The Feeling of Numbers: emotions in everyday engagements with data and their visualisation

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1. Abstract

This paper highlights the role that emotions play in engagements with data and their visualisation. To date, the relationship between data and emotions has rarely been noted, in part because data studies have not attended to everyday engagements with data. We draw on an empirical study to show a wide range of emotional engagements with diverse aspects of data and their visualisation, and so demonstrate the importance of emotions as vital components of making sense of data. We nuance the argument that regimes of datafication, in which numbers, metrics and statistics dominate, are characterised by a renewed faith in objectivity and rationality, arguing that in datafied times, it is not only numbers but also *the feeling of numbers* that is important. We build on the sociology of a) emotions and b) the everyday to do this, and in so doing, we contribute to the development of a sociology of data.

2. Keywords

data, emotions, everyday life, feelings, engagement, visualisation

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5. Introduction

In our data-driven society, data are accorded growing importance, assumed to have the power to explain our social world and relied upon in decision-making that affects all our lives. Increasingly, data matter, socially and sociologically. More and more aspects of social life are datafied: friendships, interests and emotions have been turned into quantifiable data on social media and other platforms keen to extract value from everyday social operations, a process which has been described as 'datafication' (Mayer-Schönberger and Cukier, 2013: 78). The current proliferation of data and the related quantification of sociality (Grosser, 2014) has led a number of commentators, such as Beer (2016), to note that we are witnessing a renewed faith in numbers (something which, as Porter (1995) has noted, has a long history).

Pervasive data and related quantitative rationalities create new pressures on ordinary citizens who wish to participate in civic, social and cultural life as it becomes more data-driven, for example to have the skills to comprehend large datasets and how they are operationalised. For those who do not possess this expertise, the ability to engage in data-driven conversations is off limits and, at the same time, existing, uneven power relations are reproduced and new, data-based ones emerge (boyd and Crawford, 2012). The visualisation of data is seen as one means by which to address and overcome these dangers

because of its alleged capacity to make data transparent and accessible (Few, 2008; Zambrano and Engelhardt, 2008). Indeed, visualisation is the main way that many people get access to data. Beer and Burrows (2013: 62) draw on several examples of visualisations circulating online to argue that we are currently witnessing both a 'visualization of culture' and a 'culture of visualization' (although access to visualised data is, of course, uneven).

So, on the one hand, understanding datasets requires statistical skills and confident numeracy, yet on the other hand, if the main way that we access data is through their visualisation, visual sensibilities are also required in order to make sense of data. This entanglement of the numeric and the visual is at the heart of most people's engagements with data. In most everyday encounters – in the media, on social media and elsewhere – data cannot be uncoupled from their visual representation. Data are not just numeric – they are both statistical *and* visual. In part because of this entanglement, data stir up emotions. And yet, in data studies, this has rarely been recognised, as this emerging field has been characterised by studies of the operations of data power from above and by a related absence of attention to everyday experiences of data 'from the bottom up' (Couldry and Powell, 2014). This paper contributes to sociological debate about (big) data and datafication by arguing that two important sociological fields – the sociology of emotions and of everyday life – are essential components of a sociology of data.

In the paper, we draw on empirical research on *Seeing Data* (seeingdata.org), which explored how people engage with data through visualisations. A major finding was that a wide range of emotions characterise engagements with diverse aspects of data and visualisations, which in turn demonstrates the importance of emotions in efforts to make sense of data. Given our findings, we argue that everyday engagements with data through visualisations evoke emotional responses that nuance the proposal that numbers alone are central to the logic of datafication. At the level of the everyday, *the feeling of numbers* is important. Bringing a belief in the valuable role that emotions play in social life together with the assertion that because social life is increasingly datafied, numbers are acquiring increasing importance, we argue that data are as much felt as they are experienced cognitively and rationally.

We proceed to contextualise our empirical material in debates about datafication, highlighting the limited attention to feelings and the everyday in these debates. After a brief description of the methods we used, we provide examples of our participants' diverse emotional engagements with visualisations and we focus on one case study that effectively illustrates such engagements. We end the paper with some reflections on the implications of recognising the emotional dimensions of engaging with data.

6. Datafication, emotions and the everyday

Mayer-Schönberger and Cukier (2013: 78) use the phrase 'datafication' to describe the contemporary phenomenon of quantifying aspects of life that previously did not exist numerically. 'To datafy a phenomenon is to put it in a quantified format so that it can be tabulated and analysed,' they write. Focusing specifically on social media platforms, Van Dijck (2014) argues that,

> 'With the advent of Web 2.0 and its proliferating social network sites, many aspects of social life were coded that had never been quantified before—friendships, interests, casual conversations, information searches, expressions of tastes, emotional responses, and so on' (2014: 198).

The quantification of things previously qualitative (friendship, liking, professional networks, cultural exchange) works together with rhetoric about big data's promise – as seen, for example, in *Wired* editor Chris Anderson's (2008) widely cited assertion that 'with enough data, the numbers speak for themselves' – to produce a faith in numbers. This is not a new phenomenon, as Porter (1995) noted in the 1990s, although datafication means that it is much more widespread. Porter highlights how numbers convey information in a 'familiar, standardized form' (Porter, 1995: ix) and as such can be understood 'from far away' (Porter, 1995: ix) – that is, by someone distanced from the phenomenon to

which the numbers refer. 'Quantification is a technology of distance' (Porter, 1995: ix), he writes, and Crawford (2013a: n.p.) makes a similar point about big data: they allow us to view phenomena from afar, but this means that we miss the detail that can be observed on closer scrutiny. Numbers minimise the need for 'intimate knowledge and personal trust' (Porter, 1995: ix). They are impersonal, so they seem objective.

Grosser (2014) is one of few writers who acknowledge the emotional dimensions of the current ubiquity of numbers and metrics. Focusing on social media, Grosser argues that the quantification of sociality which results from the widespread use of metrics on social media creates an incentive to increase those same metrics – likes, comments, friends and so on. He describes this as 'an insatiable desire for *more*' (Grosser, 2014: n.p.). Capitalism's own desire for growth leads to a culture which constantly audits whether the desired growth has been achieved, which is experienced by individuals and organisations as a need to excel within the audit's parameters, he writes. This constant auditing deploys quantification to enable its very existence and, subsequently, value becomes attached to quantities. Worth becomes synonymous with quantity: if numbers are rising, worth is assured, and the desire for more is met. Thus Grosser identifies how the ubiquity of metrics produces desires – in the case of social media, for better metrics.

Grosser's work aside, there is not much scholarship on the emotional dimensions of engaging with data or with their visualisations, despite several indicators that emotions might matter in this terrain. These include: widespread acknowledgement within visual studies of the ways in which visuals speak to and evoke emotions; work within the broad field of design which notes the importance of 'emotional design' (Norman, 2004); and the fact that visualisation designers acknowledge the power of visualisations to make people feel. For example, prominent data visualiser Amanda Cox of *The New York Times* said of her own response to the visualisation project *Mapping America, Every City, Every Block* about population growth and decline and changing racial and ethnic concentrations, 'I'm just seeing what I basically know … But I felt it in a way I never had before. You can feel a good data visualisation' (Cox cited in Berinato, 2013). Similarly, in a book about the visualisation design process, Andy Kirk categorises responses to visualisations along a spectrum from 'reading' to 'feeling' (Kirk, 2016: pp to follow), again acknowledging the role of emotions in engagements with data through visualisations.

This recognition of the importance of emotions amongst visualisations practitioners has not translated into studies of them by researchers: in research into engagement with data visualisations, emotions are largely absent. Rather, such studies tend to focus on specific aspects of visualisation texts, for example, colour use, grouping of elements, use of visual metaphors (Einsfeld et al., 2009; Haroz and Whitney, 2012) or on measuring effectiveness, with effectiveness defined narrowly as speed of comprehension, memorability, or the quick accomplishment of tasks (Borkin et al., 2013; Chin et al., 2009; Anderson et al., 2011; Huang et al., 2009). Most studies do not take into account sociological considerations like who users are and their socio-cultural contexts, factors that might point to the emotional dimensions of engaging with visualisations. Although there has been some acknowledgement in the field that stimulating affective, visceral responses in users might enhance the reception of visualisations (Cawthon and Vande Moere, 2007), these ideas have not been studied empirically within visualisation research.

The absence of scholarly attention to the emotional dimensions of data visualisation can be accounted for, in part, by the field's history. Visualisation has its roots in the Enlightenment pursuit of rational knowledge about an external world (Manovich, 2011; Friendly, 2008), a pursuit which differentiated reason from that which exists outside it – 'passion, prejudice, madness, subjectivity, superstition, magic, tradition' (Ramazanoglu and Holland, 2002). In this context, reason has a valorised position as a route to objective truths about the world, truths which cannot be accessed when emotion obstructs judgement, so the Enlightenment logic goes. This reason/emotion binary has, of course, been widely critiqued, by sociologists of emotions (Bericat, 2015; Hochschild, 1990), feminist philosophers (most notably Lloyd, 1993) and others. Critics have sought to redeem the epistemological value of emotions

and the role they play in knowing, deciding, engaging and being (e.g. Jaggar, 1989). Thus at the time of writing, there is an extensive sociological literature that highlights the role emotions play in many aspects of life, including, for example, cognition, class, gender, economics, work and voting. Research in these areas has insisted that emotions need to be taken seriously, as central aspects of social and cultural experience and as informing and informed by reason and rational thinking (e.g. Cohn, 1993), capacities which are said to be evoked by data and statistics. But to date, this insistence on understanding emotions sociologically has not been applied to the study of data and their visualisation. Bringing this key insight to the study of big data is one important way in which sociology can advance the emerging field of data studies.

Another way to account for the absence of attention to the emotional dimensions of engaging with data and their visualisation is that, in data studies, there is little attention to non-expert citizens' engagements with data, or what Couldry and Powell describe as 'what actual social actors, and groups of actors, are doing under these conditions [of datafication] in a variety of places and settings' (2014: 2). Michael and Lupton note that 'there is still little research that has investigated what the public make of big data, aside from reports from privacy organizations and government bodies' (2015: 7). Although this is changing (Quantified Self researchers have begun to talk to users about their feelings about their fitness data (Sharon and Zandbergen, 2016; Ruckenstein, 2014) and community big data analytics projects are beginning to emerge (Taylor et al., 2014; Couldry et al., 2016), research into everyday engagements with data is still limited. Here again, sociology can make a contribution. The sociology of everyday life, the focus of a recent special issue of this journal, insists that taking the everyday seriously as a category of analysis enables an understanding of how social structures and arrangements are lived, or 'made and unmade' (Neal and Murji, 2015: 812). A sociological focus on everyday encounters with data can similarly unveil how datafication is experienced, translated and adapted (ibid). Thus we argue not only that datafication is an important social and sociological phenomenon, but also that sociological thought can contribute significantly to scholarship in this field. We approached *Seeing Data* through the lens of these two sociologies, of emotions and the everyday. Below, we describe how we did this.

7. *Seeing Data* methods

On *Seeing Data* we used a range of methods to develop understanding of engagements with data visualisations, including experimental visualisation practice, social semiotic analysis, focus groups, interviews and diary-keeping. We focus on the latter three methods here, as they involved the non-expert participants who are the focus of this paper. Our primary method of data collection was focus groups, for which we recruited participants from pre-existing groups or communities, believing that homogeneity may result in understanding of others' lifestyles and situations and so facilitate discussion (Krueger and Casey, 2000; Sanders, 1997). In the focus groups, we asked participants, who are not expert in data visualisation, to evaluate eight visualisations, chosen to represent a cross-section that might be encountered in the everyday, primarily in the media. After much discussion, we settled on visualisations representing a diversity of subject matters, chart types, original media sources, formats (print and online) and degrees of interactivity. Another criterion was to include visualisations that aim to explain and visualisations which invite exploration. Three of our chosen visualisations were of migration data, two of which we commissioned from a leading European visualisation agency, as this topic was a case study in our research.

We carried out nine focus groups with 46 participants in four geographical locations which, given our focus on migration, we characterise in the following ways: rural/high migration; rural/low migration; urban/high migration; urban/low migration. We aimed to recruit participants who might be assumed to be interested in data, the visual, or migration, and so 'already engaged' in one of the issues at the heart of the project, and others about whom we could not make these assumptions. Our resulting focus groups included: an art class; an open data group; two East European community groups; and Asian/British Asian group; a civil society group; a young farmers' group; a rural community group; and a pilot group with representatives from most of the above communities. 27 participants were female and 19 male; ages ranged from 11 to 70, with the 30-39 age range best represented (18 participants).

Employment sectors were extremely diverse, including hairdressing and cleaning, local government, agricultural work, teaching, media, retail and information services. All participants except four (two of whom were under the age of 16) had qualifications of some kind; 19 had completed tertiary education and 11 had higher degrees. As the study took place in the UK, most participants (n=30) self-reported as British, and other nationalities included German, Indian, Lithuanian, Pakistani, Polish and Thai.

Focus group participants kept diaries of their encounters with data visualisations in the week before their focus group meetings, to introduce them to what visualisations are and where they might be encountered. We hoped that these diaries would help to initiate discussion as well as providing us with valuable data about encounters with data visualisations in everyday settings. In the focus groups, we asked participants to record their initial responses to the visualisations we showed them on a grid which identified whether they liked or learnt from each one, a sample of which is shown in Figure 1, as previous experience of running focus groups had indicated that visual information about participants' views helps to elicit discussion. The grid aimed to capture initial responses to the visualisations, specifically relating to whether participants liked or disliked them. Participants were given a £20 one4all voucher in exchange for their participation.

[Figure 1: the grid on which focus group participants recorded initial reactions to visualisations]

After the focus groups, seven participants agreed to keep diaries for a month and to be interviewed about their diary-keeping experiences, in order to provide us with further information about encounters with visualisations in their everyday lives. These longer-term diary keepers were given a £100 one4all voucher in exchange for their participation. Their demographic characteristics were diverse, but it is noteworthy that five of them were educated to degree level. They were predominantly readers of the left-leaning *Guardian* broadsheet newspaper. There was one exception: J. C. (male, 24, white British agricultural worker) who self-identified as a Conservative and/or UK Independence Party (UKIP) voter, and read the tabloid newspaper *The Daily Mail*. Together, these methods (diary-keeping, focus groups and interviews) captured data about participants' encounters with visualisations in their everyday lives and about their engagement with specific visualisations circulating in the everyday. We draw on these focus group discussions, diaries and interviews in the next section, in which we discuss the role of emotions in engaging with data through visualisations.

8. Feeling numbers: emotional engagements with data visualisations

In our research, emotions played a significant role in how visualisations and the data within them were experienced. These emotions were neither simply about the data nor simply about the visualisations: rather, they emerged in relation to a number of factors, including: the data themselves; design and visual style; the subject matter of visualisations; their source or original location; participants' skills in making sense of visualisations. In many cases it is not easy to disentangle responses to data from responses to other aspects of visualisations, but nonetheless, we saw a range of emotional responses to the **data themselves.** Jason, for example, reacted with surprise to the migration data in the visualisation in Figure 8, as he had not known how many people in the UK were born in Ireland:

> I was surprised that Irish immigrants were the most common in the UK. I think the last Census – it was the ONS thing again – it was surprising, it was something I hadn't even thought of and it was like, 'Wow!'. For all the talk of immigration things, the fact that Irish immigrants are the most common, for a lot of the time until ten years ago, it was something I didn't expect (Jason, focus group discussion).

These data called into question what Jason believed and he enjoyed that experience. In other examples of emotional responses to the data represented in visualisations, Tom wrote in his diary about a visualisation on the extinction of species that he 'felt overwhelmed by the scale of the problem'; Paul Stewart, in his diary, described an old *New York Times* visualisation of the power of the nuclear bomb as

'quite scary!' and Meg wrote in her diary that she felt fearful about future trends in UK exports, based on a visualisation of data relating to the topic that she encountered in *The Daily Mail*.

Some participants had strong emotional responses to the **visual style** of some visualisations. A visualisation of film box office receipts by *The New York Times*, shown in Figure 2, divided participants, with some drawn to it aesthetically and some put off by it. Two participants wrote in their focus group notes:

> It was a pleasure to look at this visual presentation because of the co-ordination between the image and the message it carries. (Noon, focus group notes)
>
> Frustrated. It was an ugly representation to start with, difficult to see clearly, no information, just a mess. (Mark, focus group notes)

[Figure 2: Ebb and Flow of Box Office Receipts, *New York Times*]

Noon's pleasure derived from the link between the title 'Ebb and Flow' and the visualisation's smooth lines, like waves or water flowing. In contrast, Mark found his initial dislike of the aesthetics of the visualisation were compounded by other elements such as what he perceived as a lack of information. The importance of visual style and its potential to attract people to look more deeply or not was highlighted repeatedly during the focus groups. Mrs Mat's feelings about the Better Life Index, shown in Figure 3, show how some of our participants engaged emotionally with visual style, as the floral metaphor enabled her to imagine in a positive way what better lives mean for people. She wrote in her focus group notes:

> It was very lively – Create your Better Life Index – it made me smile, these flowers remind / present better life (Mrs Mat, focus group notes).

[Figure 3: Better Life Index, by OECD]

Emotions like frustration and confusion sometimes resulted from participants' consideration of whether the data had been visualised well or not. In his diary, Paul Stewart expressed frustration about a visualisation of second languages spoken in London:

> What frustrates me is the simplicity of it. It just shows a single language for each borough but these actually represent a more complicated picture – how many people or what proportion speak which languages? Which are the third, fourth and fifth most common languages, and how prevalent are they? Overall I am left with more questions then answers.

The **subject matter** of visualisations provoked strong emotional reactions amongst participants, including pleasure, anger, sadness, guilt, shame, relief, worry, love, empathy, excitement, offence. For example, The Clicks Don't Lie (Figure 4), which shows data about the social media followers of two female pop musicians Rihanna and Shakira and which appeared in the free commuter newspaper *The Metro*, provoked predominately negative emotional responses. Participants explained that their negative responses to the visualisation resulted from their dislike of these celebrities and of celebrity in general, their view that social media data is not interesting or trustworthy, the sexualisation of the artists portrayed and because they believed the visualisation was a vehicle for depicting semi-naked women. As one participant put it, 'I hate Shakira and Rihanna – why would you visualise junk?' (Noon). The intensity of Noon's 'hate' had a direct effect on her willingness to engage with the visualisation. There are many problems with the representation of data in The Clicks Don't Lie, but Noon (and other participants) found themselves so discouraged by their dislike of the subject matter that they were unable to make a considered assessment of the visualisation. In these examples, emotional responses obstructed close engagement.

[Figure 4: The Clicks Don't Lie, *The Metro* newspaper]

We saw strong feelings in relation to the **source or original location** of the visualisations that we showed participants in focus groups and that they encountered elsewhere and recorded in their diaries. One participant felt that all media set out 'to confuse you' and therefore distrusted all of the visualisations we showed him (Chris, focus group discussion). Some focus group participants trusted the migration visualisations which we commissioned, one of which is shown in Figure 7 below, which carried the logo of the University of Oxford, a *Seeing Data* partner, because they felt that the 'brand' of this university invokes quality and authority. During the period of extended diary keeping, participants tended to see visualisations in their favoured media which they trusted (such as *The Guardian* or *The Daily Mail* newspapers), so their responses to these visualisations were also characterised by trust. J.C., who regularly reads *The Daily Mail*, demonstrated this when he remarked in his interview that 'you see more things wrong or printed wrong in *The Sun* I think'. Given the ideological similarities between these two publications, this comment points to the importance of media location in users' emotional responses to data visualisations.

Users also had strong feelings about whether they had the **skills to decode** visualisations. A lack of confidence in this regard had a profound impact on some participants' engagement with visualisations. Chris, mentioned above, reacted to all of the visualisations that we showed him in the focus group with confusion and dislike, as seen in his grid in Figure 5.

[Figure 5: Chris's grid]

Chris responded in this way because he doubted his own ability to make sense of visualisations. This lack of confidence was echoed by some of our other participants, such as Harriet who wrote in her diary about visualisations in a newspaper article on tax:

> I felt confused and a bit stupid for not being able to stay the course with this article. It's too maths based for me. Too many numbers and pie charts, I get lost in it. (Harriet, extended diary entry)

Feeling 'stupid' was the result of a perceived lack of statistical skills, such as knowing how to read particular chart types. When participants felt more skilled, unfamiliar visualisation chart types could evoke positive emotions, rather than negative ones: 'I didn't hate it because it made me want to try and put a little bit of effort into navigate those lines', said Robert about a visualisation of freshwater consumption, shown in Figure 6. Such emotional responses have important consequences for engagements with data.

[Figure 6: Freshwater Consumption]

As noted above, a number of writers have expressed concern about what Nathaniel Tkacz calls an 'emerging form of rationality' (2014) based on a trust in numbers which appears in times of big data, quantification and metrification. But to understand this as a form of rationality *alone* is to fail to acknowledge the emotional aspects of engaging with data. Our research showed that when our participants encountered data in visualisations, responses are not confined to the rational. Emotions were evoked, and they played a significant role in shaping whether participants felt like looking, how they engaged and the information that they took from the visualisations. Indeed, some of our participants explicitly acknowledged the importance of emotions when engaging with data visualisations, such as Robert, who said:

> [A visualisation] has to tell a story and create an emotional response, so a good one makes me want to relate to it or at least provokes me to think about something else that isn't just on the page […] So yeah, definitely the emotional sort of reaction to it is important. (Robert, focus group discussion)

In this quote, Robert shows that he values emotional engagements with data visualisations. Another participant, Marianne, noted the importance of acknowledging emotional responses to data alongside rational responses in her positive comments about the format in which we invited participants to structure their responses to the visualisations they encountered. Just as the grids captured whether participants liked and had learnt from the visualisations they saw, so our templates asked participants to note down what they felt, as well as what they thought, when they engaged with a visualisation either in the focus groups or in their everyday lives. In an interview which took place after the extended diary-keeping period, Marianne said:

> I like the way you phrased your questions in, 'What did you feel?' and then, 'What did you think?' And I thought this process – my immediate reaction, 'How long did I bother to look?' and then, 'Why did I look? How did I feel about it?' I thought that was a very good process, to do it in that way. And I think I'll continue to, when I see this, to do that. (Marianne extended diary-keeping interview)

Given what we found in our research, we argue that despite the intensified discourse of rationality in datafied times characterised by a growth in quantification, big data and metrics, we cannot describe everyday experiences of engaging with data as constituted only by rational reactions. Engaging with data is not just about reason and cognition. Emotional responses are also evoked by a number of factors and in a number of ways when a person engages with data in its most common form, through a visualisation. Here, debates within the sociology of emotions which are concerned with the relationship between emotion and cognition or reason are relevant (Turner, 2009; Turner, 2000). As Jagger (1989) argues, emotion can be understood as an 'epistemic resource', a way of knowing that is valuable for building a critique of the world. Similarly Damasio (2006) argues that without emotions, the ability to make rational decisions is hampered. Emotions are therefore vital components for understanding the social world, including the social world of data. In the next section, we turn the spotlight on one particular moment in our research to illustrate this point further.

9. Empathetic responses to 'Migration in the News'

Two of our participants, Sally (female, 48, white British) and Horace (male, 27, white British), both worked for a civil society organisation – as such, we considered them to be 'already engaged' with the topic of migration. One visualisation that they had very strong emotional reactions to is Migration in the News, shown in Figure 7, which visualises data about the ways that the British press describes migrant groups (including asylum seekers and refugees).

[Figure 7: Migration in the News]

In a focus group exchange between Sally, Horace and one of the facilitators, these participants showed how the visualisation prompted them to imagine the experiences of those migrating to the UK and encountering media portrayals of migrants and to feel strongly about this imagined experience. Sally said:

> I felt really bad that there's so much negative stuff in the press about refugees and migrants. Maybe that's just working for [civil society organisation], we're a bit biased, but it just makes you feel a bit for people who are refugees or migrants who are coming to live in this country and then go out and buy a newspaper and all the articles are negative and they're portrayed as scroungers and all the rest of it. You just feel that is such an unfair biased view. (Sally).

Horace agreed, explaining how his and Sally's work-based knowledge of what leads people to migrate or seek asylum is missing from the stories that most people encounter in the press:

> Coming from our perspective, we actually see the actual countries that these people are coming from, why and what they're actually escaping. We see the context behind it. Whereas if you pick up something like *the Metro*, you pick it up and read it for five minutes on the tube and then put

> it down, if you've got that much, not bile, but disproportionate amount of negative image behind it and you're only exposed to that information for five minutes, you're sitting there Kings Cross to Euston or whatever it is and you read that, and you do that day in and day out and it's the reinforcement of that imagery (Horace).

They then went on to describe the feelings that the visualisation evoked as 'felt guilty for being British' in Sally's case, and 'ashamed […] of the media as a whole' in Horace's. He elaborated:

> If somebody came here, various shades of south Sudanese or they were a legal migrant from Poland, and they pick up the paper and they read it and the first thing they go is EU is awful, or refugees have taken our jobs or murdering our children or whatever it is. […] Even though Polish people contribute an incredible part to our economy and to our culture. But it's that sort of thing; I'm kind of ashamed to live in a country that, even though these people have given up their lives and come over here and given so much to us by and large, we constantly belittle them and shout them down. I'm a little bit ashamed to be in a country that has a media that is like that (Horace).

Although both Sally and Horace drew on what they already knew about the causes of migration and asylum-seeking, it was the visualisation itself that provoked their strong emotional responses. It evoked feelings of pity, shame, guilt, and there was an air of sorrow about Sally and Horace's discussion. Aware of situations migrants and refugees might leave behind, the visualisation provoked Sally and Horace to empathise with migrants and their experiences anew.

In her discussion of the use of computerised information gathering in terrorism prevention, Amoore (2009) argues that people are turned into data through these processes, something that she characterises as 'pixellation'. She proposes that this pixellation of human subjects allows governments to make judgements about people: 'the unknown terrorist is rendered knowable through the fractured bits and bytes of a way of life,' she writes (Amoore, 2009: 19). Data depoliticise decisions about who is and who is not a potential terrorist, she proposes; their use in these processes gives them an appearance of neutrality. In her view, such pixellation of human subjects has been to put to extremely troubling use. As noted above, Porter (1995) and Crawford (Crawford, 2013b) argue that quantification 'is a technology of distance' (Porter, 1995: ix): numbers and quantities enable the viewing of phenomena from afar. We might also describe the process that Amoore calls pixellation as a form of distancing: the numbers and calculations produced through data-gathering distance these same numbers from the human subjects to which they refer and, in turn, distance viewers and consumers of these numbers from an awareness of and sensitivity to those human subjects without whom the numbers would not exist. It is because of this distancing that some writers bemoan the loss of qualitative sensitivity that accompanies quantification, such as Baym, who argues that in times of big data, 'Now, more than ever, we need qualitative sensibilities and methods to help us see what numbers cannot' (Baym, 2013: n. p.).

However, distancing is not only experienced negatively. One of our participants, Harriet, described her experience of looking at a visualisation of census data relating to the foreign-born population in the UK, Migration in the Census (Figure 8), as follows:

> It felt a bit more abstract and I liked that they were being abstract [about] something that's been quite a heated topic. […] It felt very depersonalised and abstract and I really liked that treatment of that topic, I thought that was good. (Harriet, focus group discussion)

What's more, Sally and Horace's reaction to Migration in the News suggests that quantification (or pixellation) is not only experienced as distancing. This visualisation succeeded in translating data back into people for Sally and Horace, bringing the humans who are the subject of the visualisation close. For Sally and Horace, this visualisation *diminished* the distance that quantification is said to produce, enabling them to imagine and empathise with the plight of the human subjects represented within the visualisation. Their response illustrates Butler's (2012) proposal that images of suffering can enact a

process of reversibility, in which suffering that occurs at a distance is brought close to us through its visual representation in the media. Although more abstract than other visual forms, data visualisations act as media images as well as representations of data, and as such they have the potential to evoke empathy, pity, sorrow, shame and other emotions. The visualisation of data makes it possible to *feel* numbers, metrics, data and statistics, to make sense of the figures in a way that is emotional and affective, not just cognitive and rational.

[Figure 8: Migration in the Census]

This reversal of distancing takes place precisely because the main way that non-experts get access to data is through their visualisation. Quantification distances, but the visualisation of quantities diminishes distance because data and their visual representation are entangled – for most people, data are always both statistical and visual. This entanglement is productive for thinking about how data are experienced. As we have noted elsewhere with others (Kennedy et al, 2016), unlike other visual imagery like photography, the raw material of visualisations does not exist in a perceptually available form outside of their design. Data come into being through visual design; that is, through the visual elements chosen to present them. This means that visualised data's appearance is, on the whole and especially for ordinary people, the same as their substance (Aiello, 2007). Because in everyday encounters with data, data only exist visually, there is almost always an emotional component to engaging with data. Acknowledging the *visual* dimensions of engaging with data means acknowledging the *emotional* dimensions of seeing data. In so doing, we can see that it is therefore not only numbers but also *the feeling of numbers*, or *how numbers feel*, that is important in times of datafication.

10. Conclusion: data and emotions

In this paper we argue that emotions matter in everyday engagements with data. To date, in the emerging field of data studies, the emphasis has been on critiquing the ways in which the increasing ubiquity of data, the growth of quantification and the rise of metrification have led to a renewed dominance of rationality, objectivity and a belief that 'the numbers speak for themselves' (Anderson, 2008). Drawing on the sociology of emotions, we challenge the notion that cognitive, rational thought alone comes to dominate in times of datafication, highlighting how various aspects of the forms in which people encounter data evoke emotional responses as much as they lead to cognitive reasoning. Emotions are evoked by data themselves, subject matter, the locations in which data are encountered and by people's sense of their own abilities to make sense of and engage with data. That data are primarily encountered visually, are almost always visual as well as statistical and, for ordinary people, rarely exist in a perceptually available form outside of their visualisation, leads to emotional engagements with data, what we call 'feeling numbers'.

Privileging the rational over the emotional, as the rhetoric of quantification does, also means privileging some groups over others. This is because certain groups (often white, middle-class men) are better equipped to understand mathematical and statistical information, not because they are more naturally capable of doing so, but because they are significantly better represented in maths, science and computing subjects at school and beyond. As boyd and Crawford point out, this results in those same groups acquiring expertise, and who has expertise determines who controls the 'knowledge' about the social world that results from data mining: 'Wrangling APIs, scraping, and analyzing big swathes of data is a skill set generally restricted to those with a computational background' (boyd and Crawford, 2012: 674), they argue. Patterns of representation in these groups are raced, classed and gendered – Harriet's lack of confidence and feelings of stupidity when encountering data visualisations may be seen as one example of this. Critical commentators have noted a range of concerns about the consequences of the rise of what Beer (2016) calls 'metric power', and we add to that criticism by pointing to the ways in which focusing on the dominance of rational, statistical thinking can exclude some social groups from theorisations of datafication. Thus this paper contributes to debates about what is at stake, what is lost and who loses out not only when metric power takes hold, but also when such power is assumed to invoke only the rational and cognitive. By focusing on the emotional dimensions of ordinary, everyday

engagements with data through their visualisation, we progress theoretical understanding of data, of visualisation and of their inevitable entanglement.

These issues matter for sociology in a number of ways. First, as we have noted, the emerging field of data studies can benefit from two sociological traditions, the sociology of emotions and the sociology of everyday life. The first draws our attention, as Hochschild argues, to the fact that 'what we feel is fully as important to the outcome of social affairs as what we think or do' (1990: 117). The second enables us to acknowledge that datafication is not constituted solely through data structures; rather, it is lived and experienced at the level of the everyday. By building on these two sociological traditions, this paper makes a significant contribution to the emerging sociology of data, moving it beyond a focus on operations of data power from above and focusing on lived experiences of datafication 'from the bottom up' (Couldry and Powell, 2014). Finally, this paper might be seen as a reminder that data matter socially and therefore sociologically, and so sociology needs to address their growing importance, their materialisation in everyday life, their power and its resistance.

Our research also points to the consequences of the ways in which people currently learn to relate to data through formal mathematical education – namely, it often results in a lack of confidence in numeracy skills. In our research, alongside such widespread lack of confidence in statistical literacy, we saw emotional relating to data, or feeling numbers. Because of these two findings, and because, as we suggest above, privileging the rational excludes certain groups, we might need to re-think existing cognitive approaches to statistical education and consider what feelings-based approaches to this field might contribute to developing skills for relating to data. Because emotions play a part in the process of engaging with data visualisations, we need to consider what it means for those emotions to be acknowledged, and for the potential benefits of emotional engagement with data to be recognised. Our research has shown that whilst visualisations are powerful tools for informing minds, they also have the power to affect hearts. This matters because enabling successful emotional engagements with data, for example by changing how we do statistical education, might mean including previously excluded groups in understandings of data and in engagements in data-driven conversations and decision-making.

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12. References

Aiello G (2007) The appearance of diversity: Visual design and the public communication of EU identity. In: Bain J and Holland M (eds) *European Union identity: Perceptions from Asia and Europe*. Nomos Verlagsgesellschaft Mbh & Co., 147-181.

Amoore L (2009) Lines of sight: on the visualization of unknown futures. *Citizenship Studies* 13: 17-30.

Anderson C (2008) *The end of theory*. Available at: http://www.wired.com/science/discoveries/magazine/16-07/pb_theory.

Anderson EW, Potter KC, Matzen LE, et al. (2011) A user study of visualization effectiveness using EEG and cognitive load. *Computer Graphics Forum*. Wiley Online Library, 791-800.

Baym NK (2013) Data not seen: the uses and shortcomings of social media metrics. *First Monday* 18.

Beer D (2016) *Metric Power*. Basingstoke: Palgrave Macmillan.

Beer D and Burrows R (2013) Popular culture, digital archives and the new social life of data. *Theory, culture & society* 30: 47-71.

Bericat E (2015) The sociology of emotions: four decades of progress. *Current Sociology* 64: 491-513.

Berinato S (2013) *The Power of Visualization's "Aha!" Moments*. Available at: https://hbr.org/2013/03/power-of-visualizations-aha-moment/.
Borkin MA, Vo AA, Bylinskii Z, et al. (2013) What makes a visualization memorable? *Visualization and Computer Graphics, IEEE Transactions on* 19: 2306-2315.
boyd d and Crawford K (2012) Critical questions for big data: provocations for a cultural, technological, and scholarly phenomenon. *Information, Communication & Society* 15: 662-679.
Butler J (2012) Precarious life, vulnerability, and the ethics of cohabitation. *The Journal of Speculative Philosophy* 26: 134-151.
Cawthon N and Vande Moere A (2007) The effect of aesthetic on the usability of data visualization. *IEEE International Conference on Information Visualisation (IV'07)*. Zurich, Switzerland: IEEE, 637-648.
Chin G, Singhal M, Nakamura G, et al. (2009) Visual analysis of dynamic data streams. *Information Visualization* 8: 212-229.
Cohn C (1993) Wars, wimps and women: talking gender and thinking war. In: Cooke M (ed) *Gendering War Talk*. Princeton: Princeton University Press, 227-246.
Couldry N, Fotopoulou A and Dickens L (2016) Real social analytics: a contribution towards a phenomenology of a digital world. *British Journal of Sociology* 67.
Couldry N and Powell A (2014) Big Data from the bottom up. *Big Data & Society* 1.
Crawford K (2013a) Algorithmic illusions: the hidden biases of Big Data. *Strata*. Santa Clara, CA.
Crawford K (2013b) *The hidden biases in big data*. Available at: http://blogs.hbr.org/2013/04/the-hidden-biases-in-big-data/.
Damasio AR (2006) *Descartes' Error: Emotion, Rationality and the Human Brain*. London: Vintage.
Einsfeld K, Ebert A, Kerren A, et al. (2009) Knowledge generation through human-centered information visualization. *Information Visualization* 8: 180-196.
Few S (2008) What ordinary people need most from information visualization today. *Perceptual Edge: Visual Business Intelligence Newsletter*.
Friendly M (2008) A Brief History of Data Visualization. In: Chen C-h, Hardle W and Unwin A (eds) *Handbook of data visualization*. Berlin: Springer, 15-56.
Grosser B (2014) What do metrics want? How quantification prescribes social interaction on Facebook. *Computational Culture: a journal of software studies*.
Haroz S and Whitney D (2012) How capacity limits of attention influence information visualization effectiveness. *Visualization and Computer Graphics, IEEE Transactions on* 18: 2402-2410.
Hochschild AR (1990) Ideology and emotion management: a perspective and path for future research. In: Kemper TD (ed) *Research Agendas in the Sociology of Emotions*. New York: State University of New York, 117-144.
Huang W, Eades P and Hong S-H (2009) Measuring effectiveness of graph visualizations: A cognitive load perspective. *Information Visualization* 8: 139-152.
Jaggar AM (1989) Love and knowledge: Emotion in feminist epistemology. *Inquiry* 32: 151-176.
Kennedy H, Hill RL, Aiello G, Allen W (2016) The work that visualisation conventions do. *Information, Communication and Society* 19(6): 715-735. Available at: http://dx.doi.org/10.1080/1369118X.2016.1153126
Kirk A (2016) *Data Visualisation: a Handbook for Data Driven Design*. London: Sage.
Krueger RA and Casey MA (2000) *Focus Groups: a Practical Guide for Applied Research*. London: Sage Publications.
Lloyd G (1993) *The Man of Reason: 'Male' and 'Female' in Western Philosophy*. London: Routledge.
Manovich L (2011) What is visualisation? *Visual Studies* 26: 36-49.
Mayer-Schönberger V and Cukier K (2013) *Big Data: A Revolution That Will Transform How We Live, Work, and Think*. Boston, Mass: Houghton Mifflin Harcourt.
Michael M and Lupton D (2015) Toward a manifesto for the "public understanding of big data". *Public Understanding of Science* 25: 104-116.
Neal S and Murji K (2015) Sociologies of everyday life: editors' introduction to the special issue. *Sociology* 49: 811-819.
Norman DA (2004) *Emotional Design: Why We Love (or Hate) Everyday Things*. New York: Basic Books.

Porter TM (1995) *Trust in Numbers: The Pursuit of Objectivity in Science and Public Life*. Princeton: Princeton University Press.
Ramazanoglu C and Holland J (2002) *Feminist Methodology: Challenges and Choices*. London: Sage.
Ruckenstein M (2014) Visualized and interacted life: personal analytics and engagements with data doubles. *Societies* 4: 68-84.
Sanders LM (1997) Against deliberation. *Political Theory* 25: 347-376.
Sharon, T and Zandbergen, D (2016) From data fetishism to quantifying selves: self-tracking practices and the other values of data. *New Media and Society* doi: 10.1177/1461444816636090.
Taylor AS, Lindley S, Regan T, et al. (2014) Data and life on the street. *Big Data & Society* 1.
Tkacz N (2014) Dashboards and data signals. *Programmable City Project*. Maynooth University.
Turner JH (2000) *On the Origins of Human Emotions: A Sociological Inquiry Into the Evolution of Human Affect*. Stanford, CA: Stanford University Press.
Turner JH (2009) The sociology of emotions: basic theoretical arguments. *Emotion Review* 1: 340-354.
Van Dijck J (2014) Datafication, dataism and dataveillance: Big Data between scientific paradigm and ideology. *Surveillance & Society* 12: 197-208.
Zambrano RN and Engelhardt Y (2008) Diagrams for the masses. In: Stapleton G, Howse J and Lee J (eds) *Diagrams 2008*. Berlin, Heidelberg: Springer Verlag, 282-292.

13. Author Biographies

Helen Kennedy is Professor of Digital Society at the University of Sheffield. Her research has traversed digital media landscapes, covering a range of topics and she has published widely in this field. She is currently interested in critical approaches to big data and data visualisations, and how people live with and experience data in data-rich times. She recently published *Post, Mine, Repeat: social media data mining becomes ordinary* (2016) with Palgrave Macmillan. [email: h.kennedy@sheffield.ac.uk]

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14. **Figures (high-resolution, black & white images can be provided if the article is accepted)**

Figure 1: the grid on which focus group participants recorded initial reactions to visualisations

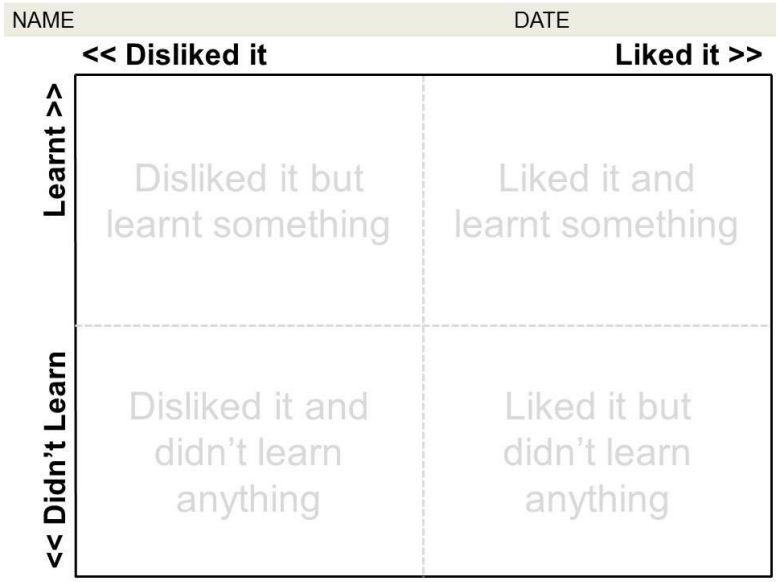

Figure 2: The Ebb & Flow of Box Office Receipts, 1986-2008, New York Times

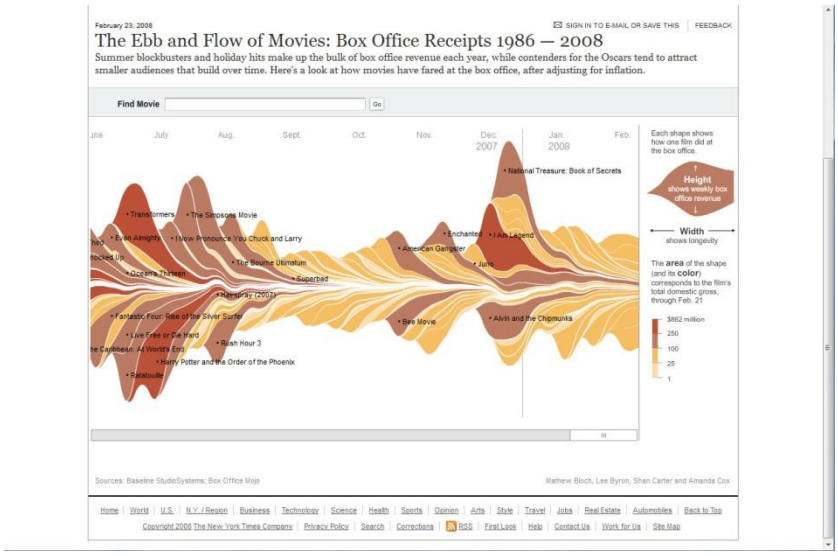

Figure 3: Better Life Index, The Organisation for Economic Co-operation and Development (OECD).

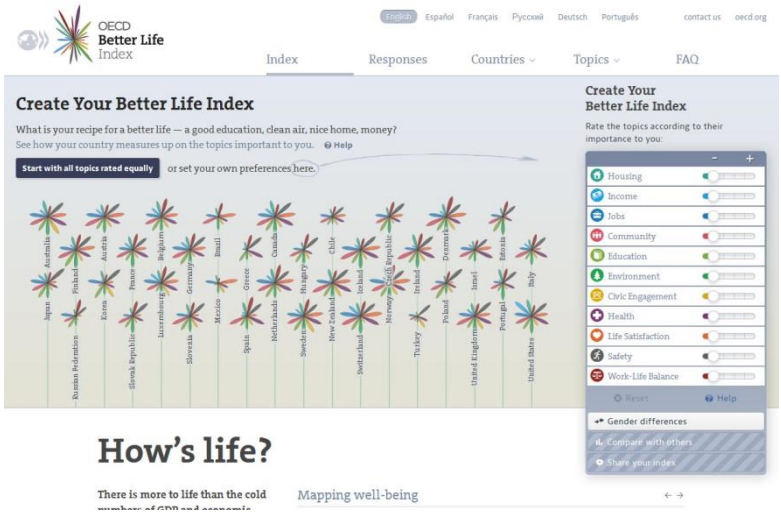

Figure 4: The Clicks Don't Lie, *The Metro* newspaper, July 2014

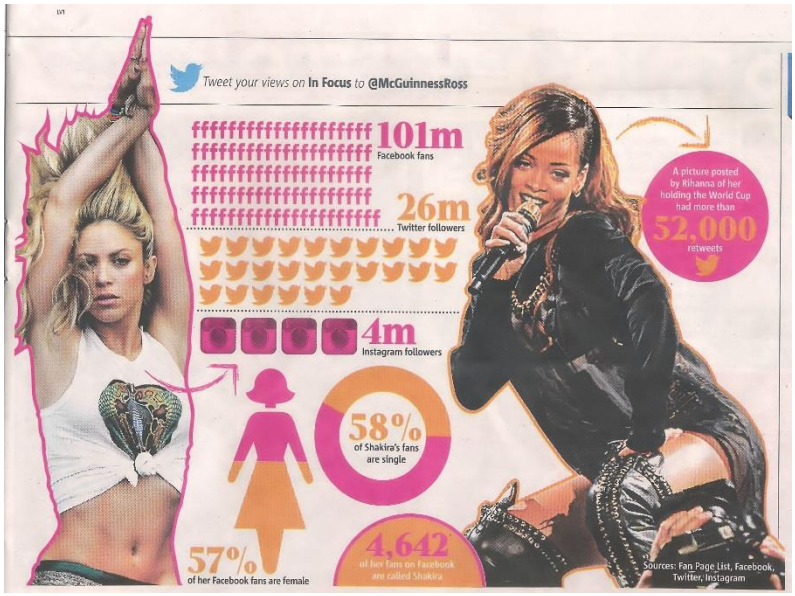

Figure 5: Chris's grid

Figure 6: Top Ten Freshwater Consumers, Scientific American magazine

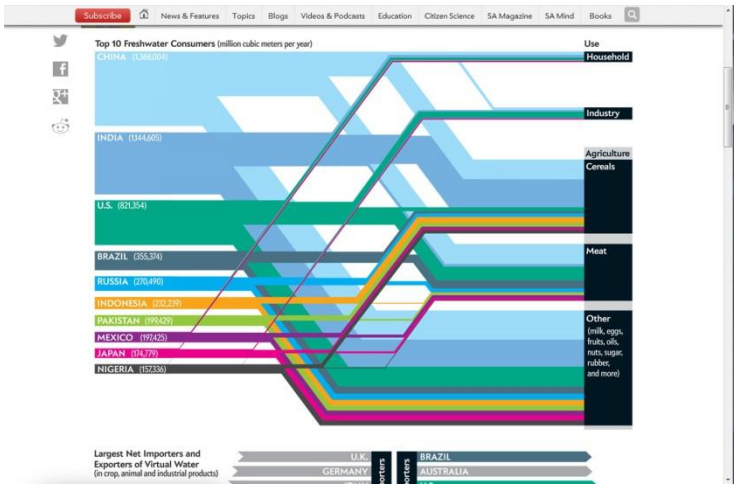

Figure 7: Migration In The News

Figure 8: [Migration In The Census]