1 The study of the blush: Darwin and after

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The blush as a puzzle

The blush is ubiquitous yet scarcely understood. In the past it has attracted little scientific attention and it is only in recent years that it has begun to attract systematic investigation. We believe that the time is right for a volume that brings together the leading international researchers in this field to review and evaluate this emerging research, to discuss issues that have arisen, to stimulate new theorizing and to map future directions for research. The scientific neglect of blushing is surprising given that the facial expression of emotion has attracted so much research for many years and occupies a central place in the study of emotion. It is all the more surprising in the light of the surge of interest in recent years in the self-conscious emotions of shame, embarrassment, pride and guilt, all of which are associated with the circumstances of blushing.

Its neglect would be understandable if the blush was straightforward to understand or was of little psychological or social consequence. However, it presents many puzzles and, as we will show in this volume, has considerable psychological and cultural significance. Why does our reaction to a social predicament or to simply realizing that we are the object of others' attention take this form at this specific site on the body, particularly as it often results in drawing attention to ourselves just when we would least want it? Why should an expression of embarrassment, shame or shyness be highly visible when these emotions are associated with hiding, keeping in the background and covering oneself up? How does a blush differ from the facial reddening that is brought about by body temperature regulation mechanisms, that accompanies other emotions such as anger and indignation, that is a symptom of the skin condition rosacea or that is experienced by many women during the menopause? How does the blush of embarrassment and shyness relate to the pallor of fear? Why is a blush uniquely human? Are there comparable expressions in other species? When a sample of leading biologists was

asked during the bicentenary celebrations of Darwin's birth to identify the largest gaps in his theory, Frans de Waal, one of the world's foremost authorities on primate behaviour, nominated the blush (de Waal, 2009). We have no convincing accounts of the evolutionary origins of the blush, its emergence in childhood, its significance in social life or how it has come to have significance. Textbooks on physiology, including specialist texts on the cardiovascular system, have little to say on its physiology. In the psychology of emotion the place of the blush in embarrassment, shyness, guilt and shame is contested or, more typically, tends to be passed over.

The blush represents a lacuna in our understanding of emotion. Indeed, knowing more about it would yield considerable insight into the nature of emotion and the autonomic neurophysiological processes involved, since, for example, a blush entails cognitive processes such as the appraisal of social contingencies, the involvement of the self in social encounters, and the contribution of the face and the body to social interactions, a contribution which has particular significance in that a blush is involuntary, uncontrollable and therefore cannot be feigned. The blush also draws attention to the moral dimension of emotion since it is associated with shame and guilt, compliance with personal and social moral standards, and our capacity to reflect upon our conduct and understand its implications for ourselves and others. Moreover, it would increase our understanding of the motivational and autonomic processes involved in people's responsiveness to interpersonal distress.

Research into the significance of the blush ought to extend beyond advancing knowledge in the psychology of emotion and interpersonal processes to embrace the problems that blushing causes many individuals. A blush is part of everyday life, a fleeting change in appearance that is typically accompanied by fluster and embarrassment and that can be psychologically uncomfortable for a time. For many of us this is a transient experience that we can readily cope with, even sometimes enjoy or find amusing or attractive. However, for many individuals their blushing is a source of great distress and they regard it as having a major and adverse impact on their life. Some are prepared to undergo irreversible surgery in order to prevent reddening from occurring. Fear of blushing (erythrophobia) has become recognized as a psychological problem and is now included as a symptom of the psychiatric condition of social anxiety disorder.

Darwin on the blush

The *Oxford English Dictionary* defines the blush as a 'reddening of the face as a sign of shyness, embarrassment or shame'. It traces its origin to the Anglo-Saxon word *ablisian*, which is related to the Dutch word

blosen. The *OED* provides examples of usage dating to the sixteenth century. In these sources the blush is regarded as a sign of shame although it is also mentioned in the context of modesty and sexual attraction. The word blush as a noun and verb, and its equivalent in other languages, has remained in common use, but it was only in the nineteenth century that the phenomenon it describes was submitted to systematic analysis. A London physician, Thomas Burgess, published *The Physiology or Mechanism of Blushing* in 1839. He made original observations on the blush, particularly on blushing in people of different 'races', and made a distinction between the 'true blush' as a sign of shame which served as a valuable social signal, and the 'false blush' as a symptom of over-sensitivity (Burgess 1839/2009). In doing so he anticipated much later work on individual differences in blushing propensity. However, scientific investigation began with the seminal chapter in Darwin's *The Expression of the Emotions in Man and Animals*, published in 1872. For many years the chapter provided the definitive account of the phenomenon in the scientific literature, and it remains common for it to be cited in articles on blushing (including the chapters within this volume).

Darwin's approach to the blush exemplifies the systematic collection of evidence that characterized all his scientific endeavours. He dispatched questionnaires to correspondents around the world requesting information on cross-cultural similarities in expressions. He reports on correspondence with Dr Crichton Browne, a doctor in a mental institution, and with colleagues overseas, aiming to establish whether people who are blind and those of low intelligence blush, whether young children do, and whether people of all skin tones do so. Darwin raised questions that we have only recently started to address through the collection of systematic empirical evidence and the development of theoretical accounts.

Darwin proffered an explanation of blushing, its relation to emotional experience, its causes and psychophysiological mechanisms. He regarded the blush as an expression of shame, modesty and shyness. He argued that it is caused by attention directed towards the self: '. . . originally self-attention directed to personal appearance, in relation to the opinion of others, was the exciting cause; the same effect being subsequently produced, through the force of association, by self-attention in relation to moral conduct' (Darwin, 1872/1999, p. 324). It is found only among humans not because only they have a developed moral sense but because they alone have a sufficiently sophisticated capacity for cognitive self-representation. He speculated on the mechanism by means of which self-attention to one's appearance could produce a blush, proposing that

attention paid to a particular area of the body triggers vasodilatation of blood vessels in that area, resulting in increased blood flow (p. 336). Darwin played down adaptive or communicative functions of the blush, arguing, for example, that 'those who believe in design, will find it difficult to account for shyness being the most frequent and efficient of all the causes of blushing, as it makes the blusher to suffer and the beholder uncomfortable, without being the least service to either of them' (p. 335). As Dixon (2003, p. 168) remarked, commenting on the lack of emphasis on the utility of emotional expression and indeed on natural selection or sexual selection in Darwin's account, a more appropriate title for the book might have been '*The Inheritance of Useless Habits in Man and Animals*'. Dixon argued that Darwin's neglect of the utility of expressions and his emphasis on the inheritance of acquired habits rather than on adaptation reflected his opposition to the theological explanation of the blush proposed by Burgess, and his reluctance to yield any ground to this position in his defence of an evolutionary thesis. Has Darwin's theory stood the test of time? This introductory chapter considers the issues that Darwin raised and indicates how these have been addressed in subsequent chapters.

The nature of the blush

Since the publication of Darwin's chapter much progress has been made in understanding mechanisms involved in the regulation of blood circulation. This includes factors involved in vasodilatation and vasoconstriction of the various types of arterial and venous vessels as these have received considerable attention in scientific research: for example, in the context of thermoregulation and physical exertion. We now have a much more comprehensive understanding of both the anatomy of the circulatory system and factors involved in controlling the circulation through vasodilatation and vasoconstriction. Research shows that blushing is the product of a much more complex process than that envisaged by Darwin.

The role of vasodilatation and vasoconstriction of blood vessels – for example, in thermoregulation – has received considerable attention in basic and more applied research: for example, in the physiology of physical activity (Astrand *et al.*, 2003). Vasodilatation of blood vessels has been shown to be controlled by several factors: action of the sympathetic nervous system, catecholamines circulating in the blood stream, and local factors that originate either in the blood vessels themselves – endothelial or myogenic factors – or in metabolic and other activities in tissue surrounding the vessels. The network of blood vessels in the

'blush region' has a distinctive structure that facilitates the movement of a large volume of arterial blood close to the surface of the skin as well as the capacity to create a 'reservoir' in the facial veins ('blood pooling'), which may both result in visible facial reddening. Yet we do not yet understand which specific processes are involved in blushing as opposed to other forms of circulation-induced reddening of people's skin. It is generally assumed that sympathetic nervous system activity is somehow involved: for example, seminal findings reported by Mellander, Andersson, Afzelius and Hellstrand (1982) showed that electrical stimulation of beta-adrenoceptors in a section of human facial vein removed from the cheek region produced rapid vasodilatation; furthermore, this effect was eliminated when a beta blocker drug was administered. Also, surgical techniques that prevent the sympathetic branch from connecting with the facial veins seem effective in reducing people's ability to blush (see Chapter 2). Peter Drummond has undertaken a substantial body of research into the psychophysiology of the blush, combining psychophysiological measurement techniques and experimental methods in order to identify the mechanisms involved in the blush. In Chapter 2 of this volume he provides an overview of this research, demonstrating the complexity of this phenomenon and how much remains to be learned.

Perhaps the major problem facing researchers in the past was that they had no means of recording or measuring the blush for analysis. For example, Darwin used photography to illustrate facial expressions, but it was impossible to capture a blush with the technology that was available to him at the time. Photography – and subsequently moving film, videotape and computer technology – has become profoundly influential in the development of the psychology of emotion, not only in providing empirical evidence for testing hypotheses about the universality of certain facial expressions but also in shaping the classification of basic emotions. The involuntary, transient reddening of the face escaped capture and this may be one reason why it has never occupied a prominent place in theorizing the emotions.

The lack of suitable psychophysiological techniques may also have contributed to the neglect of the blush. In the 1990s Don Shearn and his colleagues (Shearn *et al.*, 1992; Shearn *et al.*, 1999) were the first to tailor the available techniques in the context of blushing. Currently available instruments rely on techniques that measure changes in facial skin temperature such as thermistors and infrared cameras and techniques that measure changes in blood flow such as laser Doppler flowmetry and photoplethysmography. In Chapter 3 of this volume Ruth Cooper and Alexander Gerlach provide a systematic, critical overview of the strengths and limitations of the methods available to researchers.

They also compare these physiological measures with participants' and observers' reports on embarrassment and blushing during the experiments. As is evident in other chapters in this volume these measures have been used to address significant questions about the blush, including its communicative function, and the relation between subjective reports of blushing and physiological measures in both non-clinical and clinical samples.

Theoretical perspectives on the blush

Even if we understood the physiological mechanisms involved in blushing we would still not have provided an explanation of the blush. This question is addressed throughout this volume and is central in chapters that comprise Part II.

Darwin's explanation in terms of the direction of attention has been highly influential in psychological theories of blushing. Mark Leary and Kaitlin Toner (Chapter 4) compare three such theories: undesired social attention, communicative and remedial, and exposure theories. They review the available evidence for each of these theories and discuss their limitations. The theory of undesired social attention clearly follows from Darwin's account and was developed in a seminal paper by Leary, Britt, Cutlip and Templeton (1992), where they argued that undesired attention can be positive, negative and neutral. This theory aims to accommodate findings that a blush can be triggered by public praise or by being wished a happy birthday, and simply by realizing that you are the object of attention: for example, appearing on a public platform without necessarily having to perform. This approach links blushing to the self-conscious emotions, where research emphasizes the ability to take another perspective on the self and see oneself through the eyes of others. The blush entails inter-subjectivity, a capacity that seems absent in other species.

While Darwin seems correct in his often cited observation that the blush is uniquely human, bodily signs of dominance and submission relations are nevertheless common among nonhuman primates as are colour changes that may (just like the blush) also serve as a signalling device. The evolution and functions of animal displays have been extensively studied in ethology. In Chapter 5 Jan van Hooff surveys the role of displays across species, relating the evolution of colour vision to the functions that colour displays serve: for example, the associations among colour, social success, circulating levels of hormones and sex, where redness increases as social status (particularly among males) rises and levels of testosterone increase. He discusses the hypothesis that trichromatic

vision may have evolved in primates for discriminating changes in skin colour that are associated with sexual and emotional states: for example, the red face of rage.

Darwin argued that infants and young children do not blush because they lack self-consciousness in the early years. Research within the 'theory of mind' paradigm suggests that this capacity can be detected in children from the third year. However, there has been scarcely any research into blushing in childhood, and there is insufficient evidence to conclude whether cognitive self-representations are necessary or sufficient for blushing or even at what age the blush emerges in childhood. The paucity of this research is in marked contrast to a large body of theory and empirical research into childhood self-awareness, self-consciousness, shyness and social anxiety. Hedy Stegge (Chapter 6) discusses this research in the domain of developmental psychology in an attempt to provide a foundation for the future study of childhood blushing.

The remaining two chapters in this section build further on the link proposed by Darwin between blushing and particular emotional experiences. More specifically, these chapters take the psychophysiology of embarrassment and social anxiety as their starting point and consider how this might inform us about the mechanism involved in the blush. One strand of psychological theorizing initiated by Buss (1980) and Schlenker and Leary (1982) construes embarrassment as a form of social anxiety with the implication that the blush is a bodily expression of anxiety. Thus, embarrassment is a response to threat, of loss of reputation or of social rejection, and a blush is triggered by stimulus cues for threat. This immediately raises questions about the nature of the psychological and psychophysiological mechanisms involved in reactions to social threats: how does embarrassment differ from fear?

Ryan Darby and Christine Harris (Chapter 7) consider the, possibly unique, 'signature pattern of cardiovascular reactivity' in embarrassment where, for example, instead of the correlation between increased heart rate and blood pressure typically found in fear, there is a decoupling of heart rate and blood pressure. They argue that embarrassment is not linked to one specific area of the brain, but is associated with regions of the brain that seem to be important to theory of mind, self-awareness and the regulation of social behaviour, specifically the medial prefrontal cortex, temporo-parietal region, the basal temporal cortex and the orbitofrontal cortex. Vladimir Miskovic and Louis Schmidt (Chapter 8) review research into social anxiety, including social anxiety disorder – the fear and avoidance of interpersonal interactions, especially those with potential for scrutiny and evaluation. They review research into the neural substrates that may underlie social anxiety, drawing upon

functional neuroimaging and experimental studies. Their account emphasizes the key roles played by the various divisions of the amygdala and the prefrontal cortex in identifying and responding to sources of threat. Both chapters indicate the role of the sympathetic nervous system and raise the question whether separate mechanisms are involved in embarrassment and fear, with different pathways between a threat stimulus and an emotional response. Under what circumstances would, say, the prospect of speaking up in front of others trigger a blush as opposed to the pattern of anxious reactions associated with stage fright?

The blush in social interaction

Darwin's chapter makes no explicit reference to embarrassment, even though the usage of the word was current at that time. In apparent contrast with Darwin's view, it is now widely assumed that the blush is a sign of embarrassment – according to Buss (1980), even the hallmark of embarrassment – and a component of its characteristic display. Rowland Miller (Chapter 9) focuses upon the role of embarrassment in social interactions, presenting a catalogue of the kinds of circumstances that give rise to embarrassment and discussing its consequences for social encounters. He compares a social evaluation model of the causes of embarrassment with a dramaturgic self-presentation model and sets out arguments and supporting evidence for preferring the former model. He argues that the consequences of embarrassment are seldom as bad as people anticipate, in that there are social pressures to overcome the awkwardness that can ensue and help the individual out of his or her predicament. The negative view that people have of embarrassment is shared in many psychological accounts, which tend to regard it as an aversive state. Blushing also tends to be regarded in a negative light. In this chapter Miller argues that embarrassment and blushing do in fact serve valuable social functions and can enhance the pleasantness of interpersonal encounters.

Clearly, Miller's chapter questions Darwin's view that the blush 'makes the blusher only to suffer and the beholder uncomfortable, without being the least service to either of them'. The contribution of Susie Scott (Chapter 10) continues on this theme and provides more detailed insight into the potential impact of the blush on the blusher's beliefs and behaviours. She discusses the blush from a dramaturgic perspective within the theoretical tradition of symbolic interactionism, which she describes as the analysis of 'how social actors collaboratively work to negotiate shared "definitions of the situation" by interpreting the meaning of each other's symbolic gestures'. She draws upon protocols from a set of interviews to analyse the circumstances that evoke a

blush and the blusher's understanding of the consequences of the blush in terms of what it reveals. She distinguishes between the incompetent self that the shy person fears he or she will reveal – 'the discredit*able* stigma, one that could potentially be hidden but which threatens to reveal itself at any moment – and the blush as discredit*ing* stigma, which is already socially visible and cannot be concealed'.

Although Darwin emphasized the importance of undesirable social attention, Ray Crozier (Chapter 11) argues that not all episodes of blushing are responses to undesired attention. On the basis of analysis of circumstances where respondents to a questionnaire recall occasions when they blushed and novelists describe scenes where a character blushes, his contribution sets out 'exposure theory'. This theory aims to explain why blushing may sometimes occur in the complete absence of direct social attention, and where the blush in itself may even be the trigger for getting undesired social attention. It is explored whether perhaps the blush may be triggered by the blusher's sudden awareness of how they might be seen in a particular situation, especially in situations where something may be revealed that the blusher prefers to keep hidden. Consistent with Darwin's view, this account implies that adopting an other-perspective on the self is essential for a blush to occur.

In spite of Darwin's sceptical attitude regarding the functional value of the blush, the question of the blush as communication has attracted a substantial body of research, which is reviewed and evaluated by Peter de Jong and Corine Dijk in Chapter 12. De Jong and his co-researchers have undertaken a series of investigations into the interpretations that people make when they see someone blush. In short, their research has established that actors who have committed some misdemeanour are perceived less negatively and their actions are judged to be less serious if they are portrayed as blushing than if they are portrayed as shamefaced or as showing no reaction. Yet a blush does not always have a positive effect; what a blush conveys depends on its context. De Jong and Dijk provide a thorough analysis of the factors that influence the communicative significance of a blush. Whether or not the blush evolved to function as a signal, this chapter argues that at the very least Darwin was premature in deciding that it does not serve as one.

Blushing problems: processes and interventions

Whether or not blushing is an anxious response it is evident that many people are anxious about their blushing, and epidemiological research shows that fear of blushing is comorbid with social anxiety disorder. Dijk and de Jong (Chapter 13) discuss the psychological processes

involved in sustaining fear of blushing. Many individuals regard their blushing as the source of their anxieties, not just as a symptom of them, and the question arises whether they do blush more frequently or intensely than others do or whether their anxieties owe more to their beliefs about their blushing, including their belief that a blush creates a poor impression on others, who will think badly of them because of their reddening. Dijk and de Jong address this issue in Chapter 13, where they assess evidence on the roles that beliefs about blushing and about its social costs, as well as tendencies towards self-focused attention, play in influencing fear of blushing; they outline a cognitive model that shows how these elements come together to produce fear of blushing.

In light of the profound consequences of blushing phobia, it seems important to design interventions to help people to overcome their fear of blushing. Michelle Capozzoli, Imke Vonk, Susan Bögels and Stefan Hofmann (Chapter 14) provide a review of studies that evaluate the effectiveness of the currently available psychological interventions. There have been few randomized controlled clinical trials of psychological interventions, but the authors show that current cognitive behavioural therapeutic approaches have proved moderately successful. On the basis of this review the authors sketch options for how to improve further the available interventions to overcome fear of blushing.

In the final chapter of Part IV, Peter Drummond and Daphne Su (Chapter 15) discuss the links between blushing and rosacea. Rosacea is a disorder of the facial skin characterized by extremely sensitive skin, burning and stinging sensations, and persistent flushing of the cheeks, nose, chin or forehead accompanied by acne-like facial pustules. The disorder is widespread: the National Rosacea Society estimates that it affects some 16 million Americans (National Rosacea Society, 2011). For many sufferers it reduces the quality of their life, lowering their self-esteem and self-confidence and leading to avoidance of social situations. Drummond and Su assess the prevalence of anxiety and depression in patients with the condition. They consider the relation between blushing and rosacea and whether the former plays a causative role in the latter. Finally, they review the role of psychological interventions in helping sufferers cope with their anxiety, and discuss how this may also provide fresh clues for the treatment of blushing phobia as described in Chapter 14.

Conclusion

The volume aims to review theory and empirical research into blushing from a number of perspectives, to address the issues raised in this introductory chapter, and to suggest future directions in research. In the