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DATA JOURNALISM. VISUALIZATION OF DATA AS A REMEDY OF PERCEPTION PROBLEMS OF THE MODERN READER

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ABSTRACT

The consistent increase of information is not directly proportional to the increase in attention. Despite the availability of infinite amounts of content, the human brain, working on 'old software' cannot cope with the excess. As a result, anxiety and depression are deepening, which negatively affects the condition of modern man. Perceptual constraints are the reason for poverty of attention with the simultaneous richness of content. The aim of the conducted research is to demonstrate the superior role of image over text and to present data journalism and infographics as a remedy for the ill-conceived perceptual limitations of the modern 'new media' users. Scientific publications on data journalism, information visualization, infographics, databases, and human perception is the primary research material in this publication. The research method used for this work was the content analysis and literature studies. The conducted research allowed the authors to draw conclusions assuming that data journalism is conducive to visualization and may become a way of reliable information provision.

Keywords: infographic, data journalism, big data, information, perception, data visualisation

Introduction

Richly engraved medieval manuscripts were designed to encourage people to read, when most of them were unable to. One of the largest medieval libraries and book collections were created alongside monasteries and universities. Access to the written word was limited. Only the elites, a small group of educated people had access to it (Sadowska and Zimnoch 2015, p. 15). Now it is common, the hybridization of text, with the use of visual means makes communication more attractive and more precise. "In the fight for a highly fickle reader, who is in constant pursue after characters" (Vandendorpe 2008, p. 135) the advantages of an infographic over written word are apparent, as it allows to capture dependencies and regularities, that would be impossible to grasp in any other form.

Abundance of information – an immanent quality of digital society – is viewed by Magdalena Szpunar as a blessing, but also a curse of the 21st century. Massive amounts of texts are constantly competing for the reader's attention, whose perceptive abilities are not evolving. Effective use of the abundance of information is thus highly limited (Szpunar 2017, p. 71–72). In the 1970's Herbert Simon noted that the abundance of content implies attention deficits. Similarly, Richard Saul Wurman wrote that constantly increasing data does not translate automatically into increased knowledge, but it causes anxiety related to the feeling of inability to process all available information (Bojkowski 2016, p. 433).

Psychologists and information theorists have noticed perception problems that manifest in the channel capacity of the human organism (Toffler 1970). Organized experiments, in which participants writing on a keyboard were compared to participants playing the piano – demonstrated, that the limited capabilities of the human brain could lead to a serious breakdown of its efficiency (Toffler 1970, p. 351). Modern human living in the culture of excessive content experiences a specific paradox in relation to reception of information around him. On the one hand, he has a wide access to it, on the other hand, the magnitude of content generated by the media causes him to experience an information overload. Alvin Toffler sees information overload (Toffler 1970, p. 352) as a serious threat to society's mental health. He notices that a human being during his life is in constantly bombarded with various type of information: children in school, employees at a workplace, housewives at home. The pace of a changing society forces people to adjust to new lifestyles and confront unknown situations. They are forced to process information at a much faster rate than in the less developed societies (Toffler 1970, p. 352). Taking into consideration all those factors, it is reasonable to treat the visualization of information and data journalism as a prime remedy for the ill-conceived perceptual limitations of the human brain in the way of generating, processing, and analysing data.

Perception in the state of distracted attention

Modern mechanisms of transferring information through different streams, e.g. the Internet or television, put us in the middle of an unlimited information stream. Despite the fact that this perception could be classified as volitional, as constant reception is not forced upon an individual, from the point of view of human history, the mechanisms associated with human perception are under extreme stress.

George A. Miller, a psychologist from Rockefeller University, has noted significant limitations regarding the amount of information that a human is able to receive, process and remember. Different classifications and coding methods allow one to expand the limits of perceiving, but significant brain limitations to assimilate different content are seen in the results. The reasons for this are a result of biological and cognitive mechanisms, that constituted "adaptive answer to the problems related to survival and reproduction" (Miller 1956, p. 84). A list of those mechanisms should include feeling, perception, attention, memory, language, mathematical, logical inference, making decisions and problem solving (Friedenberg and Silverman 2006, p. 266). Narrowing it down and setting apart the sensory data forms, we should distinguish the most basic mechanisms of cognition, memory, perception, and attention. These three elements of human consciousness are the pillars of perceiving the surrounding environment and the interpretation and ability to function or react to ongoing changes in it.

In the field of memory related research there are many theories and suggestions that attempt to classify not only this mechanism, but other components as well. David Schacter and Endel Tulvig support the concept that memory is defined in terms of brain mechanics types of information that is processed and the principals of its functioning (Driscoll 2003, p. 53–54). Over the course of time many different types and models of memory were identified, for example multi-layered and sensory models (Atkinson and Shiffrin 1968, p. 89–195) or so-called short-term (Atkinson and Shiffrin 1968, p. 120) and long-term memory models (Baddeley 1966, p. 360). The process of saving and replaying elements stored in the memory is also conditioned by subjective factors, such as stereotyping (Bodenhausen 1988, p. 726–737) or reliance on past experiences (Bartlett 1932).

Perception can be defined as a specific multisensory interface between the outside and inside worlds of an individual (Bodenhausen and Hugenberg 2009). Despite many arguments among the cognitive science community, there is a consensus related to this mechanism. Firstly, there is the assumption related to the limited ability to process information. Different theories identify the limits of perceptions in different areas, unrelated to its location. Many models assume that coding, saving and replaying data from memory has its limits (Baddeley 1994, p. 365). Secondly, it is accepted, that the perception mechanism (the type of receptor does not matter in this case) is managed by a specific process that oversees the flow of information and its processing (Atkinson and Shiffrin 1968, p. 124). The third assumption is that the interaction between stimuli/information and data that have been incorporated by an individual are stored in the memory. An example of this interaction would

be two, seemingly opposite, systems – e.g. system 'up-down' and 'down-up'. In the 'down-up' system, it is accepted that the new information initiates the cognitive process that is tasked with categorizing information stored in the memory (Gibson 2005, p. 216). The concept of 'up-down' states that the existing connotations or information initialize evaluation of new stimuli (Miller 1956, p. 81–97).

The last element of the human cognitive system is mindfulness. Karol Piekarski defines it as the "method of interpreting a problem". Essentially it makes integrating stimuli easier, as well as the transfer and internalization. It is an unusually complex process that is influenced by many variables and external factors such as the type of stimuli, personal predispositions and the like (Piekarski 2017, p. 20). Mindfulness can be defined as a certain method of perceiving, while any state different from this is regarded as abnormal. The category of mindfulness, according to Piekarski, is identified in large context of visualisation, then, let's say, perception. "In McLuhan's Gutenberg galaxy, the communicative situation between a separated from the outside and concentrated on the written word reader is built on distance and the domination of sight" (Piekarski 2017, p. 20). Additionally, according to the theories regarding perception and memory, the process of concentrating attention is also determined by knowledge, skills, and experience.

As previously mentioned, we are currently dealing with dichotomy between the information environment of a human being and individual predispositions defined by species. The mechanism that could remedy the aforementioned problems is representing large information streams in such a manner, that it would allow for quick and easy internalisation, without the need for too much perceptive involvement, but would still carry enough of an information payload (Gogołek 2012).

Big data paradigm

Vast amount of information holds an equally vast amount of data. There is knowledge in raw data, that the human brain is incapable of recognizing directly. Data is everything, that is/can be processed by the mind or a computer. Data can provide a lot of different types of information, but only when we know, what it represents. Raw statistics in themselves do not communicate essential content. Only when they are corelated, visualised and interpreted they become a valuable source of information.

Quantification and digital representation of various aspects of reality is on the rise in the modern world. Massive increases of data in digital form has created the need to establish specialized tools to acquire, process and analyse. The most important is the so-called unstructured data, which is a digital trail left unwittingly by net users. This data comes from Internet's resources, such as social media, blogs, posts, portals, mailboxes, professional publications, as well as clickstreams in www. They are also generated by cell phones, computers, digital cameras, RFID readers, GPS devices, cars and even apartments (Gogołek 2012). Over time digital data started being recorded and put together into massive sets. "There is a new term in cyberculture newspeak dedicated to this problem – *big data*" (Celiński 2018, p. 138). There

is no official definition of *big data*. This term encompasses a description of large and complicated datasets that are uncomfortable to work with using traditional statistics software. The most widespread definition of this term is the 4V rule, which defines *big data* using 4 key words: *volume, variety, velocity, value*. The characteristic trait of *volume* is the significant dynamic of data increase, which needs new technologies. *Variety* is connected to the multiplicity of sources, from which data is acquired, as well as to variety of formats, in which it is represented and models, by which it is expressed. *Velocity* refers to the dynamic of data increase. It comes in streams, so it needs additional computing power for real-time analysing. In relation to the limited bandwidth net data needs to be downloaded in parts, of which only those parts that have important information value are chosen. *Value* is derived from the unique value of information, that is hidden in data. It is connected to the ability to come up with new conclusions and to discover new knowledge (Tabakow, Korczak and Franczyk 2004, p. 142–143). Another, similar definition, formulated by employees of O'Reilly Media draws attention to the technological aspect of *big data* associated with storing and processing data. The term *big data* refers to data exceeding the capabilities to process by conventional systems of databases. To acquire valuable information from this data one needs an alternative method of processing (Gray, Bounegru and Chambers 2012, p. 3).

The direct cause behind the growth of big data is a process called datafication – the tendency to produce data concerning a phenomenon that up to the certain point was not considered an interesting source of information. Datafication, as one of the elements of algorithmizing, is a new cultural paradigm. *Big data* analysis is used by commercial companies, social researchers, stockbrokers, bookmakers, special forces and modern journalists.

Data journalism

Data journalism is a relatively new topic of discussion but its beginnings go back many years before the term officially entered media-communication discourse. The use of numerical data has been present in sports journalism for many years, as well as in stock market bulletins. The basis of *The Wall Street Journal*, published in the United States since 1889, was to analyse the stock market. Now, data journalism is not only journalism based solely on numerical data, but also journalism transforming social reality into numeric format (Gray, Bounegru and Chambers 2012, p. 3). This type of journalism is the hybridised form encompassing statistical analysis, computer science, visualisation, webpage design and reporting. It is not focused on sharing information, but on understanding the wider context of information. It requires specialized knowledge and skills in the field of statistics with connection to data visualisation techniques. This new form of journalism does not require special writing skills, instead it relies on the ability to use mathematical functions (Andreotti et al. 2015, p. 244).

Numbers are inseparably connected to communication and present in the media in many different topics, creating the description of social reality. Depending on their usage they accomplish two functions: they illustrate or complete. The question of numbers in communication sciences and media was discussed by Annette Siemes in her article "Numbers in media. The role and function of numerical reality in media communication – results of empirical research" verifies the context of general functions of numbers in a communicative description of reality in the media, which is a starting point to categorising journalism based on numerical data. Siemes draws her conclusions from the analysis of texts in German, more precisely from *Der Spiegel* journal. She notes that numbers describe important aspects of reality, like time and space, money/economy, persons/groups, and other sets. She also notices that numbers, despite their precision in describing reality and phenomena, can induce a feeling of blurriness that manifests itself in terms, such as around, about, almost, to, hundreds, thousands, which in term could become a tool used to persuade or manipulate. On one hand, numbers determine precision and explicitness, on the other they represent inaccuracy and blurriness (Siemes 2010, p. 419–420).

Numbers get blurred in communication, which can make them inaccurate, but they do not lose any of their connection with contexts associated with the numerical system and counting (Siemes 2010, p. 419–420). In this context, the role of data journalism reveals itself, where the correct selection of numbers, their representation in the form of multidimensional connectivity seems fundamental, limiting the possibility of random interpretation using visual forms or text introduction. Moreover, numerical representation is connected to numbers in relation to all the elements of new media, that although they are created from the start using a computer or are converted from analogue sources, end up as numbers saved digitally. The Internet has diametrically changed journalism. Even traditional paper media, once digitalized, will never be the same again. They will always be accompanied by links and references to other information, making it a massive set of *big data*. Journalism, as every other industry, tries to find its place in this new, digital reality. To survive on the competitive, Internet market, there is a need to create content in a way that is inseparably associated with the specifics of the Internet, while at the same time uses its potential to the best of abilities (Artivia.pl Blog 2012). As Nils Mulcad, the world-famous investigative reporter and lecturer at Danish School of Media and Journalism accurately puts it: "You cannot be a journalist, if you're unable to conduct an interview. The same applies to the tools of journalism based on data analysis in the era of digital information" (Pacuła 2014).

According to the definition by Pete Warden, data journalism is the type of journalism, in which one should treat data as the protagonist, feature authors input in interpreting featured data, base the analysis on data that is available to the public (Warden 2010). Miłada Jędrysik (Cyber Central of Poland) understands data journalism as "the usage of terabytes available in the net to create visualisations, infographics, that in today's picture-oriented world can speak better, than even a masterfully written text" (Jędrysik 2012). The main advantage of data journalism

is the usage of *big data* analysis, which is a guideline to the unknown phenomena or to discover such information, that researchers, traditional journalists or the general public were unaware of. Traditional journalism is based on a certain narration whereas data journalism introduces a database. Traditional journalism tells a certain story that has a beginning and an end. The narrative form is a fundamental form of realistic representation in literature, writing, photography, movies and generally in visual arts. Databases do not tell any stories, they do not have an introduction, explanation and an ending, but they do have individual parts, of which every one is as important, as all others. Andrew Dewdney and Peter Ride have compared narration – treated as a symbolical culture form of traditional media and a database – as equivalent to the new media (Dewdney and Ride 2006, p. 264). Despite the fact that the differences in presented oppositions were diametral, it turned out that one of the tasks of a data journalist is creating an information based on controlled narration from non-linear data. Thus, the point of data journalism is to give narration to data and to establish, by the journalist, the beginning and end to the story told by and with numbers, as well as plan an appropriate structure for it. The job of a data journalist will be to select the added elements, categorize them and establish order and a thematic outline (narrative) in open data structure (Dewdney and Ride 2006, p. 264). For this kind of job, one will need programming skills, graphic design skills and the ability to work with spreadsheets. Data journalist rarely work alone. Instead they work on projects in specialized teams in which every person is responsible for a different task and has different qualifications and skills.

Infographic and data visualisation

Infovis (*Information Visualisation*) encompasses scientific research that "concentrate on using various form and graphic techniques to represent a large amount of data (large scale) in the format most legible for the viewer (Osińska 2016, p. 11). Raw data usually takes the form of rows of numbers or a stream of facts, which are often deprived of context in the form of a structured cognitive environment. Only once they are positioned in the correct topological space, their interdependence can be observed by their relationship patterns, local or global similarities and by that – their structural image. To simplify this, an infographic – the visualization of information – has the ability to transform data available to general public into meaningful information that can be understood or used by potential recipients. As Edward R. Tufte has put it: "Perfection in statistical graphics comes from presenting complicated ideas in a clear, precise and effective way" (Tufte 1990, p. 13).

Historically, this discipline should have been identified in the prehistoric era when picture writing was used to spread information important to a given community. It is hard, however, to relate this mechanism to modern infographics, as in those times the usage of pictures was necessary, as there was no form of writing yet. The most important, early example of an infographic were maps. They incorporated not only the obvious cognitive values of topography, but they also

allowed an individual to learn about cultural differences and its impact (Bagrow 2009, p. 31–33). "Traditional charts, like pie charts, column charts or linear charts – invented by Playfair – have started a very intensive period for *infovis* that was written in history with such famous infographics, as for example The March of Napoleon on Moscow" (Osińska 2016, p. 7). From a classical point of view the entire discipline, infographics, such as "Doctor Snow's map" that contributed to an important discovery of the causes of cholera, through "The Rose of Nightingale", which through the visualization of data regarding soldiers deaths during the Crimean War, allowed for establish better methods of care for the wounded. Data visualization has cemented its position as an interdisciplinary method of data representation.

Modern dynamic growth of graphic visualization of information started in the second half of the 20th century. In 1967 Jacques Bertin, in his book "Semiology of Graphics" included theoretical basis of picturing information and the theory of usage of graphic symbols. By this he expanded on the 1930's Gestalt's principals of perception regarding shape, size, brightness, granulation, color, and orientation (Koch 2001, p. 37–43). In 1977, American statistician John Tukey in his book "Exploratory Data Analysis" highlighted the role of visualization in statistical data analysis and introduced many groundbreaking solutions, such as the box plot, Tukey's test, or fournier transform. Several years later textbooks by Edward Tufte were published and regarded as classics in the discipline of graphical data visualization – "Visual Display of Quantitative Information" (1983), and later "Envisioning Information" (1990). In those books Tufte not only established the principals of graphical information design, but also introduced many terms, such as graphical integrity or so-called lie-factor and data-ink ratio (Tufte 2015).

The term infovis came into prominence with the advent of technological revolution of the 21st century. The multi-area nature of this phenomenon made collecting and accessing multidimensional volumes of data unprecedentedly simpler. This forced the implementation of solutions that made it possible to flatten complicated sets of information into a form accessible to human recipient. As Marshall McLuhan and Quentin Fore have said in their book, back in 1967: "Alphabet and printing have started the process of fragmentation, specialization and distancing, while the electronic techniques lean towards unification and participation" (McLuhan and Fiore 1967, p. 83). Historically humans forced, genetically or evolutionary, to operate on abstract, often correlated, and conditioned data. Interestingly, human achievements so far, like language, in this context, are regarded mostly useless. "A word lets us understand something only then, when it is understandable, that is when, we know the language, to which it belongs; in other cases it is dead, it is a neutral sound or a graphic sign" (Sartori 2004, p. 73). It is also important to remember that the digital revolution not only gave us access to information, but also created the tools that have enabled fast and effective visualization of information. An average user can find tens of virtual tools that give the possibility of visualizing any data in any way.

Conclusions

Societies, that have lived in a world with limited access to knowledge have concentrated their efforts on "hunting" and gathering information. Now, when we are flooded with information from every angle, the most important aspect is processing and presenting the data in the most accessible form. Constantly increasing the amount of data and the relatively constant ability of a human brain to process can result in an individual experiencing an information shock, from which one is unable to free oneself. Data journalism can be viewed as a new media discourse, that similarly to science, has established its own methods and techniques of generating communication. The ability to transform data made available to the public information that satisfies curiosity, so characteristic of humans on the one hand and on the other, by presenting them in the form of infographics, the work to overcome the cognitive barriers of the human brain. Alongside the spread of writing, came the end of communicating with pictures and the dominance of visualizing information was took over by the written word. Paradoxically, what we have abandoned now is coming back to us and becomes the remedy for information overload that we struggle with every day.

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STRESZCZENIE

Data Journalism. Wizualizacja danych jako remedium na problemy percepcyjne współczesnego odbiorcy

Stale powiększająca się liczba informacji nie jest wprost proporcjonalna do wzrostu uwagi. Pomimo dostępności nieskończonych ilości treści ludzki mózg, pracując na „starym oprogramowaniu", nie potrafi poradzić sobie z ich nadmiarem. W efekcie tego pogłębiają się stany lękowe i depresyjne, które negatywnie wpływają na kondycję współczesnego człowieka. Ograniczenia percepcyjne są powodem ubóstwa uwagi przy jednoczesnym bogactwie treści. Celem przeprowadzonych badań jest wykazanie nadrzędnej roli obrazu w stosunku do tekstu oraz przedstawienie dziennikarstwa danych i infografiki jako swoistego remedium na problemy percepcyjne współczesnego użytkownika nowych mediów. Materiałem badawczym stały się publikacje naukowe dotyczące dziennikarstwa danych, wizualizacji informacji, infografiki, baz danych i percepcji. Wykorzystana w pracy metoda badawcza to analiza zawartości i studia literaturowe. Przeprowadzone badania pozwoliły autorkom na wysnucie wniosku, że dziennikarstwo danych sprzyja wizualizacji i może stać się sposobem na rzetelne i niewywołujące lęku przekazywanie informacji.

Słowa kluczowe: infografika, *data journalism*, dziennikarstwo danych, *big data*, wizualizacja informacji, percepcja