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Scientific paper

Anxiety, disgust and negative emotions influence food intake in humans

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Abstract

A growing body of research has shown that the emotion of disgust is adaptive since it protects humans from pathogens. The possible role of anxiety and other positive and negative emotions in pathogen avoidance remain less clear. We investigated individual food acceptance after a disgust-evoking experience (a trout dissection) in a real-life setting by assessing the taking of a portion of trout. The unique contribution is that both state and trait disgust influence the likelihood of taking food after being disgusted. Participants who were more anxious, disgust sensitive or predisposed to more negative emotions avoided food after dissection significantly more frequently than their more positively affected counterparts. Males tended to accept food more often than females. Overall, these results suggest that anxiety, disgust and additional negative emotions are important in human food avoidance and that both anxiety and emotions can be considered as adaptive from an evolutionary perspective.

Keywords: Anxiety; Dissection; Emotion; Evolution; Food; Human; STAI-S; PANAS

Introduction

Pathogen stress favours individuals who are able to successfully combat diseases and successfully reproduce (Schaller and Duncan, 2007). Humans have developed a biological immune system (BIS) which is able to detect, distinguish and kill a variety of pathogens from viruses to macroparasites (Parham, 2009) and a behavioural immune system (BEH) which comprises cognitive, emotional and behavioural mechanisms that allow individuals to detect the potential presence of parasites in objects (or individuals) and act to prevent contact with those objects (or individuals) (Schaller and Duncan, 2007; Neuberg et al., 2011). Both BIS and BEH interact with one other (Schaller et al., 2010; Miller and Maner, 2011), although BIS is understood as a second line of defence, activated only after the disease could not be avoided. BEH is consequently the "cheaper" and more effective system working in the first line of defence against pathogens (Neuberg et al., 2011; Schaller and Park, 2011). Potential handicap effects by accepting poisonous food will not be discussed here because it has only been observed in non-human animals (see, e.g. Antczak et al., 2005).

To avoid disease, BEH is activated in the presence of disease-relevant cues (Kurzban and Leary, 2001) although it does not react to specific cues triggered by parasites because these may vary greatly. It instead responds in a hypersensitive way to the *perceived* presence of parasites in the sensory environment (Schaller and Duncan, 2007). It can also be compared to the 'smoke detector principle' (Nesse, 2005; Haselton and Nettle, 2006). A smoke detector is usually calibrated to be supersensitive to anything which (albeit superficially) resembles smoke in order to minimise the

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likelihood of failing to register the presence of real danger – a house fire – which would be an extremely costly false-negative error. In contrast, a false-positive error (e.g. detecting someone smoking in the toilet) is much cheaper than neglecting a dangerous fire.

Research suggests that there are individual differences in pathogen avoidance (Curtis et al., 2011) since the costs of disease transmission differ with respect to an individual's immune system (Stevenson et al., 2009; Prokop et al., 2010a, 2010b). There is actually growing evidence indicating that pathogen avoidance is manifested through changes in behavioural, emotional, cognitive and personality traits. People who think themselves vulnerable to disease transmission reveal a relatively greater level of aversive response to physically disabled individuals (Park et al., 2003), towards older adults (Duncan and Schaller, 2009), immigrants (Faulkner et al., 2004), toward obese people (Park et al., 2007) or toward disease transmitting animals (Prokop et al., 2010a, 2010b; Prokop and Fančovičová, 2010). These people pay increased attention to faces with even innocuous disfigurements (Miller and Maner, 2011) and evaluate themselves as less extroverted than less disease-sensitive people (Mortensen et al., 2010). Disease-sensitive people also engage more frequently in various anti-parasite behaviours such as increasing washing of hands (Porzig-Drummond et al., 2009), self-grooming behaviours (Thompson, 2010) or reducing physical contact with animals (Prokop and Fančovičová, 2011).

Anxiety, defined as an organism's preparatory response to contexts in which a threat may occur (Beck et al., 1985; Cisler et al., 2009), may be associated with the emotion of disgust (Cisler et al., 2007). Anxiety produces physiological responses such as an increased heart rate, stress hormone secretion, vigilance, fear of potentially dangerous environments and decreased feeding behaviour (Cohen et al., 1985, also see Bellisle et al., 1990 for different results regarding anxiety and feeding) which can be viewed as adaptive from an evolutionary perspective since it prepares the body for potential threat (Bateson et al., 2011). Reduced food intake induced by anxiety (Nordin et al., 2004) decreases the likelihood of being contaminated in environments with a high perceived threat. It is also associated with activation of the sympathetic division of the autonomic nervous system, which suppresses the parasympathetic division and consequently reduces feelings of hunger (McEwen, 2007).

Humans are omnivores (Ungar and Sponheimer, 2011) and a high variety of potential food is, on the one hand, beneficial since it heightens the probability of finding a potential food source, although it, on the other hand, generates the issue of selection of foods that do not contain deadly toxins (Pollan, 2006). Digestive infections are a major cause of morbidity and mortality (Kyne et al., 2002), thus evolutionary pressures toward selection of appropriate foods are expected.

In this study, we investigated whether anxiety, disgust and negative emotions are individual predictors of food avoidance. Specifically, we hypothesize that people with a higher disgust/anxiety sensitivity and those with a negative mood will avoid consumption. Unlike the majority of previously published studies, our data do not rely solely on self-reports. We instead made use of both paper-and-pencil tests and an actual elicitor of disgust (dissection) which stimulates visual, olfactory and tactile receptors, followed by behavioural observation of an individual's willingness to eat food. This combined approach allowed for both validation of the paper-and-pencil tests (Rozin et al., 1999) and for more precise data from real-life situations.

Methods

Participants and data collection

The participants were students from the University of Education Heidelberg who routinely participate in a basic zoology course, which includes the dissection of a fish (trout; Randler et al., 2013). The dissection of the fish was rated as the most disgusting experience during the whole semester term (Randler et al., 2013). The trout was already dead before the dissection started. The semester course included living animals, such as earthworms, mice, woodlice and snails, as well as a trout dissection and some work with models of animals. In this study, disgust ratings were taken immediately after the respective lessons and the trout dissection was rated as most disgusting, compared to living animals (such as woodlice, earthworms and snails), as well as to lessons were no animals (dead or alive) were presented. Therefore, we consider the dissection of a trout as disgust evoking experience.

The age of the students ranged from approximately 22 to 23 years when they attend this course in the curriculum (Randler et al., 2013). The study followed the ethical guidelines of the "Forschungskommission" of the University of Education Heidelberg. The study did not need an additional ethical approval because it was linked with a regular course for teaching biology. The University of Education Heidelberg is regularly funding the dissection by special subsidies to enable the teachers to make the dissection experience possible. In contrast to previous teaching a decade ago, the killing of animals has been strongly reduced (no frogs, mice, pigeons, etc.) anymore, and the trout dissection is the only one dissection left.

The battery of questionnaires was applied on a voluntary, unpaid and anonymous basis, although the majority of the students participated in the study and the rejection rate was below 10%. All the students from the courses were invited to participate in this study. Prior to the dissection (one week before) we assessed if they ate fish or not. We excluded all persons from the statistical analyses who noted that they did not eat fish at all, but all persons participated in the dissection, the questionnaire study and the offering of trout portions. A total of 80 persons (all fish-eaters) were analyzed in the study (71 women, 5 men, 4 sex unspecified). A cross-validation check with actual observed behaviour confirmed that all persons stating that they did not eat fish indeed did not take any helping of fish ($p < 0.001$). One week in advance, we used a pre-test based on trait measurements (pre-trait). We used the German translation of the trait disgust scale (Petrowski et al., 2010). In addition, we asked for the number of dissections of fish and other animals or their organs. Immediately after the dissection we applied the following test: State anxiety (STAI-S), specific state disgust, and the positive and negative affect scale (PANAS; for details see the measurements). The students were consequently asked to deposit their questionnaire in a separate room. In this room, a number of small portions of trout had been prepared for eating ("finger food"). Researchers were present in this room and thanked the students for their participation, then offered the different fish portions and collected the questionnaires. Different types of helping had been prepared, all of them with rainbow trout, the same species that has been dissected before but not one of the actual animals that had been dissected due to hygiene and safety reasons. Different types of mayonnaise, horseradish, and portions with and without bread were provided. Students had the possibility to wash their hands prior to entering the room and moist towelettes (hygiene papers) were also offered. The room was far enough from the dissection room to not see or smell the remains after the dissection. The questionnaires were deposited in a closed box (urchin) but the researchers made a sign ("x") on the blank backside of the questionnaire if the participant took one of the portions. The students were unknown to the

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