Original Article

QJEP

Quarterly Journal of Experimental Psychology
1–7

DOI: 10.1177/17470218251323236
qjep.sagepub.com
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Is trypophobia more related to disgust than to fear? Assessing the disease avoidance and ancestral fear hypotheses

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Abstract

We examined fear and disgust responses in trypophobia to distinguish between two hypotheses concerning the origin of this phenomenon. According to the hypothesis that trypophobia stems from an ancestral fear of dangerous animals, fear predominates over disgust, whereas the opposite is true according to the disease aversion hypothesis. Currently, the question of which of the two plays a more significant role in trypophobia remains unclear. Adults had to rate on Likert-type scales their level of disgust and fear when presented with photographs of frightening or disgusting stimuli, trypophobia-inducing stimuli, i.e., clusters of holes, or neutral stimuli. They also had to rate the difficulty of viewing these images. Higher levels of disgust than fear were found for the trypophobic images in both the overall sample and in the participants reporting the highest levels of discomfort when viewing them. Trypophobic images had a special status for these latter participants, as they were rated more disgusting than non-trypophobic disgusting images and more frightening than non-trypophobic frightening images. Although disgust is the dominant emotion in trypophobia, fear is also not negligible.

Keywords

Trypophobia; disgust; fear; behavioural immune system

Received: 18 July 2024; revised: 8 January 2025; accepted: 27 January 2025

Trypophobia is a term used to refer to the fear of holes (Cole, 2024). More precisely, it describes a type of visual discomfort or aversion when observing patterns of holes (Cole & Wilkins, 2013). Some individuals have been described as suffering strong negative reactions, such as increased heart rate, nausea, or goosebumps, when viewing objects that contain clusters of holes, such as lotus pods or honeycombs (Le et al., 2020; Vlok-Barnard & Stein, 2017). This aversion to clusters of holes has only recently come under scientific scrutiny, meaning that there is as yet only scant literature on the topic (Martínez-Aguayo et al., 2018; Thiebaut et al., 2024 for a review).

Trypophobia is not limited to young and middle-aged adults, but has also been found in children (Martínez-Aguayo et al., 2018; Suzuki et al., 2023), and in the elderly (Robakis, 2018). Sex differences have also been reported, with females showing stronger negative responses to trypophobic stimuli than males (e.g., Cole et al., 2024; Kupfer & Le, 2018). The fact that trypophobia is not listed in the Diagnostic and Statistical Manual of Mental Disorders (5th ed.; DSM-5, American Psychiatric Association, 2013) casts some doubt on its designation as a phobia (Can et al., 2017), even though it meets the DSM criteria for a phobia specific to an object or situation (Cole, 2024). Le et al. (2015) have developed a validated scale—the trypophobia questionnaire or TQ—that can be used to determine

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whether a person is trypophobic. The TQ comprises 17 items corresponding to symptoms most commonly reported by trypophobic individuals (e.g., feel skin crawl, feel freaked out) and two foil items rated using a 5-point Likert-type scale (1 = *Not at all*; to 5 = *Extremely*). The TQ score can range from 17 to 85, and a score above 31 is a diagnostic indicator of trypophobia. The TQ has revealed that this affliction can be very debilitating for a non-negligible number of people: About 15% of adults experience negative emotions—discomfort or even repulsion—when looking at clusters of holes (Cole & Wilkins, 2013), and the existence of internet-based support groups also suggests that trypophobia is not uncommon (Vlok-Barnard & Stein, 2017).

Some studies have adopted "a bottom-up approach" to this phenomenon and have attempted to identify the specific visual features that are capable of triggering trypophobia. It has been found that "trypophobic visual displays" have high-contrast energy at mid-range and low spatial frequencies (Cole & Wilkins, 2013; Sasaki et al., 2017). Cole and Wilkins (2013) studied the spectral compositions of images of what are considered to be the most venomous animals, such as the Brazilian wandering spider, the blue-ringed octopus, the deathstalker scorpion, or the poison dart frog, and found them to be very similar to those of trypophobic images. The aversion to trypophobic images could therefore be explained by a fear of dangerous animals, leading to the *dangerous animal* hypothesis (Cole & Wilkins, 2013; Van Strien & Van der Peijl, 2018), one of the two "evolutionary accounts" of trypophobia (see also in the paragraph below). The other account of trypophobia, named *the disease avoidance* hypothesis, refers to avoidance of contagious (skin) diseases (Imaizumi et al., 2016; Kupfer & Le, 2018) and claims that negative emotions when perceiving trypophobic stimuli arise because people associate their surfaces with infectious diseases (e.g., smallpox, tuberculosis), thus triggering pathogen avoidance (Yamada & Sasaki, 2017). Indeed, pathogen avoidance is the ultimate function of the behavioural immune system, in which disgust is a central emotion (Schaller, 2016; Schaller & Park, 2011; Thiebaut et al., 2021). Disgust is thought to have evolved to avoid contact with things (e.g., poisonous food), people (e.g., sick congeners), or situations (e.g., places during the COVID-19 pandemic) that pose a risk of disease (Curtis & de Barra, 2018).

The two evolutionary accounts of trypophobia thus lead to different hypotheses regarding the role of fear and disgust, with the dangerous animal hypothesis placing greater emphasis on fear and less on disgust, and the opposite being the case for the disease avoidance hypothesis. These two threat management systems are complementary, as they both protect people from potential threats. However, they differ in that fear triggers self-protection, whereas disgust activates disease avoidance (Neuberg et al., 2011). Current research suggests that the emotion of fear is less involved in trypophobia than the emotion of disgust (Martínez-Aguayo et al., 2018; Vlok-Barnard & Stein, 2017). Vlok-Barnard and Stein (2017) found that 60.5% of the participants reported more disgust than fear when confronted with pictures of clusters, whereas only 5.1% of them reported more fear than disgust. Moreover, trypophobia proneness (measured by the TQ, Le et al., 2015) has been found to be predicted by core disgust (Imaizumi et al., 2016) and pathogen disgust rather than by moral or sexual disgust (Kupfer & Le, 2018; McAuley et al., 2019). Findings from research using physiological measures are also consistent with the hypothesis that disgust is the dominant emotion involved in trypophobia. To give a few examples: Images containing clusters of holes elicit greater pupil constriction than fear-inducing images (Ayzenberg et al., 2018); the electrodermal activity of trypophobic individuals (but not of non-trypophobic controls) increases in response to trypophobic pictures (Pipitone et al., 2017), as does heart rate (and heart rate variability) (Le et al., 2020). These physiological responses are consistent with those obtained for disgust and suggest that the parasympathetic nervous system is activated (Calder et al., 2001; De Jong et al., 2011; Kreibig, 2010; Levenson, 1992; Stark et al., 2005). Overall, the available evidence favours the disease avoidance hypothesis over the dangerous animal hypothesis.

Our aim was to further investigate the involvement of both fear and disgust in trypophobia, as we expected this to enable us to take a position on the two theoretical evolutionary accounts of trypophobia: the *dangerous animal* account (Cole & Wilkins, 2013; Van Strien & Van der Peijl, 2018) and the *disease avoidance* account (Furuno et al., 2017; Imaizumi et al., 2016; Kupfer & Le, 2018; Pipitone et al., 2022; Yamada & Sasaki, 2017). Photographs of (1) clusters of holes, (2) frightening scenes, (3) disgusting scenes, or (4) neutral scenes were used. Participants had to rate these photographs on Likert-type scales for both fear and disgust. We used rated difficulty (on 5-point Likert-type scales) in fixating trypophobia-inducing images—hereafter "trypophobic" images/photographs—as a proxy for trypophobia sensitivity. However, similar ratings were also collected for the other types of images. If the predominant emotion is fear, this would support the ancestral fear account, whereas finding that disgust is predominant would support the disease avoidance account. More importantly, we hypothesised that trypophobic stimuli should be rated as more disgusting than fear-inducing if the disease avoidance hypothesis is correct, and vice versa if the dangerous animal hypothesis is correct. Most of the studies using photographs to measure emotional responses in trypophobia have compared photographs of clusters of holes with fear-inducing photographs (e.g., snakes, spiders) (e.g., Ayzenberg et al., 2018; Can et al., 2017; Furuno et al., 2017; Pipitone et al., 2017). Very few of them have included disgust-inducing photographs (e.g., DiMattina et al., 2024; Kupfer & Le, 2018). In the present research, we used both types of photographs as a benchmark to test the difference between fear and disgust ratings for these and for trypophobic photographs as a function of the rated level of difficulty of viewing the trypophobic stimuli.

We predicted that neutral images should receive the lowest ratings for both fear and disgust and should be more comfortable to view than the other images.

Method

Participants

Participants were 291 volunteers (257 females; mean age=21.38 years; *SD*=6.30). Most of them (54%) were psychology students at Université Bourgogne Europe and received course credits for their participation. They were recruited online through the Facebook social media platform or were contacted by e-mail via mailing lists. To our knowledge, no similar study has been conducted, and it was therefore difficult to estimate reasonable effect sizes required to calculate the sample size. We therefore planned to have a larger sample than Pipitone et al. (2022) (*N*=204), who used various kinds of pictures (e.g., body parts, animals, objects) with and without holes to measure comfort levels. Written informed consent was obtained from all of the participants before the beginning of the study. All the study procedures were approved by the Statutory Ethics Committee of the University of Bourgogne Franche-Comté.

Material and procedure

We chose 40 colour pictures: 10 frightening pictures (e.g., spider, snake, a person pointing a gun), 10 disgusting pictures (e.g., surgery, dirty toilets, mouldy burger), and 10 neutral pictures (e.g., spoon, eggs, train), all taken from the International Affective Picture System, IAPS; Lang et al., 2005), as well as 10 trypophobic pictures which were taken from the internet (www.trypophobia.com). For instance, these depicted a lotus seed head, a honeycomb, pancakes, and a rock wall full of holes. No pictures could be described as offensive. We used picture processing software (*Gimp*) to resize all the pictures to 640 × 480 pixels. Frightening and disgusting pictures were matched on arousal (p=.99) and valence (p=.38) based on Chapman et al.'s (2013) norms. The different norms are presented in Table 1.

The survey was created with LimeSurvey (www.limesurvey.com) and performed online. On the first page, a brief instruction on the conduct of the study was given, and the participants had to provide informed consent. They were then asked to provide demographic information: gender, age, native language, and educational level. Next, the different pictures were randomly presented, and the participants were asked to rate them on three dimensions: fear, disgust, and difficulty of viewing the picture (5-point Likert-type scale; 0: "*no emotion/no difficulty*" and 5: "*very much emotion/very difficult*"). Several versions of the survey were created to balance the order of presentation of the scales.

Table 1. Mean scores (and standard deviations) for each category of pictures (disgusting, fear-inducing, neutral).

Rating	Disgusting	Fear-inducing	Neutral
Disgust	6.34 (1.10)	3.09 (1.19)	1.42 (.36)
Fear	4.12 (.84)	6 (.67)	1.89 (.45)
Arousal	5.04 (.56)	5.05 (.52)	2.20 (.57)
Valence	2.85 (.59)	3.19 (.51)	6.55 (.58)

Scales are 1–9 Likert-type scales. The values are taken from Chapman et al. (2013).

Results

The by-participant means of the three ratings were computed. First, the disgust and fear ratings were entered as dependent variables in an analysis of variance, with the two emotions and the four categories of pictures as within-participant factors. Using the Holm–Bonferroni corrections, the trypophobic pictures were pairwise compared with all other pictures for the two emotions, and the same was done for the differences between disgust and fear ratings for all types of pictures. Similarly, the means of the participants' visual discomfort ratings for the different types of pictures were compared. Second, to examine in more detail the characteristics of disgust and fear in trypophobics—a group recently estimated by Cole et al. (2024) to account for 9.7% of a sample of 2,558 adults from the United Kingdom—the same analyses as described above were conducted on the subsets of participants whose visual discomfort ratings were (1) above the 9th decile (n=27) and (2) above the 8th decile and less than or equal to the 9th decile (n=29). Because the interaction effect was significant in all analyses (both ps < .001 and $n_p^2 > .7$), only pairwise comparisons are reported.

Across the sample as a whole, trypophobic pictures were rated as less disgusting than disgusting pictures, $t(290)=-22.09$, $p_{Holm} < .001$, $\delta=-2.01$,[1] and also as less frightening than frightening pictures: $t(290)=-12.33$, $p_{Holm} < .001$, $\delta=-1.04$ (see Figure 1). Trypophobic pictures were also rated as less frightening than disgusting pictures, $t(290)=-5.91$, $p_{Holm} < .001$, $\delta=-0.42$, but more disgusting than frightening pictures, $t(290)=7.27$, $p_{Holm} < .001$, $\delta=0.61$. In addition, the level of disgust was higher than the level of fear for the disgusting pictures, $t(290)=40.4$, $p_{Holm} < .001$, $\delta=2.22$, and the same was true for trypophobic pictures, albeit to a lesser extent, $t(290)=12.19$, $p_{Holm} < .001$, $\delta=0.63$. The opposite was true for the frightening pictures,

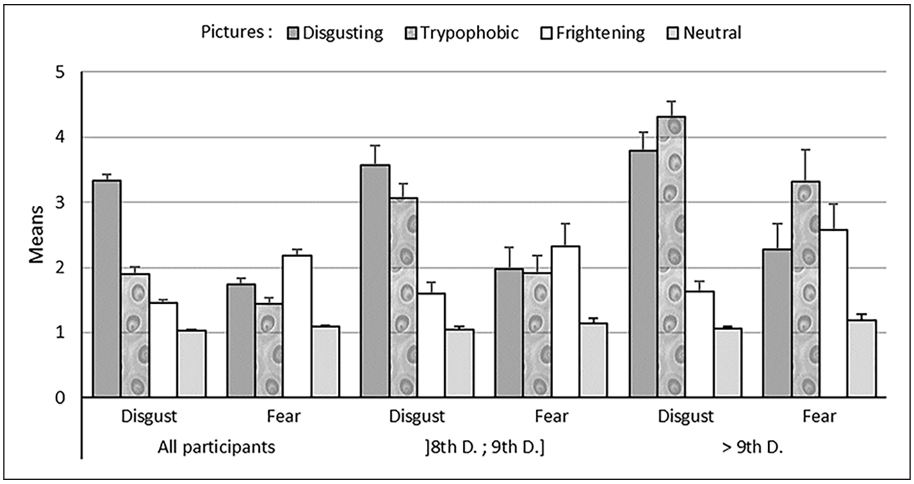

Figure 1. Means of emotional ratings as a function of trypophobic discomfort intervals.
]8th D.; 9th D.] = Participants with visual discomfort ratings of trypophobic pictures above the 8th decile and below or equal to the 9th decile; >9th D. = Participants above the 9th decile. Error bars represent two standard errors of the mean.

$t(290)=-17.99$, $p_{Holm}<.001$, $\delta=-1.01$, and, surprisingly, this was also the case for the neutral pictures, $t(290)=-6.67$, $p_{Holm}<.001$, $\delta=-0.08$. In the visual discomfort analysis, the difficulty of viewing the pictures differed significantly between picture types, $F(3, 870)=302.45$, $p<.001$, $n_p^2=.51$, with trypophobic pictures being rated as less difficult to view than disgusting pictures, $t(290)=-12.46$, $p_{Holm}<.001$, $\delta=-1.11$, but more difficult to view than frightening pictures, $t(290)=3.68$, $p_{Holm}<.01$, $\delta=0.3$. Finally, it should be noted that across the overall sample, and regardless of the type of rating, the means of the neutral pictures were reliably lower than those of all other types of pictures (all $p_{Holm}<.001$, $\delta_{min}=-0.7$).

In contrast to what was observed for the overall sample, participants with visual discomfort ratings above the 9th decile rated trypophobic pictures as more disgusting than disgusting pictures, $t(26)=2.37$, $p_{Holm}<.05$, $\delta=0.67$, and also both as more frightening than frightening pictures, $t(26)=2.46$, $p_{Holm}<.05$, $\delta=0.95$, and more frightening than disgusting pictures, $t(26)=4.43$, $p_{Holm}<.001$, $\delta=1.33$. The comparisons of disgust and fear for each type of picture yielded the same pattern of results as those reported for the full sample. However, the differences between the two emotions appeared more comparable for disgusting pictures, $t(26)=9.64$, $p_{Holm}<.001$, $\delta=1.95$, and trypophobic pictures, $t(26)=4.52$, $p_{Holm}<.001$, $\delta=1.28$.

The analysis including only participants with visual discomfort ratings above the 8th decile but below or equal to the 9th decile revealed ordering properties roughly comparable to those observed for the overall sample: Disgust ratings for trypophobic pictures were lower than those for disgusting pictures, $t(28)=-2.93$, $p_{Holm}<.05$, $\delta=-0.77$, and fear ratings for trypophobic pictures were lower than those for frightening pictures, $t(28)=-2.51$, $p_{Holm}<.05$, $\delta=-0.61$ (Figure 1). The pattern of the other examined differences was also the same as that observed with all participants included, with the exception of fear ratings, which did not differ significantly between trypophobic and disgusting pictures, $t(28)=-0.51$, $p_{Holm}>.1$, $\delta=-0.09$. Finally, it should be noted that the mean ratings of the trypophobic pictures were higher for the participants above the 9th decile than for those between the 8th and the 9th deciles (disgust: $t(54)=7.63$, $p_{Holm}<.001$, *Hedge' g*$=2.01$; fear: $t(54)=5.13$, $p_{Holm}<.001$, $g=1.35$; visual discomfort: $t(54)=15.33$, $p_{Holm}<.001$, $g=4.04$), whereas the differences were not significant for the other types of pictures (all $p_{Holm}>.1$, $g_{max}=0.3$).

Discussion

We examined whether trypophobia is better explained by the ancestral fear or the disease avoidance account. To investigate this issue, we presented adults with photographs of trypophobic images and collected subjective ratings of fear and disgust. We also included photographs that were either frightening or disgusting, but without clusters of holes. These images were used as "benchmarks" to compare the disgust and fear scores obtained when viewing these images with those obtained for trypophobic images. What do the findings tell us?

Considering the sample as a whole, the emotion of disgust clearly dominates that of fear for trypophobic images. More interesting are the findings obtained when the estimated difficulty in fixating trypophobic images is used as an index of sensitivity to trypophobic stimuli. Compared to individuals in the adjacent interval, individuals at the extreme end of the distribution (fixation scores > 9th decile)—whom we refer to as trypophobics—experience a greater sense of disgust in response to trypophobic images than that observed for "non-trypophobic" disgust-inducing images; similarly, fear is greater for trypophobic images than for "non-trypophobic" fear-inducing images. Trypophobic images therefore have a very special status for these individuals. Disgust therefore appears to be the emotion that is felt most strongly in trypophobia. However, the emotion of fear is also present to a significant degree, and the term trypophobia, which literally means fear of holes, is therefore not a misnomer. One might ask whether trypophobic participants produced higher ratings in response to trypophobic stimuli simply because these stimuli elicit more negative valence responses and/or more arousal, which would account for the high level of fear in trypophobic individuals. As we did not collect valence and arousal scores for trypophobia-inducing photographs, we cannot answer this question directly. It is an interesting possibility that could be explored in more depth in future studies of trypophobia.[2] However, if valence and/or arousal increased ratings for all negative emotions including fear, one cannot easily account for these two dimensions being restricted to trypophobic photographs in trypophobic participants. We would expect the same phenomenon to occur in these participants for the non-trypophobic fear- and disgust-inducing pictures. Indeed, a comparison of the participants "above the 9th decile" with those in the "]8th D.; 9th D.]" revealed no increase in the fear and disgust scores for these emotional but non-trypophobic images. Picture-based studies of trypophobia have rarely taken valence and/or arousal into account (only three out of 18 studies). Even though a careful review of these studies provides no clear answer concerning the possible contribution of these dimensions in the processing of trypophobic images, it nevertheless appears that specific reactions to trypophobic stimuli can be observed "independently" of arousal and/or valence.

The present study contributes to the debate surrounding the two competing hypotheses on the origin of this phobia. The results support the hypothesis that trypophobia is related to the behavioural immune system, whose ultimate function is to protect from pathogens and in which disgust is a key emotion (Schaller & Park, 2011). Both disgust and fear have evolved to elicit responses to threatening stimuli, but ultimately perform the same task through different physiological pathways. While disgust activates parasympathetic pathways, resulting in decreased heart rate and respiration (Gilchrist et al., 2016), fear excites the sympathetic nervous system and is accompanied by rapid heart and respiratory rates (Barrett et al., 2016). We interpret these simultaneous reactions as follows: The perception of trypophobic images induces avoidance of possible disease contamination and also elicits flight responses, allowing subjects to escape through the emotion of fear. Snakes provide an example of a similar elicitation of a simultaneous mixture of these two emotions in humans (Rádlová et al., 2019). Further work is needed to reconcile these two hypotheses, which are not mutually exclusive.

Our study has a number of limitations that need to be considered. First, the stimuli used. To compare the levels of disgust elicited by trypophobic images, we used other images taken from different disgust domains such as hygiene or body products. The same criticism applies to the fear images. In fact, it would be advisable to conduct a study in which the choice of disgust and fear images is more limited to compare specifically trypophobic images with specific domains of fear and disgust. In particular, it would be interesting to take disgusting images representing skin diseases or lesions and compare them specifically with trypophobic images. Second, we collected subjective measures of disgust and fear, and it would be interesting in future studies to collect objective data such as electrodermal or facial muscle measures. For example, Song and Koyama (2024) found that dot patterns (referred to as Hasu-Colla, with *Hasu* meaning lotus and *Colla* meaning collage in Japanese) stimulate the parasympathetic nervous system through pupillary constriction, suggesting that more disgust than fear is elicited. Third, our study was conducted with a predominantly female sample, and it would be interesting to examine gender differences, as women are more likely to reach the threshold for trypophobia than men (Cole et al., 2024; Kupfer & Le, 2018). Finally, we considered the most trypophobic individuals based on visual discomfort ratings, but the TQ (Le et al., 2015) could be used instead in future studies.[3]

In conclusion, our study shows that both disgust and fear are involved in trypophobia, with disgust being the dominant emotion, providing new empirical data in support of the disease avoidance hypothesis. This information may be useful to clinicians working with individuals who suffer from this strange disorder.

Declaration of conflicting interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Funding

The author(s) received no financial support for the research, authorship, and/or publication of this article.

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Data accessibility statement

The data from the present experiment are publicly available at the Open Science Framework website: https://osf.io/748kc/.

Notes

1. The reported δ were computed as the ratio of the difference between the observed means over the square root of the mean square error obtained as if a between-participants design had been used, thereby allowing us to describe the changes in the original scores [and not in the within-subjects metric, which depends on difference scores (e.g., Kline, 2013, p. 199)].
2. We thank one anonymous reviewer for suggesting this explanation to us.
3. It should be noted, however, that visual discomfort ratings and TQ scores are correlated (DiMattina et al., 2024).

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