\) Follow-up analyses indicated that for those individuals who did pass the IMC (\( n = 584 \)), this correlation became significant at the level of a trend, \( r = -.07, p = .10 \).
measures ANOVA. Results indicated a significant threat type by age interaction, $F(2, 1046) = 13.88, p = .00, \eta^2_p = .03$, that was qualified by a threat type by objective health by age interaction, $F(2, 1046) = 2.99, p = .05, \eta^2_p = .01$.\(^3\) To unpack the 3-way interaction, we examined the correlations between each threat interpretation domain and age separately within the group not on medication and the group on medication. Among the unmedicated individuals, there was a significant negative correlation between age and the general threat interpretation bias, $r = -.15, p = .00$, such that with increasing age, individuals were less likely to report a general interpretation bias in line with the positivity effect. In comparison, among the relatively less healthy individuals who were taking medication(s), there was a nonsignificant trend for a positive correlation between age and general interpretation bias, $r = .08, p = .08$, such that with increasing age, individuals taking medication(s) were more likely to report an increased general interpretation bias. The results of a Fisher’s Z transformation indicated that the difference between the general interpretation bias and age correlations for the two groups was significant, $z = -3.74, p = .00$. For individuals not taking medication(s), there was a significant positive correlation between age and physical interpretation bias, $r = .10, p = .02$, such that with increasing age, individuals were more likely to report a negative physical interpretation bias. For the relatively less healthy individuals taking medication(s), there was again a significant positive correlation between the physical threat interpretation bias and age, $r = .18, p = .00$, such that with increasing age, individuals interpreted the physical scenario as more threatening. The results of a Fisher’s Z transformation indicated that the difference between the physical interpretation bias and age correlations for the two health groups was not significant, $z = -1.32, p = .19$. Finally, for individuals not taking medication(s), there was no significant correlation between age and social

\(^{3}\) Follow-up analyses indicated that for those individuals who did pass the IMC ($n = 584$), this 3-way interaction was no longer significant, $p = .61$. 
interpretation bias, $r = -.05, p = .26$. Similarly, there was no significant correlation between age social interpretation bias scores for individuals taking prescription medication(s) for physical health problems, $r = -.06, p = .19$. Results of a Fisher’s Z transformation indicated that the difference between the social interpretation bias and age correlations for both unmedicated and medicated individuals was not significant, $z = 0.16, p = .87$.

In summary, the third hypothesis was not supported, in that objective health did not moderate the specific relationship between age and physical threat interpretations. However, unanticipated findings regarding health and the general scenario interpretations revealed a moderating role of health, such that those individuals not taking medications made healthier interpretations regarding the general scenario with increasing age, whereas those individuals taking medication exhibited a trend for interpreting the general scenario in a more negative way with increased age.

**Subjective health.**

In order to examine whether subjective health moderated the relationship between age and threat type bias, we did a repeated measures ANOVA with threat type (general, physical, and social) as a within-subjects factor and subjective health as a continuous between-subjects factor. Though there was no significant threat type by age by subjective health interaction, $F(2, 1046) = 1.60, p = .20, \eta^2_p = .00$, a significant threat type by subjective health interaction was found, $F(2, 1046) = 3.94, p = .02, \eta^2_p = .01$. In order to understand this interaction, we examined the correlation between each threat type and subjective health. There was a significant negative correlation between social interpretation bias and subjective health, $r = -.13, p = .00$, such that with greater subjective health ratings (relative to same age peers), individuals were less likely to interpret the social threat scenario as threatening. There were no significant correlations between
subjective health and general, $r = -.03, p = .29$, or physical threats, $r = .01, p = .80$. Subjective health did not moderate the relationship between age and threat interpretations, again contrary to the third hypothesis. However, a significant relationship between subjective health and the social interpretation bias was observed indicating that perceptions of greater health are associated with less social threat interpretations.

**Discussion**

The current study found support for a relationship among age and threat interpretation biases, which was moderated by participants’ objective level of physical health and type of threat domain. By examining interpretation biases in response to potential general, physical, and social threats across the adult lifespan, the current study tests the hypothesis that with increasing age, individuals will interpret general threats as relatively less threatening, in line with findings in support of a positivity effect. In light of the age-relevance of the social and physical threats, it was predicted that with increasing age, individuals would interpret the social threat as less threatening and the physical threat as more threatening (Teachman & Gordon, 2009). Lastly, this study sought to examine the influence of health as a moderator on the relationship between age and the physical threat interpretation bias.

Contrary to expectations, the correlation between the general interpretation bias score and age was not significant within the full sample. However, in keeping with predictions, a small but significant positive correlation was found between the physical interpretation bias score and age, such that with increasing age, individuals interpreted physical threats as relatively more threatening. There was also a small but significant negative correlation between the social interpretation bias score and age, such that with increasing age, individuals were more likely to interpret the threat as relatively less threatening. In regards to the third hypothesis, although
there was a significant positive correlation between age and physical interpretation bias for the entire sample, the strength of this relationship did not differ for medicated versus unmedicated individuals. This does not support the third hypothesis. However, the results of this study provide an exciting first step towards examining age and threat interpretation biases through a previously untested framework.

**Age-Relevance as a Moderator of the Relationship Between Age and Threat Interpretations**

In line with expectations, the age-relevance of the threat did moderate the relationship between age and threat type. With increasing age, the social scenario was interpreted as less threatening. The younger individuals were more likely than the older individuals to interpret an ambiguous social scenario as resulting from a negative cause. The present study’s findings are in line with previous research that found that younger adults reported more anxiety than older adults following a social stressor (Teachman & Gordon, 2009). In combination, these results suggest that the younger adults experience social threats at two levels: at the initial interpretation stage (the present study) and following an actual speech task (Teachman & Gordon, 2009). Thus, social stressors seem to be particularly salient to younger adults.

Also in line with expectations, with increasing age, individuals were more likely to interpret physical ambiguous scenarios as relatively more threatening. In line with previous research suggesting that older adults have a more difficult time regulating anxiety when the threat is physical (Teachman & Gordon, 2009), our results show that with increasing age, adults are more likely to systematically interpret ambiguous scenarios as threatening. That is, when imagining feeling “lightheaded and weak” (BBSIQ; Clark et al., 1997) older adults are more likely than their younger counterparts to interpret the feelings in a negative way. They rated that
they were about to suffer from a physical malady as more likely than that they had simply forgotten to eat. This age-related shift in interpretation bias in regards to physical symptoms makes intuitive sense in light of the decline in physical health that comes with aging, as a higher degree of alertness to physical symptoms may be appropriate and adaptive. However, this could be problematic, considering older adults also exhibit relatively greater negative emotional reactivity following physical stressors (Teachman & Gordon, 2009). Thus, while relatively younger adults exhibit a bias towards interpreting ambiguous social stressors as threatening, relatively older adults seem to show this bias for ambiguous physical stressors.

Finally, across the adult lifespan, individuals did not interpret the general threat scenario as more or less threatening with age. It was expected that with increasing age, individuals would interpret the general threat scenario as less threatening as a result of shifting emotional processing with age. Specifically, Socioemotional Selectivity Theory suggests that with increasing age individuals shift their goals from information processing towards emotion regulation, since time is perceived as more limited (Carstensen et al., 1999). It was expected that with increasing age, the present sample would be biased to interpret the general scenario as less threatening as a result of these shifting goals. So, although older adults show better memory for and more attention towards positive material (Mather & Carstensen, 2003), we did not find evidence in support of a main effect of age in interpreting ambiguous material. This finding may be partially owing to the way in which general interpretation bias was measured in the current study. The negative explanation for the general threat scenario (which inquired why you woke up in the middle of the night) was that a burglar was inside of one’s home. Perhaps all individuals, regardless of age, rated the negative option as not very likely, since burglary may not be particularly common for most of the population. Supporting this hypothesis are the results
showing that the general scenario was rated as less threatening overall than the social or physical scenarios.

Taken together, these results suggest that the age-relevance of ambiguous information influences an individual’s relative interpretation bias towards it. Older adults are more likely to endorse negative interpretations of scenarios that could potentially be a bodily threat. While this may be adaptive in certain circumstances, it is easy to think that maladaptive interpretations could arise. For example, if a healthy older woman walks up a flight of stairs and feels short of breath and feels her heart racing, she may attribute those feelings to a heart attack owing to her age, rather than to the brief physical exertion, and may begin to panic. Since threat-biased interpretations are linked to anxiety development and maintenance (Wilson et al., 2006), this could lead to her developing anxiety surrounding heart attacks or a fear of stairs or physical exertion since this causes her to feel panicked.

**Health as a Moderator of the Relationship Between Age and Threat Interpretations**

Health status (both objective and subjective) was a predicted moderator of the age and interpretation type relationship, since previous work has found that health conditions do play a role in interpretation biases (Karsdorp et al., 2008). However, results are limited and specific to certain disorders. For example, Karsdorp et al. (2008) found that the relationship between state anxiety and daily functioning was differentially mediated by interpretation biases of ambiguous heart-related scenarios between individuals with and without congenital heart disease. Importantly, prior to the present study, the relationship between interpretation biases and more general measures of health had not been examined.

When taking into account physical health status based on medication use (the objective measure), a significant relationship emerged between age and the general threat interpretation
bias. For those individuals not taking any prescription medications for physical difficulties, there was a small but significant negative correlation between age and the general interpretation bias (i.e., with increasing age, healthy individuals were more likely to interpret the general threat as less threatening). For those taking prescription medications, a trend emerged for a positive correlation between age and the general interpretation bias (i.e., with increasing age, unhealthy individuals were more likely to interpret the general threat as more threatening). Thus, those individuals who were objectively healthier, as defined by medication use, interpreted the general threat as less threatening with increasing age, as compared to their relatively less healthy counterparts, who were more likely to interpret the general scenario as more threatening with increasing age. Given that the age-interpretation bias relationship was opposite in direction for the two health groups, this may help to explain the mixed results of the positivity effect literature, in that perhaps previous study samples varied on degree of health, which may have been a critical but untested moderator. While this study was not set up as a test of the positivity effect per se, the results can help guide future work to examine the impact of health in tests of the positivity effect.

Contrary to hypotheses, the results did not show a significant effect of health as a moderator on the relationship between physical threat interpretations and age. For both objective and subjective measures of health, health did not play a significant role in the relationship between age and interpretation bias of the physical scenario. This suggests that perhaps the heightened salience of physical threats is worrisome for all older adults, regardless of health status. It could be that declining physical health is either so implicitly or explicitly associated with normal aging that all older individuals are particularly distressed by ambiguous physical symptoms. For healthy older adults especially, a seemingly ambiguous physical symptom could
signify the beginning of a decline in physical health. In addition to the physical scenario, when examining the results by the objective measure of health, health did not play a role in the relationship between age and the social scenario.

Surprisingly, however, subjective health did play a significant role in the social scenario interpretation; there was a small but significant negative correlation between the social interpretation bias and subjective health. Those who reported having better health compared to others their own age showed a bias towards interpreting the social situation as less threatening. When interpreting these results, it is important to note that subjective health may involve other processes, other than a pure rating of one’s physical health. Hooker and Siegler (1992) found that psychological well-being is intertwined with subjective health ratings; that is, when health is rated subjectively, and not by physicians or by objective means, life satisfaction and well-being influence how “healthy” one feels. Additionally, the authors note that with increasing age, this relationship becomes stronger, with psychological well-being playing a larger role in subjective health ratings. Evidence from the present study suggests that those who express feeling more subjectively healthy are also less likely to interpret ambiguous social cues as threatening. Perhaps this is in part a result of this connection between psychological well-being and subjective health. Maybe individuals who are more likely to interpret ambiguous social cues as threatening are generally more anxious and have lower levels of psychological well-being, which in turn is associated with poorer ratings of subjective health.

**Emotion Regulation and Interpretation Bias**

While the current study was not designed as an explicit test of the positivity effect (i.e., we measured a bias away from negative information towards neutral information), by examining how interpretation biases change across the adult lifespan, we are able to draw some parallels to
the broader aging and emotion regulation literature. So far, research has focused on attention and memory biases for positive information with age (Murphy & Isaacowitz, 2008) and research has not examined the positivity effect through interpretation biases. The current study found that more objectively healthy individuals interpreted a general threat (i.e., not particularly age-relevant for any age group) as less negative than their relatively less healthy counterparts. If these results are seen as another way to examine the positivity effect, this could mean that it emerges among healthy older adults, and not their unhealthy peers. Future research should examine the mechanisms behind this differential bias between healthy and unhealthy older adults. Perhaps unhealthy older individuals show this bias in attention and memory paradigms as well, or perhaps interpretation biases are a unique domain in which unhealthy older adults are particularly disadvantaged. Previous research has found that mood (Isaacowitz et al., 2008) and cognitive control (Knight et al., 2007; Mather & Knight, 2005) affect whether or not the positivity effect emerges, and that interventions aimed at training emotion regulation skills can affect both psychological and physical health outcomes (Smyth & Arigo, 2009). Future research designed to specifically test the relationship between the positivity effect and physical health will be important, since the present study’s results may suggest a link between the two. In the future, measures of health should be included in studies of the positivity effect, to examine whether or not one’s health status moderates this effect.

Future research should also continue to examine interpretation biases in light of the positivity effect by giving individuals positive, negative and neutral explanations to examine a true “positivity preference.” This is critical, considering the causal relationship found between interpretation biases and anxiety reactivity (Wilson et al., 2006). If unhealthy, older individuals
are more likely to systematically endorse negative interpretations of ambiguous stimuli, this could have important clinical applications for helping to treat anxiety in the elderly.

Limitations and Conclusion

Limitations associated with the current study involve the brevity of the measures used to assess the constructs in question. Owing to the fact that this was a study conducted online with individuals who were volunteering, all measures had to be kept brief. Specifically, the interpretation questions were taken from the BBSIQ (Clark et al., 1997), which is already a brief measure. Perhaps with more questions concerning the different domains, more robust effects could have been found. However, since significant results were found for both of the age-relevant threat types, using one question per domain seems to have provided a valid assessment. Additionally, we operationalized health by asking how many prescription medications individuals took for physical health difficulties. Other ways of defining health such as obtaining doctor’s records or asking participants for a list of medical conditions could have yielded more nuanced and, therefore, informative results than simply dividing the sample into those taking prescriptions and those not. It should also be noted that the sample of participants in the current study was also most likely a high-functioning group of individuals. Specifically, the older adults in this sample were most likely higher functioning that the average older adult, considering this was an online study. Additionally, the findings reported must be interpreted cautiously since all data was correlational. No causal relationships can be inferred from the results.

Notwithstanding, these results may have important clinical applications in terms of emotion regulation in the realm of anxiety. Older adults’ tendency to interpret a physical ambiguous scenario as threatening can be adaptive; however, it could also lead to maladaptive responses to bodily sensations. Additionally, with increasing age, relatively healthier individuals
were more likely to show a bias away from negative interpretations of an age-neutral scenario. Therefore, this could mean that healthy older adults have an adaptive interpretation mechanism that relatively less healthy older adults lack. Perhaps older adults who are already physically unhealthy also make less healthy interpretations of everyday, ambiguous scenarios. This problematic processing of ambiguous events could harm unhealthy individuals further, especially in light of the recent findings suggesting a link between feeling positive affect and mortality (Carstensen et al., 2011). These unhealthy individuals could be at an even greater risk of early mortality, not only owing to their physical difficulties, but also to their cognitive biases.

These findings provide a helpful first step towards understanding the complex relationship among age, health, and anxiety-linked cognitive processing. As the older adult population continues to grow at a rapid rate, finding ways to help this cohort age in good health not only helps their quality of life, but also the rising health care costs.
References


Table 1

*Frequencies of Age by Decade*

<table>
<thead>
<tr>
<th>Age</th>
<th>Frequency</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-24</td>
<td>236</td>
<td>17.5</td>
</tr>
<tr>
<td>25-34</td>
<td>245</td>
<td>18.1</td>
</tr>
<tr>
<td>35-44</td>
<td>232</td>
<td>17.2</td>
</tr>
<tr>
<td>45-54</td>
<td>259</td>
<td>19.2</td>
</tr>
<tr>
<td>55-64</td>
<td>224</td>
<td>16.6</td>
</tr>
<tr>
<td>65-74</td>
<td>111</td>
<td>8.2</td>
</tr>
<tr>
<td>75+</td>
<td>45</td>
<td>3.3</td>
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</table>
Table 2

Means and Standard Deviations of Dependent Variables

<table>
<thead>
<tr>
<th>Age</th>
<th>General</th>
<th>Physical</th>
<th>Social</th>
<th>Subjective Health</th>
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</thead>
<tbody>
<tr>
<td>18-24</td>
<td>-3.10 (2.19)</td>
<td>-3.29 (2.66)</td>
<td>-1.46 (2.52)</td>
<td>2.03 (.66)</td>
</tr>
<tr>
<td>25-34</td>
<td>-3.40 (2.24)</td>
<td>-3.20 (2.68)</td>
<td>-1.87 (3.02)</td>
<td>2.02 (.70)</td>
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<tr>
<td>35-44</td>
<td>-3.65 (1.80)</td>
<td>-2.80 (2.74)</td>
<td>-2.13 (2.72)</td>
<td>1.95 (.80)</td>
</tr>
<tr>
<td>45-54</td>
<td>-3.45 (1.95)</td>
<td>-2.58 (2.88)</td>
<td>-2.15 (2.62)</td>
<td>2.05 (.73)</td>
</tr>
<tr>
<td>55-64</td>
<td>-3.47 (2.07)</td>
<td>-2.14 (2.77)</td>
<td>-2.02 (2.67)</td>
<td>2.19 (.71)</td>
</tr>
<tr>
<td>65-74</td>
<td>-3.21 (2.21)</td>
<td>-1.98 (2.71)</td>
<td>-2.29 (2.59)</td>
<td>2.42 (.69)</td>
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<tr>
<td>75+</td>
<td>-3.33 (1.51)</td>
<td>-1.49 (3.19)</td>
<td>-1.50 (2.84)</td>
<td>2.13 (.62)</td>
</tr>
</tbody>
</table>

Note. To create the interpretation bias variable, the two neutral explanations’ likelihood ratings were averaged and then subtracted from the negative explanation’s likelihood ratings, such that higher scores indicate more negative interpretations of the scenarios on the Brief Bodily Sensations Interpretation Questionnaire (BBSIQ). Additionally, subjective health was rated on a likert-type scale from 0 (poor) to 3 (excellent) as compared to others of their same age.
Table 3

*Frequencies of the Objective Health Measure*

<table>
<thead>
<tr>
<th>Age</th>
<th>No prescription</th>
<th>One or more prescription</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n</td>
<td>%</td>
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<tr>
<td>18-24</td>
<td>147</td>
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<td>25-34</td>
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<tr>
<td>75 +</td>
<td>2</td>
<td>6.5</td>
</tr>
</tbody>
</table>
Appendix

Threat Interpretation Questions Taken from the Brief Bodily Sensations Interpretation Questionnaire (BBSIQ; Clark et al., 1997)

Instructions: In this section you will see short descriptions of three situations in which it is not quite clear what is happening. Your task will be to imagine each situation happening to you and to rate the likelihood of several proposed explanations.

Likert scale: 0 = Not at all likely, 2 = A little likely, 4 = Moderately likely, 6 = Very likely, 8 = Extremely likely.

1. You have visitors over for dinner and they leave sooner than you expected. Why?
   a. They did not wish to outstay their welcome.
   b. They had another pressing engagement to go to.
   c. They did not enjoy the visit and were bored with your company.

2. You feel lightheaded and weak. Why?
   a. You are about to faint.
   b. You need to get something to eat.
   c. You didn’t get enough sleep last night.

3. You wake with a jolt in the middle of the night, thinking you heard a noise, but all is quiet. What woke you up?
   a. You were woken by a dream.
   b. A burglar broke into your house.
   c. A door or window rattled in the wind.