

## Influence of anxiety, depression and looming cognitive style on auditory looming perception



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### ABSTRACT

Previous studies show that individuals with an anticipatory auditory looming bias over-estimate the closeness of a sound source that approaches them. Our present study bridges cognitive clinical and perception research, and provides evidence that anxiety symptoms and a particular putative cognitive style that creates vulnerability for anxiety (looming cognitive style, or LCS) are related to how people perceive this ecologically fundamental auditory warning signal. The effects of anxiety symptoms on the anticipatory auditory looming effect synergistically depend on the dimension of perceived personal danger assessed by the LCS (physical or social threat). Depression symptoms, in contrast to anxiety symptoms, predict a diminution of the auditory looming bias. Findings broaden our understanding of the links between cognitive-affective states and auditory perception processes and lend further support to past studies providing evidence that the looming cognitive style is related to bias in threat processing.

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An approaching sound source is one of the most ecologically fundamental warning signals for most animals. Auditory and visual cues of approaching stimuli provoke defensive behavior and/or anxiety not only in human beings and their young (Ball & Tronick, 1971; Kaye & Van der Meer, 2007), but also in other nonhuman vertebrate (Millot, Bégout, & Chatain, 2009; Schiff, Caviness, & Gibson, 1962) as well as invertebrate animals (Card & Dickenson, 2008; Gwilliam, 1963). Human beings exhibit an “anticipatory auditory looming bias.” They perceive sounds that approach them as arriving sooner and closer to them than the sounds actually are and closer than equidistant receding sounds (Bach, Neuhoff, Perrig, & Seifritz, 2009; Bach et al., 2008; Neuhoff, 1998, 2001). In addition, humans respond with greater agitation and arousal, and greater likelihood of startle, as well as expectations of potential aversive consequences to looming sounds than receding sounds (Bach et al., 2008, 2009; Tajadura-Jiménez, Väljamäe, Asutay, & Västfjäll, 2010). It therefore seems plausible that anxiety and distorted perceptions of vulnerability can on affect the anticipatory auditory looming bias. This idea is consistent with the proposal that anxiety has its evolutionary origin as a predator defense system (Fanselow & Lester, 1988). Remarkably, however, the relationships between anxiety and auditory looming perceptions have been virtually neglected.

Even though the question has not yet evidently been directly addressed, some limited support for the role of anxiety and perceived vulnerability in human auditory looming perception comes from work in adjacent areas of research. Vagnoni, Lourenco, and Longo (2012) used a visual time-of-collision paradigm (i.e., participants estimated how long it would take for approaching stimuli to reach them). Vagnoni et al. showed that participants estimated threatening images (snakes and spiders) would reach them faster than nonthreatening images (butterflies and rabbits). Moreover, their bias to do this was significantly related to the fear they reported. Coupled with this, studies by Neuhoff and colleagues have shown that women (who tend to be more physically vulnerable) exhibited a more pronounced anticipatory auditory looming bias than men (Neuhoff, Planisek, & Seifritz, 2009) and individuals who are lower in physical fitness (as assessed by grip strength) exhibited a stronger anticipatory looming bias than individuals who are higher in fitness (Neuhoff, Long, & Worthington, 2012). This small handful of studies implies that an enhanced anticipatory auditory looming bias can function as a compensatory response to perceived vulnerability.

### 1. Looming cognitive style and the processing of warning signals

A “looming vulnerability” model advanced by Riskind states that anxiety is associated with a cognitive bias to exaggerate forward threat movement (Riskind, 1997; Riskind, Rector & Taylor, 2012).

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The model posits that a key function served by threat processing (in both human and nonhuman animals) is to serve the need to rapidly detect and respond to early warning signals. The model posits the *looming cognitive style* (LCS) as a faulty cognitive bias that exaggerates this tendency (Riskind, Williams, Gessner, Chrosniak, & Cortina, 2000). LCS assesses a person's habitual exaggerated tendency to perceive threats as moving through time and space, rapidly increasing in proximity to the self and rapidly escalating in risk and danger. Research has shown that LCS is elevated in individuals with anxiety disorders (Riskind, Rector, & Cassin, 2011) and linked to a variety of processes and outcomes related to anxiety, including biased processing in threat-related memory and attention (Riskind et al., 2000), greater reactivity to stressful life events (Adler & Strunk, 2010), and emotion dysregulation and fears of loss of emotional control (Riskind & Kleiman, 2012). LCS differs from anxiety sensitivity, worry, and intolerance of uncertainty, (Reardon & Williams, 2007; Riskind et al., 2000; Riskind, Tzur, Williams, Mann, & Shahar, 2007; Riskind & Williams, 2006) for it focuses on exaggerated perceptions of the movement of threat in time and space and its rapidly increasing proximity and intensity.

The LCS measure contains two highly correlated subscales: physical looming and social looming. Physical looming, which is particularly relevant to auditory looming perception, is the tendency to overestimate the approach of looming physical dangers (e.g., an object approaching quickly). Social looming is the tendency to exaggerate the rapid approach of social threats (e.g., impending rejection). Despite the correlation of these two subscales (Riskind et al., 2000), they can have their own divergent spheres of influence. For example, biased tendencies to exaggerate the rapid increasing proximity of physical dangers (physical looming) would be relevant to the fear of such dangers, whereas tendencies to exaggerate the rapid increase of social dangers (social looming) would be more related to fear of rejection and social anxiety (Brown & Stopa, 2008; Riskind et al., 2011).

## 2. Effects of anxiety and looming cognitive style and auditory looming

Based on theoretical logic, we expected that the nature of the perceived vulnerability (or LCS dimension) would moderate the impact of anxiety on the anticipatory auditory looming bias. On the one hand, a person who has the looming cognitive style for physical threats is primed to anticipate (and be vigilant for) rapidly approaching physical dangers, and higher levels of anxiety will predict a stronger anticipatory auditory looming bias. A person who has a low level of the looming cognitive style for physical threats, however, is not primed in particular for physical threats and will show less effects of anxiety. On the other hand, a person who has the looming cognitive style for social threats is primed to anticipate the rapid approach of social threats such as rejection, and higher anxiety will be less likely to predict a greater auditory looming bias. Indeed, higher anxiety will even potentially predict a reduced anticipatory looming bias, because it might distract the person from cues of approaching physical threats. Taken together, we expect that a synergistic combination of high anxiety and a looming cognitive style for physical and social threat will predict a pronounced auditory looming bias.

## 3. Present study

The present study was designed to examine our predictions that anxiety symptoms will interact differently with each LCS dimension of personal danger in the prediction of the anticipatory auditory looming bias. A secondary aim was to test the specificity of the predicted effects to anxiety symptoms by comparing them

to depression symptoms. Even though anxiety and depression are highly inter-correlated (Brown, Chorpita, & Barlow, 1998; Clark & Watson, 1991), they are assumed to have different adaptive functions. Anxiety involves a behavioral preparation for future danger, especially in the face of uncertainty (Herry et al., 2007), whereas depression involves rumination over the past (Just & Alloy, 1997; Nolen-Hoeksema, Morrow, & Fredrickson, 1993), and except to the extent there is co-occurring anxiety, demobilization and disengagement (Allan, 1998). We expected that depression will have little effect or even an inhibiting effect on the anticipatory auditory looming bias. In addition, we predicted controlling for the effects of depression symptoms would not remove the expected interaction effects between anxiety and LCS.

## 4. Method

### 4.1. Participants

One hundred undergraduates (72% female) at a suburban university participated in the IRB-approved study for course credit. Participant age ranged from 18 to 51 years ( $M = 21.32$ ,  $SD = 4.68$ ).<sup>1</sup> Inclusion criteria included fluency in spoken and written English. Racial composition of the sample was relatively diverse: 59% Caucasian, 24% Asian, 10% African American, 1% Pacific Islander, and 6% identified as other. Measures of socio-economic status were not collected in this study. Nine participants were excluded from the analysis because their scores were outliers on the auditory looming task (3 standard deviations [SD] above the mean), bringing the final sample used in subsequent analyses to 91 participants.

### 4.2. Materials

#### 4.2.1. Looming Maladaptive Style Questionnaire (LMSQ; Riskind et al., 2000)

The LMSQ is an 18-item measure validated measure of a person's exaggerated tendency to perceive threats as moving through time and space, rapidly increasing in proximity and rapidly escalating in risk and danger (i.e., the Looming Cognitive Style: LCS). Participants respond to six vignettes describing a range of potentially stressful situations including physical health and injury (*Physical Looming*) and social rejection (*Social Looming*). Participants answer three questions about each vignette on a 5-point Likert-type scale. Individual item scores are aggregated such that higher scores indicate higher levels of looming vulnerability. The LMSQ has been shown to be a reliable measure that has predictive, convergent, and discriminant validity (Riskind et al., 2000). In the present study, adequate internal consistency was found for both LMSQ subscales ( $\alpha = 0.73$ ).

#### 4.2.2. Anxiety and depression symptoms

Anxiety and depression symptoms were assessed using the anxiety and depression subscales of the Brief Symptom Inventory (BSI; Derogatis, 1992). Each scale contains six likert scale items; total scores can range from 0 to 4 with higher scores equaling higher levels of symptoms. In the present study, adequate internal consistency was found for both the anxiety and depression subscales of the BSI ( $\alpha > 0.80$  for both scales). Other validation studies of the BSI (Boulet & Boss, 1991) find strong reliability and convergent validity in both inpatient and outpatient samples.

<sup>1</sup> We extend our thanks to Karen Schaefer for her help in collecting these data.

#### 4.2.3. Auditory looming task

Listeners were presented with a looming 3-D virtual sound source over headphones. The sound source approached the listener at 15 m/s along a path parallel to the interaural axis from distances of 84, 87, 90, 93, and 96 m. The virtual listening point was 2 m from the straight-line trajectory of the source (as if the listener were facing a street listening to a passing car). The time-to-arrival task was to press a key when the passing sound source was perceived to be directly in front of them. This was a simple perceptual task that did not involve any element of threat. The sound was a square wave with a fundamental frequency of 400 Hz and a source intensity of 88 dB SPL. The 3-D acoustic simulation included Doppler shift, atmospheric filtering, gain attenuation due to atmospheric spreading, ground reflection attenuation, and head-related transfer function from the MIT KEMAR data set (Gardner & Martin, 1995). For additional simulation details see Neuhoff et al. (2009). We told listeners that a sound would approach from the left or the right and pass in front of them. Listeners pressed a key when the source was perceived to be directly in front of them. Each starting distance was presented four times in random order. Half of the sounds approached from the left and half from the right. Listeners received ten practice trials with feedback followed by 60 experimental trials without feedback. Auditory looming scores were calculated by subtracting the perceived arrival time from the actual arrival time. Thus, positive values indicate an anticipatory bias in perceiving the arrival of the source.

#### 4.3. Analytic strategy

A hierarchical linear regression model in SPSS 19 was used to test the effects of anxiety and depression symptoms and looming cognitive style on auditory looming bias. The basic form of the model included three blocks of predictors: (1) the main effects of anxiety and depression symptoms (2) the main effects of the LCS-Physical and LCS-Social subscales of the LMSQ, and (3) the interaction effects between anxiety and each subscale. We did not include a priori the interaction effects between LCS scales and depression because they had no theoretical interest to us. However, in a post hoc analysis neither of these interactions was significant and including them in the regression analysis did not change any of the results.

### 5. Results

Table 1 presents the means, SDs, and intercorrelations of the study variables. As can be seen from the table, anxiety symptoms were significantly correlated with depression symptoms, and both LMSQ subscales. Depression symptoms were also correlated with both LMSQ subscales and the LMSQ subscales were correlated with each other. Anticipatory bias for auditory looming had a nonsignificant tendency to correlate with anxiety symptoms. No gender effects were found for anxiety or depression symptoms and looming cognitive style (all  $p$ s > 0.10). There was a nonsignificant trend for females having a higher average auditory looming score than males ( $F = 2.11$ ,  $p = 0.150$ ). Thus, as gender was not significantly associated with any predictors at  $p < 0.05$  in this study, it is not considered in the analyses. Younger age was associated with greater depressive symptoms, and both physical and social looming, thus we included age as a covariate in the analysis.

Our mean scores for anxiety and depression were slightly higher than, but generally in line with, non-patient means for anxiety symptoms ( $M = 0.35$ ,  $SD = 0.42$ ) and depression symptoms ( $M = 0.28$ ,  $SD = 0.46$ ). Moreover, five percent of the sample was above the psychiatric inpatient mean ( $M > 1.7$ ) on anxiety

symptoms. Four percent of our sample was above the psychiatric inpatient mean ( $M > 1.8$ ) on depression symptoms.

#### 5.1. Hierarchical regression analysis model

Table 2 presents the results of the regression analysis (statistics indicated that multi-collinearity in our data was not a problem, with all VIFs < 3.75 and most < 2). In this analysis, levels of anticipatory looming bias were first regressed onto age and levels of anxiety and depression symptoms (block 1), LMSQ-Physical, LMSQ-Social (block 2), and the interactions between LMSQ-Physical and anxiety symptoms and LMSQ-Social and anxiety symptoms (block 3). LMSQ-Physical, LMSQ-Social, and symptom scores were centered prior to calculating the interaction terms (Aiken & West, 1991).

Block 1 of the regression analysis accounted for 9% of the variance of anticipatory bias in auditory looming scores. Statistically significant predictors in this block were anxiety symptoms ( $b = 173.94$ ,  $p < 0.01$ ) and depression symptoms ( $b = -134.69$ ,  $p < 0.05$ ). These main effects revealed that higher levels of anxiety predicted higher levels of anticipatory auditory looming bias, whereas higher levels of depression symptoms predicted lower anticipatory auditory looming bias. Block 2 examined the main effects of the two LMSQ scales. This block did not significantly account for any additional variance in anticipatory auditory looming bias although the main effect for LMSQ-Physical showed a nonsignificant trend toward predicting an enhanced anticipatory bias.

In line with predictions, block 3 (interactions of anxiety with LMSQ subscales) significantly accounted for an additional 22% of the variance in anticipatory bias in auditory looming. The interaction effects between LMSQ-Physical and LMSQ-Social with anxiety were each significant predictors ( $b = 114.35$ ,  $-144.12$ ,  $p < 0.001$ , for physical looming  $\times$  anxiety and social looming  $\times$  anxiety, respectively). Given that the two interactions reached significance when in the same regression, we probed whether such significance was spurious, resulting from a suppression effect (Tzelgov & Henik, 1991). Each of the interactions was therefore entered into a separate regression analysis with the main effects of Time 1 for anxiety, depression, and the main effect of the pertinent looming cognitive style subscore.<sup>2</sup> When this was done, statistical significance was still obtained for both of the interactions and both retained the same forms ( $b = 102.98$ ,  $-128.34$  for physical looming and social looming respectively). Hence we probed both of the interactions by plotting them.

As per Aiken and West's (1991) recommendation, slopes of Time 1 physical looming were computed at high (1 SD score above the mean) and low (1 SD below the mean) levels of anxiety symptoms. The Y-axis of Fig. 1 pertains to anticipatory auditory looming bias corrected for depression, the two LMSQ subscales, and the interaction effect between anxiety and social looming. As the figure shows, the effect of anxiety in predicting anticipatory auditory looming perception is pronounced when physical looming is high but not low. At high levels of physical looming, higher levels of anxiety predicted higher levels of the anticipatory auditory looming bias (standardized simple slope = 162.60,  $p = 0.002$ ). But at low levels of LMSQ-Physical (1 SD below the mean), on the other hand, anxiety and anticipatory bias in auditory looming perception were not significantly associated (standardized simple slope =  $-77.24$ ,  $p = 0.339$ ). Thus, the findings are in line with the hypothesis that a

<sup>2</sup> The auditory tones used in this study might resemble the sounds of approaching cars. Thus, it is important to note that the same interaction effect patterns were found at the individual scenario level as for the whole subscale, without reference to whether the scenarios involved automobiles.

**Table 1**  
Means, standard deviations, and intercorrelations of study variables.

	1	2	3	4	5	6	7
1. Age	–						
2. Gender (Male)	–0.13	–					
3. Auditory looming perception	0.07	0.17	–				
4. Anxiety symptoms (BSI – anxiety)	–0.15	0.06	0.17	–			
5. Depression symptoms (BSI – depression)	–0.22*	–0.07	–0.02	0.78***	–		
6. Physical looming (LMSQ – physical)	–0.28**	0.17	0.14	0.35***	0.31***	–	
7. Social looming (LMSQ – social)	–0.34***	0.04	–0.12	0.33***	0.40***	0.46***	–
Mean	21.32	–	375.75	0.55	0.42	3.45	3.11
SD	4.68	–	820.54	0.66	0.55	0.75	0.83
Range	18–51	–	–291.30–3983.00	0–3.17	0–2.33	1.56–5.00	1.44–5.00

Notes: BSI, Brief Symptom Inventory; LMSQ, Looming Maladaptive Style Questionnaire.

\*  $p < .05$ .

\*\*  $p < .01$ .

\*\*\*  $p < .001$ .

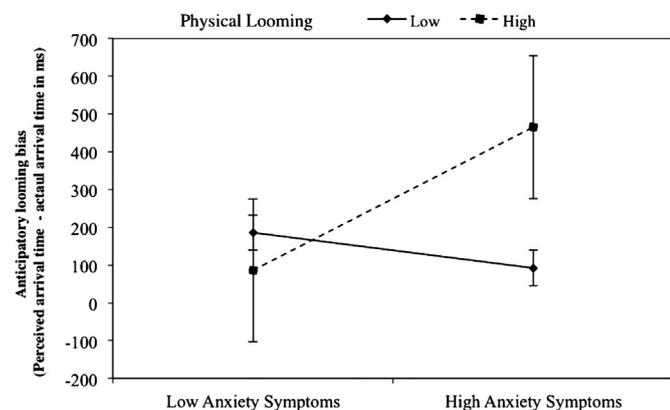
**Table 2**  
Results of hierarchical regression analysis predicting auditory looming perceptions.

Variable	B	SE	t	$r^2 \Delta$	p
Step 1				0.11	0.020
Age	3.18	7.31	0.44		0.664
Anxiety symptoms (BSI – anxiety)	173.94	58.91	2.95		0.004
Depression symptoms (BSI – depression)	–134.69	59.80	–2.25		0.027
Step 2				0.04	0.127
Physical looming (LMSQ – physical)	74.85	41.75	1.79		0.077
Social looming (LMSQ – social)	–68.82	44.04	0.071		0.159
Step 3				0.22	<0.001
Physical looming $\times$ anxiety	114.35	31.69	3.61		<0.001
Social looming $\times$ anxiety	–144.12	32.47	–4.44		<0.001

Note. BSI, Brief Symptom Inventory; LMSQ, Looming Maladaptive Style Questionnaire.

sense of personal jeopardy to physical threat is essential for anxiety to enhance the anticipatory bias for auditory sounds.

We then probed the significant interaction between anxiety and social looming. As Fig. 2 shows, at high levels of LMSQ-Social (1 SD above the mean), anxiety and anticipatory bias in auditory looming were not significantly associated (standardized simple slope =  $-103.34$ ,  $p = 0.147$ ). Yet, at low levels of LMSQ-Social (1 SD below the mean), higher anxiety significantly predicted greater levels anticipatory auditory looming perception (standardized simple slope =  $183.55$ ,  $p = 0.006$ ). Thus, increased anxiety seemed to suppress the anticipatory auditory looming bias if a sense of personal jeopardy to looming social threat was high. Overall, these findings are consistent with our hypothesis that the association between anxiety and anticipatory auditory looming would be moderated by the nature of the looming cognitive styles.



**Fig. 1.** The relationship between anxiety symptoms and auditory looming perception as a function of high vs. low levels of physical looming.

Thus, physical looming and social looming both moderated the relationship between anxiety and perception of auditory stimuli but in directly opposite ways. Anxiety seemed to most strongly enhance anticipatory auditory looming when LMSQ-Physical was high, but LMSQ-Social had the opposite pattern.<sup>3</sup>

## 6. Discussion

Although it has been shown that individuals over-estimate the closeness of a sound source that approaches (Bach et al., 2009, 2008; Neuhoff, 2001), the present study demonstrates the impact of anxiety and depression symptoms and cognitive biases (i.e., looming cognitive style; LCS) on the perception of these ecologically fundamental warning signals. We expected that anxiety symptoms and LCS dimensions synergistically combine to predict anticipatory auditory looming. In addition, we expected that depression can diminish anticipatory auditory looming. Results in this study provided support for these hypotheses.

The results found an overall main effect in the regression showing that levels of anxiety symptoms to promote a stronger anticipatory auditory looming bias. As expected depression symptoms had a directionally opposite main effect that suggested a diminution of the anticipatory auditory looming bias. Anxiety and depression symptoms each had distinct, independent effects on auditory perception when the overlap with the other was statistically controlled (despite their significant intercorrelation). These main effect findings are consistent with the idea that anxiety is more closely related to the detection and response to oncoming dangers (Clark & Beck, 2011; Riskind et al., 2000), whereas depression is more closely related to processes such as disengagement

<sup>3</sup> We conducted a series of unadjusted analyses without depression symptoms as a covariate. These analyses were consistent with the findings with depression symptoms as a covariate ( $b_{soc \times anx} = -152.21$ ,  $b_{phys \times anx} = 115.56$ ).

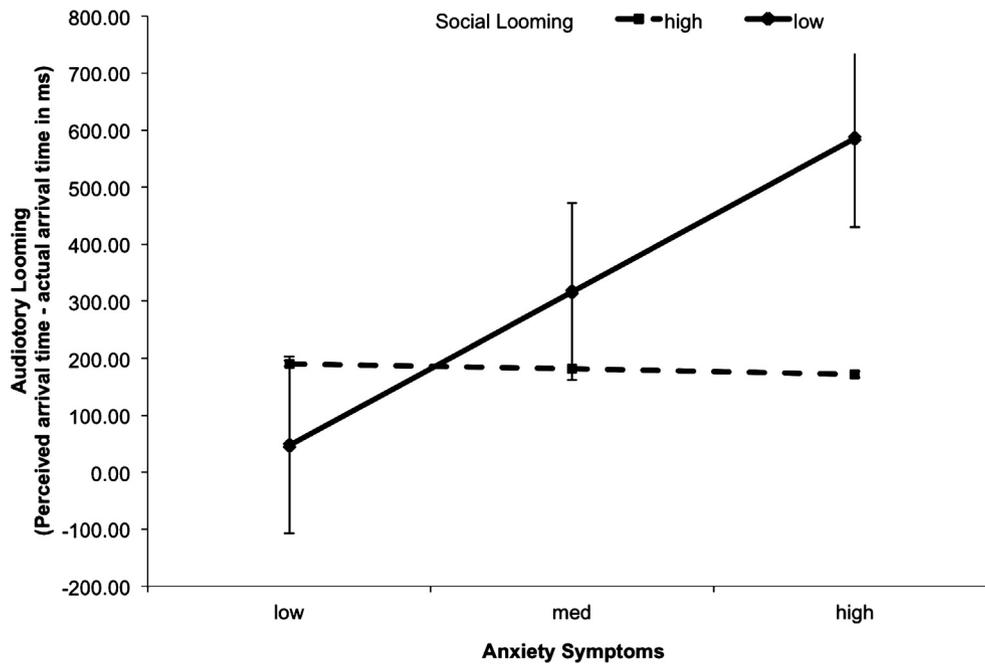


Fig. 2. The relationship between anxiety symptoms and auditory looming perception as a function of high vs. low levels of social looming.

and rumination over past negative events (e.g., Just & Alloy, 1997; Nolen-Hoeksema et al., 1993). Yet, even though these main effect results are interesting, they should be interpreted cautiously given the lack of significant bivariate relationships between anxiety and depression symptoms and auditory looming perception.

The results indicated that the impact of participants' anxiety symptoms on their sensitivity to auditory looming signals depended on the focus of their cognitive bias (the LCS dimensions). In combination with an exaggerated "physical looming" tendency to perceive physical threats as rapidly increasing in proximity and intensity, and escalating in risk and danger, increments of higher anxiety predicted a stronger anticipatory auditory looming bias. However, in combination with an exaggerated "social looming" tendency to perceive social threats such as rejection as rapidly approaching and escalating, increments of higher anxiety symptoms predicted a reduced anticipatory auditory looming bias. Importantly, these interactions were independent of main effects of anxiety, depression, and the two LCS dimensions, as well as of interaction effects between LCS and depression symptoms. Of equal importance, these two diverging interaction effects between the LCS dimensions and anxiety symptoms were not due to any reciprocal suppression effects.

Women and individuals who lack physical strength have been found to have an enhanced auditory looming bias (Neuhoff et al., 2009, 2012). An enhanced anticipatory looming bias can be seen as a compensatory response to perceived physical vulnerability. The present study, however, is the first to our best knowledge, to examine whether there are relationships between anxiety and anxiety-related cognitive biases and auditory looming perception. Thus the present findings provide important new evidence that the auditory perception of sound sources that approach is not just influenced by physical characteristics of listeners (or of the sounds themselves), but also by their cognitive-affective states and biases. In a related sphere of research, mood and affective states have been found to affect the perception of physical space such as geographic slant or height (Riener, Stefanucci, Proffitt, & Clore, 2011; Teachman, Stefanucci, Clerkin, Cody, & Proffitt, 2008). A logical next

step could then be to explore whether LCS is associated with perceptions of physical space as well as exaggerated perceptions of the movement of threat through both space and time (Riskind et al., 2012).

The present study use relatively neutral auditory tones that lacked intrinsic affective content (e.g., pleasant or unpleasant sounds), apart from their movement per se. Yet, responses to emotional stimuli can dramatically differ from those to stimuli that have a neutral emotional valence (for a review see Brosch, Pourtois, & Sander, 2010). Some researchers have even argued that embodied emotion provides a frame of reference in which all information processing takes place (Niedenthal, 2007; Niedenthal, Barsalou, Winkielman, Krauth-Gruber, & Ric, 2005). It would therefore be interesting in future studies to explore the separate and conjoint effects of anxiety and LCS on responses to auditory perceptions of pleasant and unpleasant sounds.

Considerable evidence has been amassed, in both nonclinical and clinical populations, which shows that anxiety is associated with cognitive biases (Clark & Beck, 2011). What is unique about the present study is that it extends the systematic study of cognitive biases to auditory looming perception (which in evolutionary history would have been a major focus of human ancestors). In addition, the present study contributes new evidence that a cognitive style that creates putative vulnerability for anxiety (looming cognitive style; Riskind et al., 2000) is related to how people perceive approaching sounds, an ecologically fundamental warning signal. By bringing these different areas of research together, the present study helps to bridge cognitive research on biases in anxiety and research in cognitive-neuroscience.

With regard to the LCS, the current results further support the importance of distinguishing the physical from the social looming subscales when highly domain-specific threat material is involved. Finally, this study's results are broadly consistent with the proposed cognitive vulnerability role of LCS in the onset and negative course of anxiety disorders. Recent research has shown that individuals with LCS are at elevated risk compared to other individuals, particularly after negative life stressors, for more severe anxiety symptoms (Adler & Strunk, 2010; Riskind et al., 2007). The LCS is elevated in treatment-seeking patients with anxiety disorders

(Riskind et al., 2011; Riskind & Williams, 2005) as well as individuals with a prior lifetime history of anxiety disorder (Black, Riskind, & Kleiman, 2010). These accumulating findings suggest that LCS – a cognitive bias to exaggerate the rapid movement and intensification of threat in time and space – plays an active role in creating vulnerability to anxiety disorders.

The present study had several strengths. These include its use of a widely used measure of auditory looming perception in cognitive-neuroscience, as well as well-documented measures of anxiety, depression, and looming cognitive style. The interesting findings of this study also suggest that it is possible to detect influences of anxiety and depression symptoms and cognitive style on auditory looming perception even in a population without significant psychopathology. If this is correct, and the findings were also verified in clinical samples, they might even conceivably show an interesting potential to serve as a biomarker and shed light on possible different/dissociable underpinnings (psychological and biological) of anxiety and depression.

The present study also had several limitations that should be acknowledged. First, the study relied on a nonclinical population, and it is necessary to be cautious in generalizing the results to individuals with actual diagnoses of anxiety or depression disorders. Second, the study assessed anxiety and depression with self-report measures. In order to generalize the present results to clinical anxiety, studies will be needed that use structured clinical interviews to assess anxiety and depression. Further, it could be of value in such studies to include physiological measures of arousal as well as orienting responses to auditory stimuli.

Despite the limitations, the present study makes a unique contribution to advancing current understanding of cognitive biases in anxiety by linking these to auditory perception research. The study's new findings support the idea that anticipatory auditory looming perception is linked to anxiety and depression symptoms, and internal cognitive biases (LCS dimensions) in a nonclinical, college student population. Finally, the study links cognitive clinical research and cognitive-neuroscience research on auditory perception, and identifies several cognitive-affective factors that may mediate the perception of looming sounds.

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