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Treatment Options for Fear of Blushing

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Abstract

Purpose of Review To review mechanisms of blushing and fear of blushing from physiological, neuropharmacological and psychological viewpoints, and to evaluate current forms of treatment for blushing-related fear.

Recent Findings Blushing appears to be driven primarily by sympathetic adrenomedullary and neural vasodilator discharge, possibly in association with secondary neurovascular inflammation. Psychological risk factors for fear of blushing include social anxiety, coupled with heightened self-focused attention and inflated beliefs about the likelihood and social costs of blushing. In addition, schemas of emotional inhibition, social isolation and alienation may underlie blushing-related fears. Established psychological treatments for fear of blushing include task concentration training, exposure, cognitive therapy, social skills training, psychoeducation and applied relaxation. More novel approaches include mindfulness and mindful self-compassion, video feedback and imagery rescripting. There are no established pharmacological treatments specifically for fear of blushing. However, selective serotonin reuptake inhibitors and serotonin-norepinephrine reuptake inhibitors are effective treatments for social anxiety disorder and may thus help some patients manage their fear of blushing.

Summary A reactive sympathetic nervous system may interact with psychological predispositions to intensify fear of blushing. These physiological and psychological risk factors could be promising targets for treatment.

Keywords Erythrophobia · Blushing · Sympathetic nervous system · Social anxiety disorder · Psychotherapy

Introduction

Blushing develops in situations where the blusher perceives themselves to be the focus of attention, usually in association with negative emotions such as embarrassment, guilt or shame or positive emotions such as pleasure or pride [1, 2]. During these emotions, an increase in the volume of blood flowing through superficial vessels in the face, neck and upper chest, driven by heightened sympathetic nervous system activity, reddens the skin and increases skin temperature. Along with

other internal and external cues, sensations of heat rising to the face forewarn the blusher about the presence of blushing. Particularly in socially anxious people, these cues signal danger and initiate a desire to escape. Ultimately, fear of blushing may dominate conscious awareness in socially threatening situations and trigger full-blown phobia and/or social anxiety disorder (SAD).

In fact, fear of blushing (erythrophobia) is recognised as an integral part of SAD. In the Diagnostic and Statistical Manual of Mental Disorders (DSM-5), fear of blushing is included as a diagnostic feature of SAD, criterion B: “The individual fears that he or she will act or appear in a way *or show anxiety symptoms, such as blushing*, trembling, sweating, stumbling over one’s words, or staring, that will be negatively evaluated by others” [italics added] ([3], p. 203). This appears to be particularly prevalent in collectivistic societies such as Korea and Japan [4].

Why are people afraid of blushing? From an evolutionary perspective, blushing may be adaptive in terms of deflecting aggression, avoiding social ostracism and remediating threatened relationships [5, 6]. Nevertheless, fear of blushing seems to be easily acquired—simply informing people that they just blushed is enough to heighten social discomfort during

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subsequent embarrassment, and to increase ratings of blushing intensity [7]. Individuals with this fear worry that they are viewed as unlikeable and incompetent, and assume enormous social costs to their blushing [8]. They also have heightened expectations that they will blush in social situations which, as a self-fulfilling prophecy, can enhance the blushing response by increasing emotional distress and associated sympathetic nervous system activity.

Robust increases in facial blood flow and temperature trigger interoceptive cues, which raise concerns that blushing will be noticed by others. Hence, from a physiological perspective, risk factors for fear of blushing might include a reactive sympathetic nervous system and labile facial blood vessels. Indeed, there is some evidence that this is the case—heart rate and other haemodynamic indices were found to be greater during the Stroop Colour-Word Test in people with a fear of blushing than in people without this fear [9], and blushing dissipated more slowly after social interactions in patients than controls [10]. Similarly, patients with SAD and fear of blushing had higher heart rates while watching an embarrassing video [11] and blushed more strongly while completing a social task than those with SAD alone [12]. Hence, patients with SAD and a fear of blushing may form a distinct subgroup not only in terms of symptoms [13, 14] but also physiological arousal.

A reactive sympathetic nervous system could interact with psychological predispositions to intensify fear of blushing. In particular, social interaction anxiety and schemas centering around emotional inhibition, social isolation and alienation appear to augment this fear [15••]. These physiological and psychological risk factors may be promising targets for treatment. Below, we review blushing from physiological, neuropharmacological and psychological viewpoints, and evaluate current forms of treatment for blushing-related fear.

Physiological Aspects of Blushing (Fig. 1)

Sympathetic Nervous System Involvement During heat stress, facial vessels close to the skin surface dilate to enhance transfer of heat from the bloodstream to the nearby environment (via convection, radiation and evaporation of sweat), thereby preventing dangerous increases in core body temperature. Large volumes of blood are channeled through the skin, which thus assumes a pink or reddish tinge. This important adaptive response involves an active dilatation of blood vessels over- and-above passive release of sympathetic vasoconstrictor tone (i.e. flushing involves an increase rather than a decrease in sympathetic nervous system activity) [16].

Notably, injury to the cervical sympathetic pathway not only hinders facial flushing to heat stress but also impedes blushing [17]. Hence, deliberate bilateral surgical section of this pathway reduces blushing on both sides of the face [18].

Neurotransmitters and Neuromodulators The neuropharmacology of active sympathetic vasodilatation remains unclear. The response involves postganglionic cholinergic nerve fibres, together with a complex array of neuromodulators and neurotransmitters that include not only acetylcholine but also nitric oxide, vasoactive intestinal polypeptide, pituitary adenylate cyclase-activating peptide, histamine and prostaglandins; furthermore, vasoactive neurotransmitters released from sensory nerves, such as substance P and calcitonin gene-related peptide, may play a role [19].

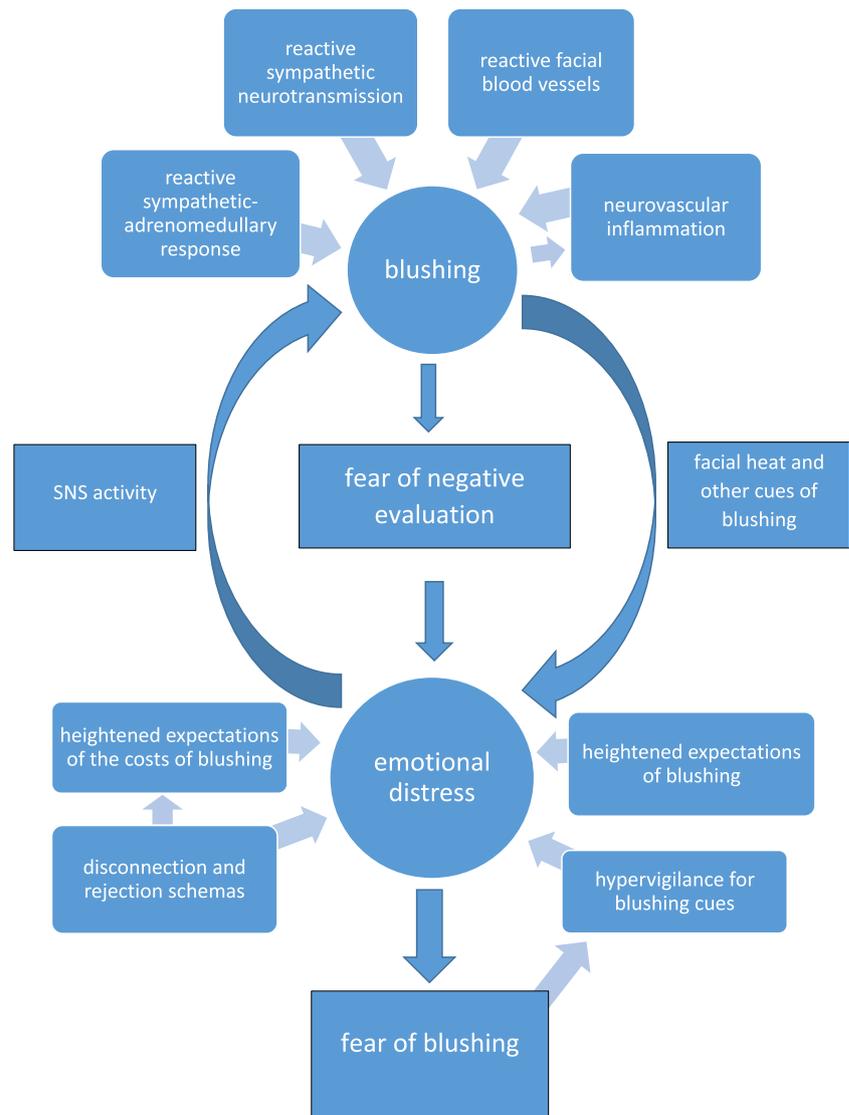
Preliminary evidence suggests that at least some of these agents also play a part in blushing. For example, facial flushing to niacin (vitamin B₃) is accentuated in socially anxious people [20–22]. Niacin induces the formation of prostanoids which, in turn, relax vascular smooth muscle and generate facial flushing. In a small pilot study, topical application of ibuprofen, which blocks prostaglandins formation, inhibited blushing during embarrassment and flushing during exercise at the site of application in the cheek [23]. Hence, rapid surges in blood flow through facial vessels may trigger inflammatory responses that amplify and maintain blushing.

The role of histamine in blushing was investigated recently in a small-scale study that involved oral administration of loratadine, a selective inverse agonist of histamine-1 receptors [24]. As histamine-1 receptors contribute to increases in skin blood flow during whole body heating [25], it was expected that reducing activity at these receptors would inhibit blushing. Unexpectedly, however, increases in facial blood flow during embarrassment were greater after the administration of loratadine than placebo. Thus, vasoconstrictor effects of histamine [26] may outweigh opposing vasodilator effects during blushing.

Hormonal Changes The physical stress of exercise triggers chromaffin cells in the adrenal medulla (similar in structure to postganglionic sympathetic neurons) to secrete large volumes of the neurohormone adrenaline into the bloodstream. In addition to triggering increases in cardiac output, adrenaline acts via β -adrenergic receptors to dilate large arteries in exercising muscles, thereby supplying the muscles with abundant oxygen and nutrients and hastening the removal of metabolic waste products. In addition, the β -adrenergic effects of adrenaline dilate cutaneous blood vessels in the face [27, 28] and elsewhere in the body [29, 30] presumably to optimise heat transfer to the environment.

Like exercise, psychological stress triggers the release of adrenaline into the bloodstream as part of the fight-or-flight response, potentially influencing facial blood flow during embarrassment and other emotional triggers of blushing. In support of this, introduction of the β -blocker propranolol into the facial skin by iontophoresis reduced blushing at the site of administration during embarrassment [31].

Fig. 1 Factors that may influence fear of blushing. Starting from the bottom of the diagram, people with a fear of blushing are hypervigilant for blushing cues and become distressed when they perceive (rightly or wrongly) that they are blushing. In turn, this emotional distress may trigger or strengthen the intensity of blushing by increasing sympathetic nervous system (SNS) activity. Individual differences in the intensity of blushing may be driven by physiological factors, such as the reactivity of facial blood vessels and their sympathetic supply, by how readily neurovascular inflammation develops in these vessels during episodes of blushing and by psychological factors, such as heightened concern about others' negative evaluation. In addition, individual differences in expectations about the costs of blushing and the likelihood of its occurrence, and the schemas that underlie these expectations, influence the degree of distress people experience when they perceive that they are blushing and, ultimately, how frightened they are of blushing



Psychological Aspects of Blushing (Fig. 1)

Blushing usually appears in social situations in which people's social status is threatened [1]. For example, violations of social norms and rules, mishaps, public performances, public critique or praise may all evoke blushing. People often report being embarrassed, shy, ashamed or proud when they blush [32]. The common feature of these emotions is acute self-consciousness—a feeling of being exposed, the centre of attention and scrutinised by other people [1]. Blushing, then, reflects ambivalent arousal—there is an urge to flee from the uncomfortable social situation but, at the same time, the person who blushes experiences social interest and fears the consequences of fleeing [33].

Although virtually everyone has blushed at one time or another, some people blush more readily than others. In particular, socially anxious people who fear their own or others' negative evaluation may be particularly prone to blushing

[33–35]. The somatic cues of social anxiety—sweating, trembling and blushing—can become a major source of fear as these symptoms often are visible to others and are experienced as embarrassing. In the extreme, blushing may be so humiliating that it evokes avoidance of all social situations that might evoke blushing.

Socially anxious people often have a negative, dysfunctional and distorted cognitive predisposition or a *negative perceptual bias* whereby they rate their performance in social interactions as inferior to the objective ratings of independent observers [36]. They not only judge their performance more negatively but also have increased levels of self-focus [37], overestimate the probability of their blushing [38, 39], the visibility of symptoms to others [40] and the social costs of these symptoms [38, 39]. Such people assess their social performance by relying on these biased appraisals; thus, negative perceptual bias is thought to be important for maintaining social anxiety and fear of blushing.

In a recent study, fear of blushing was strongly associated not only with social interaction anxiety but also with maladaptive schemas in the domain of disconnection and rejection [15••]. Specifically, the combined effects of emotional inhibition, social isolation and alienation accounted for the relationship between social anxiety and fear of blushing, suggesting that these maladaptive schemas underlie fear of blushing.

Treatment Options for Fear of Blushing: Physiological Approaches (Table 1)

Interrupting the Sympathetic Pathway to the Face In a meta-analytic review of nine case series reporting on the outcome of thoracic sympathectomy as a treatment for facial blushing, evidence was presented to support the effectiveness of this approach in terms of reduction in blushing and patient satisfaction [18]. Most patients included in these case series reported relief from facial blushing and were satisfied with the outcome. However, the procedure is not always successful and may require removal of sympathetic ganglia to abolish blushing [41].

One downside of this surgical approach is that it targets a symptom (blushing) rather than the root cause of the problem (fear). Hence, it seems likely that factors that promoted this fear (e.g. social anxiety) would persist after thoracic sympathectomy despite relief from blushing. A second shortcoming is the development of troubling side-effects after surgery (e.g. compensatory sweating and aberrant gustatory sweating and flushing). Compensatory sweating refers to excessive sweating below the level of the sympathectomy, primarily on the back, chest and abdomen, which may arise to meet the body's evaporative heat balance requirements [42]. In addition, after injury to the sympathetic chain, gustatory sweating and

flushing sometimes develop due to aberrant reinnervation of denervated sudomotor and vasodilator neurons by preganglionic neurons that normally regulate salivation. Both compensatory and aberrant gustatory sweating can reduce patient satisfaction with thoracic sympathectomy [18]. Additional concerns with thoracic sympathectomy include operative risks and the irreversibility of the procedure and associated side effects. Also, 8% of patients do not benefit from this intervention in terms of their blushing, another 15% obtain only partial relief and blushing recurs in 7% [18]. Recently, ganglionectomy together with laser speckle flowmetry to identify the sympathetic nerves and ganglia that regulate facial blood flow has been suggested as a successful redo surgery for patients who do not benefit from thoracic sympathectomy; however, the results are preliminary as they involved only eight patients [41]. Considering the invasiveness of the surgical treatment and its possible complications, there is a need for careful selection of appropriate cases. As many people with fear of blushing overestimate their actual blushing [33•], they should be screened for physiological signs of facial blushing.

Drug Treatments Unfortunately, no high-quality studies are available that evaluate the effectiveness of pharmacotherapy specifically for blushing. Antidepressants, primarily selective serotonin reuptake inhibitors and serotonin-norepinephrine reuptake inhibitors, are effective therapies for SAD [43••]. In data pooled across two multi-centre, randomised, placebo-controlled trials in patients with social anxiety disorder, the selective serotonin reuptake inhibitor sertraline inhibited blushing more effectively than placebo [44]. Whether this was due to a direct effect on the facial vasculature or to indirect anxiolytic effects is unclear. In an uncontrolled open-label study of patients who had sought treatment for fear of blushing, ratings of blushing and symptoms of SAD decreased

Table 1 Mechanisms and treatment of blushing and fear of blushing

Blushing	
Physiological mechanisms	Treatment
Active sympathetic vasodilatation	Sympathectomy
β -Adrenoceptor activation	β -Blockade
Neurovascular inflammation	Non-steroidal anti-inflammatory drugs
Fight-and-flight responses	Selective serotonin reuptake inhibitors and serotonin-norepinephrine reuptake inhibitors
Fear of blushing	Treatment
Psychological mechanisms	Task concentration training
Hypervigilance for blushing cues	Exposure therapy (e.g. systematic imaginal or in vivo desensitisation)
Use of safety behaviours in anxiety-provoking situations	Cognitive therapy and video feedback
Dysfunctional beliefs about the frequency, visibility and consequences of blushing	Applied relaxation and mindfulness training
Heightened arousal	Schema therapy and imagery rescripting
Early maladaptive schemas (emotional inhibition, social isolation and alienation)	

after treatment with sertraline [45]. The reduction in the proportion of patients reporting severe or extreme blushing after sertraline treatment (from 87% at baseline to 32% at follow-up) was smaller than in another group of patients who elected to be treated surgically with endoscopic thoracic sympathectomy (97% at baseline compared with 16% at follow-up). In another small open-label study, the selective serotonin reuptake inhibitor escitalopram was administered to 39 patients with social anxiety disorder and fear of blushing [46]. Effect sizes for decreases in fear of blushing, social anxiety and depression ranged between 0.53 and 0.86, suggesting that escitalopram may be useful for treating fear of blushing in patients with social anxiety disorder.

Beta-blockers are often administered to treat symptoms of performance anxiety, such as tremor and tachycardia [47] and, anecdotally, blushing [2, 18]. However, the efficacy of beta-blockers for managing fear of blushing requires further investigation as beta-blockers are no more effective than placebo for treating SAD [43••].

Treatment Options for Fear of Blushing: Psychological Approaches (Table 1)

Below we review established psychological treatment approaches for fear of blushing (task concentration training, exposure, cognitive therapy, social skills training and applied relaxation) [48], followed by more novel approaches (mindfulness and mindful self-compassion, video feedback and imagery rescripting). Psychoeducation and self-help approaches are also discussed.

Task Concentration Training Patients with SAD tend to focus their attention inward in social situations. Salient physiological arousal, such as blushing, increases this self-focused attention which, in turn, increases awareness of physiological reactions. This may not only increase the actual or perceived intensity of these reactions but also distract attention away from the task at hand and compromise social performance. Hence, the aim of task concentration training is to redirect attention away from bodily symptoms and toward the social task. To assess this treatment, patients with SAD and a primary fear of blushing were randomly assigned to 6 weekly sessions of task concentration training or in vivo exposure [49]. At post-treatment, greater reduction in fear of blushing was reported by patients who received task concentration training; however, this effect had disappeared at 6-week follow-up. In a subsequent study, patients with a primary diagnosis of SAD and a principal fear of blushing, trembling, sweating or freezing/immobility were randomly assigned to 8 weekly sessions of task concentration training or applied relaxation, both followed by cognitive therapy [50]. Although patients assigned to task concentration training reported greater

reductions in fear of bodily sensations and dysfunctional beliefs immediately after treatment, both treatments were highly effective in reducing fear of blushing. Differential treatment effects disappeared after both groups received 8 weekly sessions of cognitive therapy, but task concentration training-cognitive therapy was superior to applied relaxation-cognitive therapy in reducing fear of bodily sensations at 1-year follow-up. Chaker, Hofmann and Hoyer [51] used an intensive weekend intervention designed for people with fear of blushing that consisted of a combination of task concentration training and behavioural therapy. The intervention was successful in reducing fear of blushing and the effects remained stable at 6-month follow-up. More recently, the efficacy of task concentration training vs. cognitive therapy in intensified group therapy format over two weekends was investigated in 82 patients with SAD and fear of blushing [52•]. Substantial reductions in fear of blushing at post-treatment persisted at 6- and 12-month follow-up, and most participants no longer met criteria for SAD.

Exposure During exposure therapy, patients are gradually exposed to the situations in which they are frightened of blushing without applying their usual safety behaviours (e.g. using facial make-up). To our knowledge, exposure therapy alone for fear of blushing has been examined in only two controlled studies. Scholing and Emmelkamp [53] compared three treatment packages, each consisting of two treatment blocks, separated by 4 weeks without treatment sessions, for patients with SAD and fear of blushing, sweating or trembling as their primary complaint: (1) exposure followed by cognitive therapy; (2) cognitive therapy followed by exposure; and (3) cognitive-behavioural treatment. The treatment packages were equally effective, and gains were maintained at 18-month follow-up [54]. Mulkens et al. [49] used exposure as a stand-alone treatment for patients with SAD and fear of blushing as their primary complaint. Exposure was less effective than task concentration training in the short-term, but differences disappeared later on.

Cognitive Therapy and Social Skills Training By identifying, analysing and challenging the dysfunctional beliefs about the frequency, visibility and consequences of blushing, cognitive therapy aims to change the cognitions that contribute to fear of blushing. Performing behavioural experiments to test these cognitions and identifying assumptions regarding fear of blushing are usually also part of this approach. In one study that examined cognitive therapy as a stand-alone treatment for fear of blushing, patients with SAD and a primary fear of blushing, trembling or sweating were randomised to 12 weekly group sessions of cognitive therapy versus social skills training [55]. Social skills training involved talking with others about their symptoms, giving acceptable explanations for the symptoms and expressing feelings of insecurity,

employing adequate social skills while blushing, trembling or sweating and coping with the responses of other people to these bodily symptoms. Both treatments were equally effective up to 1-year follow-up. Recently, a randomised controlled trial confirmed the efficacy of cognitive therapy in intensified group therapy format [52•]. The treatment was effective for the reduction in fear of blushing post-treatment and at 6- and 12-month follow-up.

Cognitive Behaviour Therapy Most past studies have used cognitive or behavioural (exposure) therapy separately to treat fear of blushing, but these approaches have been combined in a few cases. For example, one study that employed a group intervention based on cognitive behaviour therapy and task concentration training in 55 people with SAD and fear of blushing over 11 weekly sessions was successful in reducing fear of blushing, and this reduction remained at 3-month follow up [56].

Applied Relaxation Bodily symptoms such as blushing may result from autonomic arousal associated with high bodily tension. Reducing bodily tension and inducing relaxation rapidly in feared situations is the aim of applied relaxation. To date, the efficacy of applied relaxation in SAD patients with fear of blushing has been examined in only one study [50]. Applied relaxation was highly effective in reducing symptoms of SAD and fear of blushing but, at 1-year follow-up, the combined applied relaxation-cognitive therapy treatment was somewhat less effective than combined task concentration training-cognitive therapy for reducing fear of bodily sensations.

Mindfulness is a promising approach for treating SAD [57] but has not yet been studied specifically for people with fear of blushing. Mindfulness interventions teach participants to focus their attention in a specific way: on the moment and without judgement. This focus of attention on the here-and-now (rather than, for example, on the fear that one may blush in the future or has blushed in the past) and of acceptance rather than judgement may be particularly effective for patients with fear of blushing. In a pilot study of 10 patients with SAD, mindfulness combined with task concentration training effectively reduced dysfunctional beliefs about blushing, trembling and sweating [58]. Another related approach concerns self-compassion interventions. Research on the effects of self-compassion treatments for SAD is beginning to emerge (e.g. [59]), but there are no studies yet on the effects of mindful self-compassion for fear of blushing. As people tend to isolate themselves when they feel ashamed (e.g. because of their blushing), and self-compassion likely is the antidote to shame and isolation [60], mindful self-compassion could be particularly effective for patients with fear of blushing.

Video Feedback The incorporation of video feedback into cognitive behaviour therapy helps socially anxious people to

view a realistic, objective performance of themselves to target distorted self-imagery and highlight the discrepancy between perceptions of their performance before versus after feedback. By providing an observer perspective, video feedback reduces negative appraisals of stress induced by social tasks in socially anxious people [61•]. For example, Rapee and Hayman [62] reported that participants who underestimated their performance of an embarrassing social task rated their performance as consistent with the ratings of independent observers after video feedback. Similarly, individuals with a fear of blushing overestimate the visibility of their symptoms [40]. McManus et al. [63] reported that individuals with social anxiety and accompanying blushing were able to view their symptoms more objectively after video feedback, resulting in reduced affect (see also [61•]).

Imagery rescripting is an experiential method often utilised in Schema-informed therapy and as a stand-alone therapy for phobias, including social anxiety disorder [64]. This technique involves, in part, modifying negative images, impressions or memories into a more acceptable form by enabling the patient to rescript specific traumatic memories underlying maladaptive schemas. In this technique, the individual is asked to imagine a relevant disturbing event, from the beginning, but to manipulate the memory to produce a positive outcome and to address any unmet needs of the traumatised younger self. Thus, the process of imagery rescripting provides the patient with an opportunity to alter the memory of what was experienced and reprocess the meaning associated with it. In a series of case studies of patients with SAD, the most salient targets for the imagery rescripting phase of treatment were blushing [65]. Although not yet examined as a standalone treatment for fear of blushing, imagery rescripting could prove to be useful for addressing the negative schemas that underlie this fear [15••].

Psychoeducation and Self-help Methods Although cognitive-behavioural treatments seem to be effective for treating fear of blushing, people who suffer from this fear may hesitate to seek psychotherapy because of concerns about social exposure and other people's evaluation [40]. As an alternative to psychotherapy, forms of intervention that are easily available, such as psychoeducation, or interventions that do not require social exposure, such as self-help methods, may be worth considering. Psychoeducation to treat fear of blushing has been evaluated in only one empirical study. This intervention was based on cognitive behaviour therapy principles and involved 47 participants with fear of blushing who attended six weekly sessions and one booster session [40]. The intervention focused on explaining factors involved in fear of blushing, such as anticipating the costs of blushing, self-focused attention and social skills, and was effective in reducing fear of blushing. Thus, psychoeducation may be a promising avenue for treatment.

Another possible form of intervention relies on self-help. For example, the online self-help course: “Self-help for social anxiety” [66] has a specific module targeting fear of blushing. Electronic self-help books are also available for conquering fear of blushing (e.g. [67, 68–70]). Although these self-help books promise to help people manage fear of blushing, to our knowledge, there is currently no empirical evidence of their effectiveness.

Conclusions

Encouraging leads have emerged recently concerning the basic neuroscience [71] and physiological mechanisms of blushing [23, 24]. However, this has not been matched by advances in treatment—only one randomised controlled trial of psychotherapy for fear of blushing has been published the past few years [52•], and we are not aware of any new pharmaceutical trials. Nevertheless, if the net is cast more widely, there is some reason for hope. The close association (and often comorbidity) between fear of blushing and SAD implies that treatments with proven efficacy for SAD might also be useful for treating fear of blushing. As noted above, video feedback, an integral component of cognitive therapy for SAD [61, 63], holds particular promise, and a similar case could be made for mindfulness, mindful self-compassion and imagery rescripting. These techniques build on a solid base of empirically supported cognitive-behavioural treatments for managing fear of blushing, including task-concentration training, applied relaxation, social skills training, psychoeducation and cognitive therapy.

People with fear of blushing often hesitate to seek psychological treatment [40], suggesting the need for an intervention that is easily accessed, makes minimal demands and is available outside the psychotherapists’ offices and clinics. Internet-based CBT appears to be effective for reducing SAD [72] and may thus hold potential for treating fear of blushing. Indeed, one randomised controlled trial showed that internet-based self-help programmes, even when unguided by therapists, may reduce symptoms of social anxiety [73]. However, it should be kept in mind that internet-based CBT can produce temporary negative effects such as new symptoms and negative well-being for 10–20% of participants with SAD [74]. Furthermore, individuals with a fear of blushing might not benefit from internet-based CBT as they may not experience blushing in the absence of the interpersonal exposure they would experience in either a group or individual therapeutic environment.

In the absence of specific pharmacological treatments for blushing, some patients resort to surgery, thereby putting themselves at risk of operative complications and irreversible side effects. More work needs to be done to clarify the psychopharmacology of blushing. Nevertheless, it seems likely

that blushing is driven, in part, by activation of beta-adrenoceptors in superficial vessels in the face [31]. Hence, it is interesting that infantile haemangiomas (strawberry birthmarks) respond to topical application of beta-blockers and that there are few, if any, side effects after weeks or months of this treatment [75, 76]. Anecdotal reports suggest that orally administered beta-blockers inhibit blushing [2] but randomised controlled trials of oral or topically applied beta-blockers for treatment of blushing are yet to be carried out. Another promising lead is the probable involvement of inflammatory mediators in blushing [20, 21]. Local application of the NSAID ibuprofen to a small area of the face inhibited blushing [23], but the efficacy and feasibility of this as a treatment for blushing require further investigation. More generally, selective serotonin reuptake inhibitors and serotonin-norepinephrine reuptake inhibitors are effective treatments for SAD [43••] and thus are likely to help at least a subgroup of patients with fear of blushing.

During social interactions, blushing communicates emotional discomfort or distress and, by indicating embarrassment or shame, can minimise social disapproval by signaling submission or appeasement [5, 77]. Consequently, people who blush are generally regarded in a positive light by others [5]. Nevertheless, for people who are frightened of blushing, the negative connotations of blushing, such as loss of social status with the threat of rejection or alienation, greatly outweigh any perceived gains. As this fear can dominate social exchanges, developing more effective treatments for fear of blushing is a priority.

Compliance with Ethical Standards

Conflict of Interest The authors declare that they have no conflicts of interest.

Human and Animal Rights and Informed Consent All reported studies/experiments with human or animal subjects performed by the authors have been previously published and complied with all applicable ethical standards (including the Helsinki declaration and its amendments, institutional/national research committee standards and international/national/institutional guidelines).

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- Of importance
- Of major importance

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