Bradygastric activity of the stomach predicts disgust sensitivity and perceived disgust intensity

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1. Introduction

Disgust is considered to be a basic emotion that can be recognized universally by distinct facial expressions. The facial expression of disgust – wrinkled nose, open mouth, curled lips, and protrusion of the tongue – reflects its presumed core function, namely the avoidance and rejection of improper and potentially harmful food (Rozin and Fallon, 1987). However, disgust can not only be induced by food, but also by body products, certain animals and poor hygiene, or by violations of the normal body envelope, such as blood and mutilation, and death, and even by moral concerns (Rozin et al., 2000; Schnall et al., 2008).

While the behavioral expression of disgust appears to be universal, studies on the autonomic correlates of this emotion have revealed more complex results. In a comprehensive review on cardiovascular, electrophysical and respiratory changes in discrete emotions, Kreibig (2010) recently summarized that disgust in relation to contamination and pollution (e.g., pictures of dirty toilets, cockroaches, maggots on food) results in sympathetic–parasympathetic coactivation and faster breathing, whereas mutilation-related disgust is characterized by a pattern of sympathetic cardiac deactivation, increased electrodermal activity, unchanged vagal activation, and faster breathing.

Such domain-specific differences in autonomic disgust reactions may partially reflect differences in motivational activation induced by the respective stimuli (Bradley, 2009). Unpleasant affects are held to be associated with the brain's defensive motivation system and pleasant affects with appetitive motivation (Cuthbert et al., 2000). Reports of increased arousal and greater magnitude of sympathetically mediated responses (e.g., sweat-gland activity) index increased activation of motive systems (appetitive, defensive, or both). Among autonomic responses, heart rate co-varies most strongly with affective valence, whereas skin conductance increases with the judged affective arousal (motivational intensity) of both pleasant and unpleasant pictures (Bradley et al., 2001; Cuthbert et al., 2000). Indeed, there is evidence that disgust induces a mixture of both a more general response to unpleasant stimuli activating the brain's defensive motivation system and a specific activation pattern accompanying disgust (Wright et al., 2004). This implies an overlap between autonomic changes induced by motivational activation and those reflecting a specific activation pattern accompanying disgust and suggests that both concepts should be
taken into consideration when investigating physiological disgust responses.

In addition to domain-specific differences, there is some evidence in the literature that a general physiological disgust response exists that – similar to the mimic disgust pattern – occurs in response to any type of disgust. Rohrmann and Hopp (2008) found cardiac output to be decreased during induction of both contamination-related disgust and mutilation-related disgust. They hypothesized that this decrease in cardiac output might represent a more pertinent marker of disgust because other negative emotions, such as fear, anger and sadness, either led to an increase or no change in cardiac output. They further hypothesized that the decrease in cardiac output might delineate a reaction pattern contrary to the feeding response, also known as the ‘cephalic phase response’. This response is stimulated by the sight, smell, taste and thoughts of appetizing meals and leads to an increase in cardiac output in order to redirect blood flow from skeletal muscles to the gastrointestinal tract, in addition to gastrointestinal changes preparing the stomach for the ingestion of food (Power and Schulkin, 2008; Rohrmann and Hopp, 2008).

If disgust indeed elicits a reaction pattern contrary to the cephalic phase response, then gastric activity should be part of this response. In support of this view, Stern et al. (2001) found myoelectrical activity of the stomach associated with normal digestive activity (‘normogastria’) to be decreased during sham feeding with unappetizing food. Similar to Rohrmann and Hopp (2008), the authors argued that this decrease might reflect an inhibition of the cephalic phase response, which is usually accompanied by an increase of normogastria in the EGG. A similar decrease of normogastria was found during imagining eating unappetizing food (Zhou and Hu, 2006), and when tasting a bitter substance (Power and Schulkin, 2008). A reaction pattern opposite to the classical cephalic phase response would also be in accordance with the presumed core function of disgust, namely the avoidance and rejection of improper and potentially harmful food.

However, besides one study that did not find any effects of disgusting stimuli on gastric activity (Baldaro et al., 2001), another study reported a response that was inconsistent with the prior line of research: van Overveld et al. (2008) found salivary flow to be decreased during induction of both contamination-related disgust and mutilation-related disgust. They hypothesized that this decrease in cardiac output might represent a more pertinent marker of disgust because other negative emotions, such as fear, anger and sadness, either led to an increase or no change in cardiac output. They further hypothesized that the decrease in cardiac output might delineate a reaction pattern contrary to the feeding response, also known as the ‘cephalic phase response’. This response is stimulated by the sight, smell, taste and thoughts of appetizing meals and leads to an increase in cardiac output in order to redirect blood flow from skeletal muscles to the gastrointestinal tract, in addition to gastrointestinal changes preparing the stomach for the ingestion of food (Power and Schulkin, 2008; Rohrmann and Hopp, 2008).

Based on the aforementioned findings from the literature, we expected that viewing disgusting pictures would reduce gastric myoelectrical activity associated with the normal digestive activity of the stomach (normogastria). We wondered whether this decrease in normogastria would be accompanied by an increase in the dysrhythmic components of gastric activity, i.e., either bradycardia and/or tachycardia, because of their known association with nausea. We furthermore explored whether part of the variance of changes in gastric myoelectrical activity could be explained by individual differences in the perceived intensity of disgust and/or individual levels of disgust sensitivity. With respect to the non-gastric autonomic measures, we expected increases in skin conductance responses, especially when viewing the highly arousing pictures, delineating the well-known relationship between arousal and electrophysiological activity (Bradley et al., 2001; Cuthbert et al., 2000) on the one hand, and the relationship between mutilation-related disgust and increases in electrophysiological activity on the other hand (cf. Kreibig, 2010). We furthermore expected that heart periods would increase in response to the disgust-inducing pictures, because both aversive pictures (Bradley, 2009; Bradley et al., 2003; Moratti et al., 2004) and disgusting stimuli (as far as not restricted to contamination-related disgust; cf. Kreibig, 2010) are known to induce heart rate deceleration.

1.1. Aims

The present experiment was designed to investigate the effects of viewing disgusting pictures on gastric myoelectrical activity and their relation to self-reported disgust intensity and disgust sensitivity. We selected 30 pictures from the International Affective Picture System (IAPS; Lang et al., 1999) known to explicitly induce disgust (Mikels et al., 2005). We divided them according to their normative arousal values into picture blocks with either high or moderate emotional intensity. Furthermore, we assessed disgust sensitivity by using a validated questionnaire (Schielen et al., 2002) and related this measure to disgust ratings and autonomic responses. Because women on average score higher in disgust sensitivity than men and also show more intense physiological reactions to emotional stimuli in general (Caseras et al., 2007; Codispoti et al., 2008; Rohrmann et al., 2008), we also explored possible gender differences in disgust responses.

1.2. Gastric measurements

Gastric myoelectrical activity was assessed non-invasively by positioning skin electrodes above the stomach and measuring the electrogastrogram (EGG). EGG signals contain components associated with digestive stomach activity (‘normogastria’) and the disruption of this activity (‘tachygastria’ and ‘bradygastria’). Under normogastric conditions cardiac parasympathetic activity is increased and sympathetic activity is decreased and under tachygastria conditions it is the opposite (Gianaros et al., 2003; Koch and Stern, 2004; Muth et al., 1999; Stern et al., 2007). The autonomic sequelae of bradygastria are less well understood but bradygastria also reflects a disruption of the normal digestive activity of the stomach (Stern et al., 2007). Both tachygastria and bradygastria have been observed during acute and chronic nausea (Geldof et al., 1986; Horn, 2008; Hu et al., 1989; Jednak et al., 1999; Liberski et al., 1990; Stern et al., 1985, 1987). Remarkably, dysrhythmias can appear before nausea is actually experienced (Stern, 2002).

1.3. Hypotheses

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