

Feminist cartography and the United Nations Sustainable Development Goal on gender equality: Emotional responses to three thematic maps

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Key Messages

- We researched users' emotional states before and after interacting with three map types visualizing data about female genital mutilation/cutting from the Sustainable Development Goals.
- We found that maps evoked users' emotions, but some users found the maps to be clinical and neutral despite the sensitive phenomenon they portrayed.
- Our findings support feminist critiques of existing cartographic methods as rational, disembodied science.

Thematic maps facilitate spatial understanding of patterns and exceptions. Cognitive ability, spatial cognition, and emotional state are related, yet there is little research about map readers' emotions. Feminist critiques of cartography recognize emotion and affect as legitimate experiences on par with quantitative ways of knowing. We conducted an online survey to measure users' affective states before and after engaging with three thematic map types. The maps showed data from the United Nations Sustainable Development Goal to achieve gender equality, on the proportion of girls and women aged 15 to 49 who have undergone female genital mutilation/cutting. Participants viewed a choropleth, a cartogram, and a repeating icon tile map; completed map-related tasks; rated certain map qualities; rated their affective states before and after engaging with the maps; and answered open-ended questions. The maps piqued curiosity and evoked emotions for most users, while some users perceived the thematic maps as clinical or neutral despite the sensitive topic. After viewing the maps, female participants who were affected expressed deeper engagement in their open-ended comments than males. Traditionally, cartography construes the human experience as male experience and denies or trivializes women's experiences. Our findings corroborate feminist critiques of this disembodiment and entrenched rational rhetoric of maps.

Keywords: affect, cartography, emotion, thematic maps

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La cartographie féministe et l'objectif de développement durable des Nations Unies sur l'égalité entre les genres: les réactions émotionnelles à trois cartes thématiques

Les cartes thématiques facilitent la compréhension spatiale des schémas types et des exceptions. Il y a pourtant très peu de recherches au sujet des émotions des lecteurs de cartes, notamment sur la capacité cognitive, la cognition spatiale et l'état émotif qui sont tous reliés. Les critiques féministes de la cartographie reconnaissent l'émotion et l'affect comme étant des expériences légitimes au même niveau que les façons quantitatives d'apprendre. Dans cette optique, nous avons effectué un sondage en ligne afin de mesurer l'état affectif des utilisateurs avant et après avoir consulté trois types de cartes thématiques. Les cartes affichaient des données associées à l'objectif de développement durable des Nations Unies pour réaliser l'égalité entre les genres, soit des cartes sur la proportion de filles et de femmes âgées de 15 à 49 ans qui ont subi une mutilation des organes génitaux féminins (excision). Les participants ont examiné une carte choroplèthe, un cartogramme et une carte carrelée d'icônes répétitives, puis ils ont effectué des tâches reliées aux cartes, évalué certaines qualités des cartes, estimé leur état affectif avant et après avoir consulté les cartes et répondu à diverses questions ouvertes. En conséquence, les cartes ont piqué la curiosité et évoqué des émotions chez la plupart des utilisateurs, bien que certains utilisateurs aient perçu les cartes thématiques comme étant neutres malgré le thème sensible représenté. Après avoir consulté les cartes, les participantes qui ont été troublées ont exprimé un engagement plus profond dans leurs commentaires ouverts que les hommes. Traditionnellement, la cartographie interprète les expériences humaines comme étant des expériences masculines et réfutent ou banalisent les expériences féminines. Nos conclusions corroborent les critiques féministes de cette désincarnation et de la rhétorique rationaliste sur les cartes.

Mots clés : affect, cartographie, émotion, cartes thématiques

Introduction

As representations of spatial data, maps can support productive access to information and knowledge construction (MacEachren and Kraak 2001), and may draw in readers imaginatively and emotionally (Aitken and Craine 2009). Although emotions go beyond representational means of knowing (Aitken and Craine 2009), their roles in user experience have been largely overlooked in cartography and data visualization research.

Feminist critiques of cartography and data visualization recognize emotion and affect as legitimate ways of knowing (Huffman 1997; D'Ignazio and Klein 2016). Emotions influence reflexes, cognition, memory, economics, health, well-being (Yik et al. 2011), decision-making, reasoning (Damasio 2001), and map reading; they are defining qualities of being human (Griffin and McQuoid 2012). Maps have long been critiqued for being perceived as objective and neutral (Kitchin and Dodge 2007). Maps and emotions intersect in at least three ways: maps of emotions, the use of maps to collect emotional data, and map users' emotions (Griffin and McQuoid 2012).

Our study focuses on the third, and asks whether users' affective states change by viewing thematic maps because a map is a "potentially unlimited source of emotions for its viewers" (Caquard and Griffin

2018, 18). We visualized and embodied a dataset from the United Nations Sustainable Development Goals (UNSDG) about female genital mutilation/cutting (FGM/C), in three thematic map types: choropleth, cartogram, and repeating icon tile map. We collected information on users' emotional states and attitudes from engaging with these visualizations in an online survey through tasks, self-reports of affect/emotion, map ratings, and open-ended questions. We sought to employ some methodological principles of feminist cartography and data visualization outlined (Huffman 1997; D'Ignazio and Klein 2016) by visualizing data for an issue affecting women and girls, finding a way to embody the data, and emphasizing emotion and affect as legitimate ways of knowing.

Background

Emotions and feminist critiques of science, cartography, and data visualization

Emotions are often trivialized in scientific research as irrational, biased states that are inferior to rational ways of processing information (Roeser 2012). Women have historically been cast in western intellectual tradition as under the influence of bodily emotions and desires, and as irrational and inferior creatures, unable to

transcend their embodiment (Huffman 1997). Rational thinking has historically been privileged over emotional experience (Kennedy and Hill 2017).

Feminist critiques of cartography, geographic information systems, and data visualization recognize emotion and affect as legitimate experiences, on par with quantitative methods of knowing. Rational responses are insufficient to describe everyday engagement with data. Emotions are significant in how users experience and engage with data and their visualizations, and are influenced by design, visual style, subject matter, source, and users' visualization literacy skills (Kennedy and Hill 2017). Feminist critiques of science highlight its exclusion of women and its eschewal of embodiment (Elwood and Leszczynski 2018); feminist cartography adopts an epistemology of embodiment, and acknowledges different modes of production, cartographic media, and "geometries of experience" (Huffman 1997, 267). D'Ignazio and Klein (2016, 3) developed a framework for feminist data visualization with a guiding principle to "legitimize embodiment and affect," as equally important to quantitative ways of knowing and understanding.

We use the terms "affect" and "emotion" interchangeably because when humans conceptualize and categorize an affective feeling, they experience an emotion; measures of emotion thus suggest a person's affective state. Core affects are the accessible elements of an anticipated emotional reaction, a present emotion, or a current mood; they are always present (Västfjäll et al. 2002; Feldman Barrett 2006). This understanding of emotion and affect aligns with geographic notions of emotion (Griffin and McQuoid 2012).

Female genital mutilation/cutting and the Sustainable Development Goals

The UNSDG are 17 interdependent global goals for social, economic, and environmental progress.

They comprise 169 targets measured by 232 individual indicators in a global framework.

To investigate feminist themes in cartography, we chose SDG number 5, which aims to achieve gender equality and empower all women and girls (see Table 1). Target 5.3 aims to eliminate all harmful practices including FGM/C. SDG indicator 5.3.2 is a measurement of the proportion of women and girls aged 15 to 49 who have undergone FGM/C.

FGM/C is the intentional injury to the external female genitalia for non-medical reasons, including the removal, in part or completely, of the female genital organs. It is a form of gender- and sex-based violence, and a harmful practice with no known health benefits. It is a painful and traumatic intervention. An estimated 200 million women and girls worldwide have undergone FGM/C. It is not mentioned in any major religious texts and is not mandated by religion. Even if one is unaware of exactly what it entails, the term indicates brutality and sex discrimination (WHO 2018). Social injustice on maps can trigger emotions, such as anger and injustice (Caquard and Griffin 2018), which is why we decided to map reactions to this indicator.

Three thematic map types

Thematic maps can facilitate understanding of the spatial distribution of a phenomenon. We selected three: choropleth, contiguous cartogram, and tile map with repeating icons.

Choropleth. The choropleth is a common thematic map type often used to show area-based social data. We are using it as a control, because it does not embody data or further distort the projected area. Choropleth maps use enumeration units such as census tracts or countries. The attribute values for these units are represented within the unit boundaries with colours, patterns, or shades (Torguson 2017).

Table 1
Indicator, target, and goal information for the SDG dataset portrayed in the three thematic maps shown to participants of the online study.

SDG Indicator	SDG Target	Goal
Indicator 5.3.2: Proportion of women and girls aged 15–49 who have undergone FGM/C, by age	Target 5.3: Eliminate all harmful practices, such as child, early, and forced marriage and female genital mutilation	Goal 5: Achieve gender equality and empower all women and girls

Contiguous cartogram. In a cartogram, the administrative units have been rescaled proportionally to an attribute such as population, leading to the deliberate distortion of size, shape, angle, or topology. Cartograms are well-suited for visualizing political and socio-economic data.

A contiguous cartogram deforms map regions because the original polygons are pulled, pushed, and stretched (Nusrat et al. 2018), but maintains adjacencies and statistical, topological, and geographical accuracy better than other types of cartograms (Nusrat and Kobourov 2016). Cartograms may be a more socially just form of mapping because they provide a more equitable representation of the world (Dorling 1996).

Tile map with repeating icon. In a tile map, each polygon is abstracted to a congruent, geometric shape in a configuration that retains local topology where possible. Tile maps avoid the visual imbalance of choropleth maps and favour clarity over complexity when compared to cartograms.

Dragga and Voss (2001) write about the need to humanize statistical graphics and technical illustrations. A meaningful, distinguishable symbol (in our study, scissors) can represent the data differently than a traditional geometric shape to humanize international spatial patterns of FGM/C.

Cartography, emotions, and empirical research

Huffman (1997) writes that feminist cartography adopts an epistemology of embodiment and acknowledges different cartographic media and modes of production; for example, cartograms use alternative geometry that may enable readers to compare relationships across units better than maps that show physical area. Their uptake shows people may accommodate new map types. Haroz et al. (2015) found that such pictographs—visualizations with pictorial symbols to represent the data—tempt readers to inspect a visualization more closely and can help them remember information during challenging tasks. Boy et al. (2017) found that anthropographics (representations of abstract data with icons of people) and standard charts elicit similar levels of empathy in users and suggest that anthropographics are not detrimental. We extend these alternate approaches to geometry

to the tile map, in which we abstracted the shape of each country to a congruent square with repeating symbols of scissors to represent the data.

Several authors call for more attention to the intersection of emotions and maps (e.g., Preston 2008; Aitken and Craine 2009; Craine and Aitken 2009; Elwood 2010; Fabrikant et al. 2012; Griffin and McQuoid 2012; Caquard and Cartwright 2014; Caquard 2015; Griffin et al. 2017; Roth et al. 2017; Caquard 2018), to affect and influence geospatial technologies and practices more broadly (Kwan 2007), to study the potentially emotional message a map tries to communicate (McCleary 2003; Muehlenhaus 2012), and to investigate emotions, data, and data visualizations (D'Ignazio and Klein 2016; Kennedy and Hill 2017).

Some research has looked at emotional responses to colours used in maps or Web GIS applications (Skarlatidou et al. 2011; Fabrikant et al. 2012; Weninger 2015) but research on affective and emotional properties of thematic map types is limited, and mainly about cartograms. Preston (2008) differentiates between mapping techniques that intentionally and unintentionally evoke emotional responses; the latter shift power from the map author to the map reader. Sui and Holt (2008) argue that it is necessary to understand thematic maps from more than one dimension. In particular, several researchers point to cartograms' potential for deeper engagement, to elicit moral emotions (Sui and Holt 2008; Döll 2017), and to draw attention to how maps are thought experiments (Sui and Holt 2008). Kaspar et al. (2011) suggest that cartograms may be provocative but are accepted by map users and are readable and understandable. Cartograms may heighten users' sensitivity to critical aspects of maps and map-making, and remind users that maps are consciously human-made (Sui and Holt 2008). Döll (2017) writes that cartograms trigger emotion, increase viewer attention, and may augment knowledge transfer as a result. For example, the visualization of human exposure to climate change in a cartogram might trigger compassion for people who are negatively affected. Barford (2017) found that world cartograms and visualizations depicting inequality can influence emotional responses to, and perceptions of, inequality. Users may experience lower emotional involvement with places on maps when distances appear greater because of the world map projection (Gilmartin and Lloyd 1991).

User study

Our research question was: do users' affective states change by engaging with thematic maps portraying UNSDG data about FGM/C? We first created three different maps portraying UNSDG indicator 5.3.2, and then carried out an online survey with the three thematic maps, with open and closed questions. Participants saw a choropleth (Figure 1), a cartogram (Figure 2), and a tile map (Figure 3), each visualizing the same data about the proportion of women and girls aged 15–49 who have undergone FGM/C. Survey participants also answered two questions (map-reading tasks) related to the data on each map and rated their current affective states after viewing each map.

Participants

We recruited a convenience sample of participants; we tweeted the link and emailed an invitation with

the survey link to some students and faculty of our university and members of selected Commissions of the International Cartographic Association. The research was conducted during a master's student's summer field season; both time and population to recruit for this study were limited.

There were 55 participants who reached the end of the survey among whom the gender balance was almost even. Of these, 48 had used cartograms before, and 22 had used tile maps. There were 43 participants who mentioned higher education or work experiences in a geo-related field; 28 participants mentioned a professional or educational background related to cartography, geovisualization, geomatics, geography, or GIS, and 9 mentioned occupations as researchers, lecturers, or professors.

Data and maps

The first author used one dataset to create the three maps: a choropleth, a contiguous cartogram,

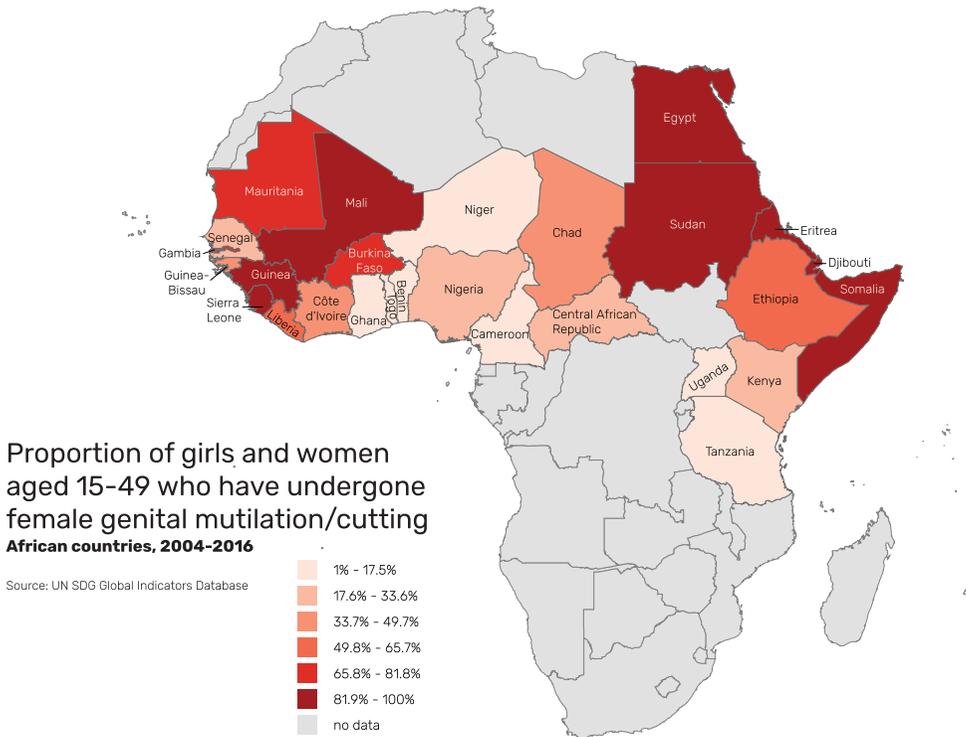
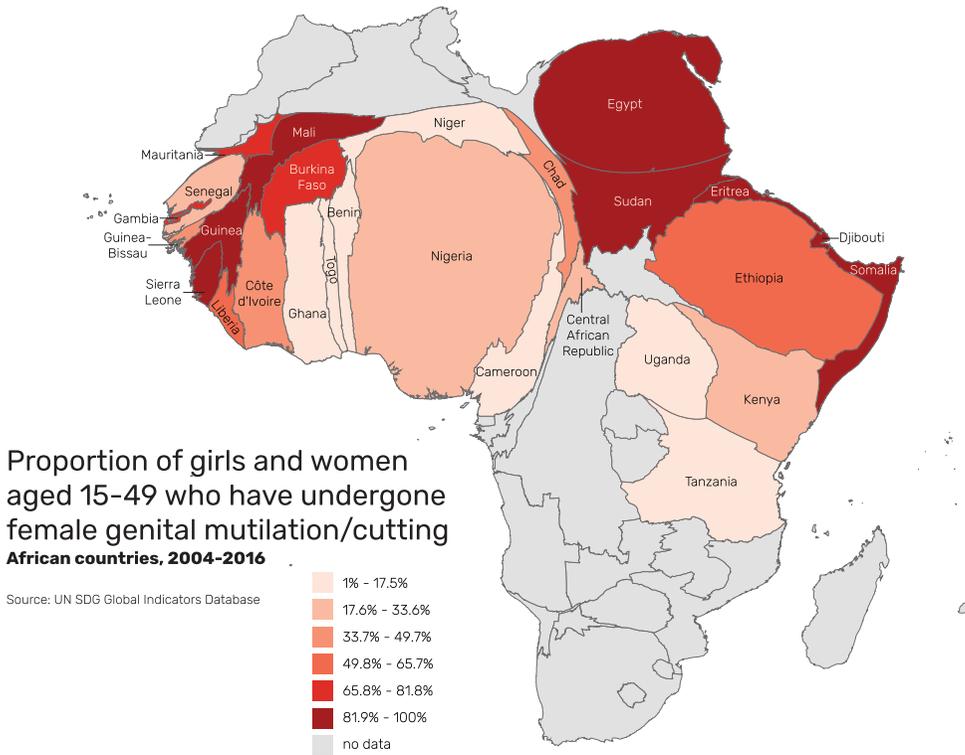


Figure 1 Choropleth map visualizing SDG Indicator 5.3.2: Proportion of girls and women aged 15–49 years who have undergone female genital mutilation/cutting.

**Figure 2**

Cartogram visualizing SDG Indicator 5.3.2: Proportion of girls and women aged 15–49 years who have undergone female genital mutilation/cutting.

and a repeating icon tile map (see Figures 1–3). The data were from SDG indicator 5.3.2, the proportion of women and girls aged 15 to 49 who have undergone FGM/C. Since data for this indicator are available from the UNSDG Global Database only for Yemen, Iraq, and 27 African countries, we produced maps of Africa. Each country with data had a single attribute value, from a single year anywhere between 2004 and 2016.

For countries with indicator data available, the data were classified into six ranges shown through colour shading in another layer in both the cartogram and choropleth. Countries without data were represented as gray. Since indicator data were unavailable for all countries, all countries shown in the cartogram were rescaled according to their population.

The tile map with repeating icon combines the basis of a tile map (each country is represented as a square) with Isotype-style repeating symbols to

represent the classified data. The topology for the tile map was adapted from Schwabish (2017) and reproduced in Adobe Illustrator. These ideas were inspired by a tile map from the ONE (2018) campaign which uses a smaller square tile within each square country to classify 1% of the population.

Survey design

The online survey, using SurveyMonkey, opened with an introduction about the study. On the second page, the participant completed the first Positive Affect and Negative Affect Schedule (PANAS) as the baseline for self-report of affect (emotion). The third page provided information about the three map types with an example of each type with a different indicator dataset for the same region, Africa. The fourth page introduced the title of the indicator 5.3.2 dataset with no additional



Proportion of girls and women aged 15–49 who have undergone female genital mutilation/cutting African countries, 2004–2016

Source: UN SDG Global Indicators Database

Figure 3
Tile map visualizing SDG Indicator 5.3.2: Proportion of girls and women aged 15–49 years who have undergone female genital mutilation/cutting.

information about the issue itself and asked an open question to gauge the user’s knowledge of FGM/C. The fifth page showed one of the three maps designed for the survey, as an image, with two multiple-choice tasks (the maps were presented in random order throughout the study). The user was asked to take a minute to explore the map before completing the two data-related map interpretation tasks below the map image. On the sixth page, the participant completed the second PANAS. The next four pages alternated between the two remaining maps/tasks and their related PANAS. The participant was then shown the three maps together, and asked to rate each map separately by marking seven qualities (e.g., interesting, useful, symbolizes information well) on a 5-point Likert scale from “strongly disagree” to “strongly agree” and to provide any additional

thoughts as comments in an open text field. This page also posed two open-ended questions referring to all the maps together about participants’ emotions experienced through the study, and what questions they had based on the maps. On the last page, users were asked to provide demographic information including age, gender, nationality and country of residence, occupation, and their experience in a geo-related field such as cartography or geomatics. Table 2 summarizes the information we collected in the survey.

To focus on the affective properties of the maps, and not the data alone, users were not given any other information about FGM/C. All users viewed the same survey questions and the same three maps, but in random order to counter potential learning bias or any effect that a particular viewing order might have.

Self-reported affect: Positive Affect and Negative Affect Schedule (PANAS). The 10-item PANAS is a self-reporting scale comprising two terms from each of five triads where the subjects rate each adjective on a 5-point scale according to how they feel during the specified time frame. Participants completed PANAS four times: once at the beginning of the study and again after using each of the three maps. The first PANAS was used as a baseline self-report of affective state and the fourth, final PANAS was used to measure affective state after engaging with all maps.

Though users completed PANAS four times, only the first and last were analyzed due to a limitation in SurveyMonkey's randomization feature, which does not record the order of maps each participant saw.

Tasks. Participants were asked to take a minute to observe each map before completing the tasks. To limit participant fatigue, each map had only two multiple-choice tasks, shown below the map. All participants completed the same two tasks for each map. These tasks were developed based on a taxonomy of cartogram tasks from Nusrat and Kobourov (2015). The first was a combination of "locate" and "identify" tasks, for which users had to locate a specific country and interpret its corresponding attribute. The second task was a "find top-k"-type task, for which users used the map to locate countries from a given list and determine which had the highest rate.

Quality ratings and attitudes. Users ranked each map on a 5-point scale from "strongly disagree" to "strongly agree" with the midpoint as "neutral," using the following qualities: interesting, useful, truthful, symbolizes information well, shows relative values clearly, easy to understand,

and emotional. Participants could supplement their ratings with comments about the map. They also answered two open-ended questions on this page:

1. Looking back at your thoughts and feelings during this study, what emotions did you experience while viewing these maps and the issue they portray?
2. Looking back at your thoughts and feelings during this study, what questions do you have from the maps?

Results and discussion

The survey results show that thematic maps of the FGM/C data do evoke emotional responses in most users. More notable is some participants' lack of emotional engagement. We coded comments by themes and keywords that emerged from the responses themselves and focus here on responses that indicated emotional reticence or denial despite the data and visualization choices.

Quantifying an issue enables viewing phenomena from afar (Kennedy and Hill 2017)—what Haraway (1988, 581) calls "the god trick of seeing everything from nowhere." It can distance users, viewers, and consumers from the sensitivity and awareness of the people or concepts to whom the data refer, and without whom the data would not be. But Kennedy and Hill (2017) also argue that visualizations may reduce this distance and evoke emotions that connect viewers with the subjects of the data.

Only four participants said they were nationals or current residents of African countries (Egypt and South Africa). The subjective and geographic distances of Africa may have influenced participants who expressed little emotional involvement, since people are less concerned with events in distant places, and cartographic choices can influence perceptions of distance, affecting emotional involvement (Gilmartin and Lloyd 1991).

Table 2

The information collected from participants in the online survey and the methods used to collect this information.

Data collected	Affect and emotion	Task responses	Attitudes	Demographics and prior knowledge about FGM/C
Collection method	PANAS, open-ended comments	On-screen, multiple-choice, map-based tasks	Likert scale ratings of map attributes and open-ended comments	Multiple choice questions and open-ended comments

Noting the gap between the maps and FGM/C, one user wrote that “the issue itself is highly emotional. None of the maps however transported this feeling to me. I was rather de-emotionalized by the maps” (P47). This user said that concentrating on completing tasks correctly detracted from the emotional experience and that the less familiar map types—cartogram and tile map—slightly increased attention and emotion due to their novelty.

The choropleth map

All the participants had used choropleths before. Of the 24 comments on the choropleth map, 8 mentioned that it was easy to use, often linked to its familiarity or wide use; for example, “simple, seen so many times before, that’s why one probably doesn’t spend too much time looking at it” (P21). Four mentioned emotions, in all cases linked to colour, though one suggested that the map should be shown with more emotions beyond the colour scheme.

The choropleth stimulated reflection on the map’s data and usability more than the FGM/C issue. Three people mentioned it was “boring”; it was also described as “neutral” and “traditional” (P21). On average users preferred the choropleth, followed by the tile map, and then the cartogram. Users gave the choropleth the highest ratings of the three maps for “easy to understand,” but lowest for “interesting” and “emotional.”

The cartogram

Although cartograms have become popular for distorting reality, shocking readers, and providing unusual perspectives (Roth et al. 2010), in our survey the cartogram did not produce a strong emotional reaction, perhaps because the country sizes were distorted by population. One participant said, “I do not think that the sizes of the countries on this map can provoke some feelings other than those caused by choropleth map” (P8); another wrote “the slightly negative emotional aspect I experience here does more refer to the difficulty to read ... rather than the content it displays” (P47).

The four negative responses to the cartograms hinged vaguely on their appearance and distortion, calling to mind issues mentioned above about unfamiliar map types and visual conventions: “I generally don’t like cartograms, they show the polygons in an unfamiliar way” (P6); or “looks like

an inflamed pancreas” (P23). And whereas some described the choropleth as “boring,” “neutral,” or “traditional,” nobody used these words to describe the cartogram, though they also did not mention that it was novel, unlike the tile map.

The tile map

Despite the distortions to geography and topology in the tile map, the average success rate across the two tasks was highest for this map type, at 97% (compared to 94% for both the choropleth and cartogram). Task success rate was determined by number of participants who chose the correct response of the four choices for each of the map-related tasks.

Though pictographs may be statistically or visually redundant—Tufte’s “chartjunk” (Kostelnick 2007)—they are not emotionally redundant (Dragga and Voss 2001). Haroz et al. (2015) found that pictographs invite users to engage with a visualization more closely. McCleary (2003, 1827) expresses concern in grappling with how to visualize human suffering or injury, because “there is no mechanical, no manufactured cartographic solution that will convey the horror of catastrophe and calamity ... how does one create displays that capture the minds and emotions of the map user?”

The tile map used scissors to indicate cutting, a symbol likely understandable even to someone unaware of FGM/C (three participants), but who had read the title of the map. Of the 28 comments on the tile map, 10 mentioned the scissors symbol, of which 9 indicated it was an apt choice in that it conveyed the seriousness or emotion of the issue or made the map more interesting. One user said, “the pictorial symbol, a scissor (sic), helps to show the seriousness of the situation explicitly” (P8). Another wrote “I like the scissors. A knife may have been even more effective, as a knife is more brutal” (P23). Others commented ambiguously: “symbols may be less precise but may allow a director [sic] connection to the displayed data (if chosen well)” (P10). One person noted that though the tile map provided information well it was geographically confusing, and the scissors were small and hard to see.

Several commented that the tile map was a neutral representation of the data: “it gives equal weight to all countries and includes a neutral representation of the rate” (P22) or “seems more

neutral in some ways than the other two” (P9). Several found it unfamiliar, requiring more time and effort to use, which could be either a hindrance or an invitation to engage further: “Different map not very common [sic]. Not very good. Requires more attention and reading to understand the data” (P21). Such comments expressing discomfort or disdain for an unfamiliar map type evoke Huffman’s (1997) note of the limitations of the cognitive category and definitions of a Western map as ones that visualize the geopolitical world we are familiar with, that can be known, and a failure to recognize other images of the world as maps that do not fit these familiar scientific or strict boundaries. The author argues for an expansion of the boundaries of what we recognize as maps because it is central to facilitate a feminist critique of masculinism in cartography and practice, and to explore new ways of cartographic representation.

A few participants asked about where and when the map types are used. Two responses about the tile maps stand out: “Where do people use the tile map? Where could that be useful?” (P48) and “Who in the world would ever use tile maps? Yuk” (P7). This reluctance to accept the maps may reflect how tile maps are increasingly popular in the media and perhaps less so in industry and academia, and that most participants were professionals in a geomatics-related field. This is a generalization and would be interesting to validate with a larger, more diverse sample size of more varied geographic backgrounds, but is a reminder of work by Fabrikant et al. (2012) that found cartographic expertise can predictably influence emotional responses to unusual colour schemes on topographic maps.

Six comments on the tile map mentioned emotions—possibly because the word was in the title of the survey. Two said the tile map was unemotional. For example: “this map is completely unemotional but it forces its reader to involve into content reading and understanding” (P33). This comment makes a distinction between the map itself and the issue presented; this participant also said in another comment, “I’m very annoyed with how women are treated at some parts of the world and I think that there should be way more maps” to raise more awareness.

One participant said that the tile map reminded them “of a data list, where the numbers are placed

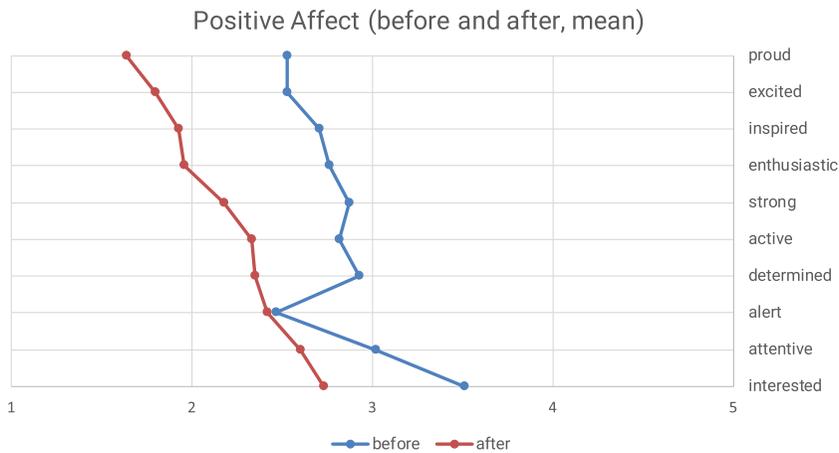
in a somehow geographical way. It certainly causes less emotions than the other map types do” (P20), which may imply that maps can provoke emotions, but visualized lists, for this user, do not. Some indicated it was relatively more emotional because of the symbol: “the scissor icons make it emotional” (P44) and “the symbols chosen to represent the percentage of women is shocking and illicit [sic] and a strong negative emotional response” (P51).

Visual conventions and design choices

Visual conventions influence and socialize the design and perception of statistical graphics (Dragga and Voss 2001). Kennedy et al. (2016) discuss the conventions that imbue visualizations and users with impressions of objectivity and neutrality: 2D viewpoints, clean layouts, geometric lines and shapes, and the inclusion of data sources. The tile map especially conveyed a geometric quality, but at the same time provided an alternative representation of space (Huffman 1997).

It is possible that these choices influenced one user’s perception of the maps as “clinical” (P11). She explained that though the issue was emotive, her emotions were not different from the beginning of the study, and that the issue felt far away and less emotionally influential than immediate personal issues. We ask: would a somehow more emotive, less clinical, and more visually persuasive map be desirable and/or influential? Hill et al. (2016) found that designs that fail to adhere to visual conventions and professional standards may be judged derisively and critiqued for poor execution, and that gendered derision is so entangled with legitimate criticisms that it has become normalized. Some participants did critique the maps or offer suggestions on how to improve usability or make the maps more emotional.

Four participants noted a discrepancy between the emotional “value” of the map topic and the actual maps. For example: “it’s a sad topic but the maps just show the data” (P10); and “No different emotions from when I started. Although it is a very emotive issue it feels far away ... while clear, the maps themselves are quite clinical ...” (P11). One noted, “I am not familiar with the topic, I think that is why it didn’t give me an emotion ... I just feel emotions looking at the maps, emotions on the visual part, instead of emotions concerning the

**Figure 4**

Mean results from the survey for all participants for each positive affect term, before and after viewing all maps.

content” (P48). This comment indicates that design choices can influence users’ emotions, but that they may be distinct from the topic or data that the map portrays.

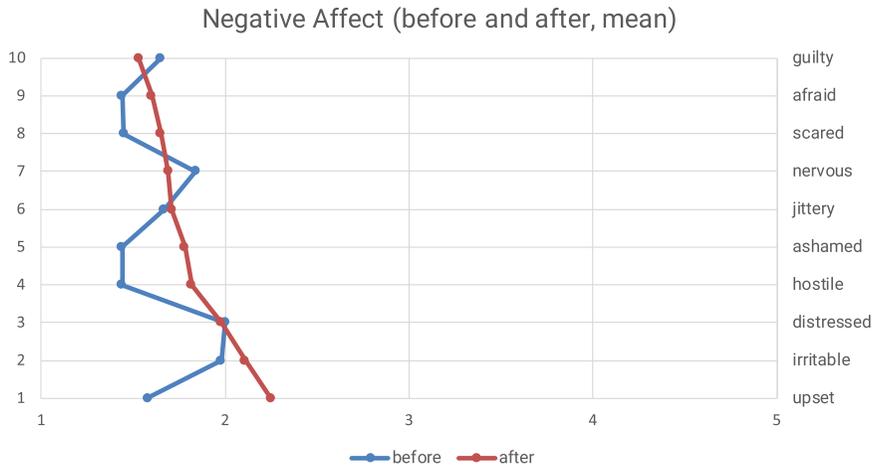
Affect/emotion and engagement

By comparing initial and final PANAS results, we see that that participants’ overall positive affect decreased, and negative affect increased through the course of the survey. Figure 4 shows a distinct decrease in the weighted mean response for positive affect terms. On average, participants were notably less excited, proud, inspired, enthusiastic, active, strong, determined, attentive, and interested by the end of the study, and somewhat more hostile, ashamed, afraid, scared, upset, and irritable.

In response to the open-ended question that asked about thoughts, feelings, and emotions experienced during the study, 21 of the 40 responses indicated a negative emotion towards or from the maps or data, such as sadness, anger, annoyance, and distress; the average PANAS scores for negative affect show an increase (see Figure 5) which reflects this emotional impact. Several users mentioned their interest or curiosity was piqued, and/or they were surprised or shocked about the indicator/dataset. However, the average score for “interested” decreased overall in the PANAS results, which could indicate that users were less interested due to survey fatigue or the maps themselves.

Any lack of emotional response to the issue did not seem to depend on gender. Five responses coded as “not really emotional” were from people who identified as female, and five were from male-identified users. Those who did express emotions expressed them differently. There was an overall qualitative difference in their response types and content, in particular for the question “looking back at your thoughts and feelings during this study, what emotions did you experience while viewing these maps and the issue they portray?” Responses to this question from males were usually remote, one-word answers or lists of one-word emotions, or non-emotional. A selection of male responses that characterize the overall responses: “Anger, guilt, shock, sadness” (P3); “interesting” (P30); “ashamed” (P41); “nothing decisive” (P50); “distressed, scared, and upset” (P21); “Emotions? I can’t say precisely how many and are the emotions I can feel looking at a map” (P17); “Not much. I feel bad for the girls and women in these countries if they don’t want to be mutilated” (P23).

Responses from females were more engaged and used the word “I” in their responses. A selection of characteristic female responses shows a more engaged response: “Anger was the feeling that I have experienced the most” (P39); “It made me very sad to see the large percentages. I thought this practice was being eradicated” (P43); “I always felt scared” (P55); “not sure, analytical?” (P6); “sadness” (P8); “not too many, it’s a sad topic but the maps just show the data” (P10); “shock, empathy, anger,

**Figure 5**

Mean results from the survey for all participants for each negative affect term, before and after viewing all maps.

indignation, and curiosity” (P51); “negative feelings associated with the theme” (P49). While some male- and female-identified users had one-word responses or lists of single words—perhaps a consequence of the multiple PANAS scales consisting of 20 single words—female emotional interest seemed greater.

By the end of the study, eight participants who identified as female had questions about the reasons and factors behind FGM, compared to only three male-identified participants.

This observation brings to mind feminist critiques of disembodied knowledge and power: traditional geography construes male as synonymous with human, denying women’s experiences (Huffman 1997). Trivializing, distorting, and reducing them to data (Kitzinger and Wilkinson 1997) represented as colours, numbers, and symbols did not trigger much emotion or empathy for several respondents in the study, most notably among male respondents.

Participants’ questions after viewing the maps mostly indicated piqued curiosity to learn more about the mapping process and data, and the issue beyond the spatial glimpse that the maps provide.

There were 30 responses to the open-ended question about emotions experienced while looking at the maps and the issue they portray. Ten expressed limited or no clear emotions, from “just facts” (P14) to “Emotions? I can’t say precisely how many and are the emotions I can feel looking

at a map” (P17). Prior knowledge of the indicator had some influence on users’ emotional reactions. P48 reacted to the map’s visual aspects, not content: “I am not familiar with the topic, I think that is why it didn’t give me an emotion.” Four participants, two male, and two female, had indicated initially that they were unaware about FGM/C, and/or had an unemotional response towards it. Only one was both unaware and did seem affected: “it is horrible, I didn’t know it existed!!!” (P39).

Equating data to “just facts” suggests a belief that data are just numbers, dissociated from the women and girls they characterize, that the numbers come across as impersonal and objective. But as Hill et al. (2016) write, data are not neutral, but are shaped in particular ways. Feminist critiques question the objectivity of data. Users who identify the data as facts may not be intentionally sexist. Rather, culturally embedded norms, such as the idea that data are neutral, may influence their assessments of the maps.

Some participants seemed keen to distinguish or express their emotions while others were adamant that they did not experience any. As most of the participants were experts in a geo-related field, they may have doubted the validity or truthfulness of emotional experiences evoked by maps. Perhaps the study should not have been explicitly titled “maps and emotions” to avoid biasing perspectives.

Opportunities for future research

This research did not engage with the women whose experiences are portrayed in the data, and it is unknown if any of the participants in the study have been involved with FGM/C. Few participants were from Africa, and familiarity or lack thereof with the continent's topography may have also affected task results. Future studies could recruit participants from a wider range of educational and geographic backgrounds and occupations, perhaps by crowdsourcing participants through tools such as Amazon Mechanical Turk (Heer and Bostock 2010).

A factorial study might independently compare affective responses to cartographic decisions (including thematic map type, design conventions and visual variables, or map projections), and to different datasets that are more and less emotional. Physiological, "objective" data such as electrodermal activity from wearable biosensors might supplement, complement, or contradict self-reported affect from the PANAS. Semi-structured interviews with participants might solicit more detailed information to supplement users' comments and ratings. It could be valuable to investigate how interactivity and linked maps could invoke emotional responses in users through additional data, information, or design.

In future research, we hope to investigate solutions to feminist critiques of maps as disembodied knowledge and power. Traditional geography construes male as synonymous with human, denying women's experience. What are alternate solutions to traditional cartographic practices and thematic maps that trivialize and distort women's experiences, reducing them to data represented as colours, numbers, and symbols? How can we convey and evoke emotion and empathy while also portraying the spatial distribution of a larger and widespread phenomenon?

Conclusion

Maps have emotive properties. Though emotions influence learning and go beyond representational means of knowing (Aitken and Craine 2009), their influence in users' experience of data visualizations and maps has largely been overlooked. Feminist critiques of cartography argue that maps

disembody knowledge and power, denying women's experience (Huffman 1997). Feminist data visualization principles call for legitimizing embodiment and recognizing affect as legitimate experiences and ways of knowing (D'Ignazio and Klein 2016).

In a choropleth map, contiguous cartogram, and repeating icon tile map, we visualized the national prevalence of FGM/C in women and girls aged 15–49, using data from UNSDG indicator 5.3.2. We implemented an online survey to collect information on participants' affective states before and after looking at these three thematic maps. We collected information on users' emotional responses, attitudes, and preferences towards the maps. Users also answered two map- and data-related tasks for each map. On average, users' positive affect decreased during exposure to the maps, and many users commented after viewing all the maps that they had experienced negative emotions during the study. Some users commented that they experienced few or no emotions because the maps were just portraying data; this suggests that some see maps, regardless of the data they portray, as objective, neutral, and incapable or inappropriate media for emotional messaging, whether intentional or not. As the indicator is about FGM/C, the results suggest the possibility that women's lived, physical experience—outside the traditional historically mapped realm of disembodied, ungendered experience—is too unfamiliar, far away, or not significant enough to elicit emotion or more attention, and that the nature of maps we made denies or trivializes women's lived experience.

We found that participants examined the repeating icon tile map and the cartogram more carefully, which are less commonly used map types than the choropleth, with less familiar views of the world. More research is needed to distinguish how multiple factors might influence affective and emotional responses and attitudes, including users' prior knowledge and experience with the issue; data quality and completeness; cartographic and design conventions and decisions; subjective and geographic distance; indicator issue; and thematic map types and users' familiarity with them and the geographic areas represented. Future research could benefit from the study of which factors increase or detract from emotional involvement with maps, place, and data.

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