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Research Paper

Goal-directed utilization of threat-relevant and non-threat-relevant expressions in social anxiety: A general deficit related to social-emotional cues in an endogenous cueing task

Timea Folyi [*,1], Laura Lindenhahn [1], Michaela Rohr [1], Dirk Wentura [1]

Department of Psychology, Saarland University, Germany

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ABSTRACT

Background: In various social-emotional situations, it is desirable to use emotional information in a flexible, goal-directed manner. When testing this flexibility in an endogenous spatial cueing task, in which threat-related facial expressions served as informative cues, socially anxious individuals showed a deficit in using the cues for task-relevant attention orienting (Folyi, Rohr, & Wentura, 2023). The present study investigated the scope of the social anxiety-related deficit in endogenous cueing by testing whether it is specifically related to threat-relevant emotions or extends to non-threat-relevant emotional faces.

Methods: First, we assessed social anxiety; second, participants with low or high social anxiety were invited to the experiment. In a block-balanced design, we presented threat-relevant (i.e., anger and fear) or non-threat-relevant (i.e., sadness and joy) expression cues to test if reduced cueing in high compared to low social anxiety extends to non-threat-relevant cues.

Results: Whereas participants with low social anxiety showed a significant cueing effect, participants with high social anxiety had no significant effect. This pattern extended to all emotional faces. However, the significant group difference was limited to the first of the two task blocks, possibly due to extensive practice and carry-over effects.

Limitations: Identifying the exact processes that hinder the flexible usage of emotional information remains an important question for future research.

Conclusions: Our results suggest that prepotent responses to social-emotional stimuli in general can hinder their goal-directed use in socially anxious individuals. Such an imbalance may have clinical implications, as it may interfere with overcoming rigid emotional responses to social-emotional stimuli.

Emotional facial expressions can inform about the internal states and intentions of others, and thereby guide social interactions and indicate appropriate behavior in diverse and novel social-emotional situations. Probably due to these biologically and socially important functions, facial expressions are processed efficiently (e.g., Batty and Taylor, 2003), and trigger several processes that are inherently linked to their emotional meaning (e.g., attention allocation, physiological responses; e.g., Gupta et al., 2019; Rohr et al., 2018). In order to achieve optimal outcomes in various social-emotional situations, however, it is often desirable to use the obtained emotional information flexibly, that is, to adapt responses to contextual goals. This requires initiating novel, goal-directed processes based on the emotional information, which are not a priori related to the emotional meaning. Because socially anxious individuals show more prepotent responses to social-emotional stimuli compared to individuals with low social anxiety (for reviews, see e.g., Bantin et al., 2016; Staugaard, 2010), social anxiety might be associated with difficulties regarding this flexibility.

Ample evidence has shown that clinical and subclinical social anxiety are associated with intense anxious response to stimuli indicative of social evaluation (e.g., Heimberg et al., 2014; Rapee and Heimberg, 1997; Wong and Rapee, 2016). The higher the threat value that a socially anxious individual attributes to particular social-emotional

* Corresponding author at: Saarland University, Department of Psychology, Campus A2.4, D-66123 Saarbruecken, Germany.
E-mail address: t.folyi@mx.uni-saarland.de (T. Folyi).

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stimuli, the more atypical they will respond to them in order to efficiently detect and eliminate the perceived threat, including preferential attentional allocation, enhanced processing, as well as attentional and behavioral avoidance (e.g., Heimberg et al., 2014; Wong and Rapee, 2016). While these processes might appear reflexive and 'stimulus--driven', they are possibly motivated by chronically activated goals, such as the goal of self-protection (e.g., Peschard and Philippot, 2016). In terms of working memory and attentional processes, theoretical models (e.g., Peschard and Philippot, 2016) suggest that social anxiety might be associated with an imbalance between salience-driven and goal-directed processes based on the intrinsic emotional-motivational meaning of social-emotional stimuli, on the one hand, and flexible processes in the pursuit of temporary goals, on the other. Nevertheless, such an imbalance has been rarely tested directly; the exceptions are studies in which an imbalance between attentional processes toward stimuli with task-relevance and stimuli with threat-relevance was investigated (see, e.g., Haas et al., 2017, and Delchau et al., 2020).

As in real life, such a conflict between attentional priorities can occur not only as a response to competing stimuli (e.g., Delchau et al., 2020), but also based on the same emotional information. In a recent study, we investigated the flexibility of using emotional information in a situation where there is a conflict between threat-related and goal-directed attentional processes signaled by emotional cues (Folyi et al., 2023). We used an emotional variant of the endogenous spatial cueing task, in which participants' task was to direct their attention to the likely peripheral target location based on the emotion (e.g., anger or fear) of centrally presented faces (see Folyi et al., 2020 for introduction of the task). After the emotional face cue, a neutral target appeared with high probability at the instructed target location. Because the faces were presented with a direct gaze, they had a purely symbolic goal-relevant meaning. When participants use the cue information, a positive cueing effect, thus, facilitated performance (i.e., shorter response times and/or fewer errors) is expected on valid trials (i.e., the target appears at the location predicted by the cue) compared to invalid trials (i.e., the target appears at the opposite location). In socially anxious individuals, the emotional cues may exert conflicting effects on attentional allocation, as an enhanced processing of the cues, a difficulty in disengaging from them, or attentional avoidance of them would conflict with the task-relevant attentional orienting.

In the general population, participants were able to direct their attention to the target location signaled by the cue with remarkable efficiency (i.e., fast, even based on masked cues; Folyi et al., 2020). This was not the case for individuals with high social anxiety: We found social anxiety-related differences in endogenous cueing with fear and anger expressions as cues (Folyi et al., 2023). Specifically, a negative relation emerged between participants' social anxiety and their cueing effect in the time range typical of endogenous attentional orienting, that is, at a cue-target asynchrony (SOA) of 600 ms. This relation was specific to social anxiety as opposed to trait anxiety. Indeed, when comparing the outer quartile groups of high and low socially anxious individuals, we found a significant cueing effect for participants with low social anxiety, while socially anxious participants showed no effect. Furthermore, this deficit in cue utilization emerged only when emotional face cues were presented in a usual, upright orientation, whereas socially anxious individuals did not show reduced endogenous cueing when faces were presented inverted, suggesting that holistic processing of the emotional faces plays a central role. These results suggest a possible imbalance in how socially anxious individuals can make use of emotional information, that is, prepotent responses to the intrinsic meaning of the stimuli seem to hinder processes that serve novel, context-specific goals. Such an imbalance may have clinical implications for social anxiety, as it may interfere with overcoming rigid emotional responses and implementing corrective responses to social-emotional stimuli.

However, the scope and specificity of a deficit in the flexible, task-relevant use of emotional cues remains an important question. Thus, it might be that it relates specifically to threat-relevant stimuli; alternatively, flexible use of all social-emotional stimuli could be affected. Looking at the related area of exogenous attentional biases to social-emotional stimuli in social anxiety, the results are diverse in terms of their specificity and the reasons for the diversity are highly controversial. Although threat-relevant emotional expressions, particularly anger, are the most commonly studied class of stimuli in this research context and many studies suggest specificity to these emotions, several studies challenge the view that exogenous attentional biases are limited to these emotions (for reviews, see Bantin et al., 2016; Staugaard, 2010). Instead, individuals with high social anxiety may be characterized by biased attention regarding all emotionally salient social stimuli, including positive emotions (e.g., Fernandes et al., 2018; Rossignol et al., 2013; Song et al., 2022), because any stimulus that is indicative of social evaluation may be considered threat-relevant in terms of their disorder-related concerns (i.e., fear of social evaluation and a chronically activated goal of self-protection; e.g., Peschard and Philippot, 2016). The conflicting results of previous research might be partially explained by methodological details in tasks that test exogenous attentional biases to social-emotional stimuli. For example, in the dot-probe task, the presentation duration of the emotional stimuli could have an impact on the specificity of the attentional bias, as attentional biases in social anxiety potentially extend to all social-emotional stimuli when presentation conditions allow for elaborate processing (for a review, see Staugaard, 2010). Furthermore, the extent of threatening social cues might vary among socially anxious individuals and might be related to the severity of social anxiety (e.g., Wong and Rapee, 2016).

With regard to the flexible usage of emotional information for novel, task-relevant processes, however, no study has yet tested the specificity and scope of the bias in socially anxious individuals. A specific bias for threat-related emotions is suggested by a limited number of studies testing an imbalance between threat-saliency based and task-relevant attentional processes (see Delchau et al., 2020; Haas et al., 2017). However, as with biases related to exogenous attentional processes, a deficit in the flexible usage of emotional cues may extend to emotional faces in general as in our task elaborated processing of facial emotions is task-relevant.

1. Overview and hypotheses

Thus, the present study presented two endogenous cueing tasks: In one task block, threat-related emotions, fear and anger, served as cues; in the other, we presented emotional face cues displaying non-threat-related emotions, sadness and joy. The presentation order of the two task blocks was counterbalanced between participants. The study directly targeted groups of low (LSA) and high socially anxious (HSA) individuals with extreme values. To this end, we conducted the study online and in two steps: In a first step, we assessed social anxiety scores of an unselected sample. In a second step, we invited participants to participate in the endogenous cueing experiment only when their social anxiety measurement fell into the low or high social anxiety groups, based on the first and fourth quartiles of the Social Phobia Scale (SPS; Mattick and Clarke, 1998).

The two cueing tasks followed the same procedure: The centrally presented cues were informative, thus, the target appeared at the peripheral location predicted by the cue emotion in 80% of trials (valid trials), and on the opposite side in 20% of trials (invalid trials). Participants' task was to categorize target letters as 'p' or 'q' as quickly and accurately as possible. In line with our former studies (Folyi et al., 2020; 2023), on each trial, cue and target stimuli were presented either with a brief SOA of 300 ms or a longer SOA of 600 ms. The former is shorter than the SOA typically used with purely symbolic cues, while the latter is in line with the time course of endogenous orienting of attention (Chica et al., 2014). We included the shorter SOA in order to keep the character of the task consistent with our previous studies (Folyi et al., 2020; 2023), thus, to ensure a high level of readiness for a potentially rapid onset of

the target. Regarding the social anxiety-related differences, we a priori focused on the 600 ms SOA-cueing effect (see Folyi et al., 2023, and the preregistration of the present study; see Supplementary Material for the analyses of the 300 ms SOA condition).

If the social anxiety-related deficit emerges specifically for threat-relevant emotions, a difference in cueing effect between LSA and HSA groups should only emerge for anger and fear cues. If the deficit in cue utilization in high social anxiety, however, extends to any emotional face cues, we expect that HSA individuals will show a reduced cueing effect compared to LSA individuals for both threat-relevant and non-threat-relevant cues. To anticipate our results, in an extended procedure including two consecutive cueing tasks, a significant group difference emerged selectively in the first of the two tasks. Because extensive practice and carry over effects seems to have influenced the results in the second cueing task, an additional analysis focuses on the first cueing task only, thus, the part of the study that is directly comparable to the one-task procedure of emotional cueing (Folyi et al., 2020; 2023).

2. Method

Ethics approval was obtained from the ethics committee of the Psychology Department of Saarland University. All data, analysis code, and materials are accessible at https://osf.io/z5ydk/?view_only=eed0d60290d743b3afc8b6229243c355. The study was pre-registered at https://aspredicted.org/5k3vi.pdf.

2.1. Participants

We oriented on the difference between high and low social anxiety groups in their 600 ms SOA-cueing effect that emerged in our former study, which was $d = 0.73$ (Folyi et al., 2023) .[2] With a sample size of 50 participants in each social anxiety group, we can detect an effect of this size with power of $1 - \beta = .95$ ($\alpha = .05$, two-tailed; calculated using G. Power 3.1.9; Faul et al., 2007). As LSA and HSA groups were based on the first and fourth quartiles of the SPS-scores of the participants in an initial social anxiety assessment,[3] we planned the sample size of the social anxiety assessment in order to achieve a sufficient sample size in our main study. Hence, we decided to invite at least $N = 200$ participants to the social anxiety assessment. Furthermore, following our preregistered procedure, we did not invite participants to the main study if their SPS measure had more than three missing values, or if their SPS and SIAS score showed a suspiciously large deviation (i.e., participants' scores are not in the same or neighboring quartiles; approximately 8% of the sample in the study of Folyi et al., 2023). Additionally, we planned to compensate for possible dropouts due to non-participation in the main study. Therefore, we decided to assess social anxiety of 260 participants.

Participants were recruited from the platform Prolific (https://www.prolific.co/), applying the following criteria: aged 18–35 years, balanced gender ratio, native English speakers, Caucasian, normal or corrected-to-normal vision. Participants were asked to participate in the first part of the study only if they are willing to participate in the second part. Participants received monetary compensation (£2.25 for the first, and £7.50 for the second part of the study). We finally assessed social anxiety of 261 participants.[4] Data from one participant was excluded due to more than three missing values on the SPS; from one participant due to self-reported age being higher than 35 years, and data from $n = 11$ were not further analyzed due to large divergence between their SPS and SIAS-scores. Hence, the valid sample was $N = 248$. The first and fourth quartile based on the SPS-scores, thus, $N = 123$ participants were invited to participate in the endogenous cueing experiment: $N = 62$ participants with SPS-scores below 18 (i.e., LSA group) and $N = 61$ participants with SPS-scores above 46 (i.e., HSA group). After an initially high participation rate following the publication of the study, the rate of participation declined rapidly. We terminated the study when there was no further participation on two consecutive days.

The sample of the main study comprised $N = 71$ participants. Data from four participants were excluded because of an a priori defined criterion, that is, a chance-level performance in an emotion-discrimination task that was used to control for participants' emotion-discrimination ability (see *Supplemental Material 1; $p > .05$* for individual χ^2; mean accuracy of 43.8% to 62.5%). Data from one further participant was excluded because of *far-out* error rates on the cueing task (i.e., mean error rate of 28.6%, more than three interquartile ranges above the third quartile with respect to the sample distribution, Tukey, 1977). The final sample had $N = 33$ participants in the low social anxiety group (with SPS-scores of 0–17, $M = 10.6$, $SD = 4.7$), and $N = 33$ participants in the high social anxiety group (with SPS-scores of 47–80, $M = 55.6$, $SD = 9.0$). Thus, the final sample size is smaller than initially expected at the planning of the sample size of the social anxiety measurement, however, power to detect an effect with the size of $d = 0.73$ has still reached $1 - \beta = .83$. The age range was 18–35 years; the LSA group comprised 11 women, 22 men (aged $Mdn = 30$ years); the HSA group comprised 24 women and 9 men (aged $Mdn = 28$ years). To control for the unbalanced distribution of gender, we conducted a control analysis including gender as factor (see *Supplemental Material 2*; to briefly summarize the results, the cueing effect did not differ by gender, and gender did not interact with social anxiety with respect to the cueing effect). Level of education, employment status, and nationality of the participants were diverse (see Table A1 of the *Appendix*).

2.1.1. Design

The experiment followed a 2 (cue validity: invalid vs. valid) × 2 (cue-target SOA: 300 vs. 600 ms) × 2 (threat-relevance: fear and anger vs. joy and sadness cues) × 2 (social anxiety group: high vs. low) mixed design. The mapping of cue emotions to left and right target locations was counterbalanced across participants. Because of the dependencies between the paired cue emotions in endogenous cueing, our experiments were not designed to find meaningful differences between the specific cue emotions (i.e., fear versus anger; joy versus sadness). Hence, we did not include the specific cue emotion as a further factor in the analyses.

2.1.2. Materials

The study was programmed in PsychoPy3 (version 2021.1.4, https://www.psychopy.org), and hosted online by Pavlovia (https://www.pavlovia.org).

(Social) anxiety assessment. We formed high and low social anxiety groups based on the SPS (Mattick and Clarke, 1998) that assesses fear of social evaluation, that is, being scrutinized during various routine activities. Additionally, in line with our former study, we assessed Social Interaction Anxiety Scale (SIAS; Mattick and Clarke, 1998) that measures a related facet of social anxiety, the anxiety experienced during social interactions. For SIAS, we included only the 17 straightforwardly worded items to calculate the total score (Rodebaugh et al., 2011).

[2] To be consistent with the number of trials in the present study (see *Procedure*), the first 3 of 5 blocks of trials were used for this calculation.

[3] We a priori decided to orient on participants SPS' score to have a simple measurement for the two-step testing procedure, while we assessed participants' SIAS score additionally (Social Interaction Anxiety Scale, Mattick & Clarke, 1998; for a similar approach, see Folyi et al., 2023, Exp. 2). Although these two measures are highly correlated (r = .85 and r = .81 in Folyi et al., 2023), they represent different facets of social anxiety: SPS is more closely related to fears of social evaluation, while SIAS to fears experienced during social interactions. Thus, they cannot be combined into a simple aggregate score to represent a unitary social-anxiety construct (see the results of the SEM in Exp. 1; Folyi et al., 2023).

[4] For one participant, the study terminated during the last instruction screen, resulting in an incomplete session. However, as the data was complete, we included it to the final dataset.

Cronbach's alpha was .95 for both scales. Mattick and Clarke (1998) reported a substantial correlation between these scales, $r = .72$. In the present social anxiety assessment the correlation was $r = .87$. In line with our former study, we additionally assessed general anxiety with the trait scale of the State-Trait Anxiety Inventory (STAI-T; Spielberger, 1983). Cronbach's alpha was $\alpha = .94$. As in our former study (Folyi et al., 2023), there were positive correlations between STAI-T and both social anxiety measures: The correlation between STAI-T and SPS was $r = .74$, and between STAI-T and SIAS was $r = .75$.

Cueing experiment. Images of eight individuals (four men and four women) were used as cues from the Radboud Faces Database (RAFD; Langner et al., 2010) and from the Karolinska Directed Emotional Faces set (KDEF; Lundqvist et al., 1998) with fearful, angry, sad and joyful facial expressions. Emotion recognition based on the validation data of RAFD and KDEF (Goeleven et al., 2008; Langner et al., 2010) were: $M = 81\%$ ($SD = 15\%$) for fear; $M = 91\%$ ($SD = 12\%$) for anger; $M = 93\%$ ($SD = 5\%$) for sadness; and $M = 99\%$ ($SD = 1\%$) for joy. Faces were framed by a gray oval such that only the facial features remained visible (see Fig. 1). Furthermore, in order to reduce the perceptual salience of their individual features, such as exposed teeth, joyful expressions were morphed with neutral expressions using the Fanta-Morph software (www.fantamorph.com). The morphed images consisted of 60% of joyful and 40% of neutral facial expression of the same individual (see Fig. A1 of the *Appendix*).

The target stimulus was either the letter "p" or the letter "q", while the letter "g" was concurrently presented as a distractor. Presentation size was 4.72 cm × 4.72 cm for cues and 0.50 cm × 0.60 cm for target stimuli. Distance between the fixation cross and the center of the possible target locations was 4.80 cm. Participants were instructed to keep about one extended arm's length of viewing distance from the center of the screen.

2.1.3. Procedure

Each participant gave informed consent prior to the procedure. The procedure of the main experiment was identical to that in Folyi et al. (2023) except of the two-task procedure with three blocks of 80 trials in each cueing task. In one task, fear and anger expressions served as cues; in the other, we presented emotional face cues displaying sadness and joy. The presentation order of the two tasks was counterbalanced across participants.

Fig. 1 depicts the illustration of a cueing trial. At the start of each trial, a white fixation cross was presented centrally against a black background for 500 ms, while four small, white markers were displayed to the left and to the right of the fixation cross, respectively. These square frames were the placeholders for the target presentation. The cue face was presented for 100 ms, while the cue-target SOA was 300 or 600 ms. Participants were informed that the emotional expression of the cue face will predict the target location on 80% of the trials, and they were instructed to use this contingency. Participants' task was to discriminate between the letters "p" and "q" as quickly and accurately as possible using the response keys of "u" and "n" on the keyboard. Error feedback was provided after a false response, while feedback was given about a too slow response when the participants' RT exceeded 1200 ms. Assignment of response keys to target letter was set randomly between participants. The trial ended with an inter-trial interval (ITI) of 1000 ms. Each cueing task consisted of one practice block of 40 trials and three experimental blocks of 80 trials each. In a block of 80 trials, each possible combination of SOA, target letter, and cue emotion was presented ten times—twice in invalid condition and eight times in valid condition.

After the cueing tasks, participants completed two emotion-discrimination tasks, in which only the emotional faces were presented again for 100 ms, participants had to categorize the depicted emotion (see *Supplemental Material 1* for the description and results of this task). At the end of the session, participants were fully debriefed. The entire session took about 45 min.

3. Results

A significance level of $\alpha = .05$ (two-tailed) was adopted for all analyses except one-tailed for cueing effects (i.e., shorter RTs are expected for valid as compared with invalid cueing).

3.1. Social anxiety measures

To account for remaining missing data in the questionnaires, we imputed scores using the mean of the participant's available responses on the same questionnaire. This was necessary for less than 1% of all items. Descriptive statistics for all questionnaires are reported in Table 1.

3.2. Cueing task

RT analyses were restricted to trials with correct responses (6.5% of all trials were incorrect responses). Furthermore, RTs below 150 ms and far-out values (i.e., RTs above three interquartile ranges above the third quartile; see Tukey, 1977) according to the individual RT distribution were excluded (0.5% of the correct responses). Mean RTs are presented in Table 2.

3.2.1. Preregistered analyses

To test differences in cueing regarding social anxiety, our main analysis focused on the social anxiety group difference with regard to the 600 ms SOA-cueing effect in the threat-relevant and non-threat-relevant conditions, respectively. (For the sake of completeness, results with 300 ms SOA are reported in *Supplemental Material 3*.) The mean cueing effects in the LSA and HSA groups are depicted in Fig. 2 as a function of the threat-relevance of the cues. In line with our assumptions, both cueing effects for LSA were significant: Yuen's one-sample *t*-test on trimmed means (with default trimming of $\gamma = .20$, using function *yuen.t.test* from the R package DescTools v0.99.45; Signorell, 2023; see, e.g., Wilcox, 2011)[5] with non-threat-relevant cues yielded $t(20) = 2.37$, $p = .014$, the cueing effect was $M_t = 23$ ms ($SD_t = 52$ ms); with threat-relevant cues it yielded $t(20) = 1.79$, $p = .044$, and the cueing effect was $M_t = 13$ ms ($SD_t = 41$ ms). As expected, both effects were non-significant for HSA: With non-threat-relevant cues the cueing effect was $M_t = 6$ ms ($SD_t = 57$ ms); $t(20) = 0.58$, $p = .285$; while with threat-relevant cues the cueing effect was $M_t = 9$ ms ($SD_t = 39$ ms); $t(20) = 1.40$, $p = .089$. However, the tests for LSA versus HSA differences with regard to cueing were not significant (we used the function *yuen* with default trimming of $\gamma = .20$ from the R package WRS2, version 1.1–4; Mair et al., 2022): For non-threat-relevant cues, the trimmed mean difference between LSA and HSA was 17 ms, $T_y(39.91) = 1.25$, $p = .220$; while for threat-relevant cues, the trimmed mean difference was 3 ms, $T_y(39.47) = 0.35$, $p = .725$.

[5] We a priori decided to conduct robust t-tests when the distribution of the cueing effects is burdened by outliers (see *Preregistration*). This was the case in the present study, there were n = 3 outliers and n = 1 extreme outlier in the distribution of participants' 600 ms SOA-cueing effect (according to Tukey, 1977; see *Fig. A2* of the *Appendix*). However, as a mistake in the preregistration, we have both stated robust t-test and Wilcoxon-Mann-Whitney test. Wilcoxon-Mann-Whitney test yielded essentially the same results as the robust t-test reported in the main text. Corresponding to the analysis in the main text, the difference in the 600ms SOA-cueing effect between LSA and HSA groups was not significant when using non-threat-relevant cues, U ($N_{LSA} = 33$, $N_{LSA} = 33$) $= 425.00$, $z = -1.53$, $p = .125$; or threat-relevant cues, U ($N_{LSA} = 33$, $N_{LSA} = 33$) $= 504.00$, $z = -0.52$, $p = .603$. In the *first cueing-task block,* corresponding to the analyses in the main text, the difference in the 600ms SOA-cueing effect between LSA and HSA groups was significant, U ($N_{LSA} = 33$, $N_{LSA} = 33$) $= 365.00$, $z = -2.30$, $p = .021$.

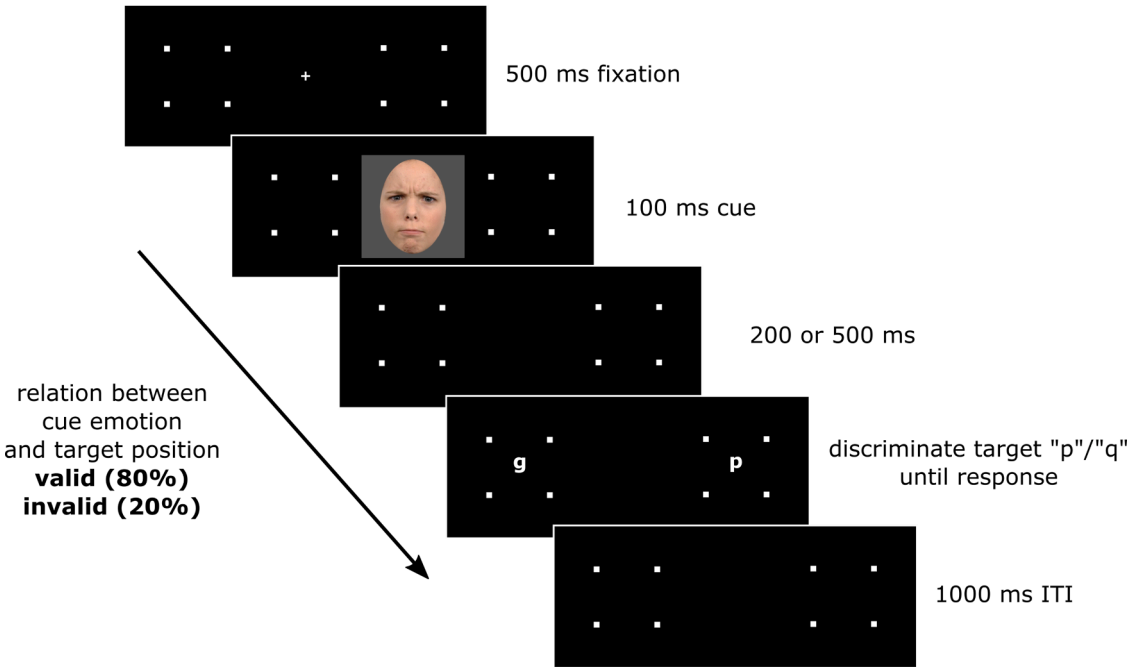

Fig. 1. Illustration of a cueing trial. Fear and anger expressions served as threat-relevant cues; joy and sadness expressions served as non-threat-relevant cues (the illustration features image 37 from the RAFD database; Langner et al., 2010).

Table 1
Range, means, and standard deviations of the SPS, SIAS, and STAI-T scores for the low (LSA) and high social anxiety (HSA) groups.

LSA ($N = 33$)				
	Min	Max	M	SD
SPS	0	17	10.6	4.7
SIAS	0	33	16	8.9
STAI-T	23	65	38.3	9.8
HSA ($N = 33$)				
	Min	Max	*M*	*SD*
SPS	47	80	55.6	9
SIAS	39	68	52.3	7.5
STAI-T	49	79	63.7	7.1

3.2.2. *Follow-up analyses*

To clarify this result, we took into consideration the most substantial change in our cueing task compared to our former studies (Folyi et al., 2020, 2023), namely, that participants had to work through two separate cueing tasks in the present study. Accordingly, they had to learn and use two emotions-to-target locations contingencies, while in our former studies participants had to complete one cueing task with one emotions-to-target locations contingency. Therefore, carryover effects

Table 2
Mean RTs (in ms; standard deviations in parentheses) with 600 ms SOA as a function of cue validity, and threat-relevance of the cues in the low (LSA) and high (HSA) social anxiety groups. Cueing effects (CE) represent the RT difference between valid-cue and invalid-cue conditions; standard errors are given in brackets.

	Valid	Invalid	CE
LSA ($N = 33$)			
Threat-relevant cues	692 (89)	713 (82)	21 [10]
Non-threat-relevant cues	678 (103)	708 (113)	30 [10]
HSA ($N = 33$)			
Threat-relevant cues	721 (70)	731 (73)	11 [9]
Non-threat-relevant cues	714 (75)	729 (82)	15 [12]

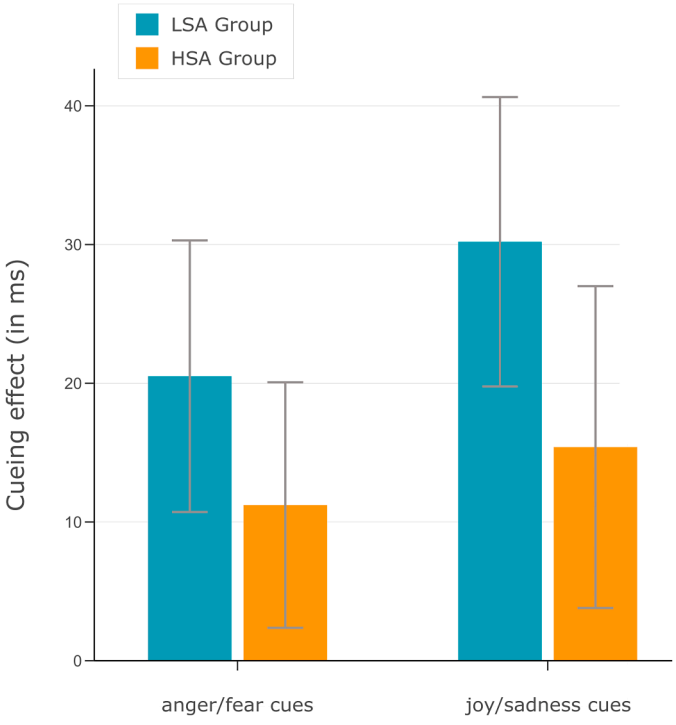

Fig. 2. Mean 600 ms SOA-cueing effects (in ms) as a function of the threat-relevance of the cue emotions (threat-relevant: anger and fear; non-threat-relevant: joy and sadness) in the low (LSA, $N = 33$) and high social anxiety groups (HSA, $N = 33$). Error bars depict standard error of the mean.

(i.e., participants who had learned to use the first emotion-to-target contingency efficiently may have had a decrease in performance when they switched to a new emotion-to-target contingency) and practice effects may have influenced the results of the second cueing task block. Fig. 3 shows the cueing effects as a function of social anxiety group and cueing-task block (mean RTs are presented in Table 3). As can be easily

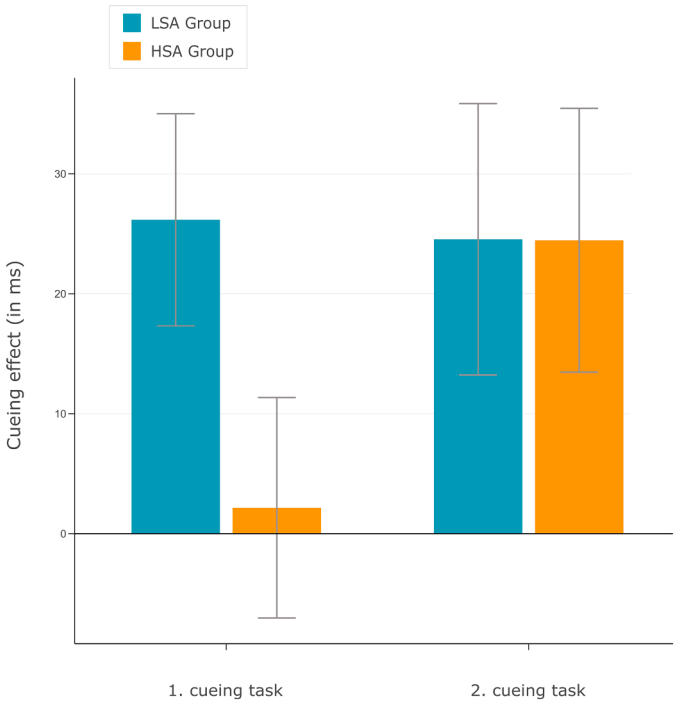

Fig. 3. Mean 600 ms SOA-cueing effects (in ms) as a function of the cueing-task block (first, second) in the low (LSA, $N = 33$) and high social anxiety groups (HSA, $N = 33$), collapsed over threat-relevance of the cues. Error bars depict standard error of the mean.

seen, the difference between HSA and LSA is limited to the first cueing-task block. To examine the group difference in the first phase, we restricted the following analysis to the *first cueing-task block*, which is directly comparable to the procedure of our former studies. This corresponds to a between-participants design regarding threat-relevance. Hence, we conducted a 2 (social anxiety group: LSA vs. HSA) × 2 (threat-relevance of the cues: threat-relevant vs. non-threat-relevant) robust between-participants ANOVA for trimmed means on the 600 ms SOA-cueing effects as the dependent variable (trimming level of 20%, using the R package WRS2, version 1.1–4; Mair et al., 2022; Mair and Wilcox, 2020; see also Wilcox, 2011). The analysis yielded a significant main effect for social anxiety group, $Q = 5.08$, $p = .031$, thus, indicating that the cueing effect differs between low and high social anxiety groups. The trimmed mean was $M_t = 19$ ms ($SD_t = 39$ ms) in the LSA, and $M_t = -6$ ms ($SD_t = 46$ ms) in the HSA group. No significant main effect emerged for the factor threat-relevance: $Q = 0.42$, $p = .523$; and the interaction of threat-relevance and social anxiety group was also not significant, $Q = 0.54$, $p = .470$, indicating comparable cueing effects for threat-relevant and non-threat-relevant cues in both groups. (For the sake of completeness, as easily can be seen in Fig. 3, social anxiety groups did not differ in the second cueing task regarding their cueing effect: $Q = 0.04$, $p = .834$, for the main effect of social anxiety group, all other $ps > .774$.)

Table 3
Mean RTs (in ms; standard deviations in parentheses) with 600 ms SOA as a function of cue validity, and cueing-task block (first, second) in the low (LSA) and high social anxiety groups (HSA), collapsed over threat-relevance of the cues. Cueing effects (CE) represent the RT difference between valid-cue and invalid-cue conditions; standard errors are given in brackets.

	Valid	Invalid	CE
LSA ($N = 33$)			
First cueing task	707 (86)	733 (97)	26 [9]
Second cueing task	664 (102)	689 (95)	25 [11]
HSA ($N = 33$)			
First cueing task	737 (80)	739 (75)	2 [9]
Second cueing task	698 (58)	722 (80)	24 [11]

4. Discussion

The present study showed that socially anxious individuals do not only show prepotent responses to social-emotional stimuli in line with their intrinsic emotional meaning (e.g., Bantin et al., 2016; Staugaard, 2010), but they are also hindered in using this emotional information in a context- and goal-dependent manner. While mainly only threat-related facial expressions have been studied in the context of social anxiety (e.g., Bantin et al., 2016; Folyi et al., 2023), the present study suggests that the social anxiety-related deficit in the flexible, goal-directed usage of emotional cues extends to non-threat-relevant (i.e., joy and sadness) expressions as well. Specifically, the cueing effects of individuals with high social anxiety did not differ regarding the threat-relevance of the cues: While both cueing effects with threat-relevant and non-threat-relevant cues were significant for participants with low social anxiety, neither cueing effect was significant for participants with high social anxiety.

While it might seem intuitive that faces with negative, threat-related emotions are particularly threatening to socially anxious individuals, theoretical models of social anxiety do not limit the scope of threatening social-emotional stimuli to these expressions (e.g., Wong and Rapee, 2016). For example, it is suggested that threat-related motivational value can be assigned to any type of social-emotional stimuli, leading to the development of several cognitive and behavioral processes that serve the detection and elimination of social-evaluative threat (Wong and Rapee, 2016). Although the present task tests task-relevant, endogenous attentional processes, our results are in line with studies on exogenous attention that suggest that social anxiety-related biases can extend to all emotional faces when presentation characteristics allow elaborate processing (e.g., Staugaard, 2010). It is a relevant question for future research to determine whether this inflexibility regarding emotional face cues is motivated by fear of negative and positive evaluation (Song et al., 2022), a negative interpretation bias (e.g., Chen et al., 2020; Heuer et al., 2010), or by fear of potential signs of a social interaction, which may be viewed as a threatening situation by socially anxious individuals (see, e.g., Heuer et al., 2007). Furthermore, in the present study, we tested the scope of the social anxiety-related deficit in endogenous cueing by pairing two threat-relevant (i.e., anger and fear) and two non-threat-relevant (i.e., joy and sadness) expression cues in two task blocks, respectively. However, in the case of a general deficit in using social-emotional cues, reduced cueing would be expected when further threat- and non-threat-relevant expressions (e.g., disgust, surprise) are presented as cues and when threat-relevant and non-threat-relevant expressions are paired as cues in one cueing task. The generalization of the effect associated with social anxiety to such designs is a task for further research.

In sum, in line with previous findings (Folyi et al., 2023), the present study points to an imbalance in high social anxiety between the use of emotional information to achieve context-specific goals on the one hand and processes inherently related to the emotional meaning of the cues on the other. Excessive activation of the latter class of processes in individuals with high social anxiety is suggested by growing empirical evidence (e.g., Bantin et al., 2016; Staugaard, 2010), including preferential attention allocation, difficulty in disengaging from the threat, and attentional and behavioral avoidance of the threatening stimuli (e.g., Heimberg et al., 2014; Wong and Rapee, 2016). Identifying the specific atypical responses to facial emotions involved in social anxiety is beyond the scope of the present study, and as they may involve multiple processes (e.g., Peschard and Philippot, 2016) and may vary between socially anxious individuals (see Wong and Rapee, 2016). Importantly, however, the emergence of such processes, that is, processes motivated by the a priori motivational value assigned to facial expressions, can lead to reduced flexibility when situational goals require the execution of

novel processes based on the emotional information.

Furthermore, although the excessive processes linked to social-emotional stimuli in social anxiety may appear 'stimulus-driven', they may also be motivated by chronically activated goals, such as the goal of self-protection (e.g., Peschard and Philippot, 2016; see also Moors, 2022; Moors et al., 2017; Moors and Fischer, 2019). In this sense, an imbalance between threat-saliency based and task-relevant processes, as suggested by the present study, does not necessarily need to be interpreted as a conflict between 'stimulus-driven' and goal-directed processes, but rather as an imbalance in resolving conflicting goal-relevant priorities relating to the emotional information (e.g., monitoring of potential threats versus pursuing the current task goals). Such an interpretation fits well with a novel theoretical framework (Moors, 2022; Moors et al., 2017; Moors and Fischer, 2019), which argues that emotional actions can be explained by default by goal-directed processes that can provide optimality (i.e., high degree of goal fulfillment due to their flexibility) and even automaticity (i.e., relative independence from poor operating conditions, such as limited perceptual awareness, time, or attention) to achieve highly valued outcomes, rather than by inflexible stimulus-driven processes. As this framework suggests, suboptimal behavior (e.g., in clinical samples) can also be understood as a consequence of goal-directed processes. Therefore, the characterization and therapeutic modification of suboptimal behavior should focus on identifying and modification of often hidden goals (see, e.g. Moors et al., 2017). Furthermore, based on the present study and former findings (Folyi et al., 2023), we would add that focusing on the flexibility to resolve conflicts between goal-relevant processes in favor of situational demands might be another important aspect of changing suboptimal behavior in clinical practice.

Notably, there was no difference between the social anxiety groups in accuracy and response latency of emotion discrimination (see Supplementary Material 1). Thus, impaired discrimination of facial emotions could not explain the results. Although this was not addressed directly in the present study, a reduced speed of facial emotion processing may also be considered to contribute to reduced cueing in severe social anxiety. However, given the presentation characteristics (i.e., 100 ms long presentation of emotional faces) and the results (i.e., comparable and fast RTs in both groups, comparable and high accuracy) of the present emotion-discrimination task, we consider a substantial contribution of such a difference unlikely. In future studies, a direct measurement of the speed of emotional face processing would be beneficial to rule out this possibility conclusively.

Our follow-up analyses revealed that significant group differences were limited to the first cueing task of the two-task procedure, thus, to the part of the study that is directly comparable to the one-task procedure of our former studies. At first sight, it seems as socially anxious individuals are able to overcome this bias with extensive practice. Practice in the task could be considered as a learning experience in which individuals make the experience that the presentation of emotional faces has no negative consequences, similar to the clinical techniques of exposure and systematic desensitization, and furthermore that their emotional information is relevant to goal achievement. Importantly, besides extensive practice, the procedure of the present study required participants to learn and use two emotions-to-target locations contingencies. Hence, carry over effects regarding the learned contingencies might have influenced the performance as well. In sum, while the present study cannot determine which reason abrogated the difference regarding social anxiety in the second cueing phase, the finding is potentially important as it indicates that a performance deficit in the flexible use of emotional information can be abolished. Future studies might investigate the mechanism of this improvement and whether it might generalize to other, more ecologically valid contexts.

4.1. Limitations

The present study has potential limitations and it raises several questions for further research. We expected socially anxious individuals to show a reduced cueing effect because the endogenous cueing task requires flexible switching from processes triggered by the intrinsic emotional meaning of the cues to processes that serve to achieve contextual goals (i.e., directing spatial attention to the signaled target location). However, identifying the exact process(es) that hinder this flexibility in socially anxious individuals remains an important question for future research. Furthermore, the final sample size of the cueing experiment was smaller than originally expected based on the estimated nonparticipation in the second part of the study; however, power to detect the expected effect size was still $1 - \beta = 0.83$. Future studies might clear how the results generalize to larger population and to clinical samples.

4.2. Conclusion

In conclusion, the present results suggest that individual differences in endogenous cueing with emotional face cues are not limited to threat-relevant emotions. Because heightened fear of social evaluation and chronically activated goals may bias attentional control towards enhanced monitoring of any signs of social threat (e.g., Peschard and Philippot, 2016), all social-emotional stimuli could be potentially threat-relevant for socially anxious individuals, limiting the flexible, goal-directed use of this information.

CRediT authorship contribution statement

Timea Folyi: Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Project administration, Resources, Software, Supervision, Validation, Visualization, Writing – original draft. **Laura Lindenhahn:** Conceptualization, Formal analysis, Methodology, Resources, Writing – review & editing. **Michaela Rohr:** Conceptualization, Methodology, Writing – review & editing. **Dirk Wentura:** Conceptualization, Formal analysis, Funding acquisition, Methodology, Writing – review & editing.

Declaration of competing interest

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests:

Timea Folyi reports financial support was provided by German Research Foundation.

Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.jadr.2024.100739.

Appendix

Table A1
Demographic information for the low (LSA) and high (HSA) social anxiety groups (in% of the respective social anxiety group).

	LSA (N = 33)	HSA (N = 33)
Handedness		
Right-handed	87.9	90.9
Left-handed	9.1	9.1
Ambidextrous	3.0	–
Highest completed education level		
High school diploma or equivalent	15.2	18.2
Technical/community college	21.2	24.2
Undergraduate degree (BA/BSc/other)	42.4	33.3
Graduate degree (MA/MSc/other)	18.2	21.2
Other	3.0	3.0
Current employment status		
Full-time employment	66.7	36.4
Part-time employment	9.1	9.1
Unemployed	18.2	27.3
Full-time student	6.1	24.2
Other	–	3.0
Country of residence		
United Kingdom	63.6	63.6
United States	12.1	–
Canada	12.1	9.1
Other	12.1	27.3

Fig. A1. Fear and anger expressions served as threat-relevant attentional cues, joy and sadness expressions served as non-threat-relevant attentional cues. In order to reduce their perceptual salience, joyful expressions were morphed with the neutral expression of the same individual (the illustration features image 37 from the RAFD database; Langner et al., 2010).

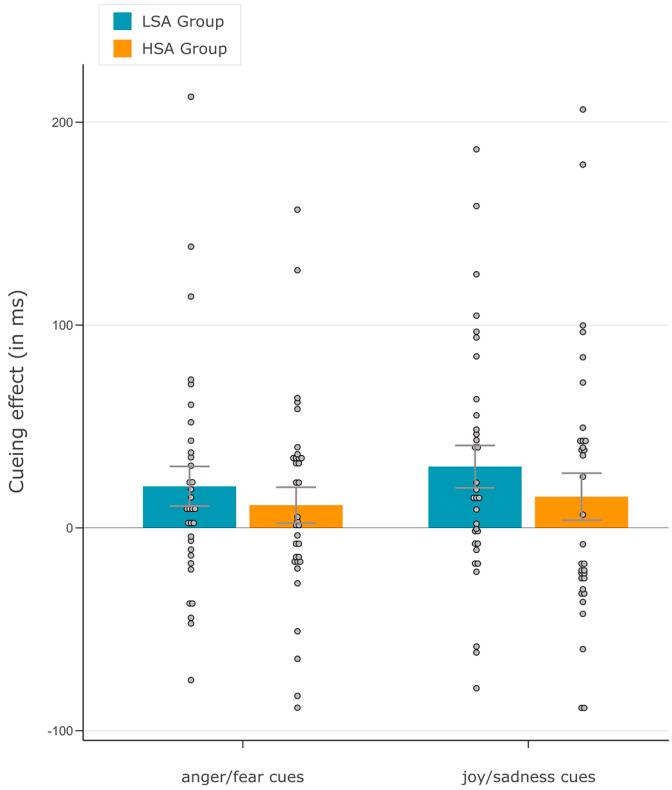

Fig. A2. Mean 600 ms SOA-cueing effects (in ms) as a function of the threat-relevance of the cue emotions (threat-relevant: anger and fear; non-threat-relevant: joy and sadness) in the low (LSA, $N = 33$) and high (HSA, $N = 33$) social anxiety groups. Error bars depict standard error of the mean. The gray dots represent individual cueing scores.

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