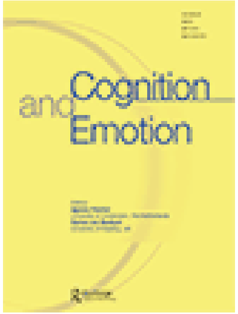

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BRIEF ARTICLE

Selective attention to emotional prosody in social anxiety: a dichotic listening study

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ABSTRACT
The majority of evidence on social anxiety (SA)-linked attentional biases to threat comes from research using facial expressions. Emotions are, however, communicated through other channels, such as voice. Despite its importance in the interpretation of social cues, emotional prosody processing in SA has been barely explored. This study investigated whether SA is associated with enhanced processing of task-irrelevant angry prosody. Fifty-three participants with high and low SA performed a dichotic listening task in which pairs of male/female voices were presented, one to each ear, with either the same or different prosody (neutral or angry). Participants were instructed to focus on either the left or right ear and to identify the speaker's gender in the attended side. Our main results show that, once attended, task-irrelevant angry prosody elicits greater interference than does neutral prosody. Surprisingly, high socially anxious participants were less prone to distraction from attended-angry (compared to attended-neutral) prosody than were low socially anxious individuals. These findings emphasise the importance of examining SA-related biases across modalities.

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Social anxiety; dichotic listening task; emotional prosody; interference effects; multimodality

Cognitive models of social anxiety (SA) (Clark & Wells, 1995; Rapee & Heimberg, 1997) postulate that attentional biases towards threat play a pivotal role in the maintenance of social fears. So far, research in SA has primarily examined visual cues, with a main focus on emotional facial expressions. Consistent with the theoretical predictions, this line of studies has indicated that, compared to their low socially anxious (LSA) peers, high socially anxious (HSA) individuals display enhanced vigilance for (e.g. Mogg, Philippot, & Bradley, 2004) and/or difficulties in disengaging from threatening faces (e.g. Schofield, Johnson, Inhoff, & Coles, 2012). A few studies (e.g. Chen, Ehlers, Clark, & Mansell, 2002) have suggested that, in contrast to LSA, HSA individuals avoid faces at later stages of processing. Less empirical attention has been paid to the way SA influences the emotional processing of cues from other modalities. Recently, Peschard, Maurage, and Philippot (2014) have proposed that the use of different modalities may extend the scope of face-based research by documenting whether biases observed in the visual modality extend to additional modalities.

The voice is a powerful carrier of information about the speaker not solely through semantic content but also through the "music of speech". The tone of voice or prosody is transmitted through changes in intonation, amplitude, envelope, tempo, rhythm, and voice quality during speech (Grandjean, Bänziger, & Scherer, 2006). One important function of prosody is to convey emotional information. Several studies suggest that angry prosody may be efficient in capturing attention. These investigations (e.g. Aue, Cuny, Sander, & Grandjean, 2011; Grandjean et al., 2005; Sander et al., 2005) have utilised dichotic listening paradigms in which a male and female voice with similar or different prosody are simultaneously presented, one to each ear. Participants are instructed to selectively focus on either the left or right ears and to identify the gender of the speaker in the

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attended ear. fMRI studies have documented greater activation in the superior temporal sulcus (Grandjean et al., 2005; Sander et al., 2005) and in the amygdala (Sander et al., 2005) to pairs containing angry and neutral prosodies relative to pairs containing only neutral prosodies, regardless of whether attention was directed to the angry prosody. Furthermore, stronger orbitofrontal (OFC) activation was found in response to pairs of angry and neutral prosody relative to pairs of neutral prosodies when the focus of attention was oriented towards anger rather than away from it (Sander et al., 2005). At the behavioural level, Sander et al. (2005) reported that pairs containing one angry prosody and one neutral prosody lead to slower responses when angry prosody presented to the left ear was attended. Another study (Aue et al., 2011) indicated that pairs containing one angry prosody and one neutral prosody elicited slower performance as compared to pairs consisting only of neutral prosodies. Contrary to Sander et al. (2005), this effect was not further modulated by attention focus nor by the laterality of the angry prosody presentation. Moreover, Aue et al. (2011) reported that pairs involving an angry prosody (relative to pairs of neutral prosodies) evoked physiological changes (e.g. skin conductance) differently modulated by allocation of attention. Together, these studies highlight the attention-grabbing power of angry prosody.

Two studies have addressed the emotional prosody processing in SA. In a first study by Quadflieg, Wendt, Mohr, Miltner, and Straube (2007), HSA and LSA participants were asked to identify the emotion expressed by meaningless utterances pronounced with either a neutral, angry, sad, fearful, disgusted, or happy prosody. Compared to LSA, HSA individuals showed better identification of sad and fearful voices and impaired identification of happy voices. Groups did not differ in their identification of neutral, disgust, and anger prosody as well as in their valence and arousal ratings for any of the utterances. In a second study, Quadflieg, Mohr, Mentzel, Miltner, and Straube (2008) asked HSA and LSA participants to identify either the gender or the prosody of the speaker (as in their first study, the same stimulus was presented in both ears). Compared to LSA, HSA individuals had enhanced OFC activation to angry compared to neutral prosody in both emotion and gender identification tasks. These findings suggest that HSA individuals exhibit biases in their identification of emotional prosody. However, these results are restricted to a task in which auditory selective attention was directed to a specific feature (gender or emotion) of a unique auditory target.

The present study explored whether SA is associated with enhanced processing of (task-irrelevant) angry prosody using a dichotic listening task in which pairs of male/female voices with either the same or different prosody (angry/angry; neutral/neutral; angry/neutral; neutral/angry) were simultaneously presented, one to each ear. This paradigm allows us to examine the interference caused by the attended and unattended channels. We included pairs containing only expressions of anger, allowing us to disentangle ambiguity vs. emotion effects (Aue et al., 2011). Participants were instructed to focus to either their left or their right ear and had to categorise the gender of the speaker. Interference effects were measured by accuracy rates and reaction times (RTs). Four hypotheses were tested.

First, consistent with previous data (e.g. Sander et al., 2005), we predicted greater interference effects (i.e. lower accuracy and longer RTs) when the focus of attention was directed towards angry rather than neutral prosody, such as mirrored by greater disruption from angry-attended trials as compared to neutral-attended trials (i.e. *Attended threat-interference hypothesis*).

Second, based on prior observations (e.g. Aue et al., 2011), we predicted that threat conveyed by the unattended channel would moderate the aforementioned interference effects (i.e. *Unattended threat-interference hypothesis*), such that Anger-Attended/Anger-Unattended pairs would lead to greater interference than Anger-Attended/Neutral-Unattended pairs, successively followed by Neutral-Attended/Anger-Unattended pairs and Neutral-Attended/Neutral-Unattended pairs.

Third, based on the literature linking SA and biased facial processing, we expected enhanced processing of task-irrelevant angry prosody in SA, resulting in greater interference effects in HSA than in LSA participants (i.e. *Enhanced threat-interference hypothesis*). However, one may expect to observe different patterns of SA-related biases between the facial and vocal modalities. Peschard et al. (2014) have suggested that, if a bias is generated at an early perceptual level and thus nested in a specific modality, this bias might not extend to additional modalities. In contrast, if the bias arises at a later stage of processing, it is likely that this bias would occur across modalities.

Fourth, we anticipated that the magnitude of these interference effects might be influenced by stimulus

Table 1. Participants' characteristics as a function of group assignment (standard deviations in parentheses).

	HSA group (N = 25)	LSA group (N = 28)	t or χ^2	p
Demographic measures				
Age	21.16 (2.11)	22.32 (1.44)	2.31[a]	<.05
Gender ratio (male/female)	3/22	7/21	1.46[b]	.28
Clinical measures				
LSAS	93.20 (14.04)	32.14 (9.24)	18.90[a]	<.001
SBSA				
Total score	85.16 (25.55)	49.46 (16.90)	6.10[a]	<.001
High standards	26.80 (5.90)	23.18 (5.41)	2.40[a]	<.05
Conditional beliefs	41.00 (15.41)	19.43 (11.51)	5.81[a]	<.001
Unconditional beliefs	17.36 (9.46)	6.86 (3.93)	5.38[a]	<.001
STAI-S	44.44 (11.74)	34.68 (9.66)	3.32[a]	<.005
STAI-T	56.92 (11.56)	40.25 (7.97)	6.17[a]	<.001
BDI-II	19.12 (8.93)	9.00 (6.92)	4.64[a]	<.001

Note: LSAS: Liebowitz Social Anxiety Scale; SBSA: the Self-Beliefs Related to Social Anxiety Scale; STAI-S: the State Spielberger Anxiety Inventory; STAI-T: the Trait Spielberger Anxiety Inventory; BDI-II: the Beck Depression Inventory-II.
[a]Value for $t(51)$.
[b]Value for $\chi^2(1, 53)$.

gender. Given the suggested association between male identity and perception of threat (e.g. Adams, Hess, & Kleck, 2015), we predicted angry prosodies vocalised by males to be processed with greater ease than female prosodies (i.e. *Facilitated male-threat processing hypothesis*).

2. Method

2.1. Participants

Fifty-eight participants were selected from a group of 254 students from the Catholic University of Louvain community based on their scores on the French version of the Liebowitz Social Anxiety Scale (Liebowitz, 1987). Specifically, participants were selected if they had a score of above 65 (HSA group) and below 45 (LSA group) on that scale. This cutoff was previously used (e.g. Rossignol, Maurage, Joassin, Fisch, & Philippot, 2013). To ensure that the screening procedure was effective, participants completed the LSAS again the day of the experiment. Five participants had to be excluded because they did not meet the LSAS criteria anymore, so that the final sample consisted of 25 participants in the HSA group and of 28 participants in the LSA group. Groups' characteristics are reported in Table 1.

After receiving details regarding the aims and the procedure of the study, each participant provided informed written consent. They received compensation (a movie ticket, worth 7 euros) for their participation.

2.2. Materials and measures

2.2.1. Self-reported questionnaires

In addition to the LSAS, participants completed the French version of the following self-report questionnaires: the Self-Beliefs Related to Social Anxiety Scale (SBSA, Wong & Moulds, 2009), the Spielberger State-Trait Anxiety Inventory (STAI; Spielberger, Gorsuch, Lusthene, Vagg, & Jacobs, 1983) and the Beck Depression Inventory-II (BDI-II; Beck, Steer, & Brown, 1996) at the beginning of the experiment. The LSAS consists of two 24-item scales that measure anxiety and avoidance of social situations. The SBSA is a 15-item questionnaire assessing the three categories of self-beliefs postulated in Clark and Wells (1995) model. The STAI is a 40-item questionnaire assessing state and trait anxiety proneness. The BDI-II is a 21-item measure of the severity of depression symptoms.

2.2.2. Stimuli

The stimuli set comprised four voices (two males and two females) enunciating the semantically neutral word "paper" in a neutral and angry manner. The recordings were taken from a standardised battery (Maurage, Joassin, Philippot, & Campanella, 2007). The proportion of female and male speakers was equal across conditions. All the stimuli were matched in term of duration (700 ms) and presented via binaural headphones. Participants could adjust the sound level of both channels simultaneously according to their hearing preference. Two additional voices (one male and one female) were selected for practice trials.

2.2.3. Procedure

Participants were tested individually. After completing the questionnaires and answering questions regarding their gender, age, and handedness (i.e. "Are you left-handed or right-handed?"), participants performed a dichotic listening task. The experiment was run via E-Prime experimental presentation software on a DELL Latitude E5530 computer. Each trial started with a 800-ms fixation cross immediately followed by the simultaneous presentation of one female and one male voice enunciating the same semantically neutral word "paper" (700 ms) but spoken with either the same or different emotional expressions (i.e. neutral/neutral; angry/angry; neutral/angry; angry/neutral) one to each ear. Participants were requested to selectively attend to either the left or the right ear in two successive blocks while performing a gender decision task on the voice presented on the attended channel. Responses were made by pressing one of two keys ("g" and "h") on an AZERTY keyboard with the participant's right and left index fingers. From the pairs onset, participants had 2500 ms to respond. The inter-trial interval from the pairs offset to the next fixation cross was 1800ms. Stimuli were randomly presented within blocks and the order of blocks as well as key assignments were counterbalanced between participants. Each block consisted of 128 experimental trials (4 vocal identities × 2 sides of presentation × 4 types of stimulus × 4 repetitions), so that the total study comprised 256 trials.

3. Results

3.1. Data preparation and statistical analyses

First, incorrect trials were excluded from the reaction time analyses (11.09%). Second, outliers deviating from three standard deviations above and below the individual's reaction times mean across all experimental conditions (1.71% of the trials with correct responses) were eliminated.

As we did not have any specific hypotheses regarding laterality effects, we collapsed across this variable. Four different Trials-Types were calculated by averaging responses to pairs of angry prosodies only, to pairs of neutral prosodies only, to pairs of neutral/angry prosodies when the emotion of the attended channel was anger, and to pairs of neutral/angry prosodies when the emotion of the attended channel was neutrality.

Percentage of correct responses and response times were then subjected to a 2 (Attended-Emotion: anger, neutrality) × 2 (Unattended-Emotion: anger, neutrality) × 2 (Gender-of-the-attended-prosody: female, male) × 2 (Group: LSA group, HSA group) repeated measures ANOVA. Attended-Emotion, Unattended-Emotion, and Gender-of-the-attended-prosody were within-subjects factors and Group was a between-subjects factor.

3.2. Response accuracy[1]

Consistent with the Attended threat-interference hypothesis predicting greater interference effects from attended-angry rather than attended-neutral prosody, a significant main effect of Attended-Emotion was found $F(1, 51) = 67.29$ $p < .001$, $\eta_p^2 = .57$, such that participants were less accurate when the focus of attention was directed to angry ($M = 82.67\%$, SD = 11.40) rather than neutral prosody ($M = 95.87\%$, SD = 2.61).

Regarding the Unattended threat-interference hypothesis anticipating that threat conveyed by the unattended channel would be processed and would moderate the effects of Attended-Emotion, the effects of Unattended-Emotion did not reach significance $F(1, 51) = .39$, NS, but an Attended-Emotion × Unattended-Emotion interaction $F(1, 51) = 7.87$, $p < .01$, $\eta_p^2 = .13$ emerged, showing that unattended-angry (relative to neutral) prosody tends to lead to lower accuracy ($M = 81.84\%$, SD = 11.69 vs. $M = 83.42\%$, SD = 11.88) when anger was attended $F(1, 51) = 3.53$, $p = .07$, $\eta_p^2 = .06$ whereas unattended-angry (relative to neutral) prosody was associated with higher accuracy ($M = 96.33\%$, SD = 2.98 vs. $M = 95.38\%$, SD = 3.08) when neutrality was attended $F(1, 51) = 4.73$ $p < .05$, $\eta_p^2 = .08$.

Inconsistent with the Enhanced threat-interference hypothesis in SA predicting greater interference effects in HSA than LSA participants, there was no significant interaction between Attended-Emotion and Group $F(1, 51) = .55$, NS and between Attended-Emotion, Unattended-Emotion and Group $F(1, 51) = .40$, NS. However, we found a significant Attended-Emotion × Unattended-Emotion × Gender-of-the-attended-prosody × Group interaction $F(1, 51) = 4.96$, $p < .05$, $\eta_p^2 = .09$. To follow-up this four-way interaction, we computed separate ANOVAs for each Group. For the HSA group, the Attended-Emotion × Unattended-Emotion × Gender-of-the-attended-prosody was not significant $F(1, 51) = .002$, NS. By contrast, for the LSA group, the three-way interaction reached significance $F(1, 51) = 9.28$, $p = .005$, $\eta_p^2 = .26$. For the identification of female voices, a significant Attended-Emotion × Unattended-Emotion interaction showed that LSA individuals identified less accurately angry female voices when the unattended male prosody conveyed anger ($M = 66.16\%$, SD = 24.81) rather than neutrality ($M = 72.77\%$, SD = 23.16). For the identification of male voices, the Attended-Emotion × Unattended-Emotion interaction failed to reach significance, $F(1, 51) = .831$, NS.

With respect to the Facilitated male-threat processing hypothesis predicting that angry prosodies vocalised by males would be processed with greater ease than female prosodies, the analysis showed a significant main effect of Gender-of-the-attended-prosody $F(1, 51) = 59.13$, $p < .001$, $\eta_p^2 = .54$, indicating greater accuracy at identifying male ($M = 96.00\%$, SD = 1.97) rather than female speakers ($M = 82.50\%$, SD = 12.05). There was a significant Attended-Emotion and Gender-of-the-attended-prosody interaction $F(1, 51) = 42.74$, $p < .001$, $\eta_p^2 = .46$. The difference in accuracy between attended-angry vs. neutral prosody was larger when participants identified the gender of female vs. male speakers ($M_{diff} = 24.32\%$, $SD_{diff} = 23.67$ vs. $M_{diff} = 2.17\%$, $SD_{diff} = 2.54$, $t(52) = 6.62$, $p < .001$). There were also several interaction effects: an Unattended-Emotion × Gender-of-the-attended-prosody interaction $F(1, 51) = 14.40$, $p < .001$, $\eta_p^2 = .22$, and an Attended-Emotion × Unattended-Emotion × Gender-of-the-attended-prosody interaction $F(1, 51) = 5.23$, $p < .05$, $\eta_p^2 = .09$. In order to clarify this three-way interaction pattern, we conducted separate ANOVAs for each Gender-of-the-attended-prosody. For the identification of female voices, a significant Attended-Emotion × Unattended-Emotion interaction $F(1, 51) = 8.65$, $p < .005$, $\eta_p^2 = .14$ showed that unattended-angry (male) prosody led to lower accuracy than unattended-neutral prosody but only when angry prosody was attended ($M = 68.02\%$, SD = 24.34; $M = 72.66\%$, SD = 23.98 respectively). By contrast, for the identification of male voices, the Attended-Emotion × Unattended-Emotion interaction did not reach significance $F(1, 51) = .24$, NS. Other effects or interactions did not reach significance (Fs < .99).

3.3. Reaction times

Consistent with the Attended threat-interference hypothesis predicting larger interference effects from attended-angry rather than attended-neutral prosody, a significant main effect of Attended-Emotion $F(1, 51) = 98.40$, $p < .001$, $\eta_p^2 = .66$ was found, such that gender identification was slower when attention was directed towards angry relative to the neutral prosody ($M = 985$ ms, SD = 162 vs. $M = 890$ ms, SD = 134 respectively).

In disagreement with the Unattended threat-interference hypothesis anticipating that threat conveyed by the unattended channel would be processed and would moderate the effects of Attended-Emotion, we did not identify a significant effect of Unattended-Emotion $F(1, 51) = .04$, NS, or a significant Attended-Emotion × Unattended-Emotion interaction, $F(1, 51) = .01$, NS.

Opposite to the Enhanced threat-interference hypothesis in SA predicting greater interference effects in HSA than LSA participants, an Attended-Emotion and Group interaction $F(1, 51) = 3.95$, $p = .05$, $\eta_p^2 = .07$ indicated that the difference in RTs between attended-angry vs. neutral prosody was smaller for HSA individuals ($M_{diff} = 75$ ms, $SD_{diff} = 48$) than for their LSA peers ($M_{diff} = 112$ ms, $SD_{diff} = 82$), $t(51) = 1.99$, $p = .05$ (see Figure 1). The Attended-Emotion, Unattended-Emotion, and Group interaction did not reach significance, $F(1, 51) = 1.91$, NS.

Regarding the Facilitated male-threat processing hypothesis, the analysis showed a significant main effect of Gender-of-the-attended-prosody $F(1, 51) = 57.14$, $p < .001$, $\eta_p^2 = .53$, indicating faster gender identification of male ($M = 905$ ms, SD = 144) as compared to female voices ($M = 971$ ms, SD = 152). There was also a significant Attended-Emotion × Gender-of-the-attended-prosody interaction $F(1, 51) = 4.58$, $p < .05$, $\eta_p^2 = .08$. The difference in RTs between attended-angry vs. neutral prosody was larger when participants had to identify the gender of female vs. male speakers ($M_{diff} = 109$ ms, $SD_{diff} = 108$ vs. $M_{diff} = 78$ ms, $SD_{diff} = 60$, $t(52) = 2.15$, $p < .05$). Furthermore, a significant Attended-Emotion × Unattended-Emotion × Gender-of-the-attended-prosody interaction was observed $F(1, 51) = 5.94$, $p < .05$, $\eta_p^2 = .10$. To follow-up the three-way interaction, we conducted separate ANOVAs for each Gender-of-the-attended-prosody. For the identification of female voices, the Attended-Emotion × Unattended-Emotion interaction was not significant $F(1, 51) = 2.09$, NS. By contrast, for the identification of male voices, the two-way interaction was significant $F(1, 51) = 4.08$, $p < .05$, $\eta_p^2 = .07$, indicating that unattended-angry prosody (female) led to shorter RTs than unattended-neutral prosody but only when angry prosody was attended ($M = 935$ ms, SD = 174; $M = 954$ ms, SD = 148, respectively). Other main effects or interactions failed to reach significance (all Fs < 3.45).

4. Discussion

This study investigated the processing of task-irrelevant prosodies in HSA and LSA individuals during a gender identification task. Consistent with the Attended threat-interference hypothesis and previous data (Sander et al., 2005), a difficulty to ignore angry (vs. neutral) prosody of the attended voice was found. Both response accuracy and reaction times suggest that, once inside the attention focus, angry

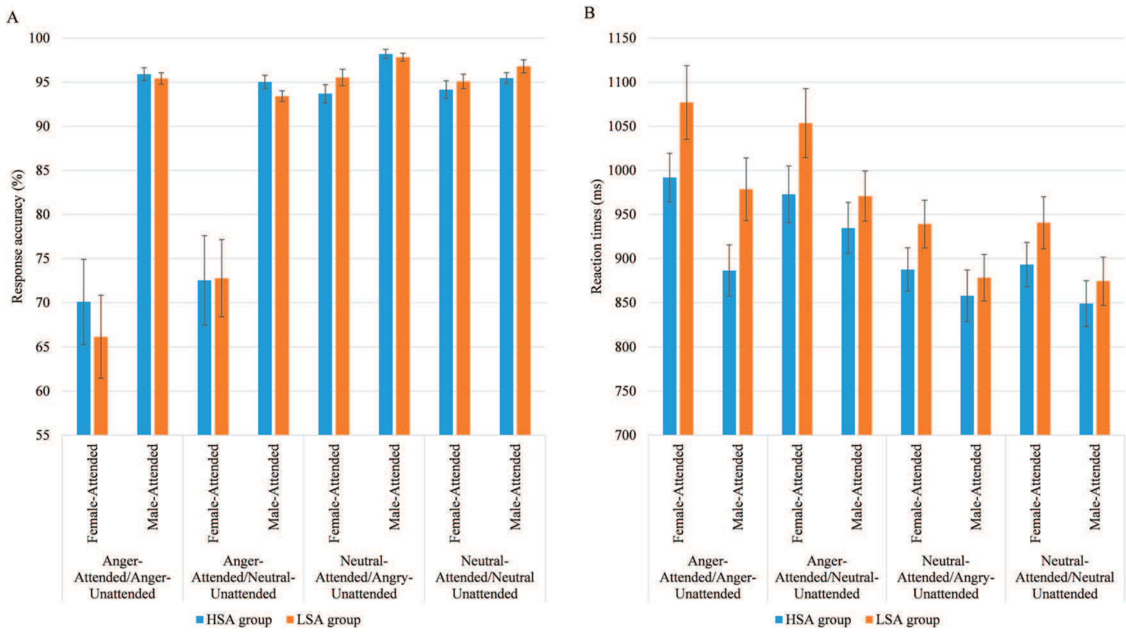

Figure 1. Mean response accuracy (A) and reaction times (B) for all conditions and groups.

prosody holds attentional resources, disrupting the ongoing gender identification task. Unlike prior dichotic listening experiments (e.g. Aue et al., 2011; Grandjean et al., 2005; Sander et al., 2005), our study included pairs of angry prosodies, which allows to determine whether the interference arises from an emotion effect or from the presence of conflicting information (i.e. the emotions presented to each ear are mismatched contrary to the pairs containing neutral prosodies only). One contribution of this study is to provide evidence of lower accuracy and longer reaction times when angry (relative to neutral) prosody was attended (regardless of the emotional congruency between the attended and unattended channels), suggesting an emotion effect rather than a conflict effect.

In contrast to our Unattended threat-interference hypothesis, angry prosody presented to the unattended ear did not systematically moderate the interference effects. Specifically, no significant interaction between Attended and Unattended-Emotion was evidenced at the level of reaction times. In this respect, previous findings are inconsistent and based on a few studies. On one hand, our results are congruent with those reported by Sander et al. (2005), but they contrast with other findings (Aue et al., 2011) reporting slower decisions for pairs mixing angry and neutral prosodies than from pairs of neutral prosodies, regardless of the attention focus. By contrast, the interaction between Attended- and Unattended-Emotion was significant at the level of response accuracy, with unattended-angry (relative to neutral) prosody being associated with lower accuracy when anger was attended but with higher accuracy when neutrality was attended. The unattended prosody interference effects seem to be dependent upon stimulus gender interaction.

Another contribution of our study is to consider the influence of SA on the processing of task-irrelevant prosody. Reaction times showed that HSA individuals were less vulnerable to the interference caused by attended-angry (relative to attended-neutral) prosody than were their LSA counterparts. Importantly, they did not make more mistakes than their LSA counterparts. These findings seem at odd with the attention control theory (Berggren & Derakshan, 2013) and previous studies (e.g. Moriya & Sugiura, 2012) suggesting that anxious people are less efficient in inhibiting distractors. It should be noted that they have been mainly derived from research in the visual domain. Several explanations for this decreased interference effect can be put forward. First, SA has been associated with a prioritisation of attention to threat, a favoured access and better maintenance of this information in working memory (for a review and integration of findings, see Peschard & Philippot, 2016). Given this facilitated threat processing in SA and the low cognitive load imposed by the task, HSA individuals may have engaged their remaining attentional resources more quickly towards attended-angry (relative to attended-neutral) prosody than LSA individuals, thereby fostering gender processing. Second, one explanation is that HSA participants may be more prone to expect threat and may thus be less disturbed by it than their LSA peers. However, such reasoning is speculative and future studies are necessary.

Our study adds to the literature by examining the influence of gender-specific vocal characteristics on the processing of task-irrelevant prosody. Results evidenced the expected facilitated male-threat processing. Both response accuracy and reaction times findings showed larger interference effects from angry-attended (relative to neutral-attended) prosody when identifying the gender of female rather than male speakers. Furthermore, our results showed that, for the gender identification of angry female voices, unattended-angry (male) prosody led to lower accuracy than unattended-neutral prosody. On the other hand, for the gender identification of angry male voices, reaction times revealed that unattended-angry (female) prosody led to quicker responses than unattended-neutral prosody. These results fit with previous research (e.g. Becker, Kenrick, Neuberg, Blackwell, & Smith, 2007) supporting a behavioural advantage for anger expressions portrayed by male relative to female faces. According to a functional-evolutionary perspective (Tay, 2015), cognitive mechanisms may be attuned by natural selection to anger posed by males because they pose a greater threat. In a related vein, this phenomenon may arise from the expresser's vocal features: male voices may inherently sound angrier than female voices. These findings may also be due to gender-based expectations regarding the emotional experience and expressions of men and women. According to Western gender stereotypes, women are expected to be affiliative whereas men are presumed to be dominant and more likely to show anger.

Several limitations and caveats for future research may be underlined. First, our study was conducted with a young, educated non-clinical population. Replications with clinical samples are needed to generalise to representative populations. Second, our sample was predominantly female. Forthcoming examinations may take into account the influence of participant gender, which may influence the perceptions of emotional prosody. Third, future studies may examine whether this impact of prosody is specific to anger or can also arise for other affective states. Fourth, it is unclear to what extent the nature of our task (judging the non-emotional aspect of the voice) impacted the findings. Replicating the study with prosody judgments will extend our understanding of the conditions under which threat-interference is observed.

In conclusion, our results suggest that threat expressed as angry prosody or as male-vocal characteristics affects gender identification by inducing interference or facilitation patterns. Interference effects from attended-angry prosody were *less* pronounced (shorter RTs) in HSA than LSA individuals. Our results stress the importance of studying threat processing in a multi-modal perspective to probe the modality specificity or generalisation of SA-related biases.

Note

1. Given the fact that HSA group showed higher scores than LSA group for BDI-II, an ANCOVA was conducted on both response accuracy and reaction times. Regarding response accuracy, the main effects of Attended-Emotion $F(1, 50) = 17.95$, $p < .001$, $\eta_p^2 = .26$ and of Gender-of-the-attended-prosody $F(1, 50) = 17.88$, $p < .001$, $\eta_p^2 = .26$ were significant. There were also several significant interactions: Attended-Emotion × Gender-of-the-attended-prosody $F(1, 50) = 12.01$, $p = .001$, $\eta_p^2 = .19$, Unattended-Emotion × Gender-of-the-attended-prosody $F(1, 50) = 5.97$, $p < .05$, $\eta_p^2 = .11$. In contrast to the ANOVA, several interactions failed to reach significant: Attended-Emotion × Unattended-Emotion $F(1, 50) = 2.76$, $p =$ NS, Attended-Emotion × Unattended-Emotion × Gender-of-the-attended-prosody $F(1, 50) = 2.46$, $p =$ NS and the Attended-Emotion × Unattended-Emotion × Gender-of-the-attended-prosody × Group $F(1, 50) = 2.45$, $p =$ NS. There were no other significant main effects or interactions ($Fs < .50$). With respect to reaction times, the main effects of Attended-Emotion $F(1, 50) = 16.47$, $p < .001$, $\eta_p^2 = .25$ and of Gender-of-the-attended-prosody $F(1, 50) = 11.84$, $p < .001$, $\eta_p^2 = .19$ as well as the Attended-Emotion × Group interaction $F(1, 50) = 4.50$, $p < .05$, $\eta_p^2 = .08$ were found significant. Contrary to the ANOVA, the Attended-Emotion × Gender-of-the-attended-prosody interaction $F(1, 50) = .21$, $p =$ NS and the Attended-Emotion × Unattended-Emotion × Gender-of-the-attended-prosody interaction $F(1, 50) = .99$, $p =$ NS did not reach significance. Other main effects or interactions did not reach significance ($Fs < 2$)".

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