

Human Cognition and Data Journalism

Makri Elina¹

Veglis Andreas²

ABSTRACT

Data journalism storytelling has become an important aspect of journalism during the twenty-first century. This cross-disciplinary research draws the attention of data journalism stakeholders to the mental operations (conscious choices and nonconscious mental processing) of a person who experiences storytelling with data. It is argued that data journalists can learn from the availability heuristic, the cognitive bias, and other concepts of cognitive science in an effort to become more attentive to the mental mechanisms of their audience. Research from other disciplines, such as law (guilt determination) and economics, suggests that taking nonconscious decision-making seriously would be very productive for the field. Evidence suggests that a better understanding of the human brain's decision-making as well as of cognitive control may provide important insights for the data storytellers. This study is undertaken with an initial focus on the reasons why the audience acts upon emotional stories rather than data and statistics. We begin by arguing that data collection methods, measurement, and quantification may not be the only 'obscure' and difficult part to control for a data journalist, but after the cleaning, the analysis, and the visualization, the workings of the brain of the receptor, play a crucial role on what the individual will decide to do. The acts of journalism do not enter a *tabula rasa*, but rather a *terra incognita*. The research also examines the role of the language use by the data journalist; and whether language can overshadow data and consequently influence the reader's perception on the information from an article.

The study uses theories from various disciplines (communication, psychology, neuroscience, and cognitive science) and gathers data by the use of qualitative research through interviews with cognitive scientists, neuroscientists, and psychologists.

Keywords: Data Journalism, Cognitive Science, Data storytelling, Data, Bias, Language, perception.

¹ Researcher, Media Informatics Lab, School of Journalism and Mass Communications, Aristotle University of Thessaloniki, Greece, e-mail: elina.makri@gmail.com

² Professor, Media Informatics Lab, School of Journalism and Mass Communications, Aristotle University of Thessaloniki, Greece, e-mail: veglis@jour.auth.gr

INTRODUCTION

Today data journalism is considered to be one of the rising specialties of journalism (Diakopoulos, 2013; Howard, 2014; Howard, 2012; Veglis & Bratsas, 2021). According to The Data Journalism Handbook (Bounegru et al, 2012), data can be the source of data journalism, or it can be the tool with which the story is told—or it can be both. Several studies have covered extensively the “life” of data, which has three parts: quantification, analysis, and communication (Stray, 2016). More often than not, journalists use data from other sources and do not proceed with data collection which is time-consuming and impractical in many cases (Zamith, 2019). Much has also been written about the limits of quantification, the process that creates data (“*quantification is a problem without a home*”), the challenges of measurement, and if the collection method is obscure, so is the data (Stray, 2016). Many times, the journalist has little control over this process. Usually, the journalist's involvement comes after the data collection (Bounegru et al, 2012). Let us consider this part of the process as a black box. It is the process before the final columns, rows, in csv or excel files. What do we measure and what do we choose not to count?

With this cross-disciplinary research, this study aims to indicate that there is another black box that comes after the visualization part. Data conveys the meaning that the journalist has given to the story. Chosen words can frame the story. Subjective feelings of the journalist can impact the story. Moreover, data journalism investigations are addressed to human beings, who already have a way to perceive the world, powerful beliefs, and an individual notion of fairness. Data stories do not enter a *tabula rasa*, but rather a *terra incognita*. Subsequently, the main focus of this study is to investigate the second black box, which is the brain of the receptor.

The human brain is the most complex biological structure on Earth. It has about 100 billion neurons--each of which has thousands of connections to other neurons (National Science Foundation, 2013). This complex organ harbors thoughts, behaviors, emotions, and conscious and unconscious mental mechanisms of which the human agent is not totally aware, mostly unaware (Damasio, 1994). In fact, conscious processes might not only be the tip of the iceberg but a very, very small tip, with implicit processing responsible for the overwhelming majority of computation in the brain (Keysers et al., 2008). These processes guide the human animal's actions and control behaviors. Although major scientific achievements have been made in the last fifty years, the human brain remains thoroughly unknowable. The field of human decision-making started to be studied by mathematicians mainly in the 19th century.

It is a legitimate question to ask, why journalists should care about the processes of decision-making. But what is the use of journalism if it does not inform the audience and help them decide? Journalism's impact is measured by the audience and institutions' reactions.

The problem is how well journalism stakeholders know their audiences and how well they know the mechanisms that made institutions evolve and regulate a great part of human behavior (Anderson, Bell, & Shirky, 2015). For example, language is not exactly innate in the human brain. It evolved because of culture. Language does not emerge spontaneously

in a socially isolated brain; unlike attention, it does not self-install (Donald, 2008). Journalists write about human actions and fairness in society. It is worth considering how ‘fair’ it is to write about human behavior without any consideration for the sources of human action. Especially at a time when the advances in psychology and neuroscience point toward a pseudo distinction between conscious and unconscious actions of the human agent. If that is the case, it is worth asking on what grounds journalists hold individuals accountable. Journalists also go back in time in order to construct a story and present facts. They may not do it with the severity of the legal order, but reconstructing past events is prone to errors (Engel and Singer, 2008). They cannot avoid intuition and inferences, of different types, as is the case with legal practitioners.

Data journalism follows the same pattern. It may rely on data for the story, but storytelling is an indissociable part of most acts of journalism (Roeh, 1989). Data journalists find one or many stories in the data and interpret and communicate the story. Data and facts can have several possible interpretations. Finding a story in the data will always be an act of cultural creation (Stray, 2016).

As data journalism makes accurate use of scientific methods and scientific reasoning - apart from research and storytelling - it is important to turn to science to understand also how we need to present the data to the audience, which goes beyond the different ways of visualization (humans are not only visual beings) (Bounegru & Gray, 2021). We argue that is also important to understand how the human brain reacts to data in combination with strong worldviews orientations and beliefs, policy-relevant facts, and stories.

1 LITERATURE REVIEW

Data is not something that exists in nature (Stray, 2016). Data collection is a human enterprise and in the social sciences, there is room for interpretation of the different datasets. The relationship between story, data, culture, and truth is one of the key problems of twenty-first-century journalism (Stray, 2016).

Individuals choose specific news brands to consume news, this news brand is also an identity, a purchased proxy for identity, and a proxy for a worldview (Garber, 2011). People choose to see the world through the ‘eyes’ of a certain publication. In the social media era, we mostly talk about the influence of social networks and how they restrain our “worlds”, the ‘limited’ world we see through social media, and people we friend and follow on social media. This is a far older story, although with more options today, the bias becomes more effective. What we share on Twitter, and what we comment on Facebook, is the new proxy for identity (Garber, 2011).

According to the Cambridge Dictionary³, a cognitive bias is a way a particular person understands events, facts, and other people, which is based on their own particular set of beliefs and experiences and may not be reasonable or accurate. There are many cognitive

³ <https://dictionary.cambridge.org/dictionary/english/cognitive-bias>

biases since there are several brain systems (think of them as information process systems) that control our core cognition and behavior. Biases make people create their own "subjective reality". Biases are independent of education and culture. And as with many mechanisms in the human-animal, they evolved or survived evolution for a reason (De Martino, Kumaran, Seymour, and Dolan, 2006).

For cognitive science, bias is a basic human function with a purpose: to help people make faster decisions (Glimcher, 2003). Biases are within the human brain, and we do not know much about them. As soon as people start imagining and perceiving things, they are already biased.

The American philosopher and cognitive scientist Daniel Dennett, wrote in his book "The Intentional Stance", about how useful it is to understand causality in terms of the folk concepts such as beliefs, desires, intention, and expectation, these 'things' that we cannot touch or see but we know that they are somewhere there and how compelling it is for people to explain other people's behaviors or beliefs in this way (Dennett, 1987). Dennett argues that humans adopt a stance, a predictive strategy of interpretation that presupposes the rationality of the people - or other entities – they are hoping to understand and predict (Dennett, 1988).

Language is not exactly innate in the human brain in the sense that it does not self-install, it does not emerge spontaneously in a socially isolated brain, unlike attention (Donald, 2008). It has powerfully evolved because of culture. Culture plays a crucial role in actually making language possible. The raw capacity for language may indeed be there in the abstract sense that it is latent in every neurologically normal human, but it will remain unrealized unless culture has an opportunity to guide the brain through the very subtle and complex process of language acquisition (Donald, 2008).

The language introduces biases and human choices are remarkably susceptible to the manner in which options are presented (De Martino, 2006). Language and culture are indissociably connected. And as a culture frames individuals, so does the language. For this reason, it is important to gain some perspective on the way data is communicated through the language.

The crucial role that language plays was highlighted in a study at Yale University. The researchers investigated why the public conflict over societal risks persists in the face of compelling and widely accessible scientific evidence (Kahan, Peters, Dawson, Slovik, 2017). They recruited 1111 American citizens of various social and political backgrounds. They explicitly measured the subject's numeracy. The stimulus consisted of four versions of a problem involving the interpretation of data and causal inferences. The study results indicated that when data, correctly interpreted, threatened the subject's outlooks, high-numeracy partisans had no meaningful advantage over low-numeracy individuals. Additionally, when policy-relevant facts become identified as symbols of membership in and loyalty to affinity groups that figure in important ways in individuals' lives, they will be motivated to engage empirical evidence and other information in a manner that more reliably connects their beliefs to the positions that predominate in their particular groups

than to the positions that are best supported by the evidence (Kahan, Peters, Dawson, Slovic, 2017).

There is evidence of the different cognitive biases all stakeholders have (both audience and journalists), regardless of their culture and level of education. Based on the above the following research questions were investigated:

RQ1: Is there a connection between the data journalism articles one reads and how they relate to the already structured perception of the world the individual has?

For this research question, we looked into the different cognitive biases with a special focus on the confirmation bias which is more evident when reading the news (than the bias connected with the reward system of the brain). The confirmation bias has an effect as soon as more options of media outlets and messages are available.

RQ2: Is the language used by the journalist to build the context & storytelling around data an important factor that influences audience perception?

For this research question, the study examined whether the language could overshadow data through specific experiments done on subjects who are high and low in numeracy.

Data itself has no meaning. Meaning comes by connecting data to the world. Using language, different things can happen, the journalist builds a story (does not report raw data) and there are various biases, and underlying, subtle messages that are communicated with the language to the audience. Moreover, language communicates beliefs and desires, intentions, and expectations, which help people explain other people's behaviors or beliefs.

2 METHODOLOGY

This study was undertaken and funded under the JOLT (Harnessing Digital and Data Technology for Journalism) which is a Marie-Skłodowska-Curie European Training Network funded by the European Commission. The aim of the JOLT project was to investigate how to harness digital and data technology for journalism (<http://jolt.eu>).

This cross-disciplinary research seeks to draw the attention of data journalism stakeholders to the mental operations (conscious choices and nonconscious mental processing) of a person who experiences storytelling with data. The research method employed in this study is qualitative analysis. The qualitative analysis is based on structured interviews with experts from the fields of cognitive science, neuroscience, and psychology, fields that as previously discussed relate to the perception of data journalism articles from the audience. As it is qualitative research, there was an emphasis on explaining why people think and behave in certain ways- behaviors-, the role of the social context, and the meaning attached to them (rather than counting numbers).

Most of the cognitive science and cognitive neuroscience experts interviewed are members of the Human Brain Project, one of the biggest scientific research projects worldwide with a mission to explore the multi-level complexity of the brain in space and time and to

transfer the acquired knowledge to brain-derived applications in health, computing, and technology. The data of the interviewees are included in Table 1.

Table 1: Data of the interviewees.

Name	Affiliation	Date of Interview
Participant 1	Professor of Cognitive Neuroscience	April 5, 2021
Participant 2	Assistant Professor at Department of Mathematics and Computer Science	March 3, 2021
Participant 3	Professor of Cognitive neuropsychiatry	April 15, 2021
Participant 4	Professor of Cognitive and Systems	April 8, 2021
Participant 5	Psychologist, writer and former psychology professor.	May 17, 2021
Participant 6	Assistant Professor in Medical Neurosciences	April 26, 2021
Participant 7	Cognitive scientist	February 2, 2021

Virtual interviews (VI) were carried out between March and May 2021 through Jitsi (open-source video conferencing software). Due to internal movement and travel restrictions related to the COVID pandemic, no face-to-face interviewing (FTFI) was possible.

During the interviews the following questions were discussed:

- Why does the audience act upon emotional stories rather than data and statistics?
- What is the role of cognitive bias when people read the news?
- If and how important is the role of the language used by the journalist (does the language overshadow data analysis and evidence)?
- What is the impact of frames in data journalism?
- If there is a connection between the data journalism (and in general journalism) a person reads and how it relates to the already structured perception of the world this person has

The interviews were conducted by following the ethics regulations of the academic institution where the study was carried out. Specifically, the research was conducted with respect for fundamental human rights, the value of human beings, the autonomy of the persons involved, and their privacy and personal data. It was also compliant with generally accepted principles of research integrity and the criteria of good scientific practice.

During the interviews, the scientists pointed out other patterns, concepts, and principles that need further examination and may prove useful for the data journalist and the person who experiences storytelling with data. Before interviewing the experts, data-driven

articles and investigations were presented to them to make sure they understand the difference from other acts of journalism.

3 RESULTS

RQ1: Is there a connection between the data journalism articles one reads and how it relates to the already structured perception of the world the individual has?

Cognitive scientists pointed out in the interviews that all people have a worldview. It is a basic human drive to make sense of the world. People have an opinion about the world, and what is to have a good or safe world (which can have a cultural connotation) but the fact that people have a unique view of the world, really speaks about the inner workings of the brain. All individuals construct their models of the world, and they interpret the world in accordance with their models. Biases, perceptions, and the workings of the brain play a crucial role in understanding every stimulus that comes from the outside world. Acts of journalism are no exception.

Participant 1 said in the interview: *“When reading the news, people use all internal biases to make sense of the story, to go faster in interpreting the information, and when reading news that does not support their claims, they feel uneasy and contradicted”*.

Moving to the issue of bias, Participant 4 argued that: *“Unconscious bias towards associating something sour and colourful with speed, which is pretty absurd but most people do this. So bias is already there on a perceptual level, very early in the brain”*. He also added: *“Another example is to associate sweet or sharp edges with sweet or salty. Most people associate sweet taste with round shapes. And there are companies that make use of this like Cadbury which makes chocolates, round shapes so to have subjectively a sweeter taste.”* Participant 4 claimed that there is an unconscious bias on how people like something, and they are not aware of that. He added that biases are independent of education and culture. Bias is also important for discovery, and scientists know that non-human primates have them as well.

In this study, we will not analyze in detail the many cognitive biases. We refer to the notion and how some of those biases, linked to the normal functioning of the human brain, can impact decision-making faster than data and facts. Even worse, they can block them. What is most relevant for journalists is the confirmation bias, the tendency for humans to search for, interpret, favor, and recall information in a way that confirms or supports their prior beliefs or values. People will not only select information and facts consistent with their views, but they will also ignore contrary information.

For Participant 4, humans, consciously or subconsciously, try to build a story in order to make their observations complete or to explain them. This is a very basic drive. We also see it when people talk about themselves, even war criminals, they do not see themselves as intrinsically bad. When they are asked in the tribunal why they killed all these people, they will reply, *‘well, it was in order to protect my own people’*. There is always this

element of justification in it. Participant 4 added: *“The story presents a complete overview of a situation and it will resist other facts if they are counterfactual. People will put them away as irrelevant, nonsensical or untrue unless there is a tipping point and the counter-evidence comes so strong and they cannot applaud the story. This is a remarkable trend to keep our worldviews unified and consistent.* He went on to explain why people need to do that. Participant 4 suggested that it is a better basis to take firm actions and decisions because if people had to sustain two worldviews that might be contradictory, then they would become very doubtful, and they wouldn’t be able to effectively act. He concluded *“Sometimes it's better to make a poor decision than no decision at all. It's a survival thing.”*

Participant 1 gave the example of the Necker cube, a visual stimulus that a person can perceive in two different ways: from above and from below. It looks three-dimensional and people can interpret the same visual stimulus in two different ways. However, humans only perceive it in one way. There is a super strong perceptual bias.

Participant 1 suggested that the case of the Necker cube is a very simple and stupid stimulus and one can imagine what can happen in more complex situations where people are dealing with politics, religion, pandemics. He also added *“Blaming the people that they cannot see the other side of the coin, is not right because we see with this simple stimulus, the cube, this is the way our brain works. Why do we perceive the Necker cube in a particular way? Because we are going to act up on the cube and the way to grab it depends on the way one perceives it.”*

The above information suggests a positive answer to the research question if there is a connection between the data journalism articles a person chooses to read in accordance with the structured perception of the world the individual has. There are many parameters, which can not be anticipated by the journalists, about how the reader will perceive the data journalism article.

RQ2: Is the language used by the journalist to build the context & storytelling around data an important factor that influences audience perception?

Most of the interviewees agreed that language can overshadow data and consequently influence the perception of the reader (independently of the subject’s ability in numeracy) about the information he gets from the article. Next, more information on the opinions of the scientists is being presented along with some specific remarks they made.

Participant 4 mentioned that humans are born with a “disposition” to learn a language. but unless culture and education come along, language will not emerge naturally. It is not the same as innate numerosity. He explained: *“Humans have a good natural sense of numbers which goes approximately up to 20. It is not about being able to count but rather the notion of ‘many’ or ‘few’. This innate numerosity exists even before the language. But the language can trigger emotions that can be even stronger than the inner mechanisms humans have to make basic comparisons.*

Participant 3 said that we know from prospect theory that if you frame a problem as a loss or as a gain it makes a difference in what people choose. He went on to say that language makes a big difference, that depends on the meta belief of the subject. Participant 3 argued that one subject can exhibit big language bias while another subject can be more resistant to it and also in some contexts, we can manipulate the reliance on the language system. He concluded that other factors play a role and thus one cannot say that the language system overrules facts.

Participant 4 said that "*words frame people*". Specifically, he referred to the famous economic theory of Daniel Kahneman, a psychologist, and economist who won a Nobel prize in Economics in 2002 for working on the influence of irrationality on decision-making. Participant 4 argued that: "*that shows very clearly that framing is a big thing*"

Participant 3 also made a comparison with the vision: "*Vision is also a function of expectation. Always the things we see, are not the facts. An example is the colors. There are extreme examples where if people do not have any prior expectation, they can not identify what they are seeing but if they do, then can tell someone else that it is something else.*"

Participant 1 supported that language can overshadow data. He went on to argue that by picking the words one can introduce his own biases unconscious. Participant 1 mentioned that "*there are these effects very well known, for instance, the framing effect, the way you establish a story. The way you present the option that people can choose from is going to affect..*"

Similarly, Participant 5 agreed that language can outshine data. He argued that "*The numbers are valuable as the person who is using them to make a decision.*" He concluded that this fact may undermine the value of data journalism since it does not matter what data you show to people because they will still reach the conclusion they want.

While further research needs to be done on the role of emotions in data storytelling (those of the data journalist and those of the reader), the above research and the collected interviews suggest that there is evidence that language plays a pivotal role in communicating data despite the reader's basic or high ability in numeracy.

4 CONCLUSIONS

"*Data is only useful because it represents the world, but that link can be fragile.*" (Stray, 2016). While our suggestion is that all journalists need to be aware of the workings of the brain, data journalists, as closer to science, need to be particularly aware of those notions. Underlying mental mechanisms are crucial for building a story, weighting on evidence, and engaging in sense-making out of past events. The legal institutions have come into scrutiny for the way judges and jurors (where the criminal justice system includes them) reach their verdict, lawyers' syllogism in the way to interpret evidence, and the way to proceed to inferential conclusions and apply the law to facts. These might be productive avenues for future research for neurobiologically minded journalists. And it would be an interesting

experiment to test how a story written by a journalist would be rewritten by a neuroscientist. Would the neuroscientist connect the facts and build a story in the same way as a journalist, or get the same meaning of the data as a data journalist?

Further research also needs to be done on the impact of data journalism articles on the audience. A prime example would be election forecasts since there is evidence that some people find predictive models published by data journalists and statisticians confusing and an argument that they might keep people from voting (Benton, 2020).

This is an ongoing research and findings need also to be discussed and cross-tested with interviews with data journalists. What happens if the high numeracy skilled individual who selectively uses his greater capacity to draw inferences from quantitative information (that as we see in the paper generates greater polarization among high-numeracy partisans than low-numeracy partisans) is the data journalist himself?

This research is also at the border between disciplines. The effort is to pique interest and challenge further discussions, to draw the attention of data journalism stakeholders to the mental operations (conscious choices and nonconscious mental processing) of a person who experiences storytelling with data.

Heuristics, the many cognitive biases, implicit processes, “irrationality”, information that is not always under conscious control, and the role of emotions as essential to rational thinking and normal social behavior, are concepts that are already been examined thoroughly in other disciplines which study or regulate human behavior such as the criminal justice system and economics (Moreno-Bote, Ramírez-Ruiz, Drugowitsch, & Hayden, 2020). Journalists write about the actions of humans and institutions. One would wonder how this is possible without knowing more about the origins of human behavior which creates cultures and institutions.

5 ACKNOWLEDGMENTS

The authors received funding from the European Union’s Horizon 2020 research and innovation programme under the Marie Skłodowska-Curie grant agreement No 765140.

6 REFERENCES

- Anderson, C. W., Bell, E., & Shirky, C. (2015). Post-Industrial Journalism: adapting to the Present. *Geopolitics, history & international relations*, 7(2) pp. 32-123.
- Benton J., (2020). Should news outlets stop making election forecasts based on polling data? Nieman Lab. <https://www.niemanlab.org/2020/10/should-news-outlets-stop-making-election-forecasts-based-on-polling-data/>
- Bounegru, L., & Gray, J. (2021). *The Data Journalism Handbook: Towards a Critical Data Practice*. Amsterdam University Press.
- Bounegru, L., Gray J., & Chambers L. (2012). *The Data Journalism Handbook*. O'Reilly Media https://datajournalismhandbook.org/uploads/first_book/DataJournalismHandbook-2012.pdf
- Damasio, A. R. (1994). *Descartes' Error: Emotion, Reason, and the Human Brain*. Avon Books New York USA.
- De Martino, B., D. Kumaran, B. Seymour, and R. J. Dolan. (2006). Frames, biases, and rational decision-making in the human brain. *Science* 313:684–687.
- Dennett, D. C. (1988). The intentional stance in theory and practice. In R. Byrne, & A. Whiten (Eds), *Machiavellian intelligence: social expertise and the evolution of intellect in monkeys, apes, and humans*. (pp. 180-202). Oxford University Press United Kingdom. https://www.researchgate.net/publication/271180035_The_Intentional_Stance
- Dennett, D. C. (1987). *The intentional stance*. MIT press.
- Diakopoulos N. (2013). The Rhetoric of Data, *Tow Center for Digital Journalism*. <http://www.nickdiakopoulos.com/2013/07/25/the-rhetoric-of-data/>
- Donald, M. (2008). How culture and brain mechanisms interact in decision making. In, C. Engel & W. Singer (Eds.), *Better than conscious. Decision making, the human mind and implications for institutions*. MIT Press.
- Engel C., & Singer W. (2008). Better than Conscious. The Brain, the Psyche, Behavior and Institutions, In C. Engel & W. Singer (Eds.), *Better than conscious. Decision making, the human mind and implications for institutions*. MIT Press.
- Garber M. (2011). The personal(ized) brand: Yet another reason The Economist is trouncing competitors. Nieman Lab. <https://www.niemanlab.org/2011/11/the-personalized-brand-yet-another-reason-the-economist-is-trouncing-competitors>
- Glimcher, P. W. (2003). *Decisions, Uncertainty, and the Brain: The Science of Neuroeconomics*. Cambridge MA MIT Press.
- Howard, A. (2014). *The Art and Science of Data-Driven Journalism*. Tow Center for Digital Journalism. Columbia University. DOI: <https://doi.org/10.7916/D8Q531V1>
- Howard, A. (2012). Profile of the Data Journalist: The Human Algorithm. *Radar*. O'Reilly. <http://radar.oreilly.com/2012/03/profile-of-the-data-journalist-2.html>
- Kahan, D. M., Peters, E., Dawson, E. C., & Slovic, P. (2017). Motivated numeracy and enlightened self-government. *Behavioural public policy*, 1(1), 54-86.
- Keysers R., Boyd, R., Cohen, J., Donald, M., Schooler, J., Spelke, E., & Trommershäuser, J. (2008). Explicit and Implicit Strategies in Decision Making, In C. Engel & W. Singer (Eds.), *Better than conscious. Decision making, the human mind and implications for institutions*. (pp. 225-258). MIT Press.
- Moreno-Bote, R., Ramírez-Ruiz, J., Drugowitsch, J., & Hayden, B. Y. (2020). Heuristics and optimal solutions to the breadth–depth dilemma. *Proceedings of the National Academy of Sciences*, 117(33), 19799-19808.
- National Science Foundation (2013). Prying Open the Black Box of the Brain. Research News. https://www.nsf.gov/discoveries/disc_summ.jsp?cntn_id=128239
- Roeh, I. (1989). Journalism as storytelling, coverage as narrative. *American Behavioral Scientist*, 33(2), 162-168.
- Stray, J. (2016). *The Curious Journalist's Guide to Data*. Columbia Journalism School. https://www.cjr.org/tow_center_reports/the_curious_journalists_guide_to_data.php
- Veglis, A., & Bratsas, C. P. (2021). Data Journalism: Definition, Skills, Difficulties, and Perspectives. In *Encyclopedia of Information Science and Technology*, Fifth Edition (pp. 1140-1151). IGI Global.
- Zamith, R. (2019). Transparency, interactivity, diversity, and information provenance in everyday data journalism. *Digital journalism*, 7(4), 470-489. DOI: <https://doi.org/10.1080/21670811.2018.1554409>

© 2022 The Author(s). Open Access – This article is under the CC BY license. The use, distribution or reproduction is permitted, provided the original author(s) and the copyright owner(s) are credited and that the original publication in this journal is cited, in accordance with accepted academic practice. No use, distribution or reproduction is permitted which does not comply with these terms.