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Mouth proximity influences perceived disgust of visual stimuli

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ABSTRACT

The emotion of disgust likely evolved to protect humans against oral contamination by pathogens. Accordingly, objects positioned in close proximity to body parts -where infection can easily invade the human body-should be perceived as more disgusting than objects positioned in more neutral places. In the present study, we experimentally altered the distance of various edible and non-edible stimuli from the human mouth and found that mouth proximity enhanced disgust ratings, and more particularly for non-food stimuli. Interestingly, stimuli that were shown near the foot, i.e., far away from the mouth, were also given high disgust ratings, probably due to different contextual integration of emotional conflict. These findings suggest that disgust is enhanced when the risk of oral contamination increases, and thus, that disgust is context-dependent.

1. Introduction

Disgust is a basic emotion with deep evolutionary roots, which most likely evolved to protect humans against contamination by pathogens (Darwin, 1872/1965; Rozin & Fallon, 1987). Most of the human body covers skin (Romanovsky, 2014), which is an effective barrier against pathogens (Niyonsaba & Ogawa, 2005). Indeed, the natural acidity of the skin provides a hostile environment for bacteria (Madison, 2003). Ingestion of many pathogens - such as viruses, bacteria, protozoa, fungi or nematodes – is the most common type of infection in humans (Loynachan, 2013). Therefore, it is reasonable to hypothesize that the evolutionary origin of disgust is primarily related to oral contamination (Darwin, 1872/1965; Fančovičová et al., 2022; Rozin et al., 2008; Rozin & Fallon, 1987). However, it also possible that disgust evolved as a broader mechanism designed to protect ourselves against infectious diseases (Curtis et al., 2004; Oaten et al., 2009; Plutchik, 1980; Tybur et al., 2009). For instance, disgust sensitivity is specifically related to fear of certain groups of animals that evoke revulsion due to the presence of mucus (e.g., snails) and being sources of contamination and/or are associated with dirt (e.g., cockroaches, spiders) (Davey, 1991; Matchett & Davey, 1991). Likewise, humans perceive insects as similarly disgusting as pathogens despite many species being harmless (Lorenz et al., 2014; Matchett & Davey, 1991; Prokop & Jančovičová, 2013; Rozin & Fallon, 1987). This superficial recognition of pathogens ultimately benefits the prevention of disease transmission because the costs of pathogen infection are higher than the avoidance of noninfectious animals (Nesse, 2001).

Because humans cannot survive without eating on a regular basis and do not eat the same type of food since we are an omnivorious species, they need to evaluate food quality by sensory organs and healthiness before ingestion (Rappaport et al., 1992; Rozin & Fallon, 1987). Rotten food and food susceptible to microbial contamination are perceived as more disgusting than still edible food (Becker et al., 2016; Calder et al., 2007; Curtis & Biran, 2001), but when the activation of disgust becomes miscalibrated it may cause dysfunctional eating behaviors (e.g., Aharoni & Hertz, 2011; Hildebrandt et al., 2015). In addition, heightened disgust is associated with specific phobias (Olatunji et al., 2007; Polák et al., 2021) and anxiety disorders (Cisler et al., 2009; Woody & Teachman, 2000). For instance, people diagnosed with blood-injury-injection phobia are more disgust sensitive people than non-phobic people (Kiss et al., 2022; Olatunji et al., 2007). Spider phobic people are more disgust sensitive than spider non-phobic people (Mulkens et al., 1996; Polák

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et al., 2020, 2021).

Typically, food disgust is more pronounced in females than in males (Pellegrino et al., 2015) and females are generally more prone to pathogen disgust than males (for reviews see Al-Shawaf et al., 2018; Oaten et al., 2009). A common explanation for heightened disgust sensitivity in females is that females need to be more careful of potential pathogens because they protect not only their health but also the health of their offspring (Curtis et al., 2004; Polák et al., 2020; but see Prokop & Jančovičová, 2013; Prokop & Fančovičová, 2016). Alternatively, females are at a higher risk of contracting sexually transmitted infections (Al-Shawaf et al., 2018; Fleischman, 2014), which is costly in terms of impaired reproductive success, which could contribute to their heightened disgust sensitivity relative to males.

The activation of the emotion of disgust is crucial to ultimately protect the body from the risk of contamination (Pellegrino et al., 2016; Porzig-Drummond et al., 2009). However, disgust can be strongly context-dependent. Concerning food and disgust, Fančovičová et al. (2022) found that disgusting food stimuli triggered greater visual attention than disgusting non-food stimuli, suggesting that humans pay strong attention to the visual processing of contaminated food. However, we are not aware of a study that has investigated how disgust sensitivity varies concerning the direct risk of oral contamination. Our study was therefore aimed at addressing this important issue.

We hypothesize that if disgust primarily evolved to avoid oral contamination, then disgusting stimuli positioned near the mouth should be perceived as posing a greater risk of contamination than disgusting stimuli that are displayed far away from the mouth. Because disgusting stimuli displayed near the mouth should be perceived as emotionally conflicting, we further predicted that disgusting non-food stimuli positioned near the mouth should be perceived as being more disgusting than disgusting food stimuli, because the human body is not adapted to process the former type of stimuli. If these two predictions are true, then this would provide evidence for the hypothesis that disgust is context-dependent. Finally, in line with previous findings in the literature (Al-Shawaf et al., 2018), we anticipated that females should be exhibit higher levels of disgust than males whatever the context in which disgusting stimuli are rated.

2. Methods

2.1. Participants and procedure

The participants were 287 Slovak volunteers (aged 18 to 73 years, M = 26, SE = 0.09) selected based on their age (older than 18). They were recruited online via the university website, similarly to other research in this field (e.g., Curtis et al., 2004; Fessler & Navarette, 2003; Prokop & Fančovičová, 2016). The language of the online questionnaire was Slovak, and it was administrated online using the Google docs form. Before undertaking the online questionnaire, the participants were provided with a brief overview of the research. They were informed that the main aim of the research was to investigate which visual stimuli are perceived by humans as disgusting. After providing informed consent, the participants were asked to provide their age and sex. The online questionnaire took approximately 5–7 min to complete. All the study procedure was approved by the Statutory Ethics Committee of Trnava University.

2.2. Visual stimuli

We developed 48 visual stimuli with the same confederate who helped us create various categories of objects close to the human body (see below). Visual objects were divided into disgusting (edible vs. inedible) and non-disgusting (edible vs. inedible) categories (Table 1). This categorization was based on previous research showing that rotten food (Curtis & Biran, 2001; Tybur et al., 2009), spiders, cockroaches, and caterpillars are considered disgusting (Matchett & Davey, 1991; Prokop & Randler, 2018), whereas Lady beetles (Prokop et al., 2010) and probably other colourful insects (Prokop & Fančovičová, 2013) are not. Each object listed in Table 1 was photographed in four treatments: 1) close to mouth, 2) in hand, 3) separately 4) close to the foot (Fig. 1). Participants rated perceived disgust of each picture (e.g., How disgusting do you consider this food?) on a 7-point Likert scale (1 = not at all disgusting, 7 = extremely disgusting).

Table 1
Categories of visual stimuli used in the research.

	Food	Non-food
Disgusting	Rotten apple	Garden spider (*Araneus diadematus*)
	Rotten pizza	Oriental cockroach (*Blatta orientalis*)
	Rotten schnitzel	Turnip moth (*Agrotis segetum*)[a]
Non-disgusting	Apple	Lady beetle (*Coccinella septempunctata*)
	Pizza	Firebug (*Pyrrhocoris apterus*)
	Schnitzel	Western conifer seed bug (*Leptoglossus occidentalis*)

[a] Caterpillar.

2.3. Statistical analyses

The data were analysed with a Linear Mixed Model (LMM). The disgust score was the dependent variable. Participant identity was introduced as a random effect. Treatment (i.e., positioning of the stimuli near the mouth, hand, foot, or separately), Edibleness of stimuli (Food or Non-food), and Disgust (whether the stimuli was a priori considered disgusting or non-disgusting) were introduced as predictors. All analyses were run with the GENLINMIXED module of IBM SPSS (2019) ver. 26.

3. Results

Departures from normality of residuals and participants' random effects were checked graphically, considering skewness and kurtosis coefficients. Both appeared reasonably symmetrical (residuals: $G1 = 0.04$, random effects: $G1 = -0.32$), and their tails did not depart significantly from those of a normal distribution (residuals: $G2 = -0.18$, random effects: $G2 = -0.32$). Given LMMs appear relatively robust from departures from these assumptions (e.g. Schielzeth et al., 2020), the raw-data were used with no transformation in the model.

3.1. Main effects

The LMM model was significant (Table 2) with a variance of participant's random effect differing significantly from zero ($Z = 11.97$, $P < .001$). Older age was associated with lower disgust sensitivity (estimate = −0.018, $P < .01$) and females (M = 4.25, SE = 0.02) were more disgust-sensitive than males (M = 3.56, SE = 0.04, $P < .001$). The main effect of treatment was significant ($P < .001$), with pairwise comparisons revealing that stimuli placed close to the mouth were rated as being more disgusting than stimuli positioned near the foot ($P < .001$), placed on the hand ($P < .001$) or shown in isolation ($P < .001$, Table 3). In addition, stimuli positioned near the foot were significantly more disgusting compared with those placed on the hand ($P < .001$) and with stimuli presented in isolation ($P < .001$, Table 3). If also significant, the difference between stimuli placed on hand and stimuli placed apart was less salient ($P = .026$). Not surprisingly, disgusting stimuli (M = 5.02, SE = 0.02) were rated as more disgusting than neutral stimuli (M = 2.79, SE = 0.03, $P < .001$). Finally, Food stimuli (M = 3.9, SE = 0.03) were rated similarly disgusting to non-food stimuli (M = 3.91, SE = 0.03, $P = .605$).

3.2. Interaction terms

Treatment × Disgusting/Non-disgusting stimuli interaction ($P <$

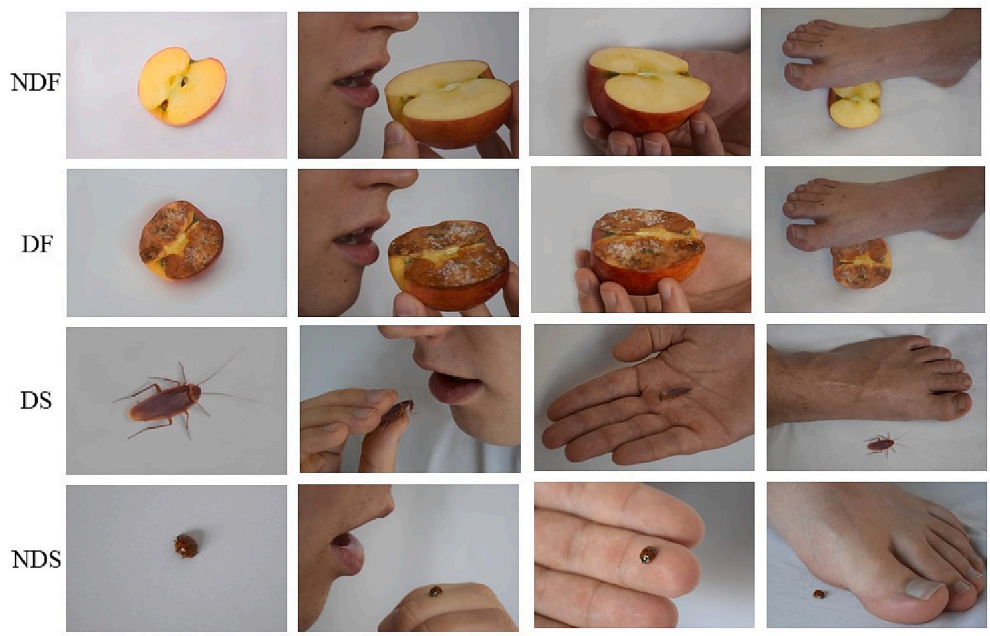

Fig. 1. A subset of the types of non-disgusting food (NDF), disgusting food (DF), disgusting non-food stimuli (DS) and non-disgusting stimuli (NDS) positioned separately, near the mouth, in hand and near the foot (from left to right).

Table 2
LMM on disgust ratings.

	F	df1	df2	P
Age	10.31	1	13,755	.001
Gender	26.47	1	13,755	<.0001
Disgust	4685.04	1	13,755	<.0001
Treatment	244.9	3	13,755	<.0001
Food/non-food	0.268	1	13,755	.61
Gender × disgusting/non-disgusting	12.4	1	13,755	.001
Gender × treatment	6.17	3	13,755	<.0001
Gender × food/non-food	48.09	1	13,755	<.0001
Disgust × treatment	102.49	3	13,755	<.0001
Disgust × food/non-food	826.01	1	13,755	<.0001

Table 3
Disgust ratings of all stimuli (a priori considered disgusting or non-disgusting) positioned near different body parts.

	Mouth	Hand	In isolation	Foot
Mean	4.67	3.66	3.58	4.41
SE	0.04	0.04	0.04	0.04

.001) suggests that disgusting objects were rated as most disgusting when seen near the mouth compared with the other places: hands, feet, or in isolation (all Ps $< .001$) while the differences between these last were reduced (Ps between 0.002 and 0.244). Non-disgusting objects, however, were rated as most disgusting when positioned near the foot (Fig. 2), with a relative low observed difference with those near the mouth ($P < .001$) relatively to the differences appearing with stimuli positioned alone or placed on the hand (both Ps $< .001$).

Treatment × Food/Non-food ($P < .001$) suggests that food stimuli were most disgusting when positioned near the foot ($P < .001$), while non-food stimuli were most disgusting when positioned near the mouth ($P < .001$). One exception was the difference between the Hand and In isolation levels for food stimuli ($P = .661$), but all differences were significant at $P < .001$ (Fig. 3).

Food/Non-food × Disgusting/Non-disgusting stimuli interaction term ($P < .001$) suggests that disgusting food-related stimuli were rated

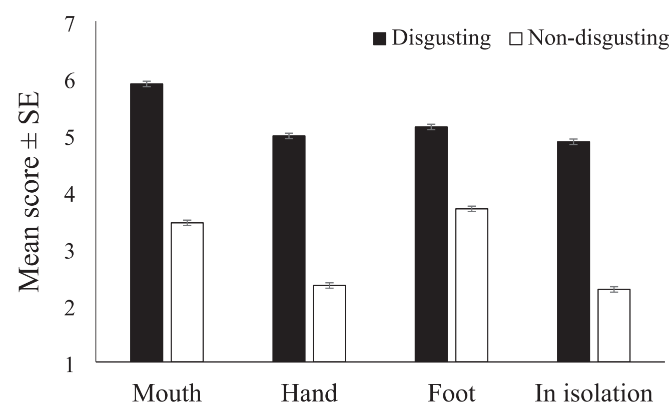

Fig. 2. Disgust ratings of stimuli a priori considered disgusting and non-disgusting across treatments.

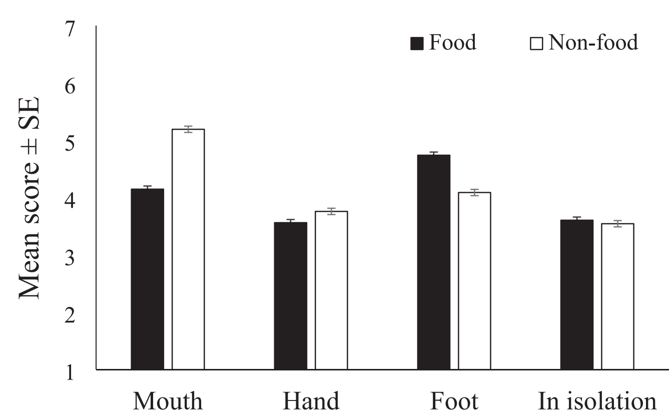

Fig. 3. Disgust ratings of food and non-food stimuli with respect to treatment.

higher than disgusting non-food stimuli ($P < .001$), but the reverse was true for non-disgusting stimuli ($P < .001$): food was rated less disgusting than non-food (Fig. 4).

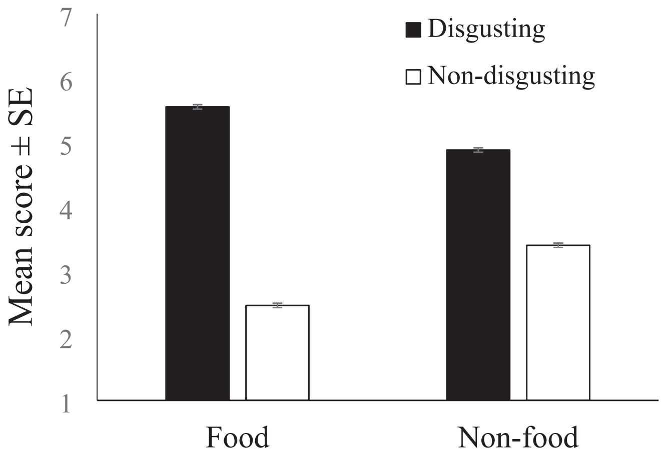

Fig. 4. Disgust ratings of stimuli a priori considered disgusting and non-disgusting with respect to their relatedness to edibility (food vs. non-food).

Gender × Disgusting stimuli interaction (P < .0001) suggests that females rated both disgusting (M = 5.42, SE = 1.34) and non-disgusting stimuli (M = 3.08, SE = 1.34) as more disgusting than males (disgusting vs. non-disgusting stimuli, M = 4.62, SE = 1.34 vs. M = 2.51, SE = 1.34) (both Ps < 0.001), but this gender difference was somewhat more pronounced for disgusting stimuli.

Gender × Treatment interaction term (P < .001) suggests that although females rated all stimuli more disgusting than males (all Ps < 0.001), compared to males, the differences between the stimuli positioned near the mouth and foot with the other stimuli were somewhat more pronounced for females.

Gender × Food/Non-food stimuli (P < .001) suggests that females rated non-food stimuli (M = 4.37, SE = 1.34) more disgusting than food stimuli (M = 4.13, SE = 1.34), but that the reverse was true for males (non-food stimuli vs food stimuli, M = 3.46, SE = 1.34 vs. M = 3.66, SE = 1.34, both Ps < 0.001).

4. Discussion

In the present study, we were mainly concerned with the issue of avoidance of oral contamination. Using edible (versus non-edible) stimuli that were disgusting or not (control stimuli), we found that both disgusting and control stimuli positioned near the mouth were perceived as more disgusting than the same stimuli positioned away from the mouth (i.e., presented apart or near the hand). This finding supports the idea that the evolutionary origin of disgust is primarily related to oral contamination (Darwin, 1872/1965; Fančovičová et al., 2022; Rozin et al., 2008; Rozin & Fallon, 1987). Disgusting food items were given higher disgust ratings overall than disgusting non-food stimuli, further supporting the superiority of disgusting food in perceived risk of contamination compared with non-food stimuli (Fančovičová et al., 2022). Interestingly, disgusting non-food stimuli positioned near the mouth were perceived as more disgusting than disgusting food stimuli which also supports the avoidance of oral contamination. Conflicting visual stimuli create a mental association between an emotional distractor (disgusting stimuli) and a neutral target (mouth representing the entrance to the body) (Zimmer et al., 2014) that capture visual attention (Vuilleumier, 2005). Therefore, heightened attention could be responsible for high disgust ratings of potentially invasive disgusting stimuli positioned near the mouth. Taken as a whole, the present findings strongly support the idea that disgust is context-dependent (Elad-Strenger et al., 2020).

One surprising, but interesting, finding is the observation that stimuli positioned near the foot, i.e., furthest from the mouth, were rated almost as disgusting as stimuli shown near the mouth. One significant difference between stimuli positioned near the mouth and foot was that food stimuli were more disgusting near the foot, and non-food stimuli were more disgusting near the mouth. Foot odour is caused by bacterial metabolism (Caroprese et al., 2009; Tachibana, 1976), thus, an emotional conflict could be contextually integrated differently as it is the case with the mouth. Visual association with the foot can interact with individual experiences with foot odour, and objects positioned near the foot would be considered at risk of being contaminated with foot bacteria. Furthermore, pictures of feet could be easily associated with hygienic disgust (Haberkamp et al., 2017). Food stimuli near the foot were perceived as more disgusting than non-food stimuli, perhaps because their edibility would be reduced after contact with the foot. This phenomenon can be illustrated by the law of contagion (Rozin et al., 1986). Once in contact with a potential source of contamination, a stimulus acquires its (contaminating) properties.

As expected, females had higher levels of disgust than males (Al-Shawaf et al., 2018; Oaten et al., 2009). Recent studies have shown that females are generally more concerned with food-related risks (Niewczas-Dobrowolska, 2022; van der Vossen-Wijmenga et al., 2022), and engage more in food hygiene behaviour than males (Ammann et al., 2019). It worth noticing, however, that our data showed no specific food-related disgust but a greater disgust sensitivity in females, particularly with emotionally conflicting stimuli (objects positioned near the mouth and foot). Overall, these findings support gender-specific concerns about disease contamination (Al-Shawaf et al., 2018; Curtis et al., 2004; Oaten et al., 2009; Tybur et al., 2009). Perhaps using emotionally conflicting stimuli in future research, rather than conventional disgusting stimuli, would be more beneficial for examining evolutionary hypotheses of gender differences in disgust sensitivity.

In conclusion, our study makes a strong theoretical contribution by showing that disgust sensitivity is context-dependent. Inedible stimuli positioned near the mouth-where the risk of pathogen invasion to the body is high-are perceived as more disgusting than disgusting stimuli positioned in places with a low risk of pathogen contamination (on hands or in isolation). In contrast, edible stimuli placed near odour-producing feet are at risk of contamination and are therefore considered more disgusting than inedible stimuli or stimuli positioned in a neutral place.

Informed consent

Informed consent was obtained from all individual participants included in this study.

CRediT authorship contribution statement

Pavol Prokop: Conceptualization, Methodology, Writing – original draft, Writing – review & editing, Visualization, Supervision. **Jana Fančovičová:** Investigation, Resources. **Dominika Šramelová:** Investigation. **Gaëtan Thiebaut:** Conceptualization, Writing – review & editing. **Alain Méot:** Software, Formal analysis. **Patrick Bonin:** Conceptualization, Writing – review & editing.

Declaration of competing interest

None.

Data availability

Data will be made available on request.

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References

Aharoni, R., & Hertz, M. M. (2011). Disgust sensitivity and anorexia nervosa. *European Eating Disorders Review, 20*(2), 106–110. https://doi.org/10.1002/erv.1124

Al-Shawaf, L., Lewis, D. M., & Buss, D. M. (2018). Sex differences in disgust: Why are women more easily disgusted than men? *Emotion Review, 10*(2), 149–160. https://doi.org/10.1177/17540739177099

Ammann, J., Siegrist, M., & Hartmann, C. (2019). The influence of disgust sensitivity on self-reported food hygiene behaviour. *Food Control, 102*, 131–138. https://doi.org/10.1016/j.foodcont.2019.03.023

Becker, C. A., Flaisch, T., Renner, B., & Schupp, H. T. (2016). Neural correlates of the perception of spoiled food stimuli. *Frontiers in Human Neuroscience, 10*, 302. https://doi.org/10.3389/fnhum.2016.00302

Calder, A. J., Beaver, J. D., Davis, M. H., Van Ditzhuijzen, J., Keane, J., & Lawrence, A. D. (2007). Disgust sensitivity predicts the insula and pallidal response to pictures of disgusting foods. *European Journal of Neuroscience, 25*(11), 3422–3428. https://doi.org/10.1111/j.1460-9568.2007.05604.x

Caroprese, A., Gabbanini, S., Beltramini, C., Lucchi, E., & Valgimigli, L. (2009). HS-SPME-GC-MS analysis of body odor to test the efficacy of foot deodorant formulations. *Skin Research and Technology, 15*(4), 503–510. https://doi.org/10.1111/j.1600-0846.2009.00399.x

Cisler, J. M., Olatunji, B. O., & Lohr, J. M. (2009). Disgust, fear, and the anxiety disorders: A critical review. *Clinical Psychology Review, 29*(1), 34–46. https://doi.org/10.1016/j.cpr.2008.09.007

Curtis, V., Aunger, R., & Rabie, T. (2004). Evidence that disgust evolved to protect from risk of disease. *Proceedings of the Royal Society B, 271*(Suppl. 4), S131–S133. https://doi.org/10.1098/rsbl.2003.0144

Curtis, V., & Biran, A. (2001). Dirt, disgust, and disease: Is hygiene in our genes? *Perspectives in Biology and Medicine, 44*(1), 17–31. https://doi.org/10.1353/pbm.2001.0001

Darwin, C. (1872/1965). *The expression of the emotions in man and animals*. Chicago, IL: University of Chicago Press.

Davey, G. C. (1991). Characteristics of individuals with fear of spiders. *Anxiety Research, 4*(4), 299–314. https://doi.org/10.1080/08917779208248798

Fančovičová, J., Prokop, P., Šramelová, D., Thiebaut, G., Méot, A., Witt, A., Bonin, P., & Medina-Jerez, W. (2022). Does food play a prominent role in visual attention to disgusting stimuli? *Journal of Ethology, 40*(1), 23–29. https://doi.org/10.1007/s10164-021-00722-1

Elad-Strenger, J., Proch, J., & Kessler, T. (2020). Is disgust a "conservative" emotion? *Personality and Social Psychology Bulletin, 46*(6), 896–912. https://doi.org/10.1177/0146167219880

Fessler, D., & Navarette, C. (2003). Domain specific variation in disgust sensitivity across the menstrual cycle: Evidence in favour of an evolutionary account of sexual disgust. *Evolution and Human Behavior, 24*, 406–417. https://doi.org/10.1016/S1090-5138(03)00054-0

Fleischman, D. S. (2014). Women's disgust adaptations. In V. A. Weekes-Shackelford, & T. K. Shackelford (Eds.), *Evolutionary perspectives on human sexual psychology and behavior* (pp. 277–296). New York, NY: Springer.

Haberkamp, A., Glombiewski, J. A., Schmidt, F., & Barke, A. (2017). The DIsgust-RelaTed-Images (DIRTI) database: Validation of a novel standardized set of disgust pictures. *Behaviour Research and Therapy, 89*, 86–94.

Hildebrandt, T., Grotzinger, A., Reddan, M., Greif, R., Levy, I., Goodman, W., & Schiller, D. (2015). Testing the disgust conditioning theory of food-avoidance in adolescents with recent onset anorexia nervosa. *Behaviour Research and Therapy, 71*, 131–138. https://doi.org/10.1016/j.brat.2015.06.008

IBM Corp. (2019). *IBM SPSS statistics for windows, version 26.0*. Released. Armonk, NY: IBM Corp.

Kiss, B. L., Birkás, B., Zilahi, L., & Zsido, A. N. (2022). The role of fear, disgust, and relevant experience in the assessment of stimuli associated with blood-injury-injection phobia. *Heliyon, 8*(12), Article e11839. https://doi.org/10.1016/j.heliyon.2022.e11839

Lorenz, A. R., Libarkin, J. C., & Ording, G. J. (2014). Disgust in response to some arthropods aligns with disgust provoked by pathogens. *Global Ecology and Conservation, 2*, 248–254. https://doi.org/10.1016/j.gecco.2014.09.012

Loynachan, T. E. (2013). Human disease from introduced and resident soilborne pathogens. In E. C. Brevik, & L. C. Burgess (Eds.)*, 2013. Soils and human health* (pp. 107–136). Boca Raton, FL: CRC Press.

Madison, K. C. (2003). Barrier function of the skin: "la raison d'etre'' of the epidermis. *Journal of Investigative Dermatology, 121*, 231–241. https://doi.org/10.1046/j.1523-1747.2003.12359.x

Matchett, G., & Davey, G. C. (1991). A test of a disease-avoidance model of animal phobias. *Behaviour Research and Therapy, 29*(1), 91–94. https://doi.org/10.1016/S0005-7967(09)80011-9

Mulkens, S. A. N., de Jong, P. J., & Merckelbach, H. (1996). Disgust and spider phobia. *Journal of Abnormal Psychology, 105*(3), 464–468. https://doi.org/10.1037/0021-843X.105.3.464

Nesse, R. M. (2001). The smoke detector principle. Natural selection and the regulation of defensive responses. *Annals of the New York Academy of Sciences, 935*, 75–85. https://doi.org/10.1093/emph/eoy034

Niewczas-Dobrowolska, M. (2022). Consumers attitude toward lack of food safety. *British Food Journal, 124*(13), 432–444. https://doi.org/10.1108/BFJ-03-2022-0277

Niyonsaba, F., & Ogawa, H. (2005). Protective roles of the skin against infection: Implication of naturally occurring human antimicrobial agents β-defensins, cathelicidin LL-37 and lysozyme. *Journal of Dermatological Science, 40*(3), 157–168. https://doi.org/10.1016/j.jdermsci.2005.07.009

Olatunji, B. O., Smits, J. A. J., Connolly, K., Willems, J., & Lohr, J. M. (2007). Examination of the decline in fear and disgust during exposure to threat-relevant stimuli in blood- injection-injury phobia. *Journal of Anxiety Disorders, 21*(3), 445–455. https://doi.org/10.1016/j.janxdis.2006.05.001

Pellegrino, R., Crandall, P. G., & Seo, H. S. (2015). Hand washing and disgust response to handling different food stimuli between two different cultures. *Food Research International, 76*, 301–308. https://doi.org/10.1016/j.foodres.2014.12.027

Pellegrino, R., Crandall, P. G., & Seo, H. S. (2016). Using olfaction and unpleasant reminders to reduce the intention-behavior gap in hand washing. *Scientific Reports, 6*, 18890. https://doi.org/10.1038/srep18890

Plutchik, R. (1980). *Emotion. A psychoevolutionary synthesis*. New York: Harper and Row.

Polák, J., Rádlová, S., Janovcová, M., Flegr, J., Landová, E., & Frynta, D. (2020). Scary and nasty beasts: Self-reported fear and disgust of common phobic animals. *British Journal of Psychology, 111*(2), 297–321. https://doi.org/10.1111/bjop.12409

Polák, J., Sedláčková, K., Janovcová, M., Peléšková, Š., Flegr, J., Vobrubová, B., Frynta, D., & Landová, E. (2021). *Measuring fear evoked by the scariest animal: The effect of gender, age, education, and disgust on spider phobia*. Preprint. https://doi.org/10.21203/rs.3.rs-827887/v1

Porzig-Drummond, R., Stevenson, R., Case, T., & Oaten, M. (2009). Can the emotion of disgust be harnessed to promote hand hygiene? Experimental and field-based tests. *Social Science & Medicine, 68*(6), 1006–1012. https://doi.org/10.1016/j.socscimed.2009.01.013

Prokop, P., & Fančovičová, J. (2013). Does colour matter? The influence of animal warning coloration on human emotions and willingness to protect them. *Animal Conservation, 16*(4), 458–466. https://doi.org/10.1111/acv.12014

Prokop, P., & Fančovičová, J. (2016). Mothers are less disgust sensitive than childless females. *Personality and Individual Differences, 96*, 65–69. https://doi.org/10.1016/j.paid.2016.02.064

Prokop, P., & Jančovičová, M. (2013). Disgust sensitivity and gender differences: An initial test of the parental investment hypothesis. In *, 7. Problems of psychology in the 21st century* (pp. 40–48).

Prokop, P., & Randler, C. (2018). Biological predispositions and individual differences in human attitudes toward animals. In R. R. N. Alves, & U. P. Albuquerque (Eds.), *Ethnozoology: Animals in our lives* (pp. 447–466). London, UK: Academic Press.

Prokop, P., Usak, M., & Fančovičová, J. (2010). Health and the avoidance of macroparasites: A preliminary cross-cultural study. *Journal of Ethology, 28*(2), 345–351. https://doi.org/10.1007/s10164-009-0195-3

Oaten, M., Stevenson, R. J., & Case, T. I. (2009). Disgust as a disease-avoidance mechanism. *Psychological Bulletin, 135*(2), 303–321. https://doi.org/10.1037/a0014823

Rappaport, L., Peters, G., Huff-Corzine, L., & Downey, R. (1992). Reasons for eating: An exploratory cognitive analysis. *Ecology of Food and Nutrition, 28*, 171–189. https://doi.org/10.1080/03670244.1992.9991269

Romanovsky, A. A. (2014). Skin temperature: Its role in thermoregulation. *Acta Physiologica, 210*(3), 498–507. https://doi.org/10.1111/apha.12231

Rozin, P., & Fallon, A. E. (1987). A perspective on disgust. *Psychological Review, 94*(1), 23–41. https://doi.org/10.1037/0033-295X.94.1.23

Rozin, P., Millman, L., & Nemeroff, C. (1986). Operation of the laws of sympathetic magic in disgust and other domains. *Journal of Personality and Social Psychology, 50*(4), 703–712. https://doi.org/10.1037/0022-3514.50.4.703

Rozin, P., Haidt, J., & McCauley, C. R. (2008). Disgust. In M. Lewis, J. M. Haviland-Jones, & L. F. Barrett (Eds.), *Handbook of emotions* (pp. 757–776). Guilford, New York: The Guilford Press.

Schielzeth, H., Dingemanse, N. J., Nakagawa, S., et al. (2020). Robustness of linear mixed-effects models to violations of distributional assumptions. *Methods in Ecology and Evolution, 11*, 1141–1152. https://doi.org/10.1111/2041-210X.13434

Tachibana, D. K. (1976). Microbiology of the foot. *Annual Review of Microbiology, 30*(1), 351–375. https://doi.org/10.1146/annurev.mi.30.100176.002031

van der Vossen-Wijmenga, W. P., Zwietering, M. H., Boer, E. P., Velema, E., & den Besten, H. M. (2022). Perception of food-related risks: Difference between consumers and experts and changes over time. *Food Control, 141*, Article 109142. https://doi.org/10.1016/j.foodcont.2022.109142

Vuilleumier, P. (2005). How brains beware: Neural mechanisms of emotional attention. *Trends in Cognitive Sciences, 9*, 585–594. https://doi.org/10.1016/j.tics.2005.10.011

Zimmer, U., Koschutnig, K., Ebner, F., & Ischebeck, A. (2014). Successful contextual integration of loose mental associations as evidenced by emotional conflict-processing. *Plos One, 9*(3), Article e91470. https://doi.org/10.1371/journal.pone.0091470

Tybur, J. M., Lieberman, D., & Griskevicius, V. (2009). Microbes, mating, and morality: Individual differences in three functional domains of disgust. *Journal of Personality and Social Psychology, 97*, 103–122. https://doi.org/10.1037/a0015474

Woody, S. R., & Teachman, B. A. (2000). Intersection of disgust and fear: Normative and pathological views. *Clinical Psychology: Science and Practice, 7*, 291–311. https://doi.org/10.1093/clipsy.7.3.291