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Mothers are less disgust sensitive than childless females

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ABSTRACT

Disgust is a basic emotion which motivates avoidance of disease cues. Females consistently display higher disgust sensitivity than males, although the evolutionary origin of this difference remains unclear. We examined the parental investment hypothesis, which posits that higher disgust sensitivity amongst females is adaptive since mothers may be more sensitive to potential pathogens which can negatively influence their offspring's survival. Contrary to the parental investment hypothesis, mothers demonstrated lower disgust sensitivity than childless females. Neither the total number of reported children, nor having at least one dependent child, resulted in heightened disgust sensitivity. Reduced disgust sensitivity may be caused by the source effect, which suggests that familiar stimuli are perceived to be less disgusting than unfamiliar stimuli. Lower disgust amongst mothers caring for a dependent offspring may facilitate cleaning of offspring's feces, dirty clothes or removal of uneaten foods.

1. Introduction

According to evolutionary perspectives on emotion (Al-Shawaf, Conroy-Beam, Asao, & Buss, 2015; Darwin, 1872; Nesse & Ellsworth, 2009; Tooby & Cosmides, 2008), disgust is a basic human emotion which motivates avoidance of pathogens (pathogen disgust), sexual partners (sexual disgust) and avoidance of moral norm violators (moral disgust) (Tybur, Lieberman, & Griskevicius, 2009). Pathogen disgust demonstrates cross-culturally consistent facial expressions (Ekman, 1972) and its elicitors (e.g., feces) are also cross-culturally similar (Curtis & Biran, 2001; Curtis, Aunger, & Rabie, 2004). Blind people also produce similar disgust expressions as healthy people (Galati, Scherer, & Ricci-Bitti, 1997). Subjects viewing disgust-relevant stimuli show increased brain activation in the occipital–temporal lobe, in the prefrontal cortex, in the thalamus (Phillips et al., 1997) and amygdala (Stark et al., 2003; Schienle, Schäfer, Walter, Stark, & Vaitl, 2005). This suggests that pathogen disgust is a universal emotion that evolved to motivate the avoidance of contact with disease-causing objects or people (Curtis et al., 2004; Oaten, Stevenson, & Case, 2009; Tybur, Bryan, Lieberman, Caldwell Hooper, & Merriman, 2011; Tybur, Lieberman, Kurzban, & DeScioli, 2013).

Females are typically more disgust sensitive than males (e.g., Curtis et al., 2004; Davey et al., 1998; Haidt, McCauley, & Rozin, 1994; Olatunji et al., 2009; Prokop & Fančovičová, 2010; Schienle, Schäfer, Stark, Walter, & Vaitl, 2005; Schienle, Stark, Walter, & Vaitl, 2003; Tybur et al., 2009, 2011; for a review see Oaten et al., 2009). Higher sensitivity in the pathogen disgust domain occurs with pubertal females (Prokop & Jančovičová, 2013) and is influenced by sex hormones (Fessler & Navarette, 2003), suggesting that these differences are related functionally and physiologically to reproduction and mating.

Guided by an evolutionary perspective, there are at least two hypotheses for explaining heightened sensitivity to pathogen disgust amongst females (Fleischman, 2014). The vulnerability to disease hypothesis suggests that females are more disgust sensitive in sexual and pathogen domain due to their higher vulnerability to sexually transmitted diseases such as HIV, chlamydia, human papilloma virus and herpes virus (Madkan, Giancola, Sra, & Tyring, 2006). Higher vulnerability to diseases would explain why females demonstrate a greater avoidance of pathogen-relevant stimuli (Porzig-Drummond, Stevenson, Case, & Oaten, 2009; Prokop & Fančovičová, 2010; Prokop, Usak, & Fančovičová, 2010; Fleischman, 2014). In contrast, the parental investment hypothesis is based on different contributions by females to offspring compared with males (Trivers, 1972). While males produce large amounts of sperm cells, females (particularly mammals) invest time and energy into gravidity, lactation and protection of offspring. It is therefore reasonable to expect that women who care for infants, who need to be protected from infectious diseases, should be more sensitive to disease cues than childless women (Curtis et al., 2004; Fleischman, 2014; Oaten et al., 2009).

In this study, we examined the parental investment hypothesis in order to test why females are more disgust sensitive than males from an evolutionary perspective. We predict that 1) mothers are more disgust sensitive than childless females, 2) females with more children are more disgust sensitive than females with less children and that 3) females with dependent children are more disgust sensitive than females with older children.

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2. Methods

2.1. Participants

The participants were 299 Slovak females (aged 16 to 48 years, $M = 26.8$, $SD = 6.6$) selected based on their age (being older than 16) and reporting a heterosexual orientation. The participants were recruited for the study online via university website and the study was conducted online, similarly as with other research in this field (e.g. Curtis et al., 2004; Fessler & Navarette, 2003). The language of the online questionnaire was Slovak. A total of 124 females reported being childless and 174 females reported having at least one child ($M = 1.6$, $SD = 0.7$, $n = 174$). One female did not report whether she has any children and two females did not report the age of their children. The reported age of the mothers ($M = 29.4$, $SD = 6.94$) was higher than the reported age of the childless females ($M = 23.1$, $SD = 3.5$) (t-test, $t = 9.33$, df = 269, $p < .001$). Thus, the effect of age was controlled in the statistical analyses. The reported age of the children varied between 1 month and 30 years. We classified children till the age of 5 years as dependent, because survival in this age group is at the highest risk of being contaminated by ingestions of pathogens (Curtis, 2011). The survival of these young children is consequently highly dependent on the parent's abilities to control their behavior (Rottman, 2014).

2.2. Research instruments

2.2.1. Disgust inducing visual cues of pathogens

Ratings of objects were used as complementary research instruments because these are often more sensitive than disgust scales (Fleischman & Fessler, 2011a, 2011b, J. M. Tybur, pers. comm.). Following Prokop and Jančovičová (2013), we presented 16 color pictures to participants. Each picture contained one insect and was presented individually. Overall, eight out of the sixteen pictures presented to each participant were insects, either disease-relevant (head lice [*Pediculus capitis*], hard tick [*Ixodes ricinus*], human flea [*Pulex irritans*] and mosquito [*Anopheles gambiae*]), or their disease-irrelevant antipoles (Old World swallowtail [*Papilio machaon*], ladybird beetle [*Coccinella septempunctata*], leaf beetle [*Chrysomela fastuosa*] and azure damselfly [*Coenagrion puella*]). Similar invertebrates were used by Prokop and Fančovičová (2010). The images of the objects holding a potential disease threat were taken from a published study examining people's perception of pathogens (Curtis et al., 2004) and recently used by Little, DeBruine, and Jones (2011) and Prokop, Rantala, and Fančovičová (2012). Each high pathogen image had a low pathogen counterpart, for example, a plate of viscous liquid looking like bodily fluids (high pathogen cue) or a blue chemical dye (low pathogen cue). More details can be found in Prokop and Jančovičová (2013). The pictures were presented in a random order. Each picture was presented for 30 s. During this time, participants rated their disgust toward the presented pictures (e.g., How disgusting would you consider this animal?) on a 7-point scale (1 = not at all, 7 = extremely disgusting). The reliability of the ratings was high (Cronbach's alpha = 0.87). We calculated the individual scores for the disgusting pictures (DP, pictures with disgusting animals and high pathogen cues pooled) and the control pictures (CP, pictures with control animals and low pathogen cues pooled) by summing the responses to the constituent items.

2.2.2. The Three Domain Disgust Scale

There is general agreement that the emotion of disgust has three relatively independent domains: pathogen, sexual, and moral disgust. Pathogen disgust (PD) refers to disgust elicitors caused by the sources of various pathogens (e.g., stepping in dog excrement). Moral disgust (MD) refers to disgust that pertains to social transgressions (e.g., deceiving a friend). These social transgressions broadly include non-normative, often antisocial activities such as cheating, stealing, etc. Sexual disgust (SD) refers to disgust which motivates sexual avoidance of an unsuitable mating partner or other reproductively costly behavior (e.g., performing anal sex or being in a situation with a high probability of having sex with a stranger). We were particularly interested in pathogen disgust and, consequently, decided to use the pathogen disgust (PD) domain of the Three Domain Disgust Scale (Tybur et al., 2009). We also measured moral disgust (MD) from the same questionnaire (Tybur et al., 2009) in order to examine whether possible changes caused by the experimental manipulation would influence the PD domain, but not the MD domain. Both the PD and MD subscales consist of seven Likert scale items (1 = not at all disgusting, 7 = extremely disgusting). Examples of the items are: Stepping in dog excrement, and stealing from a neighbor, respectively. The PD and MD domains had acceptable reliabilities (Cronbach's alpha = 0.74 and 0.80, respectively). We calculated the individual scores of DP and MD by summing the responses to the constituent items.

2.3. Statistical analyses

Continuous data were ln(x + 1) transformed to achieve normality (Kolmogorov–Smirnov test) and a Multivariate Analysis of Covariance (MANCOVA) with having at least one child (or not) as the categorical predictor and the summed scores from the measured domains (PD, MD, DP, and CP) as the dependent measures was performed. Age is known to correlate with disgust sensitivity (Oaten et al., 2009) and was therefore treated as a covariate. In order to see the more detailed influences of having children on disgust domains, the results of univariate ANCOVAs were examined. Partial η^2 was used in order to measure the effect size (0.01 was considered small, 0.04 moderate, and 0.10 large; Huberty, 2002). The total reported number of children (dependent variable) fits with the Poisson distribution. The Generalized Linear Model with the Poisson distribution was therefore used for examining these data.

3. Results

There were no effects of having a child or not on the scores obtained from the PD, MD domain and the DP and CP pictures ($F(4292) = 1.46$, $p = .21$, $\text{eta}^2 = 0.02$). The associations between the participant's age and the dependent variables were, however, significant ($F(4292) = 5.17$, $p < .001$, $\text{eta}^2 = 0.07$). Considering univariate results, mothers demonstrated significantly lower disgust scores than childless females both in the pathogen disgust domain and in the Pathogen pictures (Table 1). Note that the identical means for the pathogen disgust are raw data, but least-squares means of ln(x + 1) transformed data favored higher scores of childless females (least-squares $M = 1.53$, $SD = 0.11$) compared with mothers (least-squares $M = 1.49$, $SD = 0.17$). There were no differences in the moral disgust domain or in the control pictures between these two groups of females (Table 1). Pathogen and moral disgust scores increased with the age of the participants ($F(1295) = 12.75$ and 7.15, $\beta = 0.23$ and 0.18, $p < .001$ and 0.01, $\text{eta}^2 = 0.04$ and 0.02, respectively), but not with the scores from the disgusting and control pictures ($F(1295) = 0.91$ and 0.65, $\beta = 0.06$ and -0.05,

Table 1
Differences in disgust domains and the ratings of pictures between females with and without children (untransformed means and standard deviations). Reported statistical analyses are based on ln(x + 1) transformed data.

	Disgust				Pictures			
	Pathogen		Moral		Disgusting		Control	
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Without children ($n = 124$)	32.2	6.7	35.3	7.2	36.9	9.4	17.9	7.2
Mothers ($n = 174$)	32.2	8.3	35.5	7.7	34.7	10.8	16.3	6.7
$F(1295)$	4.19	–	1.38	–	4.85	–	1.78	–
p	0.04	–	0.24	–	0.03	–	0.18	–
η^2	0.01		0.005		0.02		0.006	

both $p > .33$, $\eta^2 = 0.003$ and 0.002, respectively). Prediction 1 was not supported.

Apart from age, there was no association between pathogen disgust, moral disgust, disgusting and control pictures and the number of children (Table 2, Figs. 1, 2). Prediction 2 was not supported.

When taking into account only mothers, those who reported having at least one dependent child ($n = 138$) scored similarly in all domains than females who had children older than 5 yrs. ($n = 33$) in pathogen and moral disgust as well as in mean scores from the disgusting and control pictures ($F(1168) = 0.08$, 1.09, 0.006 and 3.42, all $p > 0.066$, all $\eta^2 \leq .02$, respectively). Age was, once again, significantly and positively associated with the pathogen disgust score ($F(1168) = 7.21$, $\beta = 0.24$, $p = .008$, eta$^2 = 0.04$) and negatively with the score from the control pictures ($F(1168) = 4.1$, $\beta = -0.18$, $p = .04$, $\eta^2 = 0.02$). There were no associations between age and moral disgust and age and disgusting pictures ($F(1168) = 3.32$ and 0.5, $p = .07$ and .48, $\eta^2 = 0.02$ and 0.003, respectively). Inclusion of childless females or the total number of children (covariate) into the model did not significantly change the results of these analyses. Prediction 3 was not supported.

4. Discussion

This study examined the evolutionary significance of gender differences in disgust sensitivity on a sample of Slovak women. The parental investment hypothesis posits that females are more disgust sensitive than males because infants who are highly dependent on maternal care need to be protected from possible disease-carrying objects or subjects (Curtis et al., 2004; Fleischman, 2014; Oaten et al., 2009). This research did not support this hypothesis because mothers were less disgust sensitive than childless females (prediction 1) and the number of children (prediction 2) or having dependent children (prediction 3) was not associated with disgust sensitivity.

Very few works have explicitly examined the parental investment hypothesis as a possible explanation for heightened disgust sensitivity amongst humans. Prokop and Jančovičová (2013) experimentally manipulated the visual and acoustic exposure of participants to cues associated with parental investment (a picture of an infant's face and the sounds of an infant crying), but found no differences, compared with the control group, in the scores of participants in the pathogen disgust domain or in the ratings of disgusting pictures. Their research was focused, however, on young participants (10–15-year-olds), who could be less sensitive to cues associated with parental investment compared with adults. In a related research conducted on adults, Prokop and Fančovičová (2010) failed to find any associations between the number of children and the fear of a large carnivore predator, although they did not control for the effect of dependent children. These shortcomings were accounted for in the present study, but, once again, no support for the parental investment hypothesis was found.

Mothers showed lower disgust scores for both pathogen disgust and disgusting picture domains compared with childless females. Although the effect sizes were small, no similar differences occurred in the control variables (moral disgust and control pictures) supporting the domain-specificity of these associations. Lower disgust sensitivity amongst mothers can be explained by the source effect suggesting that disgust sensitivity depends on the source of disgusting stimuli

Table 2
Generalized Linear Model with Poisson distribution on total number of reported children.

	df	Wald χ^2	p
Intercept	1	29.21	<.0001
Age	1	82.19	<.0001
Pathogen disgust	1	0.24	.63
Moral disgust	1	0.004	.95
Disgusting pictures	1	0.15	.70
Control pictures	1	1.83	.18

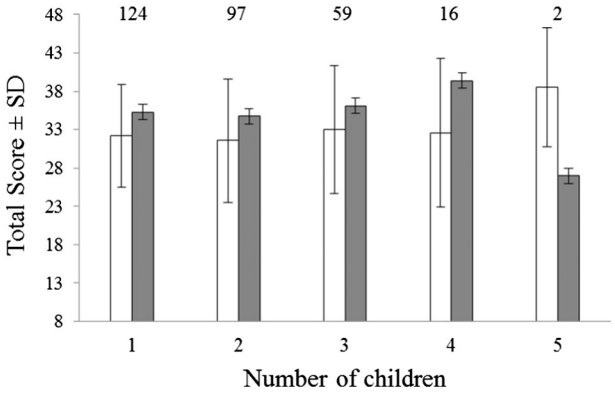

Fig. 1. Total scores from the pathogen disgust (open bars) and the moral disgust (gray bars) domain. The numbers above the bars are the sample sizes.

(Case, Repacholi, & Stevenson, 2006). Disgust sensitivity is lower particularly when considering familiar objects or subjects (Case et al., 2006; Curtis et al., 2004; Peng, Chang, & Zhou, 2013; Van Dongen, 2001). Mothers, for example, consider the feces of their own children (Case et al., 2006) and the smell of their biological children (Dubas, Heijkoop, & van Aken, 2009; Weisfeld, Czilli, Phillips, Gall, & Lichtman, 2003) less disgusting than someone else's feces and the smell of their stepchildren, respectively. Heightened disgust for strangers may be favored by natural selection since strangers are more likely to carry novel pathogens for which the immune system is not yet prepared (Fincher & Thornhill, 2012; Navarrete & Fessler, 2006; Rottman, 2014; Stevenson & Repacholi, 2005). Reduced disgust sensitivity could be adaptive because it allows for cleaning of offspring's feces and dirty clothes, changing diapers or the removal of uneaten foods. Caring for domestic pets, for example, also reduces disgust sensitivity (Prokop & Fančovičová, 2011; Prokop, Fančovičová & Fedor, 2010). This suggests that these results involve the influence of other evolved mechanisms, which relate to habituation to disgust elicitors (Rozin, 2008; Viar-Paxton & Olatunji, 2012).

One alternative to presented explanations is that the parental investment needs not to be predicted by any differences in disgust sensitivity between females with and without children. Perhaps the child protective functions of greater disgust in females begin pre-emptively shortly after puberty (Prokop & Jančovičová, 2013) when the likelihood of conception increases. Human puberty, however, coincides with increased reproductive effort (Ellison, 2003). Further research is required to disentangle the role of parenting and mating in disgust sensitivity amongst females.

The second alternative is that an embryo may be more sensitive to pathogens than a fully formed child, so women are more prone to

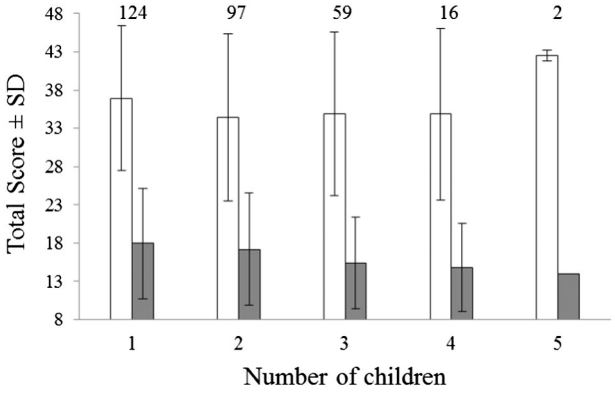

Fig. 2. Total scores from the disgusting pictures (open bars) and the control pictures (gray bars). The numbers above the bars are the sample sizes.

disgust in order to avoid pathogens which may harm the development of their unborn children. This would predict that women who are pregnant will be more sensitive to pathogen disgust than women who are not (Fessler, Eng, & Navarrete, 2005). In addition, women also care more closely for infants than fathers (Maestripieri & Pelka, 2002; Rhoads & Rhoads, 2012), it would pay off for them to avoid any exposure to pathogens that can be transferred to their children. In pre-industrial societies, sexually mature women before menopause are either pregnant or care for children (Galdikas & Wood, 1990). Accordingly, the selection forces are likely to favor pathogen disgust sensitivity which remains heightened irrespective of whether a woman has children or not which produces the observed sex difference.

It is worth noting that disgust sensitivity in this study increased with the age of participants. Old age is associated with a heightened threat of illness (Rubenstein, 2006), and so disgust sensitivity might be expected to increase during aging and reduce disease transmission. This expectation was confirmed in the present study. Oaten et al. (2009) in their review showed that, in contrast to expectations, older people are less disgust sensitive than younger people probably due to more extensive exposure history to disgust elicitors. It is possible that the age range of the participants in this study was not sufficient enough for detecting the previously reported patterns, because a majority of females (78%) were of an age between 16 and 30 years.

The main limit of this study is that it did not investigate to what extent females were taking care of their children, only that they had children. On the other hand, we found that differences between mothers and childless females were domain-specific, thus, motherhood significantly influenced female's responses on disgust domains. Future research should address this shortcoming when examining the associations between parental investment and disgust sensitivity. The second limitation is that the data presented here come from a single culture, whereas the parental investment hypothesis is not limited to any specific culture. More data from larger, more diverse samples obtained from various cultures are necessary before definite conclusions can be made.

To conclude, this study casts doubt on the traditional explanation of the origin of gender differences in disgust sensitivity. Mothers tend to be less disgust sensitive than childless females. This suggests that disgust sensitivity is suppressed by caring for children. Additional research on familiar and unfamiliar disgust elicitors (that is, those disgust elicitors that one comes into contact with regularly as a mother and those that one does not) is necessary to see if this "desensitization" hypothesis is true. It may be that gender differences in disgust sensitivity are more influenced by mating than by parenting.

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