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The effect of disgust on pain sensitivity

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HIGHLIGHTS

- Disgust can induce effects similar to the acute phase response.
- Here we examine if it can also induce increased pain sensitivity.
- Immediately after a disgust induction pain was reduced, but later it increased.
- Negative and positive inductions produced the reverse outcome.
- We suggest that disgust may enhance pain sensitivity.

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ABSTRACT

Experiencing the emotion of disgust leads to delayed up-regulation of immune-related functions, increased core-body temperature and reduced appetite. These changes parallel those of the acute phase response, which occurs when a pathogen is detected by the immune system. Here we examined whether a further predicted aspect of the acute phase response is evident following disgust induction, namely increased pain sensitivity. Participants attended a two-session experiment. On one session they experienced an emotion induction (being randomly assigned to either disgust, negative or positive groups) and on the other they received a neutral control induction. Before and after each induction, and at 15 and 30 min post-induction, participants engaged in a cold-pressor task, rating pain intensity at 10 s intervals for 90 s on each occasion. Relative to neutral control and pre-test, average pain intensity decreased then increased across time following the disgust induction, with the reverse pattern in the negative and positive emotion inductions. These findings are the first to suggest that disgust may lead to an increase in pain sensitivity over a time course paralleling changes observed for core-body temperature and immune-related function, although the mechanisms underpinning these effects remain to be identified.

1. Introduction

It has been suggested that the emotion of disgust functions in humans as part of a larger system of defensive behaviours and physiological responses, which assist us in avoiding infectious disease [1]. This functional account of disgust arose primarily because of the close association between stimuli that elicit this emotion (e.g., corpses, faeces, wounds, rotten food) and their capacity to transmit pathogens [2]. This account has received additional support in recent years from the finding that exposure to disgust elicitors, as well as cues that remind participants of disease, can serve to activate the innate immune system [3–5]. For example, participants who viewed pictures of disgusting stimuli were found to have elevated levels of tumour-necrosis factor alpha (TNF-a) in their saliva around 30 min post-induction — an effect not observed in control conditions that use equally affectively negative stimuli [5,6]. Not only can disgust stimuli activate the innate immune system, this seems to extend to increasing core body temperature as well [6]. Viewing disgusting images, but not equally emotionally negative control images, resulted in progressive increases in core body temperature, which were maximal at around 30 min post-induction [6].

The temperature-related finding, and the immune system changes, led us to hypothesise that disgust might produce changes in the body that parallel the acute phase response. In the acute phase response, the immune system detects the presence of a pathogen and reacts to them both locally and systemically [7]. This systemic reaction includes fever, elevated levels of cytokines, tiredness and social withdrawal, loss of appetites (e.g., food), and increased pain sensitivity [8]. Paralleling this pattern of responding, disgust does appear to increase core body temperature [6], elevate levels of cytokines including TNF-a and IL-6 [3,5,6], and disgust is associated with feelings of nausea and reduced appetite for food [9,10]. In the study reported in this manuscript we focussed on whether a further parallel to the acute phase response is present, namely increased pain

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sensitivity. To our knowledge only one study has investigated pain perception following experiencing the emotion of disgust, and this found that latency to report pain was increased immediately after induction of disgust, relative to a neutral control [11]. This study did not, however, examine whether any increased pain sensitivity occurred at later time points (i.e., around 30 min post-induction), which would parallel changes observed for temperature and immune-related effects.

While we might hypothesise differences in pain sensitivity based upon disgust inducing an acute phase response, this is of course not the only way that experiencing this emotion might affect pain perception. Unlike the other basic negative emotions (i.e., fear and anger), disgust primarily activates the parasympathetic branch of the autonomic nervous system e.g., [12]. As autonomic function changes markedly during pain perception e.g., [13], it is likely that disgust-induced changes in parasympathetic activation would affect participants' experience of pain during the period that the emotion was being experienced. However, while some effect would be expected, it is not obvious what the precise nature of this impact would be nor its time course. A further emotion-related effect on pain perception concerns the degree to which they affect participants' orientation to the internal or external milieu. As the negative emotions generally deal with external threats, they may favour an outward shift of attention, thereby acting to reduce pain perception via distraction [14]. In this case, we would expect the effect to occur in close proximity to the experience of the emotion.

To test whether disgust leads to increased pain sensitivity following longer delays – and to determine its effects on pain more broadly – we had participants randomly assigned to one of three experimental groups. Each group received an emotion induction on one day and a neutral control induction (viewing images of everyday household objects) on another, in counterbalanced order. This allowed us to ascertain the unique effects of each emotion induction on participants' perception of pain by measuring their baseline responding during the neutral control induction. The content of the emotion inductions differed between groups, with one set of participants receiving a disgust induction, one a negative induction (i.e., unpleasant, fear and anger provoking stimuli) and another a positive induction. This then allowed us to compare between groups, the unique effect of each emotion induction on pain perception. This between group manipulation was adopted so as to reduce the demands the study made upon participants (i.e., number of pain tests and experimental sessions). We included a negative emotion induction so that we could determine if any pain-related effect arose simply because disgust induces negative affect. A positive emotion induction was included to determine whether any form of valenced and arousing stimulation might account for any pain-related effect (e.g., via distraction).

For the emotion inductions the requisite state was induced by showing participants particular sets of images. We established the success of the emotion inductions by having participants evaluate their emotional state before and after the induction. Pain sensitivity was tested using a variant of the cold pressor task, which is a well-established experimental technique for inducing pain, and from which reliable and valid self-reports of pain can be obtained e.g., [15]. On each day of testing participants' pain sensitivity was established, prior to the induction, and then three times afterwards; immediately, at 15-min and 30-min post induction. As we expected the most interesting alterations in pain sensitivity to emerge at the later time points (i.e., consistent with the immune and temperature related changes noted above), this necessitated multiple cold-pressor tests. Consequently, the temperature of the water was set at a warmer-level than normal. On each test participants were asked to keep their lower arm immersed in the cold water for 90 s, reporting their pain intensity at 10 s intervals. Finally, we asked all participants to complete individual difference measures of disgust sensitivity [16, 17] so that we could determine if any observed effects were stronger in participants who report experiencing this emotion with greater frequency and intensity.

2. Method

2.1. Participants

Ninety-six undergraduate participants (31% male; M age = 20.2, SD = 3.3), all with no pre-existing medical condition that could affect pain responses, were randomly assigned to one of three experimental groups. Participants were recruited from the first-year psychology subject pool and from the university community, the latter being paid a small sum ($20) for taking part. Half of the sample self-reported as being Australians of Caucasian descent, with the remainder mainly composed of Australians of Asian descent. This proportion did not significantly differ between the experimental groups. Just over one-third of the sample was born overseas, and again this proportion did not significantly differ between the experimental groups. Each participant consented to take part in the experiment and the protocol was approved by the Macquarie University Human Research Ethics Committee.

2.2. Stimuli

The pictorial stimuli used for the inductions were all obtained from the International Affective Picture Series (IAPS, [18]) and were shown twice in randomised order to participants on a 60 cm computer monitor.

Disgust induction: IAPS disgust-related stimuli (e.g., vagrant, roaches, vomit), items; 1280, 2710, 2750, 3030, 3051, 3150, 3160, 3400, 7359, 7380, 9140, 9181, 9252, 9290, 9300, 9301, 9320, 9342, 9405, 9500. Negative induction: IAPS negatively-valenced stimuli (e.g., pointed guns, domestic violence, plane crash wreckage), items; 2141, 2455, 2800, 3180, 3500, 6230, 6300, 6311, 6313, 6315, 6510, 6571, 6830, 6838, 8485, 9041, 9050, 9421, 9611, 9910. Positive induction: IAPS positively-valenced stimuli (e.g., skydiving, white-water rafting, water skiing), items; 5480, 5621, 5950, 8030, 8034, 8080, 8160, 8178, 8179, 8180, 8185, 8186, 8191, 8192, 8200, 8260, 8300, 8341, 8400, 8490. Based upon the IAPS normative data, there was no significant difference in affective valence between the Disgust (M = 2.5, SD = 0.4) and Negative (M = 2.4, SD = 0.4) image sets, and both of these sets differed in affective valence from the Positive image set (M = 6.8, SD = 0.8; two-sample t-tests, both ps < 0.01). For arousal, there was no significant difference on the IAPS normative data between the Disgust (M = 5.6, SD = 0.8) and the Negative (M = 5.9, SD = 0.8) image sets, and both of these sets were significantly less arousing than the Positive (M = 6.6, SD = 0.5; two-sample t-tests, both ps < 0.01) image set.

The Neutral induction set (experienced by all participants) contained the following images: IAPS household objects (e.g., chair, rolling pin, book), items: 7000, 7002, 7004, 7006, 7009, 7010, 7020, 7025, 7030, 7035, 7050, 7080, 7090, 7150, 7175, 7179, 7211, 7217, 7233, 7235. Using the IAPS normative data, these images had a mean valence score of 4.9 (SD = 0.2) and a mean arousal score of 2.6 (SD = 0.5). Needless to say, both of these scores significantly differed from the mean valence and arousal scores of each of the emotion image induction sets (two-sample *t*-test; all ps < .01).

Pain intensity was measured using a 100-point scale (anchors; 0 = No pain, 20 = Mild pain, 40 = Moderate pain, 60 = Moderately severe pain, 80 = Very severe pain, 100 = Worst possible pain). This scale was visible throughout testing and participants were asked to select a number between 0 and 100, which best reflected the degree of pain intensity that they were currently feeling.

Emotion ratings were completed on seven point category scales (anchors 1 = Not at all to 7 Very). Participants were asked to rate how sad, angry, disgusted, tense, fearful and happy they were. These items were selected for rating as they encompass the principal states likely to be induced by the image sets.

The cold-pressor task was conducted using a refrigerated circulating water bath (Lab Companion RW-2025G), with the temperature set at 13.5 °C. This temperature was based upon pilot work, so that