Received: 12 April 2021 | Revised: 29 September 2021 | Accepted: 18 October 2021

DOI: 10.1002/hsr2.496

Health Science Reports Open Access WILEY

RESEARCH ARTICLE

Visual representations of SARS-CoV-2, emotions, and risk perception of COVID-19

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Abstract

Background and Aims: Before COVID-19 was declared a global pandemic, the U.S. Centers for Disease Control and Prevention (CDC), the National Institute of Allergy and Infectious Diseases (NIAID), and many other organizations published many images of its pathogen (namely SARS-CoV-2) to raise public awareness of the disease. Despite their scientific and aesthetic values, such images may convey metaphoric meanings and cause a subsequent impact on viewers' fear and disgust. This study investigated how exposure to the SARS-CoV-2 images might shape viewers' fear, disgust, and risk perception of COVID-19.

Methods: Seventy images depicting the SARS-CoV-2 were collected from the websites of CDC, NIAID, and third-party organizations in early 2020. We first showed the images to a group of 492 adults recruited from the Amazon Mechanical Turk (MTurk) and asked them to rate their levels of fear and disgust for each image. Results of this pre-test allowed us to identify images that evoked high, medium, and low levels of fear and disgust, which were then used as treatment stimuli for an online experiment with a national sample of 500 U.S. adults.

Results: Exposure to the selected SARS-CoV-2 images caused different levels of disgust, but not fear, among the members of the national sample. Noticeably, the images evoking the highest level of disgust backfired among those who were least concerned about COVID and caused less fear than images evoking the lowest level of disgust. Image exposure was not associated with risk perception of the disease.

Conclusion: This study found that the seemingly objective visualizations of the SARS-CoV-2 are not emotionally neutral. Scientists, agencies, and media professionals should be mindful of the potential emotional impact of science visualizations, such as when creating the iconic image for COVID-19 or other infectious diseases.

KEYWORDS
COVID-19, emotions, infectious diseases, public understanding, science visualizations

1 | INTRODUCTION

Before COVID-19 was declared a global pandemic in March 2020, the CDC and NIAID published a series of publicly accessible pictures depicting the pathogen that causes the disease, named Severe Acute Respiratory Syndrome coronavirus 2 (SARS-CoV-2). These SARS-CoV-2 images were quickly adopted by various forms of media and frequently appeared in public education materials. The Emergency Operations Center of the CDC tasked its visual information specialists to illustrate an image of the virus shortly after initial cases were identified.[1] This illustrative image gave the virus a detailed, solo close-up shot and was meant to convey the "immediacy and clarity" that the public craved at the beginning of the crisis.[2] The red and gray "spiky ball," as it was colloquially known, had become one of the most identifiable icons that visually defined the pandemic in the United States.

Later, the NIAID posted more than 100 of SARS-CoV-2 images on its Flickr account for public consumption. These images were produced by the Rocky Mountain Laboratories using the scanning electron microscopes (SEM) and transmission electron microscopes (TEM).[3] While SEM images show how the new coronavirus emerges from the surface of human cells, the TEM images produce cross-sections of its inner structure. Differing from the CDC's spiky ball image, these images do not reveal the ultrastructural morphology exhibited by the coronavirus but display what scientists can observe in their labs. Alongside their aesthetic and scientific values, these images also serve as prominent visual cues for the virus and frequently appear on mass media and other popular outlets.

The visual representations of the SARS-CoV-2 not only show what the virus may "look" like, but also convey metaphoric meanings that can subsequently evoke negative emotions, such as disgust and fear. Disgust is a unique emotion that initially evolved as an effective mechanism for orally rejecting harmful substances.[4] In a similar vein, fear, which is "an intervening variable between sets of context-dependent stimuli and suites of behavioral response," helps humans avoid or cope with threat.[5] Both emotions present evolutionary significance in protecting human beings from exposure to infectious disease.[4,6]

In centuries past, lethal infectious diseases were often visually portrayed as metaphoric figures (eg, grim reaper, hunting ghosts) that instill a sense of the supernatural and terrifying.[7] Such metaphoric images function as "visual bites" that "signal the presence of a prepackaged unit of thought."[8] For example, although the "spiky ball" image and similar renditions portray the virus as lifeless, to some, they look like "menacing alien machines" that can be perceived as artificial and invasive.[9] Similarly, many TEM and SEM images display grouped circles and cluttered dots that resemble other pathogens, such as bacteria and fungus. Images displaying irregular 3D shapes can remind viewers of visually similar threats, such as tumors or cancer cells. As a result, individuals may transmit negative impressions of the source threats, such as harmful, infectious, and intrusive to the SARS-CoV-2 and hence perceive high levels of fear and disgust.[10]

Furthermore, the presence of obnoxious colors and visual patterns can heighten the potential emotional effects of metaphoric meanings. Decades of research showed that colors are frequently associated with emotions of various valence and strength.[11,12] The effects of color on emotions are primarily caused by hue and can be explained by the color-meaning associations.[13] For example, viewers may associate the combined use of yellow and green in some SARS-CoV-2 images with vomit and therefore develop feelings of sickness and disgust.[13] What is more, the other color dimensions, including saturation and brightness, can interact with hue to shape viewers' emotions.[14] For example, although red and green usually evoke stronger and more positive feelings than blue, the reverse is true when the colors are highly saturated.[14] That explains why many SARS-CoV-2 images with predominately lowly saturated and dull colors appear to be more dreadful and less pleasant than those with highly saturated and bright colors.

Noticeably, images with high-contrast energy at low spatial frequencies, such as holes or repetitive patterns, can trigger disgust and even induce trypophobia, which is an aversion to the sight of irregular patterns or clusters of small holes.[15] Such visually intense patterns may even cause fear when being used in combination with bright and highly saturated coloration (eg, snakes with expressive scales).[16] Many SEM images display clutters of dotted viruses, while the TEM images show groups of crown-shaped circles. These images often use bright, saturated colors to portray the virus while using muted, dull colors to de-emphasize the background. Although the contrast helps create visual hierarchy and enhances the visibility of portrayed viruses, it may elicit fear and disgust because of the visual intensity of the patterns.

Given these considerations, we hypothesized that the SARS-CoV-2 images of various visual appearance will influence people's fear and disgust toward the pathogen. Furthermore, we wondered if exposure to the images that elicited high levels of fear and disgust would polarize viewers' emotions, such that those who feel very negatively about COVID-19 would perceive significantly more fear and disgust when viewing these images than those who feel less negative. In addition, given the inherent relationship between negative emotions and risk perception,[17-20] we hypothesized that exposure to images that elicit the highest level of fear and disgust will cause a significantly higher level of risk perception than exposure to the images that evoke the lowest level of fear and disgust. We examined these hypotheses in the following study.

2 | METHODS

The goals of this study were to (a) identify the existing SARS-CoV-2 images that can trigger different levels of fear and disgust and (b) examine how such images may influence a national sample of U.S. adults' emotional response to COVID-19 and their risk perception of the disease.

2.1 | Experimental stimuli

To achieve these goals, we first searched and collected all SARS-CoV-2 images available via the CDC's Public Health Image Library[21]

and the NIAID's Flickr page.[22] In addition, we visited the Association of Medical Illustrator's website and collected all images depicting the pathogen featured in an article titled "Medical and Scientific Visualization of SARS-CoV-2."[23] This search allowed us to identify high-quality images produced by third-party illustrators. In total, we collected 84 unique images. To assure the formatting consistency of the visual stimuli, we excluded images with annotations, labels, captions, or logos indicating the original source (N = 14). The final sample of 70 images included all unduplicated images published by CDC and NIAID, as well as some artistic and illustrative portrayals of the viruses generated by third-party organizations, artists, and illustrators.

To further identify images that can evoke distinct levels of fear and disgust among viewers, we conducted an online survey of 492 participants aged 18 or older recruited from the Amazon MTurk on June 10, 2020. Notably, Amazon MTurk participants tend to be younger, more educated, and liberal compared to the U.S. general population.[24] We displayed the selected images in a random order and asked participants two questions regarding how much fear and disgust they had felt after seeing each image on a five-point-scale (1 = none at all to 5 = a great deal). Each participant received $2 as compensation upon the completion of the survey.

Results of this pre-test showed that the levels of fear and disgust are highly correlated (Pearson's $r = .945$, $P < .001$). However, there was significant difference in the level of fear and disgust evoked by different images (see Figure 1). It appeared that images that evoke relatively high levels of fear and disgust are likely to resemble other disease-causing threats (eg, tumors, cancer cells, bacteria etc) and/or display a combination of highly contrasting colors and trypophobia-inducing patterns. In contrast, images that were composed of regular shapes (eg, circle), simple patterns, and achromatic or less intrusive colors (eg, black, gray, light blue etc) were likely to elicit lower levels of fear and disgust. Noticeably, systematically identifying the exact visual features that associate with fear and disgust in the collected images of SARS-CoV-2 was beyond the scope of the current study. What we attempted to do was to identify a subset of SARS-CoV-2 images that could reliably trigger distinct levels of disgust and fear and be used as experimental stimuli for the follow-up study.

Based on the ratings of each image, we selected and grouped images that triggered high, medium, and low levels of disgust and fear. Also, to maximize the representativeness of the selected images, we purposefully chose images displaying a variety of colors, shapes, visual patterns for each group (see Figure 2). Results showed that Group 1 images elicit the highest level of fear ($M_{Fear} = 2.91$, $SD_{Fear} = 1.08$) and disgust ($M_{Disgust} = 3.07$, $SD_{Disgust} = 1.06$) than Group 2 images ($M_{Fear} = 2.71$, $SD_{Fear} = 1.01$; $M_{Disgust} = 2.72$, $SD_{Disgust} = 1$) and Group 3 images ($M_{Fear} = 2.31$, $SD_{Fear} = 0.98$; $M_{Disgust} = 2.30$, $SD_{Disgust} = 0.98$). A series of paired t-tests indicated that images selected for Group 1 evoke higher level of disgust than those in Group 2 ($t_{489} = 11.94$, $P < .001$) and Group 3 ($t_{489} = 17.80$, $P < .001$). Group 1 images also evoked higher level of fear than those in Group 2 ($t_{489} = 7.30$, $P < .001$) and Group 3 ($t_{489} = 16.19$, $P < .001$). Similarly, Group 2 images triggered higher level of disgust ($t_{489} = 12.68$, $P < .001$) and fear ($t_{489} = 13.91$, $P < .001$) than those in Group 3. These images were used as experimental stimuli for the treatment groups.

2.2 | Data, sample, and procedure

An online experiment was fielded between July 23 and August 3, 2020, using a national sample of 500 U.S. adults aged 18 or older. The sampling firm, Marketing Systems Group, recruited SSRS Opinion Panel members randomly based on nationally representative Address Based Sample (ABS) design. The SSRS Opinion Panel is a nationally representative panel of U.S adults aged 18 or older, run by the market and survey firm, SSRS. To recruit participants from under-represented

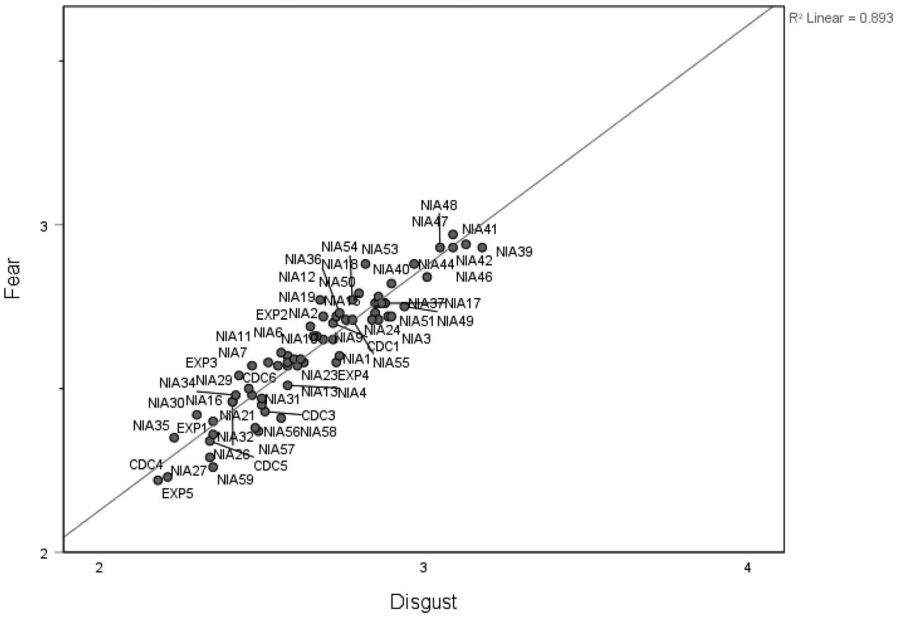

FIGURE 1 Perceived fear and disgust for SARS-Cov-2 images. Amazon MTurk workers' average levels of fear and disgust reported post exposure to 70 SARS-CoV-2 images. Data point labels indicated the image ID. Full scales on both axes are 1 to 5. Data was collected on June 10, 2020

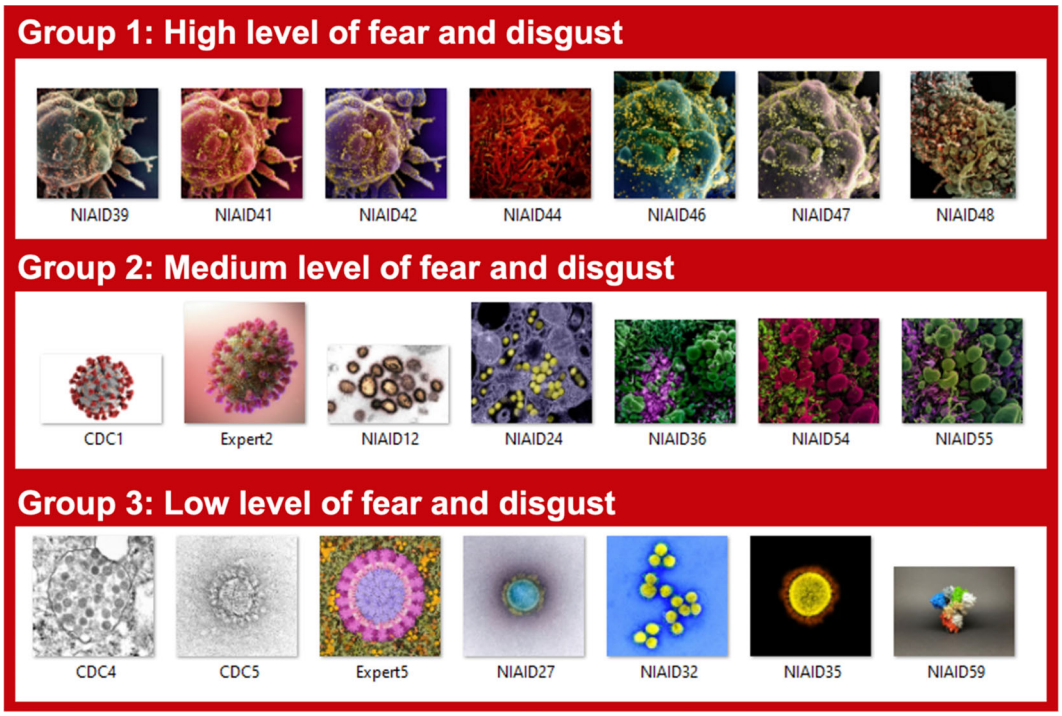

FIGURE 2 SARS-Cov-2 images evoking different levels of fear and disgust. Images of various appearance were selected based on the results of the Amazon MTurk pre-test. Group 1 images evoked the highest level of fear and disgust, whereas Group 2 and Group 3 image evoked the medium and low levels of fear and disgust, respectively. Readers may want to use color mode when printing these images as the visual difference can be much less discernable when images are in black and white

groups, a bilingual, random digit dialing (RDD) platform was used to recruit participants who are Hispanic, African American, or from lower income and lower education populations.

Upon the completion of the study, participants received $5 in the form of an electronic gift card. In total, 1297 panelists were contacted; the response rate was 43% for the RDD sample and 35% for the ABS sample. All responses were weighted using the weights adjusted for sex, age, education, census region, civic engagement, household telephone usage, and internet access.

Participants were randomly assigned to one of four groups, three of which viewed the SARS-CoV-2 images selected based on results of the pre-test (ie, Group 1, Group 2, and Group 3 images), whereas the fourth group received no visual stimuli. Respondents first answered a series of questions regarding their experience with COVID-19 and emotional response to the pandemic. After viewing seven images, participants reported fear, disgust, and risk perception of COVID-19.

2.3 | Measures

Disgust and fear were reported using two questions: "Thinking about the images you just saw, how much disgust/fear do you feel?" on a five-point-scale (1 = none at all to 5 = a great deal). Two questions were asked to measure participants' risk perception of COVID-19. The first question asked, "How risky do you think COVID-19 is?" on a five-point scale (1 = not risky to 5 = very risky). The second question measured participants' worry level regarding COVID-19 (1 = not worried to 5 = very worried). The two items were averaged to measure risk perception. In addition, participants reported how they feel about COVID-19 using a series of semantic differential scales (from 1 to 5), including "depressed – cheerful," "sad – happy," "angry-peaceful," "concerned – unconcerned," "afraid – unafraid." The mean value was used to measure participants' preexisting feelings toward the COVID-19 pandemic.

2.4 | Data analysis

We conducted the statistical analyses between February 10 and March 31, 2021, using SPSS, version 26 (IBM Corporation). To test our hypotheses, we used a series of factorial analyses of variance to examine the main effects of experimental treatment on fear, disgust, and risk perception. We also conducted analysis of covariance (ANCOVA) to examine the interactive effects of experimental treatment and individuals' preexisting feelings toward COVID-19 on fear and disgust. All *P* values were 2-sided, and we considered a *P* value of less than .05 to be significant.

2.5 | Ethics and permissions

The study received approval from the Texas Tech University institutional review board. Participants were informed that they would be shown visual representations of the SARS-CoV-2 and report their

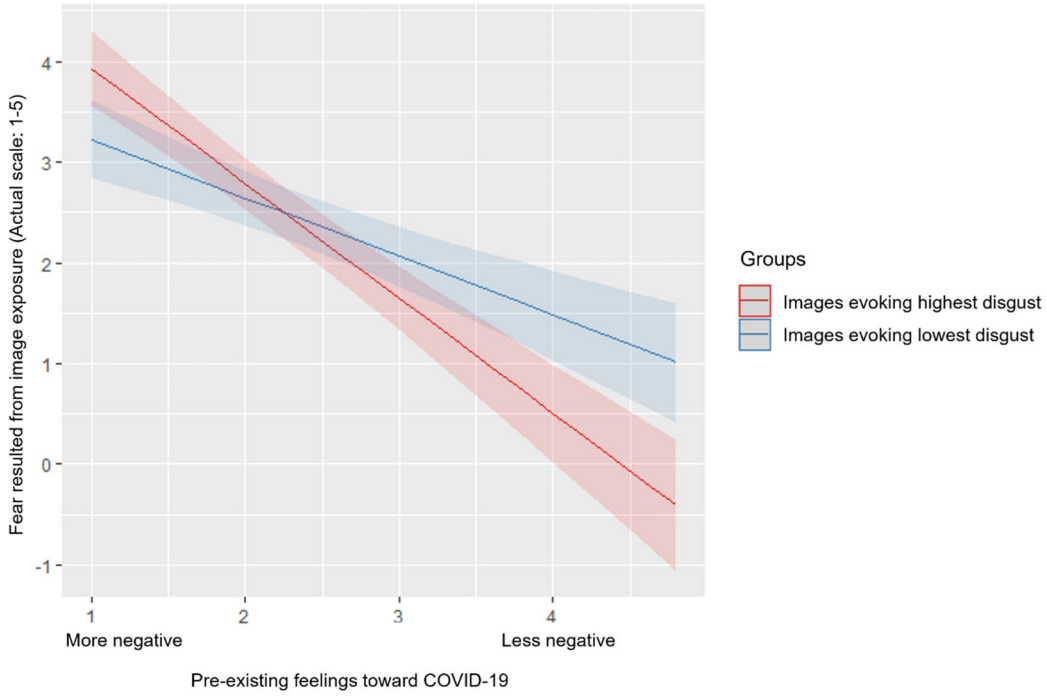

FIGURE 3 Interactive effects between emotional response to COVID-19 and group assignment on fear. The lines indicated predicted values. The shaded area indicated confidence intervals at the 95% level

opinions on the COVID-19 pandemic. Participants indicated their consent via an electronic form before completing the survey.

3 | RESULTS

The 500 participants in the online survey were demographically diverse and representative of the national population (mean [SD] age, 47.0 [17.4] years; 257 women [51.3%]; 192 high school or less education [38.4%]). Results from factorial analyses of variance showed that participants did not report significantly different levels of fear after viewing the images. However, image exposure was associated with a significant difference in disgust ($F_2 = 6.49$; $P = .002$; $\eta_p^2 = 0.034$). A pairwise comparison suggested that participants who viewed Group 1 images and Group 3 images differ in their disgust post-exposure ($t_{238} = 3.41$, $P = .001$). The mean difference between other pairwise groups (ie, Group 1 vs Group 2, Group 2 vs Group 3) was not significant.

In addition, older, non-white individuals, as well as those with lower household income, reported a higher level of fear when viewing the images; however, females, non-white individuals, as well as those with lower education and household income reported a higher level of disgust when viewing the images. Image exposure was not associated with any significant change in participants' risk perception of COVID-19. Nonetheless, females, older and non-white individuals were likely to report a higher level of risk perception after viewing the images.

Furthermore, one's preexisting feelings toward COVID-19 were strongly related to fear resulted from image exposure. Specifically, those who felt more negatively about COVID-19 perceived more fear after seeing the images than those who felt less negatively ($F_1 = 144.19$, $P < .001$, partial $\eta_p^2 = 0.303$). An analysis of covariance suggested that the interactive effects between feelings toward COVID-19 and image exposure on fear is significant ($F_2 = 5.46$, $P = .005$, partial $\eta_p^2 = 0.032$). Specifically, the relationship between individuals' preexisting feeling and fear was more significant among those who viewed the Group 1 images (ie, images that evoked the highest level of disgust in pre-test) than among those who viewed the Group 3 images (ie, images that evoked the lowest level of disgust in pre-test) (see Figure 3). In other words, people's fear became polarized along their preexisting feelings toward COVID-19 after seeing the images that elicited the highest level of disgust.

4 | DISCUSSION

Visual representations of science, ranging from symbols, photographs, illustrations, or data graphs, are increasingly used as effective tools for public communication.[25,26] When it comes to the health and medical realm, science visualizations can help nonexperts acknowledge the physical forms of living organisms or delineate invisible objects, such as bacteria or viruses. When properly designed, science visualizations can attract attention, pique curiosity, facilitate understanding, and enhance trust in the conveyed message.[25] As Rosello (1998) argued in an analysis of the HIV virus images, scientific images could indicate that "some people know and work very hard at transmitting knowledge, the truth" and therefore elicit feelings of mastery or even "aesthetic appreciation and intellectual pleasure."[8]

Nonetheless, despite their scientific and aesthetic values, science visualizations can shape viewers' emotional responses to the portrayed subject due to their metaphoric meanings as well as the presence of visually intense patterns. This study identified the SARS-CoV-2 images published by CDC, NIAID, and third-party organizations and illustrators. A pre-test revealed that the selected images evoke distinct levels of fear and disgust among a group of participants recruited from the Amazon MTurk. However, exposure to the images that elicited low, medium, and high levels of fear and disgust, caused different levels of disgust, but not fear, among the members of a national sample of U.S. adults (N = 500). Especially for those who felt less negatively about COVID-19, exposure to the perceivably most disgusting images backfired, as such images made them perceive lower levels of fear than exposure to the least disgusting images. Image exposure did not associate with any significant change in risk perception of the disease.

5 | LIMITATIONS OF THE STUDY

First, although we failed to detect a relationship between image exposure and risk perception, such result can be confounded by the ongoing pandemic amid which the data was collected. The U.S. entered a "new phase" of the COVID-19 pandemic at the time of data collection with a total of 155 000 infected cases.[27] The exacerbated pandemic might increase participants' risk perception of COVID-19 to an extremely high level, rendering the between-group difference insignificant. Any interpretation of the results should not overly underestimate the effects of image exposure on risk perception merely based on the insignificant findings of the study. In addition, the study only recruited participants from the U.S. and used visual stimuli generated mostly by U.S. organizations and institutions. Considering the cultural differences in the associations between visual features (eg, colors) and emotions,[28,29] the results might not be generalizable to citizens of other countries. Future studies should incorporate the implications of cultural factors when examining the effects of science visualizations on targeted populations.

6 | CONCLUSIONS

Science visualizations are instrumental in educating the public about a wide variety of health issues. However, seemingly objective images can be emotionally biased and polarize the viewers' affective response to the depicted subject. Scientists, journalists, and designers should be aware of the emotional implications of science visualizations. Especially when designing an iconic image or visual targeting a diverse audience, practitioners should empirically examine the emotional impact of their material before using it as part of a large-scale campaign or educational program. It is important to assure the visuals not only inform the public of the depicted subject but also convey the most appropriate and intended emotions.

ACKNOWLEDGMENT

None declared.

FUNDING

None declared.

CONFLICT OF INTEREST

The authors reported no potential conflicts of interest.

AUTHOR CONTRIBUTIONS

Conceptualization: Nan Li.

Data Curation: Nan Li.

Formal Analysis: Nan Li.

Writing - Original Draft Preparation: Nan Li, Amanda L. Molder, Shiyu Yang.

Writing - Review and Editing: Nan Li, Amanda L. Molder, Shiyu Yang.

All authors have read and approved the final version of the manuscript.

Nan Li had full access to all the data in this study and takes complete responsibility for the integrity of the data and the accuracy of the data analysis.

TRANSPARENCY STATEMENT

Nan Li affirms that this manuscript is an honest, accurate, and transparent account of the study being reported; that no important aspects of the study have been omitted, and that any discrepancies from the study as planned (and, if relevant, registered) have been explained.

DATA AVAILABILITY STATEMENT

The datasets analyzed in the paper are available from the corresponding author upon readers' requests.

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REFERENCES

1. Berlin J. Know that coronavirus image with red spikes? Here's how the artists at the CDC created it. https://www.chicagotribune.com/coronavirus/ct-viz-coronavirus-how-it-was-drawn-20200403-ka4t4zyab5ejpcp5y7ukn2mb4u-story.html. Accessed September 13, 2021.
2. Giaimo C. The spiky blob seen around the world. https://www.nytimes.com/2020/04/01/health/coronavirus-illustration-cdc.html. Accessed September 13, 2021.
3. NIAID Now. New images of novel coronavirus SARS-CoV-2. https://www.niaid.nih.gov/news-events/novel-coronavirus-sarscov2-images. Accessed September 13, 2021.
4. Rozin P, Fallon AE. A perspective on disgust. *Psychol Rev*. 1987;94:23-41.
5. Ralph A. The biology of fear. *Curr Biol*. 2013;23(2):R79-R93. doi: 10.1016/j.cub.2012.11.055
6. Curtis V, Aunger R, Rabie T. Evidence that disgust evolved to protect from risk of disease. *Proc R Soc B Biol Sci*. 2004;271(Suppl 4):S131-S133.
7. Vaught JC. *Rhetorics of Bodily Disease and Health in Medieval and Early Modern England*. United Kingdom: Routledge; 2016.
8. Rosello M. Pictures of a virus: ideological choices and the representation of HIV. *Fr Cult Stud*. 1998;9(27):337-349.

9. Valko A. A 'Menacing, alien machine'. https://michigantoday.umich.edu/2020/07/20/a-menacing-alien-machine/. Accessed September 13, 2021.
10. Rozin P, Nemeroff C. The laws of sympathetic magic: a psychological analysis of similarity and contagion. *Psychol Sci*. 1990;1(6):383-384. doi:10.1017/CBO9781139173728.006
11. Valdez P, Mehrabian A. Effects of color on emotions. *J Exp Psychol Gen*. 1994;123(4):394-409.
12. Machajdik J, Hanbury A. Affective image classification using features inspired by psychology and art theory. Paper presented at: Proceedings of the 18th ACM international conference on multimedia. 2010. doi: 10.1145/1873951.1873965
13. Kaya N, Epps HH. Relationship between color and emotion: a study of college students. *Coll Stud J*. 2004;38(3):396-405.
14. Wilms L, Oberfeld D. Color and emotion: effects of hue, saturation, and brightness. *Psychol Res*. 2018;82:896-914. doi:10.1007/s00426-017-0880-8
15. Newman T. What emotion does this image evoke? Fear or disgust? https://www.medicalnewstoday.com/articles/320553. Accessed September 13, 2021.
16. Rádlová S, Janovcová M, Sedláčková K, et al. Snakes represent emotionally salient stimuli that may evoke both fear and disgust. *Front Psychol*. 2019;10:1085. doi:10.3389/fpsyg.2019.01085
17. Karg ST, Wiener-Blotner A, Schnall S. Disgust sensitivity is associated with heightened risk perception. *J Risk Res*. 2019;22(5):627-642. doi:10.1080/13669877.2018.1474244
18. Slovic P, Peters E. Risk perception and affect. *Curr Dir Psychol Sci*. 2006;15(6):322-325. doi:10.1111/j.1467-8721.2006.00461.x
19. Lerner JS, Gonzalez RM, Small DA, Fischhoff B. Effects of fear and anger on perceived risks of terrorism: a national field experiment. *Psychol Sci*. 2003;14(2):144-150. doi:10.1111/1467-9280.01433
20. Sjöberg L. Factors in risk perception. *Risk Anal*. 2000;20(1):1-12. doi:10.1111/0272-4332.00001
21. Public health image library. https://phil.cdc.gov/. Accessed September 13, 2021.
22. NIAID. https://www.flickr.com/photos/niaid/. Accessed September 13, 2021.
23. Eckert AH, Dan. Medical and scientific visualization of SARS-CoV-2. https://www.ami.org/press/press-releases/2020/402-medical-and-scientific-visualization-of-covid-19. Accessed September 13, 2021.
24. Hufff C, Tingley D. "Who are these people?" evaluating the demographic characteristics and political preferneces of MTurk survey respondents. *Res Polit*. 2015;2:1-12. doi:10.1177/2053168015604648
25. Gigante ME. *Introducing Science through Images: Cases of Visual Popularization*. Columbia, SC: Univ of South Carolina Press; 2018.
26. Kelleher C, Wagener T. Ten guidelines for effective data visualization in scientific publications. *Environ Model Softw*. 2011;26(6):822-827. doi:10.1016/j.envsoft.2010.12.006
27. AJMC. US enters new pandemic phase; US to pump $2 billion into vaccine; Pandemic highlights health illiteracy. https://www.ajmc.com/view/what-we-re-reading-us-enters-new-pandemic-phase-us-to-pump-usd2-billion-into-vaccine-pandemic. Accessed September 13, 2021.
28. Gao XP, Xin JH, Sato T, et al. Analysis of cross-cultural color emotion. *Color Res Appl*. 2007;32(3):223-229.
29. Ou LC, Luo MR, Woodcock A, Wright A. A study of colour emotion and colour preference. Part I: colour emotions for single colours. *Color Res Appl*. 2004;29(3):232-240.

How to cite this article: Li N, Molder AL, Yang S. Visual representations of SARS-CoV-2, emotions, and risk perception of COVID-19. *Health Sci Rep*. 2022;5:e496. doi:10.1002/hsr2.496