

Big Data between audio-visual displays, artefacts, and aesthetic experience

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This article discusses artistic practices and artefacts that are occupied with exploring data through visualization and sonification strategies as well as with translating data into materially solid formats and embodied processes. By means of these examples, the overall aim of the article is to question critically how and whether such artistic practices can eventually lead to the experience and production of knowledge that could not otherwise be obtained through more traditional ways of representing data. The article, thus, addresses both the problems and the possibilities entailed in extending the use of large data sets – or Big Data – into the sphere of art and the aesthetic. Central to the discussion here is the analysis of how different data structuring principles and the discourses that surround these principles shape our perception of data. This discussion involves considerations about various notions of the ‘database’ and ‘narrative’, as well as ‘aesthetics’ and ‘aesthetic experience’, with the latter conceived as a theoretical field and methodological approach for understanding the interplay between sensation, information, experience, and knowledge production.

Introduction: Big (Bang) Data on display

From the large body of literature that exists on the topic today, it is clear that it has been a more than difficult task to arrive at a fully agreed-upon definition of what Big Data is.

In discussions ranging from the economic and societal impact at large (Aiden & Baptiste, 2013) to implications for specific scientific research environments (Kitchin, 2014; Hayles, 2012) to influence on the everyday personal lives of individuals (Mayer-Schönberg & Cukier, 2013), Big Data has become a common but nebulous term. One key notion, however, that should be advanced here is the distinction between, on the one hand, references to large amounts of data in general and, on the other, the capitalized term 'Big Data'. As David Chandler has pointed out, the latter implies that we understand Big Data "as a set of ideas and practices discursively cohered around a certain approach to knowledge production" as opposed to recognizing it as a mere descriptive term for large data sets (Chandler, 2015, p. 836). However, Chandler links his observations with questions about governance and power, which will not be our focus here. Yet, the description of Big Data as something that is generally conceived as being "capable of changing the ways in which knowledge of the world is produced" (ibid., p. 834) is central to the discussion that follows below in this article – namely, because it addresses how 'knowledge production' is closely related to sense-making processes that are catalysed by the translation of data into specific perceptible, aesthetic forms.

A rather comprehensive impression of what such data translations may look, sound, and feel like was provided by an exhibition named "Big Bang Data", which was launched at Barcelona's CCCB (Centre de Cultura Contemporània de Barcelona) in May 2014.¹ It presented itself as the biggest exhibition yet dealing explicitly with Big Data in order to explore, as it was phrased on the exhibition website, "the emergence of the database as a framework for cultural and political thinking and the effects of datafication of the world".² Considering the scope and magnitude of the exhibition, including its thematization of creative and aesthetic uses of data and large data sets, it stood out from the average gallery exhibition of digital and otherwise data-related art. Thus, as a significant event,³ the exhibition seemed to have the aim of disseminating a broader understanding of the particular concept of Big Data that was not defined from a strictly scientific (cf. Heller et al., 2015) or commercial business intelligence perspective (cf. Marr, 2015). This was primarily done through the presentation of a large selection of works and artistically-driven projects, which provided visitors with an *experience* of Big Data through various materials and modalities. This experience could, furthermore, be characterized as *aesthetic* in that the exhibition displayed Big Data not only as a theoretical and abstract concept but as something we are actually able to see, hear, feel, and even taste – from the audio-visual, animated installation *Exit* by Diller Scofidio + Renfro, which "quantifies and shows the growth of the migration of the global population",⁴ to 'static' objects such as Nicholas Felton's *Annual Reports*⁵ and more interactive, dynamic artefacts such as *Sand Falls* by Domestic Data Streamers,⁶ to Moritz Stefaner's participatory *Data Cuisine* event in which the audience would prepare and cook a meal based on the research and representation of "local open data in local food".⁷ A more detailed discussion of some of the works mentioned here will be presented below. Overall, a substantial part of the exhibition concerned different approaches for communi-

cating aggregated data by creating sensory effects through specific aesthetic expressions out of which information and meaning related to the particular data sets used could subsequently be derived.

Such approaches, we shall argue here, can be fundamentally understood through the concept of aesthetics in its original sense of having to do with “perception, including our perceptual capacities, perceptual practices, and perceptual experience”, as outlined by philosopher Richard Shusterman (Shusterman, 2012, p. 106). Shusterman refers to one of the founding fathers of early modern aesthetics – i.e., aesthetic theory and philosophy as it developed within modernity – Alexander Gottlieb Baumgarten, whose 18th-century ideas of aesthetics implied both the old Greek notion of “aesthesis” as a “general theory of sensory cognition” and the modern notion of aesthetics as a scientific discipline in its own right (ibid.). The other important strand of early modern aesthetics discussed by Shusterman relates to the philosophies of Immanuel Kant and G.W.F. Hegel, respectively. Shusterman explains how Kant’s focus on the concept and judgment of beauty and Hegel’s subsequent connection of aesthetics with particular practices and concepts of *art* marked a departure away from Baumgarten’s understanding of aesthetics as perception and toward aesthetics as “conception”, as ‘pure’ philosophy (ibid., p. 107). According to Shusterman, this conceptual ‘turn’ derived from Hegel dominated the way questions of aesthetics throughout most of the 20th century would be conceived as the critical philosophy of fine arts (ibid.) - that is, until recently, when we have witnessed a return to what Shusterman sums up as the revival within “contemporary aesthetics” of “its [aesthetics’] original conception as focused on sensory perception” and as something that has to do with “the practical action of common life” and does not focus primarily on the *beauty* of a particular artwork (ibid., p. 108). One of the contemporary aesthetic theorists Shusterman mentions as part of this ‘revival’ is Martin Seel. Seel also departs from Baumgarten’s idea of aesthetic perception as contributing “to knowledge” and continues this discussion through his own definition of an “aesthetics of appearing”, which we shall address later (Seel, 2005).

Different notions of data aesthetics – database vs. narrative

As mentioned above, the Big Bang Data exhibition aimed to explicate Big Data as a wide-ranging cultural phenomenon tightly interrelated with our daily digital lives, while presenting this broad notion of Big Data primarily through the lens of artefacts and artistic practices. Seen from the perspective of aesthetics, this double venture would, then, amount both to the ‘practical action of common life’ (cf. Baumgarten), and to conceptual ideas about beauty and taste (cf. Kant and Hegel), with the latter aspect of aesthetics relating to subjective experience and judgment instigated from the interplay between our imagination and the formal qualities of objects perceived (Kant, 2007 [1790], p. 74). The present article will develop this notion of the relationship between perception, imagination and conceptualization as it relates to how artefacts represent Big Data. For now, it suffices to

keep in mind that aesthetics does not only concern ideas of beauty or appealing design but also pertains to how sensory perception can essentially lead to cognition and knowledge.

Turning our attention again to *Big Bang Data* and briefly toward the paratextual aspects framing the exhibition, we find one specific mention of “aesthetics”. This consists of a passage from media scholar Lev Manovich’s seminal *The Language of New Media* and refers to his suggestion that, with the computer age, we have moved from “narrative as the key form of cultural expression” to the “database” in relation to which we should also develop “poetics, aesthetics, and ethics” (Manovich, 2002, p. 195). Although it is the only reference relating directly to the concept of aesthetics, the quote is placed distinctly on the landing page of the website - thus providing a clear framing of the exhibition, which implies a particular relationship between the database and aesthetics. Furthermore, it indicates a development in which narrative has been displaced in favour of new types of cultural expression.⁸ At a certain level, this can be read as a curatorial subscription to an understanding of the database as a new point of departure for how we can think about the relationships between ways of structuring and storing data, artistic practices and artworks, and aesthetics. Even though Manovich proposed this shift from narrative to database more than a decade ago and despite the fact that it has since become “commonplace parlance in the discourse on digital media”, it continues to spur critical debate (Galloway, 2011, p. 378).

Thus, another prominent contemporary theorist on digital media, N. Kathrine Hayles, has also included this discussion in her scrutinizing analysis of how we conceive and use digitally-mediated information. One of Hayle’s later investigations of this field, *How We Think – Digital Media and Contemporary Technogenesis* (2012), involves a kind of response to Manovich’s claim about the foregrounding of the database in favour of narrative. In opposition to that point of view, Hayles argues that narrative is “essential to the human life-world” (Hayles, 2012, p. 181). As she explains: “[N]arrative modes are deeply influenced by the evolutionary needs of humans negotiating unpredictable three-dimensional environments populated by diverse autonomous agents” (ibid., p. 179). Even though the concept of narrative as such is not very explicitly delineated by Hayles, it is clearly developed from classic theories of narratology (cf. Gérard Genette) and literary analysis (cf. Mieke Bal) and, thereby, generally rooted in an aesthetic approach to textual interpretation. Yet, in addition to these overall arguments about the continued importance and function of narrative, she also acknowledges, following Manovich, that the apprehension of current forms of data does not simply align with traditional narratological models focused on temporality: “Data sets and databases, by contrast, lend themselves readily to spatial displays, from the two-dimensional tables typical of relational databases to the more complex n-dimensional arrays and spatial forms that statisticians and data analysts use to understand the stories that data tell” (ibid., p. 180). As it will be shown in the following paragraphs of this article, this relation may not only concern spatially- (and visually-) arranged displays but also other types of organisation of materials that appeal to our cognitive and sensory faculties through, for instance, sonic and haptic qualities. Hayles also discusses in detail the char-

acteristics of the “relational” database, which has become *the* most pervasive format. Yet, rather than claiming a strict opposition between narrative and database, she suggests how we can understand them as fundamentally interdependent:

Rather than being natural enemies, narrative and database are more appropriately seen as *natural symbionts* [...] Because database can construct relational juxtapositions but is helpless to interpret or explain them, it needs narrative to make its results meaningful. Narrative, for its part, needs database in the computationally intensive culture of the new millennium to enhance its cultural authority and test the generality of its insights (Hayles, p. 176)

Following Hayles’ account of this, we shall further discuss whether artistically-oriented projects driven by, for instance, visualization and sonification strategies can be experienced as demonstrating a strong or weak awareness of this co-existence between database and narrative. Prior to that, however, another observation of Hayles’ should be mentioned since it concerns one of the fundamental attributes of Big Data as such – that of scale and disorderliness – and the importance of data visualization in this context. The conception of data magnitude as a defining property for what eventually became subsumed under the term ‘Big Data’ was already suggested by Laney in 2001. From that point on, the so-called “three Vs” (“Volume”, “Velocity”, and “Variety” - i.e., disorderliness) have repeatedly been referred to in both scientific and popular definitions of Big Data (Laney, 2001). While Hayles seems deliberately to avoid referring directly to Big Data, she adapts to the basic notion of scale and disorderliness as defining features of the database. Consequently, like a number of data analysts and engineers, she argues that visualization tools have become increasingly necessary “as scale grows exponentially larger” (Hayles, p. 33). Hayles also advances a commonly-agreed-upon quality of data visualization as something that “helps sort the information and make patterns visible. Once the patterns can be discerned, the work of interpretation can begin” (ibid.). It is crucial here, however, to be aware of what Mark Hansen has pointed out about “data-driven aesthetics”: that “data has no natural ‘look’, no natural ‘visualization’” (Hansen, 2013) – a topic we shall also investigate further.

The other important point for our extended discussion below is the kind of taxonomic distinction made by Hayles as she describes the assumption that “the discovery of patterns is sufficient, without the necessity to link them to meaning” as opposed to the view that “data must lead to meaning for them to be significant” (Hayles, p. 33). This distinction is relevant for our discussion of the role of databases as that which “collect, parse, and store”, whereas the “primary purpose of narrative is to search for meaning” (ibid., p. 181; 180). In the analysis of different works that follows below, we shall extend these arguments and observations derived from Hayles in order to clarify how the overall questions concerning aesthetics, perception, and knowledge production relate to practices of data visualization and sonification. First, we shall introduce a digital work that will serve as an example for our continued discussion, *Listen to Wikipedia*.

***Listen to Wikipedia* – an audio-visual experience of the database?**

Besides being one of the world's most used knowledge web resources, accessed by millions of visitors per day, Wikipedia is also a "cloud of self-managed, user generated information" based on an easily accessible and open platform for producing, extracting, and making additional use of data and metadata (Leadbetter, 2010). The Wikipedia site is built on a relational database management system to which Hayles also refers in her discussion of different sorts of databases. From a rudimentary user perspective, browsing through the content of Wikipedia will quickly establish an immediate experience of the database as vast and constantly changing because of its open character as a "social cloud" in which the content of any individual article is always potentially being edited (ibid.). The experience of the volume of Wikipedia's data is normally bound to a sequential browsing procedure that takes the user from page to page via hyperlinks. In a way, this procedure could easily be seen as an example of a user-generated "hypertext" narrative, since this was suggested as a certain approach to understanding how we receive and produce literary texts in purely digital environments (cf. Manovich 2002, p. 61). Although Wikipedia is a knowledge database and not a literary text, the clicking of links and jumping from page to page implies a similar processing of information, which is not without its limitations. Hayles, thus, refers to how several studies have shown that hypertext and hyperlinks do not enhance comprehension but, rather, degrade it and challenge the integration of new information into "existing knowledge schemas" (Hayles 2012, p. 63).

In an attempt to abandon this navigation procedure, in which the experience of Wikipedia is somewhat equivalent to a 'hypertext experience', Mahmoud Hashemi and Stephen LaPorte (aka Hatnote) have created *Listen to Wikipedia*, a website that grabs data from Wikipedia's 'recent changes' feed and turns that data into sounds and visuals.⁹ The very basic function of the site is simply to create a visualization and sonification of the flow of real-time edits of Wikipedia. Whereas visualization is a well-known procedure for transcoding and rendering data perceivable as either static or moving images, sonification is the auditory, but less used, equivalent in which the mapping and transcoding methods result, instead, in an audible output.¹⁰ *Listen to Wikipedia* simultaneously deploys a visual rendering of circular forms that change colour and size and slowly disappear after their emergence, as well as sounds that vary in pitch and loudness according to different parameters. These dynamic visual and sonic elements reflect the various changes applied to the Wikipedia database in which, for instance, the sound of bells indicates "additions" and plucked strings indicate "subtractions".¹¹ Similarly, green circles signal "anonymous edits", purple circles are "bots", and white circles refer to "registered users". The interface of *Listen to Wikipedia* also allows the user to adjust the intensity and ratio of the audio-visual output according to the choice of how many different geolocations from which one wishes to include the editing activities. The interface also enables the user to click on any of the emerging circles, which then opens up a new browser tab showing the metadata of the particular edit in regular text format. Even though the title of the work emphasizes the

listening activity rather than the visual monitoring, the overall experience of *Listen to Wikipedia* can be described as audio-visual. But what do we actually perceive when we engage with this alternate version of Wikipedia?

Whether one is primarily looking or listening, or using both sensory modalities simultaneously, it can be argued that, first and foremost, *Listen to Wikipedia* gives us an experience of real-time database activity. Rather than directing us toward what would normally be considered Wikipedia's main content, i.e., the encyclopaedic articles on many different subjects, *Listen to Wikipedia* makes us see and hear the dynamic character of the database and its absolute foundation – namely, the continuous edits being done globally every second, which is crucial for the collective knowledge production to take place. Unless one is an active contributor to Wikipedia, these networked activities and data exchanges would normally go unnoticed, but here they are foregrounded. Furthermore, this happens through the use of visual and sonic renderings, which produce an aesthetic experience that literally makes us *sense* the database instead of reading it conventionally as textual information. *Listen to Wikipedia* thereby changes the basic experience of the Wikipedia database from a hypertextual and sequentially-discrete (i.e., moving from page to page) reading process to an experience of spatially-organized elements (i.e., the circles) and non-visual elements (i.e., the sounds) that unfold and change continuously over time corresponding to the real-time editing activities. The creators themselves, Hatnote, suggest that the changing visual elements give us “a relative visual sense of traffic from those sources” while the sounds would indicate that same traffic and provide an effect of “something reassuring” that has to do with “knowing that every user makes a noise, every edit has a voice in the roar”.¹² Recalling Hayles' discussion of data visualization mentioned above and her distinction between the discovery of patterns for their 'own sake' as opposed to pattern discovery as something that must lead to meaning for the data to be significant, we can understand *Listen to Wikipedia* as actualizing an experience of patterns that leaves us, essentially, with an overall impression of the database dynamics rather than leading us to search for 'deeper meaning' in the form of a coherent or semantic narrative.

Furthermore, we should ask whether this qualifies as an *aesthetic* experience? Subscribing to the notion of aesthetics as sensory perception mentioned above, Shusterman has elsewhere defined “aesthetic experience” with reference to its phenomenological character. This type of experience is, thus, not a “mere empty subjective state” but always has “an intentional object of some kind, even if the object is only imaginary”, according to Shusterman (Shusterman, 2008, p. 82-83). That aesthetic experience has an intentional object entails that it is “about’ something”, that it has “some dimension of meaning”, and “is not a blind sensation devoid of signification, but rather a meaningful perception” (Shusterman, 2008, p. 83). So, what could such ‘meaningfulness’ be in relation to *Listen to Wikipedia* if we see it as different from the type of meaning derived through a straightforward narrative or semantic content? One way to understand this work, then, would be that it uses inherently non-narrative means to convey the immenseness of this database. We can actually hear

each individual data contribution to the Big Data 'sea' that makes up Wikipedia – of which the English Wikipedia alone now includes 5,032,266 articles and averages 800 new articles per day.¹³ Via *Listen to Wikipedia*, we do not simply read about this activity but apprehend it as it happens. That type of meaning can also be seen as corresponding to what Martin Seel has discussed as "aesthetic knowledge" (Seel, 2005, p. 2). According to Seel, "aesthetic knowledge is specialized in perceiving complex phenomena – not in order to analyze them in their composition but to make them present in their intuitive density" (ibid.). As mentioned above, one of the central tasks of designers and data engineers working with sense-making is to reduce complexity to a graspable and, most often, visual form. This is not the case with *Listen to Wikipedia*, which does not immediately lend itself to further analytical scrutinization. But the 'aesthetic knowledge' produced by it still entails meaning.

We shall, thus, argue here that the experience of sensing every Wikipedia edit through emerging and fading images and sounds offers us an 'aesthetic knowledge' – that is, a knowledge that makes us aware of a certain mode of contemporary, networked information distribution that arises from the communal production of data as a participatory act not by explaining or by 'spelling out' the complexity of this phenomenon via textual narrative but by making it 'present', to use Seel's wording. Besides providing an alternate and entertaining experience of Wikipedia, *Listen to Wikipedia* can, therefore, also be appreciated as an expression of what Lisa Gitelman has defined as the very basic condition for the production of data – namely, that "[d]ata require our participation. Data need us" (Gitelman, 2013, p. 6).¹⁴

Data as 'capta' – fact and interpretation

While the aesthetic experience of *Listen to Wikipedia* does not prove helpful for traditional data analytical or scientific endeavours, it does turn our attention toward a fundamental condition for many projects that try to make sense of Big Data – namely, the struggle to find a balance between representing the 'raw' data as adequately as possible, while reducing the complexity of that data in order to present it in a way that enables a given recipient to grasp the information that was intended to be communicated. Later, we shall return to Seel's notion of 'aesthetic knowledge' as it relates to how we can perceive complexity; but, in the following, we focus on the more general challenge of how to present complex data in an apprehendable way. The idea of data-sense-making as a discipline emerged during the 1970s as a response to what was considered "an oncoming information explosion" (Cairo, 2012, p. 15). Implied in this work were the models used for explaining the process of how to handle the ever-growing amount of data. These were based on so-called DIKW Hierarchies, referring to "Data, Information, Knowledge, Wisdom" (ibid.). The basic layout of these models described the process of 1) gathering data from the outer world, 2) encoding the different levels of subsequent data, 3) perceiving and processing that data as structured information, which would 4) eventually be processed by the given recipient as knowledge

and wisdom (ibid.). As stated by data visualization expert Alberto Cairo, these models may be overtly simplistic but are often used to understand the basics of visualization practices that have become the most widespread tool for making sense of Big Data (ibid.).

It is not our intention here to go into the more technical details of data visualization processes but, instead, to address problems with these types of ‘information architecture’ models (i.e., the DIKW models) when they are used as a central point of departure for designing and thinking about data visualization. The problem with these models relates to what Gitelman has described as an often repeated fallacy in how we conceive of data as the starting point for the processes that eventually lead to knowledge:

data are apparently before the fact: they are the starting point for what we know, who we are, and how we communicate. This shared sense of starting with data often leads to an unnoticed assumption that data are transparent, that information is self-evident, the fundamental stuff of truth itself (Gitelman, 2013, p. 2).

According to Gitelman, this notion is highly problematic since we should be aware of how data are always “familiarily ‘collected’, ‘entered’, ‘compiled’, ‘stored’, ‘processed’, ‘mined’ and ‘interpreted’” (ibid., p. 3). And Gitelman here stresses as a significant point of uncertainty the final term “interpretation”, which seems to “haunt” the other terms. The main problem is that data are never just ‘there’ – neutrally ‘before the fact’ – but are always ‘imagined’ according to certain disciplinary and institutional “norms and standards” (ibid.). As Gitelman notes, “every field has its accepted methodologies and its evolved structures of practice” (ibid.). And this is also true for the kind of visualization practice we have already mentioned briefly and will examine more below. In relation to data visualization, one of the most crucial questions concerns what Johanna Drucker describes in her recent discussion of the topic:

[m]ost information visualization are acts of interpretation masquerading as presentation. In other words, they are images that act as if they are just showing us what is, but in actuality, they are arguments made in graphical form (Drucker, 2014, p. 11).

Even though Drucker may be said to state the obvious, the fact that data visualizations are always interpretations is often not addressed critically: “data does not have an inherent visual form that merely gives rise to a graphic expression” (ibid., p. 8). What Drucker argues in her book on the topic, *Graphesis – Visual Forms of Knowledge Production*, is that we need to establish a more developed and critical approach to data and information studies – especially from a humanities perspective. Drucker simply confronts how the contemporary state of humanist research in this field is characterized by collapsing “the critical distance between the phenomenal world and its interpretation” (ibid., p. 125). As Drucker repeatedly asserts, we have to understand that “[d]ata are *capta*, taken not given, constructed as an interpretation of the phenomenal world, not inherent in it” (ibid., p. 128).

In a number of ways, David Wright discusses data visualization along the same lines as Drucker, but he also specifically concentrates on the relation between visualization and software code and, in particular, the 'gap' that exists between the two: "The greatest material distance between human senses and computer code, when compared to the simplest material connections between them, delineates the imaginative possibilities of data visualization (Wright, 2008, p. 86)". Similar to Drucker, Wright encourages us to take a more critical approach toward the field of data visualization, as this has now become "a more generic term that covers the sensory presentation of data and processing" (ibid., p. 83). According to Wright, a central requirement for this practice is the task of "algorithmically deriving a sensory expression from the structures implicit in digital data" (ibid., p. 86). Despite his quite austere description of the inherent problems with transferring data from a code state to a material state ready for human perception, Wright considers visualization techniques to be an efficient way to overcome them.

Nicolas Felton – data between transparency and artefact

Following the observations by Wright, Drucker, and Gitelman, we will now look at different examples of artistic visualization projects. The first artist in question, Nicholas Felton, was also part of the Big Bang Data exhibition, where copies of one his so-called *Annual Reports* were on display.¹⁵ During the past eight years, Felton has published annual reports on himself that expose his visualization skills as a designer and address questions about the collection of personal data. Felton has kept minute track of as much as his everyday life as possible, day and night. This includes geolocations, personal interactions, his commuting, texting, mailing, etc. The two Felton reports (the 2012 and 2013 editions) were exhibited in Barcelona as part of the exhibition section called "We Are Data – From Quantification to Commodification of 'the Self'".¹⁶ According to the accompanying curatorial text, we may understand the reports as "an objective visualization of deeply personal relationships". Moreover, "Felton's project shows us what [happens] when this data is visualized, what may seem like inconsequential details aggregate into a narrative".¹⁷ Recalling the discussion above in Hayles, Felton's reports seem to reflect this 'search for meaning' that is closely tied to the function of narrative structuring principles. The principles used here are not primarily textual narratives but visual abstractions of tracked events that we may then interpret as a coherent 'story' about a year in Felton's life. The reports are neatly crafted book objects, containing detailed and artistically elaborate, custom-designed graphs, bars, and charts that can be read as revealing information about Felton's lived experiences.¹⁸ However, one may question whether this amounts to an 'objective visualization' as claimed.

As Drucker explains, the use of graphs and charts often works as "a kind of intellectual Trojan horse, a vehicle through which assumptions about what constitutes information swarm with potent force"; and, accordingly, these assumptions are "cloaked in a rhetoric taken wholesale from the techniques of the empirical sciences that conceals their episte-

mological biases under a guise of familiarity” (Drucker, p. 125). Drucker’s point is that these visual expressions have become so “naturalized” that they pass as “unquestioned representations of ‘what is’” (ibid.). As mentioned above, they are essentially ‘arguments’ made in graphical form, interpretations of a phenomenal world or events observed from that world, rendered in abstract figures that appeal to our search for meaning and narrative as something fundamental to how we, as humans, make sense of any kind of data (cf. Hayles above). In an interview with Felton about his *Annual Reports* project, it is obvious that he is aware of the subjective visual ‘rhetoric’ he applies when choosing which data to render into what sort of diagrammatic or graph format. Asked about whether or not he believes it would be possible to create a “totally objective report”, he answers that the “primary objective is to make it reflect my experience, so if I do some query on a set and I don’t recognize it, then I know I’ve done it wrong, or the data’s just not that interesting”.¹⁹ In this way, Felton reviews the actual graphical expression and the particular data sets chosen for how well they may appeal to a given recipient. On one hand, this amounts to what we may understand as an analysis of the ‘rhetorical’ effect and strength of the graphics; but, on the other hand, it also entails a methodical meditation on the fundamental mechanism of data visualization – namely, that of deriving a ‘sensory expression’ from the ‘structures implicit in digital data’, as pointed out by Wright above. As Felton explains the process, however, there is no direct computational or algorithmic activity involved in this. It is primarily his own evaluation and experience of how well the graphics communicate a stronger or weaker relationship with the particular data set used. In this situation, it can also be argued that we see a conflation of the level ‘database’ – i.e., that which collects, parses, and stores (cf. Hayles), which, in this case, is done by Felton himself – and the level of narrative – i.e., the visualization. So, Felton’s ‘database’ differs from, for instance, Wikipedia, since he himself has been responsible for both producing data (by simply doing things and living) and collecting data (by tracking his activities). The interview quote clearly shows, however, that Felton is aware that his ‘data are capta’, taken not given, constructed by himself and, subsequently, visually rendered through a process that again involves subjective interpretation. In other words, the reports are done with an awareness that they imply a *distance* between the data derived from the phenomenal world (via Felton’s experiences and tracking) and the graphic models used to present the data.

As mentioned by Drucker, the problem with the most common models of data visualization, such as graphs and bars, is that we perceive them uncritically as representations of ‘what is’ because they have become ‘naturalized’. We read them as having very little or no distance to the phenomena they are meant to represent, according to Drucker. From a historical graphic design perspective, the diagrams, graphs, and charts that Felton produces are partly inspired by how these models have developed stylistically throughout the 20th century primarily from such disciplines as statistics, empirical sciences, and business (Drucker, p. 7). However, they also differ from the standard models used within these disciplines and stand out as explicitly customized and with a high level of craftsmanship

that is much more varied, compared to the automated results one can easily produce by means of the many off-the-shelf software solutions available today. As such, they are not so much experienced as ‘naturalized’ expressions that reflect what Drucker terms a “realist approach” to visualization, which assumes “transparency and equivalence” (Drucker, p. 126). Instead, the reports present themselves deliberately as *artefacts*, the primary purpose of which is not to establish an ‘objective’ or transparent link to a particular dataset. They make us *experience* relations, distances, networks, numbers, etc., by giving us a *sense* of these aspects of Felton’s life through a particular visual rhetoric. Several of the visualizations found in the reports are aesthetically appealing images that do not, for the most part, clearly communicate a specific semantic content. Rather, they become meaningful through their spatial positioning of graphical elements,²⁰ through accumulations of dots and pixels²¹ that are not prone to scientific scrutiny but, instead, lend themselves to being perceived as *aesthetic knowledge*, that is – again referring to Seel – experienced not in order to allow us to analyse the complex phenomena behind the data in their detailed ‘composition’ but to make the phenomena present ‘in their intuitive density’ (cf. quote above). Put in another way, these visualizations obviously cannot be ‘reverse engineered’, which means that we are not able to go from the level of the graphs or charts to the particular data points behind them. They present themselves first and foremost as interpreted re-presentations, not as objective presentations.

From ‘beautiful’ data to knowledge?

When the Felton reports are considered this way, we also approach an aspect related to aesthetic experience and aesthetic knowledge that concerns the concept of beauty as derived from Kant’s and Hegel’s philosophical aesthetics. This topic is discussed thoroughly elsewhere in this publication. However, the elaborate design of the visualizations in Felton’s *Annual Reports* and their presentation in the form of well-crafted artefacts instigate a strong sense of what we may broadly refer to as ‘beauty’. Surveying the current field of data visualization as a professional design venture of which Felton is also part, we find numerous references to ‘beauty’ and ‘the beautiful’. A well-known example is David McCandless’ *Information is Beautiful* (McCandless, 2012) and *Knowledge is Beautiful* (McCandless, 2014), both bestselling books within the field. Like Felton, McCandless is primarily occupied with static forms of visualization, which are also often referred to as infographics. Cairo suggests that we distinguish between visualization and infographics as two related disciplines that exist on the same continuum and which are both fundamentally about the conveying of information (Cairo, p. xvi). The difference, however, concerns the degree to which they allow “exploration”. Thus, according to Cairo, infographics are mainly about “presenting” data as unambiguously as possible where visualization allows for “multiple readings”. For instance, Cairo refers in this context to “the beauty” of the visualization of Stefanie Posavec – another prominent designer and artist – emphasizing its “careful selec-

tion of typefaces and colors” and how its complex patterns “convey a different message to each viewer” (Cairo, p. xvi; xvii). Even though Cairo’s definition seems simplistic, it is also illustrative because it points to the way in which this type of visualization is estimated by its ‘open-endedness’ as something that qualifies it as ‘beautiful’. Roughly speaking, Cairo’s reference to “beauty” is in line with the core notions of beauty and the beautiful found in Kant’s aesthetics in which the experience of beauty is explicated as being the opposite of logical and rational conceptualization in that it sets free our subjective imagination and catalyses reflection (Kant, 2007, p. 60ff). Again, this discussion is not our main focus here but is mentioned for the sake of theoretical context and background, indicating that Cairo is repeating common notions about the concept of beauty.

We should, however, point to one other aspect that also emerges with this discussion – namely, that the field of data visualization is obviously placed somewhere between contemporary art and design practices. This has been a topic of ongoing discussion within the field itself (Watz, 2015), and it can also be compared to how the relation between ‘art’ and ‘crafts’ has been understood historically. Both ‘art’ and ‘crafts’ are concepts that have changed over time and have done so in a kind of continuous dialogue with the concepts of aesthetics and beauty, which have also changed (Shiner, 2001). We will not attempt here to explain in depth the complex history of the interrelated definitions of arts and crafts that have been made in the development of an overarching ‘system’ of ‘art’ (ibid., p. 6). But it is important to recognize that Cairo’s suggested distinction between infographics and visualization – which corresponds to his distinction between ‘presentation’ (qualified by its immediate ‘use value’) and art (qualified by its openness to free exploration) – has a historical background. This distinction implicitly reflects how crafts have traditionally been conceived differently from art - with various references to the concept of beauty. As Larry Shiner explicates via Kant, the notion of beauty as it relates to aesthetic experience separates “crafts” from “art” and even subdivides “art” into “fine arts” and “agreeable arts” (Shiner, p. 147). For Kant, this means that proper aesthetic reflection, which involves setting the “imagination” “in free play”, is only established from the experience of fine arts and the quality of beauty pertaining to that. This recursion to Kant is merely to emphasize that the references of Cairo and McCandless to beauty are to some degree derived from the philosophical aesthetic ideas about that same concept we find in Kant.

Obviously, the visualizations discussed above are not thought of as being completely without purpose or determination - which, to Kant, is what qualifies as a truly aesthetic experience of beauty. But the works of Felton and McCandless, among others, are situated ambiguously in some cases between visual designs that demonstratively invite one or just a few ways of being read as opposed to visualizations that propose multiple interpretations and urge the viewer to dwell on them. These visualizations, thus, establish an altogether different experience that may very well lead to ‘knowledge’ but not through a straightforward ‘decoding’ activity. As we shall see, this way of obtaining knowledge through another type of experience is also hinted at by McCandless himself. Compared with Cairo’s definitions

and the examples he mentions, we find both types of graphic work in McCandless' books. In the short and non-scientific "introduction" to *Knowledge is Beautiful*, McCandless does not distinguish "graphics" and "visualization" as two inherently different approaches, but he does distinguish between data, information and knowledge. In addition to echoing the division between these terms referred to above as the DIKW model, he also describes the difference as follows: "Information focuses on the 'now' and the 'what' [...] In contrast knowledge feels like it's more concerned with causes and consequences" (McCandless, 2012, p. 2). McCandless also points out how information "grows" into knowledge through "contextualization" (ibid.) As McCandless' description is non-scientific, what is interesting here is not the simplistic analytical distinction as such but, rather, the way he defines the experience and process for obtaining actual 'knowledge': "When you understand something, you're able to perceive its structure: its connections, its relationships, its significance relative to everything else. How it fits. You see-feel-intuit the fit. You know it" (ibid.). McCandless' tentative characterization of the "see-feel-intuit" experience comes quite close to what we have hitherto discussed as aesthetic experience and aesthetic knowledge - namely, where knowledge is something that *appears* rather than it is logically deduced and determined, cf. Seel's notion of an aesthetics of appearing. According to Seel, the way that artworks and comparable aesthetic phenomena communicate differs from other forms of "linguistic presentation or other presentation". This is because artworks produce an "individual sequence of sign elements – in contradiction to (non-literary) writing, the spoken word, press photos, traffic lights" (Seel, 2005, p. 96). One of Seel's main points here is that these 'configurations' of sign elements is "accessible only to lingering sensuous perception" (ibid.). This state of sensuous perception can again be related to the Kantian notion of how the experience of beauty can temporarily 'release' our imagination and provide freedom "from the constraints of conceptual knowing, free from the reckoning of instrumental action" (Seel, 2005, p. 4). Following both McCandless and Cairo, a crucial aspect of the way we experience the type of more aesthetically complex data visualizations as mentioned above is that they make us discover new patterns, constellations, relations, etc., which can eventually provide new knowledge based on the data and datasets that still essentially drive the visualization. In other words, successful data visualization enables us to acquire new and, perhaps, unexpected knowledge through an aesthetic experience as opposed to the type of data presentation that merely functions as 'instrumental' illustration and does not lend itself to further exploration.

In *Beautiful Data – A History of Vision and Reason since 1945*, media theorist Orit Halpern conducts a thorough investigation of the history of big data and interactivity, among other things. In much the same critical vein as Drucker, she also challenges general assumptions about the value and applications of data visualization and concentrates on how "discourses of data, beauty, and 'smartness' should, therefore, present us with numerous critical historical questions" (Halpern, 2014, p. 5). Despite the title of the book, it does not deal much with the concept of beauty as such, but it serves as a point of departure for

inquiring into the narratives that emerge within these current discourses. Thus, Halpern highlights the problematic presupposition that data *per se* is valuable and points out that this is often argued for by reference to the label “beautiful” (ibid.) She observes how there seems to be an urge to make “designers, engineers, and programmers...address the important aesthetic component of making this data useful, which is to say, ‘beautiful’” (ibid.). And Halpern continues:

Despite the seeming naturalness of data and its virtues, therefore, there is nothing automatic, obvious, or predetermined about our embrace of data as wealth. There is, in fact, an aesthetic crafting to this knowledge, a performance necessary to produce value (ibid.).

Seen in relation to what we have just described above, Halpern’s diagnosis could be read as a critique of the discourse about beauty and data that surrounds, for instance, McCandless’ work. However, in the following and last section of this article, we shall instead try to advance Halpern’s interest and concerns about how data and data visualization can become relevant. This is done by looking into two more examples of artistic work that concentrates on visualizing and otherwise ‘crafting’ data.

Alessandro Carboni – dancing about data

As described above, Nicolas Felton’s *Annual Reports* are examples of a very distinct aesthetic formalization of highly personalized but also complex data sets. Besides their formal qualities, which we have already discussed, the reports may also be seen as compelling cases that address both the difficulties and the possibilities that relate to the handling of data derived from our own lives in a meta-perspective. The first example also concerns an artistic practice of collecting and making data manifest through particular aesthetic formats. It is also a practice in which the data used are the product and result of an individual subject’s life, which has been recorded by that same subject. The Italian artist Alessandro Carboni works within an interdisciplinary field, focusing primarily on the exploration of complex relationships between body and space. In a recent and still ongoing project, this was carried out through different mapping strategies in various city spaces from which data has been collected, structured, and then re-presented in different, more or less finite forms.²² Carboni uses his body and limbs to measure gaps, divisions, relations, and distances. Often, he crams himself into tight spaces or strikes odd poses in order to catch the diversity of the spaces and elements measured. What sets Carboni’s practice apart from many other artists working with mapping and the collection of data into managed sets and formats is that he uses his own body as the primary medium or tool for this process. Recently, this practice has manifested itself in the shape of the “em:toolkit”, which Carboni describes as “an urban mapping and performance practice tool” (Carboni, 2013). He says that the main purpose of this project is “to capture, embody and represent data exclusively with the body” (ibid.).

Basically, what Carboni does is to engage in a process of moving around in a given city space according to a three-step procedure, which he describes as consisting of:

observation, [in which] you define the location, the physical space in which you would operate [...] With the **analysis**, you circumscribe the 'event' and formulate a body-action, as a datafication of the experience [...] [T]he **extraction**, which operates as an execution and repetition of the body-action (ibid.)

The final extraction, 'execution', and repetition via the body take place as a performed series of choreographed movements for an audience (or viewed as video recordings).²³ What Carboni then achieves is not so much the creation of a narrative in the traditional form of a story but the physical enactment and re-enactment of a choreography of the data collected through his actions and interactions with the city space. The final choreographies then comprise the collected data of specific city sites obtained through measurement on a human subjective scale and the translation of the data into a series of formalized, performed actions. These actions also include a number of graphic representations or schemes that function as sets of instructions, which allow other participants to re-enact the same choreography.²⁴

Carboni's practice may also be considered as a monitoring of the city without digital connectedness, without GPS- or WiFi-linked tracking algorithms. It is a mapping of city data that can be seen as an emphatically 'human' take on otherwise computer-based operations such as data collection, extraction, and execution. Still, Carboni insists on terming the active measuring procedure within the urban space with reference to a digital-technical vocabulary, i.e., the references to 'extraction' and 'execution'. By doing this, Carboni claims a close relationship with the ordering of input and output data derived from software theory and coding practices in which 'execution' denotes the point at which a program is set to work autonomously (Mackenzie, 2006, p. 21). So, while engaging in a distinctly physical, embodied, and human-scale practice, Carboni simultaneously positions his project from the perspective of a certain data discourse. In fact, we might even consider his data-derived physical choreography as being directly inspired by computational processes – not only on an abstract discursive level but also in the way that his repetition of movements based on data measurement takes on an algorithmic-like function. An algorithm can basically be described as "a procedure that performs a processing, involving the execution of a sequential number of steps that organize data towards a result" (Parisi & Fazi, 2014, p. 113). Similarly, Carboni describes his practice as how "the extracted body-action becomes a unity of movement which can be repeated".²⁵ Carboni's explicit references to an embodiment terminology as well as to the aforementioned notions of basic computational functions, thus, evoke alternative perspectives for thinking about these interrelations. In this way, he also directs our attention toward what Bill Brown has discussed as a "rhetoric of embodiment [which] has been essential in efforts to describe media's materiality" - with the difference that it is the level of 'data' rather than 'media' that is the focus here (Brown, 2010, p. 52).

In a way, Carboni's practice can be read as a counterexample of what has elsewhere been advanced as a problem for art and artists in the age of ubiquitous and Big Data – namely, Big Data's inherently 'non-human' scale and volume. The issues with scale and accessibility are reflected in numerous discussions about which techniques to use in order to be able to mine and discover patterns that are not immediately reachable by our perceptual apparatus. This very basic concern is reflected, for instance, in an often-quoted text by Jay Stanley, who points out that patterns, correlations, and relationships cannot be perceived by the human brain "on [its] own because the scales involved are beyond our ability to process (either the time scales at work, or the sheer number of data points)" (Stanley, 2012). Similarly, Rita Raley argues that the scale and complexity of the data structures at issue are "such that they cannot be processed by human intelligence alone" (Raley, 2013, p. 132). Connecting this discussion with an actual analysis of a series of artworks, we may also consider what Mark B.N. Hansen has referred to as "the digital artifactualization of computational time *that nonetheless appears within the thresholds of human perceptual experience*" (Hansen, 2009, p. 295). From a theoretical perspective, Hansen here calls attention to a type of digitally-based artworks that forces us to consider "whether contemporary technical mediations of time are in fact *beyond aesthetics*, which is to say, operative at a level and with an autonomy that simply bypasses circuits linking technics and human beings" (ibid., p. 296). Hansen rightfully emphasizes the necessity for rethinking notions of temporality and spatiality within digital and computational systems and the effect this would have on our notion of aesthetics.

Seen from this perspective, Carboni's work appears almost as a deliberate rejoinder to the argument that computational processes and data-based art practices should sidestep aesthetics and human participation. To the contrary, with Carboni's practice as described above, we experience the execution of data, the running of the 'algorithm' and the 'program' at a pace we can easily follow. Furthermore, we are even able to execute the 'program' ourselves by making use of Carboni's set of instructions and learning by watching him perform them in a shared physical space. If one chooses to engage in this performance, what actually happens is, then, a re-living of the same spaces, relations, and positions in which Carboni originally found himself when he carried out his measurement procedures in the first place. Thus, by using the "em:toolkit", we genuinely experience the data through our corporeal activity. The knowledge we achieve from this activity is not primarily textual or visual but a kind of embodied and re-lived knowledge about a particular site and its spatial and physical qualities.

Despite the fact that we can hardly talk about Big Data from a sheer volume perspective in the case of Carboni's datasets, his practice is a genuinely interesting example of how to negotiate the problematic distances and connections between 1) observing the complex phenomenal world, 2) collecting and ordering data derived from that complexity, 3) interpreting the data, and 4) formalizing and materializing the data in order to make them accessible for an audience to perceive.

Domestic Data Streamers – the city square as database

As mentioned above, part of the Big Bang Data exhibition concentrated on how to disseminate the influence of Big Data on our everyday lives. One of the artist groups at the exhibition working with exactly this approach is Domestic Data Streamers. On their official website, which uses the terms “experiences”, “art”, and “knowledge” interchangeably, an animated banner reads: “Transforming data into experiences, art, knowledge”.²⁶ Elsewhere on the site, we learn that they are mainly occupied with “the challenge of transforming raw data into interactive systems and experiences”.²⁷ For the exhibition itself, they produced an installation called *Sand Falls* – a physical data ‘display’ connected with sensor devices that tracked how much time individual visitors would spend in front of five groups of works at the exhibition. *Sand Falls* used custom-designed glass containers into which sand was continuously falling, depending on what the measuring devices recorded; thus, the data were transformed into an analogue, physical form that allowed for a reading of the collective time spent by visitors with the different groups of art works.²⁸ Our focus, however, will be on another of their recent installation projects called *The Mood Test*, which has been conducted in different versions from 2013-2015. This installation differs from *Sand Falls* in that it is situated outside at different public squares in Barcelona. At the same time, it concerns some of the same basic intentions of translating aggregated data into visual displays using non-traditional materials and setups compared to the average graphical interfaces used on computers for data visualizations. In short, *The Mood Test* concept is about gathering data based on people’s feelings on different topics and issues.²⁹ The Domestic Data Streamers team would interview random people passing through the square from a predefined questionnaire, and the answers were subsequently mapped onto a wall on the selected square by drawing circles of different colour and size corresponding to variations in the data that were derived from the answers – either simultaneously or immediately after the answers were given. The process in each version of the installation lasted 24 hours and resulted in a colourful visualization spreading horizontally across a wall, displaying the collected data set. The artists themselves describe the purpose of the project as something “which gives new uses to the urban surroundings, transforming a wall into a mirror that reflects those who live there. As an ongoing project, the idea is to keep on describing the people who bring it to life year after year”.³⁰ The questions asked, among other things, were about “people’s compassion levels depending on their age and we visualized it in real time” or “their optimistic and pessimistic attitudes towards life in relation to the hour of the day”.³¹ As with the previous examples of art works and artistic practices discussed above, Domestic Data Streamers are here addressing certain crucial aspects related to how we can understand and make use of Big Data. In this case, *The Mood Test* can be seen as tapping into the field of so-called sentiment analysis – a process normally applied through Natural Language Processing (NLP) procedures in which algorithms are deployed for classifying the tone of a text or the attitude of the author as being either positive or negative (Clark, 2008, p. 167). Comparably, *The Mood Test* is also about tracking, quantifying, and displaying how people

feel, but Domestic Data Streamers have reduced the complexity of the 'algorithmic' principle for their sentiment analysis to a minimum. In a way, similar to what Carboni did with his 'algorithmically inspired' choreography performance, the artists here lay open a procedure of data processing that would often be completely 'black-boxed' and unfathomable due the high complexity and speed with which our computational technology handles data. When looking at the actual, formalized graphical results of the 'handheld' data aggregation and interpretation, the colourful wall of *The Mood Test* very much resembles what can be observed in contemporary and computer-aided data visualizations – for instance, what we have described in relation the Nicolas Felton reports. As such, the aesthetic experience of the formal qualities of the wall visualization does not fundamentally differ from the experience of Felton's visual rhetoric – that is, if observed as an isolated artefact. But if the project is considered as a full process, open to public participation and engagement, then we should recognize the knowledge that can be gained from visualization; because all aspects involved in the final visualization have taken place *in situ* and as a collective effort, the *distance* or gap between database (or dataset) and the resulting visual narrative with which we are presented appears much less prominent. Ideally, the data may be accessed easily and, in a certain way, 're-lived' because the participants are able to identify and locate the original data point (their specific contribution to the dataset) within the overall visual narrative – that is, if they can remember when and where their input was registered. To some degree, this is reminiscent of Carboni's practice, which also afforded a kind of re-lived space, although that procedure involved several more steps to translate the artist's initial experience of the spaces and their characteristics into the actual choreography performed.

The Mood Test visualizations are, of course, 'constructed interpretations of the phenomenal world' rather than 'inherent in it', to recall Drucker's argument. However, since the process for arriving at the formalized end result entails such direct involvement by the people who inhabit that very lifeworld and who provide a multitude of different views and experiences of it, one can argue that Domestic Data Streamers actually succeed in "transforming a wall into a mirror that reflects those who live there" –through their artistic choice of a specific data visualization strategy and aesthetics.

Conclusion

In this article, the intention has been to outline and discuss critically a number of topics and questions related to artistic renderings and explorations of data sets that, in most cases, would qualify as Big Data. However, the main point was not to set up decisive criteria for defining features of Big Data as a concept but, rather, to describe how artistic practices and artefacts can create *aesthetic experiences* of data. As part of this investigation, different notions of database and narrative were scrutinized in order to clarify the relationship between the two. The dynamics between database and narrative appears central to how we understand the process from data set to visualization. In other words, if we take an aes-

thetic approach to Big Data an essential part of the discussion should involve the constant interplay between, on one hand, artistically-focused strategies of translating data into lived experience and, on the other, the vast amounts of aggregated data that reflect another kind of numeric and computational logic. The discussion, which here centred around Hayles' theoretical work on the subject, was also extended to include the critical approaches of Gitelman and Drucker, whose shared emphasis on the lack of awareness about data as something that is always contextualized and interpreted – never just 'given' – is important to remember. While these theoretical ideas were used to set a specific frame and helped delineate some of the central discourses that have surrounded Big Data, the inclusion and analysis of different examples of art works and practices served the purpose of challenging those same assumptions and arguments.

A main point of the article has been, then, to demonstrate how artists are finding new ways of dealing with data and Big Data. The works and practices analysed throughout the article employ very different and often alternative strategies to highlight, discuss, and explore the complex relationships among data aggregation, mapping procedures, and aesthetic, narrative expressions. From these observations, the article also argued that in relation to certain notions of aesthetics and aesthetic experience the concept of beauty is not necessarily key. Rather, 'aesthetic' here entails that we understand perception as a knowledge-generating process and as something that also relates to everyday life. What was referred to as aesthetic experience and aesthetic knowledge, as explicated by Shusterman and Seel, thus provided a more nuanced understanding of how the concept of beauty often appears in relation to contemporary data visualization practices and discourses. The discussion about 'beautiful' information and 'beautiful' knowledge, referred via David McCandless, was then not so much to examine in detail theories of the judgment of beauty and taste in a strictly Kantian sense but, instead, to look into what the labelling of data visualization as 'beautiful' actually meant. Here, it seemed clear that the notion of beauty is primarily part of a discourse that surrounds current data visualization practices and implies that a given representation of data retains a certain level of complexity, which motivates us to explore it more freely.

Several of the works and artists included appear very conscious about which interpretative and aesthetic choices should be made to arrive at the intended result for an audience or individual recipient. For example, it was argued that, in some instances, the artistic approach to data visualization produced a minimized distance between the origin of the data – i.e., the site and the circumstances that produced the data – and the summarized aesthetic expression of the data *qua* visualization. The consequence of this, among other things, is that artistic projects of the type described here enable an understanding of the otherwise hidden processes and procedures that produce the narratives from which we are seeking meaning. Here, it was significant that the focus on and the actual inclusion of a participatory aspect in the construction of the database and data sets would provide another kind of insight - also from a public perspective, as was the case with both Hatnote's *Listen*

to *Wikipedia* and Domestic Data Streamer's *The Mood Test*. A final and important point concerned the way in which these data-oriented art works and practices are often able to engage recipients in a mode of *aesthetic experience* that eventually generates knowledge and insights but does so in a much less instrumental manner.

Notes

- 1 For detailed information on the exhibition, see <http://bigbangdata.cccb.org/en/sec-exhibition/>. Where nothing else is stated, quotes from and references to the exhibition relate to this website. The exhibition was visited 25-27 Sept. 2014.
- 2 Ibid.
- 3 The ambitions for the exhibition also show in that, since the launch in Barcelona, Big Bang Data was presented in Madrid, and there will be a U.K. version during 2015 as well. Cf. <http://www.cccb.org/en/exposicions/touring-activities/big-bang-data/217018> (accessed 12 Dec. 2015).
- 4 <http://bigbangdata.cccb.org/en/exit-diller-scofidio-renfro/> (accessed 12 Dec. 2015).
- 5 <http://feltron.com/FAR13.html> (accessed 12 Dec. 2015).
- 6 <http://domesticstreamers.com/portfolio/sand-falls/> (accessed 12 Dec. 2015).
- 7 <http://bigbangdata.cccb.org/en/sonard-data-cooking-workshop-amb-moritz-stefaner-i-susanne-jaschko-en/> (accessed 12 Dec. 2015).
- 8 cf. <http://bigbangdata.cccb.org/en/> (accessed 12 Dec. 2015).
- 9 <http://listen.hatnote.com/> (accessed 12 Dec. 2015).
- 10 For a brief discussion of 'sonification', see Sterne & Akiyama, 2012.
- 11 <http://listen.hatnote.com/#en> (accessed 12 Dec. 2015).
- 12 <http://blog.hatnote.com/post/56856315107/listen-to-wikipedia> (accessed 12 Dec. 2015).
- 13 https://en.wikipedia.org/wiki/Wikipedia:Statistics#cite_note-2 (accessed 12 Dec. 2015).
- 14 Gitelman also refers here to Manovich's early discussion of this in terms of the database, cf. Manovich, Lev: "Database as Symbolic Form", in *Convergence*, June 1999, vol. 5, no. 2, pp. 80-99.
- 15 See samples from the 2013 edition of the *Annual Report* here: <http://feltron.com/FAR13.html>.
- 16 <http://bigbangdata.cccb.org/en/topic-we-are-data/> (accessed 12 Dec. 2015).
- 17 <http://bigbangdata.cccb.org/en/annual-reports-nicholas-felton/> (accessed 12 Dec. 2015).
- 18 Samples from the 2013 edition of the *Annual Report* may be found here: http://feltron.com/FAR13_09.html (accessed 12 Dec. 2015).
- 19 <http://motherboard.vice.com/read/nicholas-felton-quantified-literally-everything-he-said-in-2013> (accessed 12 Dec. 2015).
- 20 http://feltron.com/FAR12_02.html (accessed 12 Dec. 2015).
- 21 http://feltron.com/FAR13_09.html (accessed 12 Dec. 2015).
- 22 <http://progressivearchive.com/> (accessed 12 Dec. 2015).
- 23 Examples can be watched on the website: <https://spaceasprocess.wordpress.com/emtoolkit-introduction> (accessed 12 Dec. 2015).
- 24 See <https://spaceasprocess.wordpress.com/emtoolkit-introduction> (accessed 12 Dec. 2015).
- 25 Ibid.
- 26 <http://domesticstreamers.com> (accessed 12 Dec. 2015).
- 27 <http://domesticstreamers.com/press/> (accessed 12 Dec. 2015).

28 <http://bigbangdata.cccb.org/en/data-falls-domestic-data-streamers/> (accessed 12 Dec. 2015).

29 <http://domesticstreamers.com/portfolio/the-mood-test/>.

30 Ibid.

31 Ibid.

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