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# Methodological Innovation in Industry-based Journalism Research: Opportunities and Pitfalls using Psychophysiological Measures

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## ABSTRACT

Since the media industry, due to a constantly developing media landscape, demands rapid and regular innovation of empirical methods, methodological innovation become a more compelling problem in industry compared to academic journalism research. This paper exemplifies methodological innovation in industry journalism research by means of a case study: NeuroJour, an industry pilot research project focusing on brain processing of digital journalism. The NeuroJour project involved testing four different psychophysiological methods: Primarily EEG, and eye tracking supplemented by EDA and facial coding – all of which are viewed as promising, innovative approaches to studying the complex and dynamic ways in which audience effects occur. Based on NeuroJour, this paper offers insight into the opportunities and pitfalls of applying psychophysiological measures in industry research on digital journalism, but also into how methodological innovation in industry and academic journalism research can cross-fertilize.

## KEYWORDS

Methodological innovation; industry journalism research; audience research; digital journalism; cognition; emotion; psychophysiology

## Introduction

Over the past decade or more, the term “change” describes the development in both the journalism industry and in journalism studies. In journalism studies, the decade has been labelled the fifth period in the history of journalism studies “the sociotechnical period”, referring to scholars taking an interest in the intersecting social and technological dynamics of journalism’s transformations in the digital age. This is differentiated from the previous period by the speed at which everything changes (Lewis and Westlund 2015), including changes related to new technology and devices, the multiplication of online media as sources, the economic relationships surrounding the journalistic profession (Carlson et al. 2018, 11), the advent of mobile and social media platforms, societal challenges, such as the issue of trust in the media and the rise of populism (Lecheler, de Haan, and Kruike-meier 2020), and consequently a renewed necessity of understanding how audiences react to this constantly changing media landscape.

One would expect that the changes in topics studied in journalism research would also lead to methodological innovation. However, as Lecheler, de Haan, and Kruike-meier (2020) note, there is very limited discussion on methodological innovation in journalism studies, because journalism research is question-driven rather than methods-driven: “Yet, journalism research observes an industry that can today only be described as a moving target, and any approximation at understanding journalistic innovation must go hand in hand with innovation in research strategies ...” (Lecheler, de Haan, and Kruike-meier 2020, 858). Consequently, they propose that future research in journalism studies focus on multi-method studies that bring together different perspectives on the complex digital media landscapes. They argue that scholars should have the courage to innovate by experimenting with new methods, and to critically look into how they can incorporate novel methods that help better understand the field of journalism as it is increasingly fuelled with uncertainty (Lecheler, de Haan, and Kruike-meier 2020, 860–61). This is precisely what the innovation case study in this article, NeuroJour, sets out to do, since it introduces and tests new methods to study journalism and the complex and dynamic ways in which audience reactions occur.

This paper argues that the methodological innovation taking place in industry-based journalism research is mostly overlooked. Nevertheless, the fast-changing media landscape makes it imperative for the media industry to develop new methods to understand not least their audiences. The interest in audience reactions is not specific to the industry, but is also seen in academic journalism research - it has even been termed the “audience turn” in journalism studies (Costera Meijer and Groot Kormelink 2016; Swart, Peters, and Broersma 2017). However, the need to study audience reactions is key for media companies to survive in today’s highly competitive media market, and therefore the pressure on methodological innovation is high.

This paper first describes industry-based journalism research and its need for methodological innovation in general. The paper then presents a case of methodological innovation in the Danish media industry: NeuroJour, a joint project between three media companies and academic researchers intended to provide insights into the cognitive and emotional processing of digital journalism when applying psychophysiological measures. The theoretical background for using such methods are presented, and afterwards it is described how the methods were tested in practice, and how this resulted in recommendations for using such methods in industry journalism research. Finally, the paper discusses what can be learned from the case as far as cross-fertilized methodological innovation between academic and industry journalism research is concerned.

### ***Methodological Innovation in Industry Journalism Research***

Industry-based journalism research has been profoundly influenced by academic journalism research, not least its audience turn. The audience turn has advanced in active dialogue with work representing a turn to questions of emotion (Wahl-Jorgensen 2020). This turn in journalism studies is motivated by the need to find ways to establish a closer emotional connection with an audience believed to be disenfranchised, fragmented, and distrustful (Lecheler 2020). This work draws on well-established research agendas in mass communication research on audience effects, and it primarily uses experimental methods, informed by the individual-level perspectives of psychological approaches

which contrast with the sociological orientation of much work in journalism studies (Wahl-Jorgensen 2020). The complexity of the development in this disrupted field of journalism production and consumption and the intensified focus on users and emotions have consequences for the conventional, often sociological, approaches used to examine and study media effects. Since emotion is inseparable from cognition, it is important to recognize how all brain processes influence the consumption of journalism. Academic researchers across the humanities and social sciences have increasingly recognized the importance of how the brain processes information cognitively and emotionally in social and political life. In journalism studies, however, these approaches are rarely utilized, since mainstream journalism studies focus on the conscious content of communication, such as information and expressed emotions along with pragmatic dimensions of news use. This limitation has led to a call for intensified attention to “people’s experiences of journalism by focusing beyond cognitive and pragmatic dimensions of news use to include emotional, sensory, and haptic experiences” (Meijer 2020, 399). A promising avenue in this regard is the application of psychophysiological measurements, where physiological outcomes, such as skin conductance, heart rate, and facial EMG, are employed to study emotional psychological reactions to journalistic products. Psychophysiology is a branch of psychology that deals with the interaction between the mind (psyche) and body (physiology). The dependent variable (what the researcher measures) is a physiological measure, and the independent variable (what the researcher manipulates) is behavioural or mental phenomena.

The issues discussed in academic journalism research are paralleled in industry conducted journalism research, not least as far as methods are concerned. In the industry, acquisition of knowledge about journalism consumers goes hand in hand with the application of appropriate research methods. In an everchanging media landscape, empirical methods need to be in motion, and therefore industry journalism researchers are expected to develop and implement methods that suit the present-day media environment. Industry journalism researchers typically provide insights for media organization decision-makers, and these insights are used as strategical and practical tools. They deliver insights on how to improve the quality of journalism, but also for value and profit purposes: how an organization will gain value, financial foothold, or a larger share of the journalism audience. Hence, industry journalism researchers take a keen and ongoing interest in innovating up-to-date research methods. They consider methodological innovation not only necessary to investigate and understand an ever-changing media landscape, but often also consider it a welcome source of stimulation and inspiration. Following Kubitschko and Kaun (2016), methodological innovation can be considered a continuum “positioned between the notion that innovation is reserved for new research methods . . . and the idea that innovation is simply an extension of existing methodologies” (Kubitschko and Kaun 2016, 4). In industry journalism research, methodological innovation is typically an extension of existing methodologies, often merely an application of existing methods to ascertain if and how this application might create a better understanding of news consumption. Innovating methods by extending existing methodologies occurs because industry journalism researchers rarely have the time nor the finances to develop completely new research methods. In practice, this is done by developing, applying, and critically reflecting on the relevance and application of already existing research methods. Accordingly, the work of industry journalism

researchers can be regarded as one of the contributing elements in methodological innovation of journalism, albeit a rather hidden one. Both basic and applied journalism research inspire and stimulate industry-based journalism research, for instance by training graduates in modern research techniques and by disseminating theories, concepts, and research results. However, the opposite rarely happens. This is the aim of this paper: To present an example of methodological innovation in industry-based journalism research and how this pilot project can stimulate methodological innovation in academic journalism studies.

### ***NeuroJour: A Case of Methodological Innovation in Industry Journalism Research***

The pilot project NeuroJour is used as an example of methodological innovation in industry-based journalism research. The researchers involved in the project were facing a demand from decision-makers to find innovative methods to understand both conscious and subconscious cognitive and emotional processing of digital journalism. It is a challenge to capture such processes with traditional research methods and metrics frequently used in the industry, for example self-reports, can be limiting if the assessment is disruptive to the real-time task, and, more importantly, because respondents may not be accurate when judging their cognitive and emotional states (Lohani, Payne, and Strayer 2019). Besides, frequently used metrics in industry audience research departments rely on media metrics companies, and they only provide insights into a very limited part of audiences' cognitive and emotional experiences. NeuroJour was established to address such challenges, and the mission statement reads as follows:

The NeuroJour project is an innovative pilot project across research departments in the journalism industry to test psychophysiological measurements, which can potentially provide media companies and journalists with tools to improve the experience for journalism users. (Internal project report, 2020)

The NeuroJour project partners were acutely aware that providing insights into the cognitive and emotional processing of digital journalism demanded more than the typical extension of existing methodologies. Therefore, they decided to expand the methodological toolbox. Jewitt, Xambo, and Price (2017) state that methodological innovation in the social sciences can be considered a continuum of how methods move across research contexts and disciplines (Jewitt, Xambo, and Price 2017, 105). Following Jewitt, Xambo, and Price (2017), methodological innovation in the social sciences can expand, resituate, transfer or generate new methods. The expansion of methods occurs within its originating discipline; the resituating of methods occurs across contexts within its discipline; the transfer of methods occurs when a method is reformed or remixed across disciplinary borders; and the generation of new methods occurs through inter-disciplinary mixing (Jewitt, Xambo, and Price 2017, 107). The methodological innovation in NeuroJour is a transfer of methods since methods (psychophysiological measures) is reformed or remixed across disciplinary borders. The NeuroJour project is a highly relevant case of methodological innovation, demonstrating how methodological innovation was done in practice by developing, implementing, and critically reflecting

upon the relevance and application of already existing research methods, namely psychophysiological methods.

The project team consisted of seven industry-based journalism researchers from The Danish Broadcasting Corporation (DR)/DR Audience Research, TV2 Denmark/TV2 Analysis, and Jysk Fynske Medier (JFM)/JFM Research, two journalism scholars and a project leader. The three media organizations are competitors, but the partners decided to team up and collaborate. The project team decided to primarily focus on EEG (motivational engagement) and eye tracking (fixation time) to access conscious and subconscious audience effects when reading digital articles from DR, TV2 and JFM. Besides, EDA (skin conductance) and facial coding (facial expressions) were included as supplements. The methodological innovation took place in a learning-by-doing environment, where a hands-on approach to innovation, development and learning was prioritized. This meant that all the involved project partners interacted with the psychophysiological equipment from iMotions, for example by giving instructions, preparing and mounting equipment to adapt and learn, but also in order to be able to properly evaluate the applicability of the psychophysiological measures. Furthermore, after data collection was completed, all project partners participated in a workshop to analyze, discuss and interpret the data. And finally, the outcome was evaluated, specifically regarding applicability into journalism research in the industry.

NeuroJour will be presented and discussed in four steps. First, to inspire the choice of methods to be included in NeuroJour, common physiological indicators used in media and communication research is reviewed. Second, the design and method used in the NeuroJour pilot project are described. Third, a framework of opportunities and pitfalls for using psychophysiological measurements in industry journalism research is proposed. Finally, the discussion reflects on how the methodological innovation occurring in industry-based journalism research can stimulate academic journalism studies.

## **Psychophysiological Measures to Understand the Cognitive and Emotional Processing of Digital Journalism**

Cacioppo and Tassinary (1990) offer the following definition of psychophysiology and its purpose: "Psychophysiology concerns the study of cognitive, emotional, and behavioural phenomena as related to and revealed through physiological principles and events" (Cacioppo and Tassinary 1990). In psychophysiology, three domains exist: self-reports, measures and behaviour (Cacioppo, Tassinary, and Berntson (2007, 8). Self-reports involve participant introspection and self-ratings of internal psychological states or physiological sensations, for example a self-report on arousal levels. Self-reports provide an understanding of the participants' subjective experience and an understanding of their perception; however, its pitfalls include the possibility of participants misunderstanding a scale or not being able to recall events correctly. Measures of physiological responses are beneficial because they provide recorded, accurate and perceiver-independent data. The downsides are that any physical activity or motion influence responses, and that basal levels of arousal and responsiveness can vary from individual to individual. Finally, one can measure behaviour, which involves the observation and recording of actual actions. On the one hand, the benefits of using behavioural measures are that

they can record accurate and perceiver-independent data; on the other hand, the disadvantage is that one can control behaviour.

Psychophysiology relies on three main assumptions. The first assumption is that psychological activity has a physical basis in electrochemical reactions in the brain and the body and that such psychological activities therefore require physiological support (Potter and Bolls 2012). Secondly, it is assumed that these bodily reactions dynamically change over time and affect each other. Therefore, an understanding of the processes going on in the body and an apprehension of the context of the individual are highly important to understand what physiological measures actually mean psychologically (Bailey 2017, 1). Thirdly, it is assumed that the psychological responses to cognitive or emotional processes are small. This assumption limits the conclusions that can be drawn from the measures, and therefore it is key to triangulate and include other measures, such as multiple psychophysiological measures, behavioural measures and/or self-reports (Bailey 2017).

Psychophysiological measures are divided into two groups: peripheral psychophysiological measures, focusing on activity in the autonomic nervous system; and central nervous system measures, concentrating on activity in the brain and spinal cord. Peripheral psychophysiological metrics include, for example, electrodermal activity, while central measures include electroencephalography (EEG) (Bailey 2017, 1). Psychophysiological measures are typically online, covert, and continuous (Blascovich 2003, 2). The term online refers to physiological measures able to pinpoint temporal accuracy. The measure can be linked in time to the psychological process being studied, and, thereby, it provides simultaneous evidence of the process. Covert means that the physiological measure provides data that are hidden and neither observable to the participant nor the observer. Given their covert nature, physiological measures do not provide conscious feedback to participants, and the participants have no control over their responses (Blascovich 2003, 2). The term continuous refers to physiological measures providing repeated measures at high rates, and, given computer technology, physiological measures can be recorded with near-perfect reliability over time (Blascovich 2003, 2).

As a first step, in innovating the methods used to understand audience brain processes while reading digital journalism, the industry-based journalism researchers from DR, TV2 Denmark and JFM were presented with the literature reviewed above by journalism scholars, the project leader and a software supplier from iMotions. The section below briefly presents the studies which inspired decisions on methodological design in the NeuroJour project.<sup>1</sup>

### ***Eye Tracking – A Short Description and Inspirational Studies from Journalism Studies***

Eye tracking is a sensor technology that makes it possible for a computer to know where a person is looking. An eye tracker is a device for measuring eye position (point of gaze) and eye movement. Continuous monitoring of point of gaze accurately reveals where a person is looking at any given moment, and these overt eye movements help report an attention system that cannot be directly gauged (Cummins 2017).

The NeuroJour project team were especially inspired by studies of how various message elements attract attention or how individual characteristics direct attention

allocation (Bucher and Schumacher 2006) (Holsanova et al. 2006), and research which studied attention via inclusion and exclusion of lower-third crawls and headlines, the results indicating that these features reduce attention to more primary content (Josephson 2008). Furthermore, NeuroJour found inspiration for eye tracking measures in Kruike-meier, Lecheler, and Boyer (2018) investigation of how news consumption influences learning across different platforms, and in a study focusing on audience evaluations of news visualizations, where results showed that news consumers do read news visualizations, regardless of the platform on which the visual is published. Further, the results showed that visualizations are appreciated, but only if they are coherently integrated into a news story and thus fulfil a function that can be easily understood (de Haan et al. 2018). Lastly, Hassler, Maurer, and Oschatz's (2019) study on how involvement affects attention inspired NeuroJour. Their results showed that news users mostly focus on text on news websites, whereas multimedia elements (e.g., pictures or videos) are rarely used (Hassler, Maurer, and Oschatz 2019).

Based on these experiences and results from journalism studies, the NeuroJour project group decided to incorporate eye tracking (fixation time and heatmaps) in the pilot project.

### ***EEG - A Short Description and Inspirational Studies***

Electroencephalography (EEG) is a non-invasive technique that provides a direct measure of the electrical activity in the brain through placement of electrodes on the scalp. Through the analysis of event-related brain potentials (ERPs) and frequencies, EEG allows researchers to investigate physiological mechanisms underlying perception and behaviour (Read and Innis 2017).

It has not been possible to find examples of research using EEG in the field of journalism studies. However, studies from related fields, i.e., media studies, have used the frontal electroencephalographic (EEG) alpha asymmetry as an index of approach/withdrawal motivation during natural reading of a newspaper on the traditional print medium and a tablet computer. The results show that reading the print newspaper induced relatively greater left frontal cortical activation, suggesting higher approach motivation during reading on paper than on a tablet (Rajanen, Salminen, and Ravaja 2015). Another related study which inspired NeuroJour examined emotional, motivational, and evaluative responses to positively and negatively valenced online news messages about companies with a good or bad corporate reputation. The findings show that corporate reputation affects emotional and motivational processes, and that the emotional tone of messages and reader comments in online news affects reputation formation.

These results persuaded the NeuroJour project to also include EEG (motivational engagement) in the pilot project.

### ***Electrodermal Activity – A Short Description and Inspirational Studies from Journalism Studies***

EDA is a measure of the electrical activity on the surface of the skin, and it is influenced by the amount of sweat produced by an individual, which is directly associated with activation of the sympathetic nervous system (Bailey 2017, 2). EDA is a relatively



slow-moving response system, since there is a latency of the elicited SCRs and SCLs of approximately 1-4 seconds (Bailey 2017). An EDA measurement involves a recording of changes in electrical conductance of the small current between two recording electrodes. Electrical conductance across the surface of the skin changes due to the activity of eccrine sweat glands (Potter and Bolls 2012, 112).

A study on gender differences in responses to negative news from journalism studies by Soroka et al. (2016), using EDA greatly inspired NeuroJour. Measurements of skin conductance are used to examine whether there are differences in the extent to which women and men are aroused by and attentive to negative news stories. They detect no gender differences in arousal in response to negative news stories (Soroka et al. 2016). The other inspirational study was an experiment which examines the effect of tabloid and standard packaging styles on calm and arousing news stories (Grabe, Lang, and Zhao 2003). The authors investigate the combined influence of form and content on information processing and viewer evaluations of television news. Results indicate that tabloid production features enhance memory for calm news items but overburden the information processing system when applied to arousing news content. They show that formal features have an influence on the meaning viewers derive from news content, and that they rate news packaged in the tabloid format as less objective and believable than stories without these features (Grabe, Lang, and Zhao 2003).

The research from these solid research projects convinced the NeuroJour project to include EDA in the pilot project but only as a supplement, because EDA is a slow-moving response system with a latency of approximately 1-4 seconds the NeuroJour research team foresaw challenges with relating EDA to reading digital journalism, since it can be difficult to determine which written element or picture an emotional reaction belongs to.

### ***Facial Coding – A Short Description***

When a human face expresses emotion by smiling, showing disgust or crying, it informs others about an affective state. By observing and evaluating changes in a human face such as the eyebrows, eyelids, nostrils, and lips, a person can read another person's facial expressions and get a glimpse into her/his mind. Recently, automatic software solutions have been developed which makes it easy and fast to detect emotions from video recordings of human faces by measuring emotional valence e.g., the extent to which an emotion is positive or negative. The facial expressions are detected in real time using automated computer algorithms that record facial expressions via webcam (Farnsworth 2019). Even though it is commonly assumed that a person's emotional state can be inferred from his or her facial expressions, this assumption has recently been critiqued. In her book, Barrett et al. (2019) argues that how people communicate emotions varies substantially across cultures, situations, and even across people within a single situation. She continues to stress that technology companies building devices to read emotions from faces assume that certain questions about emotional expressions have been answered satisfactorily, when in fact this is not the case. Her research into the scientific evidence suggests that very little is known about how and why certain facial movements express emotion, and, therefore, it is not advisable to use such conclusions in important, real-world applications. Barrett et al. (2019) argues that a more accurate description is that

facial coding detects facial movements, not emotional expressions. So-called emotional expressions are more varied and context-dependent than originally assumed, and most of the published research was not designed to probe this variation or characterize this context dependence (Barrett et al. 2019).

In the review, it has not been possible to find journalism studies using facial coding. The hesitating strategy towards incorporating facial coding into journalism studies seems to be a wise strategy at the present time since the software companies continue to use flawed assumptions and questionable science as the basis for their algorithms. Despite this, the NeuroJour research team decided to incorporate facial coding as a supplement in the pilot project, partly because it was a standard tool in iMotion software and partly because the majority of group members were keen to test the functionality.

## **Design and Methods**

### ***Experimental Design and Measures***

The NeuroJour project team wanted to examine which digital journalistic content was more cognitively and emotionally engaging and able to catch attention. The dependent variables included focus of visual attention, emotional response (arousal), valence of emotional expression and motivational engagement. The independent variable consisted of 12 conditions that differed by type of framing (with and without solution-oriented framing) and by having or not having visuals in feature articles. Based on a discussion of needs among NeuroJour team members and possibilities within the iMotions software, the project partners decided to prioritize eye tracking and EEG, because they are valid measures which have no latency. EDA and facial coding were used as a supplement to test functionality.

### ***Eye Tracking: Fixation Time and Heatmaps***

To study which parts of the stimulus material caught the visual attention of the participants, the project group decided to concentrate on fixation time which is one of the basic output measures of visual attention. Gaze points show what the eyes are looking at. If a sequence of gaze points is very close – in time and / or space – this gaze cluster constitutes a fixation, denoting a period when the eyes are locked towards an object. The fixation time directed towards a certain part of an article relative to other parts shows that more visual attention has been directed there. Eye tracking does not reveal why this happens, but it provides a starting point for understanding which aspects of the article best capture and sustain attention. To obtain an overview, the NeuroJour research team decided to create heat maps. Heat maps is a graphical representation of the eye tracking data which uses a system of color-coding to represent different values: in descending order the red, yellow, and green colours represent the fixation length directed towards parts of the image, headline or text.

### ***EEG: Motivational Engagement***

The frequency-based analysis metric frontal asymmetry was used to access the respondent's motivational engagement to read an article. According to iMotions (Farnsworth 2019), this index of engagement and motivation typically uses beta (12–25 Hz) or

gamma (> 25 Hz) band power. Recent evidence suggest that frontal asymmetry can be used for testing respondents' engagement when confronted with for example news articles (Farnsworth 2019), and, therefore, frontal asymmetry reflects a person's momentary "approach-avoidance" tendencies to either engage or withdraw. Indirectly, this momentary engagement also reflects motivation (Farnsworth 2019).

### ***EDA: Skin Conductance Response (SCR)***

Bailey (2017, 6) explains that EDA is used to index two different kinds of psychophysiological activities. One is called tonic or skin conductance level (SCL) and is the long-term change in psychological activity. The other, which was applied in the NeuroJour pilot project, is called phasic or skin conductance response (SCR) and is a response to very specific, short-term stimuli (Bailey 2017, 6), like visual elements in digital articles, e.g., video clips and interactive elements. The electrodermal metric included corresponds to the number of SCR peaks that occurred during the recording period.

### ***Facial Coding: Emotional Valence***

The Affectiva technology in iMotion software was used to test facial coding. Affectiva's technology enables the tracking of a respondent's smirks, smiles, frowns and furrows, which supposedly measures the respondent's levels of surprise, amusement or confusion. Affectiva technology also captured participants' facial expressions and provided an automated classification of emotional valence (positive and negative). The measures for valence indicated the percentage of time an emotional expression fit the classification of positive or negative valence (Farnsworth 2019).

### ***Participants***

The total number of participants was 55 (20 female and 37 male) between the ages of 18 and 60 ( $M = 35,9$ ) from Funen and Southern Jutland. They were recruited via a convenience sample from the internet web panels of DR and JFM and supplemented with students from The University of Southern Denmark. To comply with methodological recommendations they were all, right-handed, had no damage to their eyes and none of them were epileptics (Potter and Bolls 2012).

### ***Procedure***

The pilot study was conducted during the period September 25<sup>th</sup>-30<sup>th</sup> 2019 at Jysk Fynske Medier in Odense, Denmark. The procedure consisted of five steps. First, participants were asked to complete a consent form while the equipment was mounted and GSR and eye tracking equipment was calibrated. Second, participants were given instructions, and they were asked to keep their hand movements to a minimum during the experiment to avoid generating noise in the data. To ensure data integrity, distance from the monitor and tracking quality was controlled during the entire study, and it was stressed that they should read the articles as naturally as possible, but they were allowed to skip the article or move on, even if they were not quite done reading it. Third, they were asked to perform two simple tests to calibrate the EEG, these tests having a duration of nine minutes. Fourth, participants watched a calm video to make them relax. Fifth, they

each read four articles, and the order of these was pseudo-randomized. The entire procedure had a duration of 60-75 minutes. All respondents received a gift certificate of DKK 200.

### Stimuli

The stimulus material consisted of 12 different digital articles from the three different media in an A-version (with the elements of interest) and a B-version (without), see [Table 1](#) for an overview of the stimulus material. Eight different feature articles, four with (A-versions) and four without (B-versions) visuals were tested. DR and TV2 chose long digital feature articles including visuals because these media organizations were unsure how visuals affect readers cognitively and emotionally. DR (*The creator of Counterstrike* and *Denmark's (perhaps) oldest porn film*) and TV2 Denmark (*The Danish boxer Mikkel Kessler* and *Elite soldier*). For the same reason, JFM chose digital articles with a solution-oriented framing, since their organization took a strategic turn in this direction. The articles created by JFM were on driving too fast in a small Funen town with and without solution-oriented framing, and on a local debate about whether a preservation-worthy house could be demolished.

Each participant read four articles randomized between the following: one DR article (content A) with visuals and one DR article (content B) without visuals. One TV2 article (content A) with visuals, and one TV2 article (content B) without visuals. A JFM article (content A) with solution-oriented elements, and a JFM article (content B) without (see [table 1](#)). This provided several advantages. First, by having participants read four articles each, approximately 40 participants read each version of an article, which provided an acceptable level of participants for experiments with these measures. Second, it allowed for pseudo-randomization of the 12 articles, making sure they all appeared an even number of times in different order.

### Data Collection Apparatus, Data Reduction and Analysis

A Tobii Pro X3 eye tracking system attached beneath a 27-inch monitor, with a sampling rate of 60 Hz, recorded eye movements while participants read the articles. For each participant, Shimmer3 GSR electrodes were attached to two fingers of the nondominant.

**Table 1.** Stimulus material.

	Subject	A-version	B-version
DR feature	The creator of the computer game Counterstrike	With visuals	Without visuals
DR feature	Denmark's (perhaps) oldest porn film	With visuals	Without visuals
TV2 feature	The Danish boxer, Mikkel Kessler's boxing match against a fierce competitor	With visuals	Without visuals
TV2 feature	Elite soldier	With visuals	Without visuals
JFM	Traffic speed in a village on the Danish island Funen	Solution-oriented framing	Without solution-oriented framing
JFM	Conservation-worthy houses being demolished	Solution-oriented framing	Without solution-oriented framing

According to traditional recommendations, electrodes were placed on the third phalanx of the hand's index and middle fingers (Fowles et al. 1981). Affectiva and iMotions technology captured real-time, frame-by-frame (30 fps) facial expression from a video stream, using a webcam mounted on the computer display. Behavioural engagement was measured via EEG (ABM B-Alert X24 EEG). All data was collected using the iMotions data integration platform (version 7.2). In the data reduction and analyses process, the total aggregated level of each psychophysiological measure was mapped for each article to compare the overall effect of solution-oriented framing and visuals.

### **Preliminary Results from the NeuroJour Pilot Case Study and Practical Considerations of Using Psychophysiological Methods in Industry-based Journalism Research**

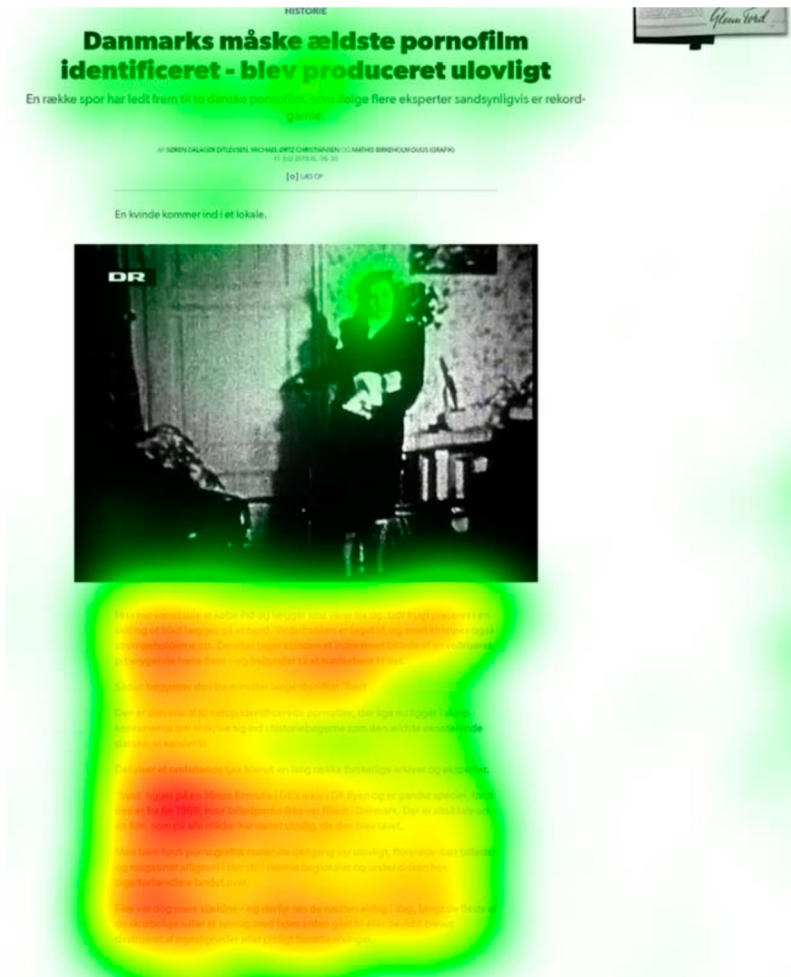
Since the focus of this paper is methodological innovation, only a few results from the case study are presented as examples. Furthermore, as NeuroJour is a pilot project all results are preliminary.

#### ***Eye Tracking: Focus for Visual Attention Represented via Heatmaps***

The NeuroJour pilot project provided an illustrative example of the advantage of using eye tracking. The test results from the DR article about Denmark's (perhaps) oldest porn film, which is an example of an A-version of a feature article including visuals, was depicted in a heatmap. The preliminary results show that there is only a slight difference between articles with and without visuals, which may be because the text in the feature articles contains a strong narrative that sustains readers' attention [Figure 1](#).

The NeuroJour research team found heatmaps very applicable in their daily practices communicating research results to journalists and decision-makers, and they were content with the comprehensive overview of how respondents behave while reading digital journalism.

In a reflection on the practical considerations, the research team concluded as a first advantage of using eye tracking that visualization tools and analysis tools are available as part of the software. Second, the video-based eye tracking equipment is becoming relatively inexpensive compared to other equipment for psychophysiological measurements. They also recognized several challenges. First, not every participant can use an eye tracker; for example, some types of spectacles and eye surgery can make it difficult to collect valid measures. Second, eye tracking must be conducted in a controlled research environment; for example, the lighting condition must be kept stable and consistent. Third, data extraction is labour-intensive, and, therefore, enough time must be allocated for this in the study design. Fourth, context is important when interpreting eye tracking data. For example, it is typical to consider attention to stimuli as a positive outcome, but it can also mean that a respondent has difficulties using an interface. Therefore, it is essential to know that eye tracking simply reveals where a person is looking, and not why a person is or is not looking at a certain element. This can lead to difficulties in data interpretation; for example, fixations do not represent attention or understanding, and they do not preclude covert rumination on elements not in the visual field or 'day-dreaming' (Cummins 2017, 1).



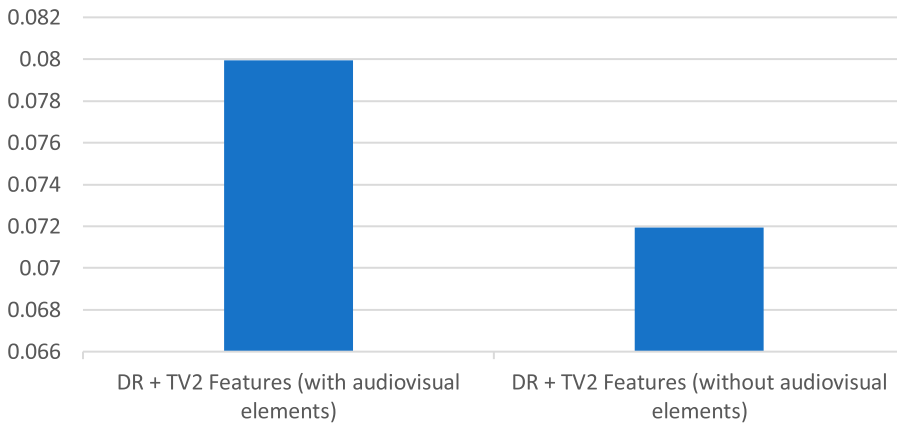
**Figure 1.** Eye tracking: heatmap.

### **EEG: Behavioural Engagement**

The feature articles from DR (*The creator of Counterstrike and Denmark's (perhaps) oldest porn film*) and TV2 Denmark (*The Danish boxer Mikkel Kessler and Elite soldier*) were used as stimulus material. Eight different feature articles, four with (A-versions) and four without (B-versions) visuals were tested using the EEG measure frontal asymmetry which is related to motivational engagement. The bar graph in [Figure 2](#) shows that the feature articles with visuals generate a higher level of motivational engagement than the feature articles without visuals.

Based on this preliminary result, the NeuroJour research team concluded that visuals in feature articles are relevant to include as means to create motivational engagement when reading longer feature articles. Since this study was a pilot study, the research team decided to explore this result in further detail in future studies. On the general level, the NeuroJour researchers found EEG (behavioural engagement) to be applicable in their daily practices and found the results interesting and useful.

## Feature articles with and without visuals (EEG, motivational engagement)



**Figure 2.** Motivational engagement (frontal asymmetry) for eight different feature articles four with visuals (A-version) and four without (B-version).

In a discussion of the practical considerations of applying EEG measurements in their daily work, the project team concluded that EEG equipment is relatively expensive, but still it is much cheaper than fMRI, if one needs insight into brain activation. Many factors need to be taken into consideration when deciding to record EEG. One is the number of electrodes to use. It is possible to use only a few, but a greater number of electrodes provides greater spatial resolution. However, this comes with the cost of additional preparation time to fit the electrodes on the scalp and with the cost of additional time spent on a large file size for the data. Also, the requirements for setting up a lab must be considered. Several steps must be taken to ensure the best possible data quality. First, sources of electrical noise should be removed, for example from monitors or other equipment (Read and Innis 2017, 16). A soundproof environment is recommended to avoid participants being distracted by noise. Likewise, participants should be seated in a comfortable, wheelless chair (to avoid fidgeting) and in a temperate room. Fidgeting may introduce muscle artefact influencing data quality negatively, and therefore the experiment must not be too long for participants to feel comfortable (Read and Innis 2017, 16). Also, long experiments may dry out gelled or saline-soaked electrodes. Consequently, experiments must be kept relatively short or be broken into blocks, and a specially designed lab needs to be allocated in the media companies. Furthermore, considerable time is needed to mount the electrodes on the scalp of the participant, sometimes 20 minutes or more, and to conduct a calibration of the equipment, often 9 minutes if it runs smoothly. Also, pre-processing of data takes a substantial amount of time to complete. All such cost factors can be challenging in industry-based journalism research.

### **EDA: Skin Conductance Response (SCR)**

When studying how web news articles effect respondents emotionally, the NeuroJour project, as expected, showed that EDA is not an easy measure to apply. The NeuroJour

researchers wanted to understand the emotional reaction to visuals and texts. However, EDA proved unsuitable, because the phasic or rapid component of the EDA signal increases its amplitude relatively slowly, with a 1-4 second delay after the emotional event occurs. This latency is problematic when respondents are asked to read digital journalism. When reading online, the respondent scrolls and jumps up and down, right and left through the article, and this nonlinear way of consuming digital journalism makes it difficult to use EDA because it is not possible to precisely determine to which written element or visual an emotional reaction belongs. However, when studying journalistic products with a linear structure, like radio news or TV news, current affairs or documentaries, EDA is more applicable because the linear structure makes it possible to determine which element in a time frame of 1-4 seconds caused an emotional reaction among respondents.

In a reflection on the practical considerations, the NeuroJour team concluded that, on the practical side, EDA is relatively inexpensive compared to other measures, for example EEG, and relatively easy to measure and quantify. However, EDA also has some practical limitations; it is key that responses to environmental stimuli are controlled, for example, changes in temperature, light, sound in the laboratory, and that the participant, as far as possible, keeps the hand being measured at rest. These aspects make it necessary to set up a lab or office space dedicated to research purposes, and this is not always possible in industry-based journalism research.

### **Facial Coding: Emotional Valence**

Figure 3 shows respondents' valence while reading the different digital news stories. All news stories generated low positive and negative valence and high levels of neutral valence. This suggests that can be difficult to detect positive and negative valence levels among respondents reading digital journalism.

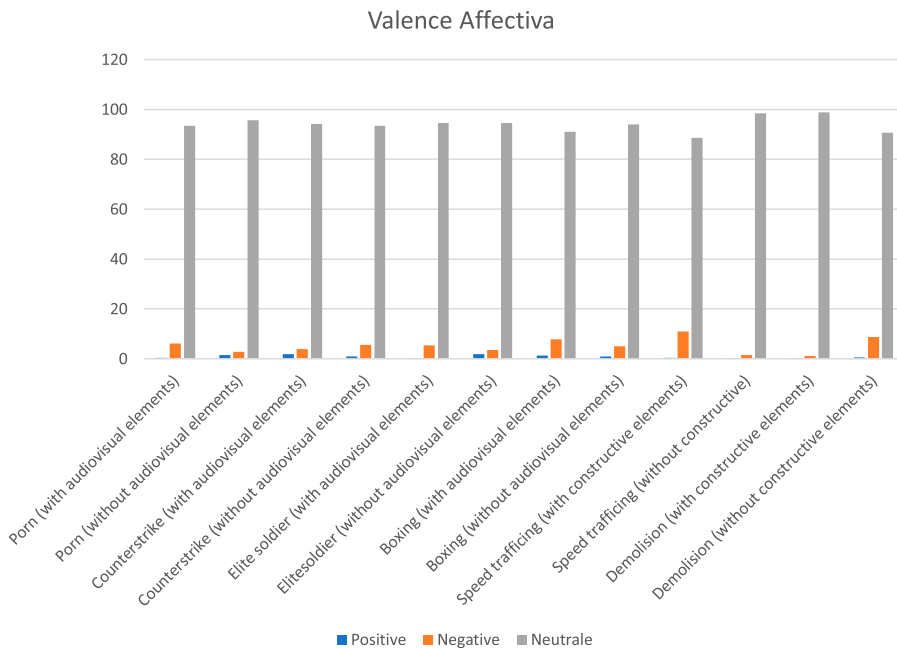
The NeuroJour team concluded that incorporating facial coding as a useful measure for testing audience reactions to written digital journalism should be done with caution due to high levels of neutral valence, and because the algorithms employed by the software companies are based on theoretically flawed assumptions and unreliable evidence.

## **Conclusion: Framework of Opportunities and Pitfalls Using Psychophysiological Measurements in Industry-based Journalism Research**

Based on the NeuroJour methodological innovation, the following section proposes a framework of opportunities and pitfalls using psychophysiological measurements of cognitive and emotional mental processes in journalism research. The framework includes reflections derived from both the literature on psychophysiological measures and from the pilot project testing different psychophysiological methods of data collection on digital journalism.

Among the opportunities, the NeuroJour research team found that the psychophysiological measures can provide more objective and precise information of respondent's emotional and cognitive processes than can traditional self-report measures or user metrics. Specifically, the mental processes measured are mostly involuntary, and therefore psychophysiological measures are not contaminated by social desirability, participants'





**Figure 3.** Facial coding: measurement of valence.

answering style or interpretation of questionnaire item wording, limits of participant memory, or, equally important, by observer bias. Moreover, psychophysiological measures can be recorded automatically and continuously in real-time without disturbing the participant's natural behaviour. Another benefit seen by the research team was the sensitivity of the psychophysiological method. The measures are sensitive enough to pick up responses smaller than the human eye can detect. Combined with other methods, such as self-reports and observational data, psychophysiological methods add significant precision to studying the effects of digital journalism. One of the Neuro-Jour team members from JFM Research puts it like this:

The general advantage of applying psychophysiological measurements in industry research on digital news usage is that they can measure what captures or does not capture the news media user, how, when and potentially why. And through that, they can help to improve media products ... It also means that they can develop knowledge and thus tools for journalists and editors in order to capture the media user.

However, there are also important downsides revealed by testing the methods in practice, first and foremost because they are time consuming and costly. The best results require controlled experiments with careful monitoring of variables, large enough sample sizes and expertise in electrical signal processing. The data acquisition devices are typically expensive, and attention and time should be given to training researchers and to device maintenance. Also, experimental preparations and procedures during testing (setting up the equipment, placing electrodes, testing the signals) take considerably more of researcher's and participants' time than when using, for instance, self-reports, and since research participants are payed to take part in industry research, this is an

important restraint. Lastly, a lack of adherence to research protocols and guidelines can seriously jeopardize meaningful use of these methodologies. The NeuroJour research team concludes:

The downside is that they [psychophysiological methods] are time consuming and more complex than traditional or digital methods, and at the same time require costly investments. We recommend starting with one or two methods in analysis departments or media organisations ... This makes it easier to use, and fixed procedures can be made for the methods, which make collection and analysis much faster so that data collection, processing, analysis and presentation can potentially be completed in, for example, a week.

In addition, the use of psychophysiological measures in an industry-based journalism research requires new skills. The tools, protocols, methods and approaches appropriate to study mental processes related to digital journalism is imported from other disciplines, and, therefore, they are not yet within the arsenal of the social science or humanities methodologies typically used in industry-based journalism research; unfortunately, they seem largely absent from the curriculum applied in training students of, for example, market research, media and journalism studies. Some NeuroJour team members state that a productive starting point to expand their department's methodological toolbox is to collaborate with professionals or scholars from neighbouring disciplines. A final, potential pitfall is that it can be tempting to claim that psychophysiological methods provide a tool for measuring the journalistic experience itself. However, it is only possible to tap into those parts of the journalistic experience that have a recognized measurable physical concomitant.

Based on the literature review and the experiences from testing different psychophysiological methods of data collection on digital journalism, the NeuroJour research team found EEG and eye tracking measures to be particularly useful because neither have a latency, and they give insight into the motivational engagement and the visual attention to different parts of digital journalism. The combination of eye tracking and EEG facilitates an understanding of both what the journalistic audience pays attention to and how they respond emotionally and cognitively. The NeuroJour pilot project also displayed disadvantages of some of the measures. The main disadvantage of EDA pertaining to studying digital journalism is the relatively slow response (a response latency of 1–4 seconds) after the stimulus has occurred (Dawson, Schell, and Filion 2007). In instances when near-real time physiological responses need to be detected, EDA is too slow. During periods of rapid attentional shifts, the latency of EDA measures becomes a problem because it is difficult to determine which element in the news article caused a peak in arousal. This is the main reason why EDA is difficult to apply when studying nonlinear journalistic content like digital journalism. Based on the experiences from NeuroJour and the literature review, facial coding should be used with caution to access subconscious effects of reading digital journalism and other journalistic products due to the questionable science on which it is based.

In [Table 2](#), the above-mentioned discussion of opportunities and pitfalls are summed up as advisable applications of eye tracking, EDA, facial coding and EEG when studying mental processes related to the consumption of digital journalism:

While eye tracking, EDA and EEG produce a significant understanding of the direct and often subconscious responses, surveys allow the understanding of the conscious side of

**Table 2.** Advisable applications of psychophysiological measures for studying digital journalism.

Psychophysiological measures	Physiological response			Relevance to answer different questions
	Attention	Valence	Arousal	
Eye tracking (fixation time)	+	–	–	Useful to investigate visual behaviour, e.g., whether an article captures attention or whether attention dwells on specific parts of an article.
EEG (motivational engagement)	+	–	+	Useful for testing participant engagement when confronted with journalistic content, since it reflects a person's momentary "approach-avoidance" tendencies to either engage or withdraw.
EDA (SCR)	+	–	+	Useful to assess the role of arousal in understanding how consumers respond to journalistic form and content.
Facial coding (facial expression)	?	?	?	Not useful at present.

audience mental processes to digital journalism. Self-reports provide an understanding of conscious liking and memories from the articles to which the participants have been exposed. As mentioned, it is generally advisable to avoid an overreliance on a single measure, using instead multiple channels to capture psychological phenomena like emotional responses to digital journalism.

As far as future methodological directions, NeuroJour highlighted two important aspects: ecological validity and methodology guidelines. Psychophysiological research has made great progress in developing methods to quantify cognitive and emotional mental processes. To be able to interpret what changes in a physiological signal may imply about the psychological phenomena being examined, most research has been conducted in cautiously controlled research environments. As far as industry-based journalism research is concerned, it is highly relevant to find ways to conduct research outside a laboratory setting to increase the ecological validity of the results because industry audience researchers logically take an interest in what people naturally encounter in real world circumstances. Furthermore, the emerging field interested in emotional responses to journalism lacks a useful and widely accepted journalism-specific theoretical background and a greater knowledge of psychophysiological methods and measures; when this is in place, methodology guidelines for studying mental processes and effects engaged during journalism consumption can be developed. This will allow for an easier and quicker research process which is highly important in the media industry. It would also allow for a tighter control of experiments and, eventually, more reliable, generalizable and useful results for the benefit of journalism users.

### **Discussion: Methodological Innovation in Industry-based Journalism Research to Stimulate Journalism Studies**

In academic research, methodological innovation usually comes at slow pace; in industry-based journalism research, methodological innovation is more common since a constantly developing media landscape demands frequent and rapid innovation of empirical methods. Therefore, the question arises of how the methodological innovation taking place in industry journalism research can stimulate and fertilize methodological innovation in academic journalism research. One rather obvious answer to this question is to strengthen the relationship between academic and industry journalism research,

allowing the methodological innovation taking place in the industry to inform and speed-up the methodological innovation in academic journalism studies. This can be done, for example, as in the NeuroJour project, by conducting joint research projects or by resource-sharing in processes of methodological innovation. Another answer is for journalism studies to have the courage not just to expand and re-situate methods, but also to transfer and generate research methods. There is a limitation in building on previous research in a field, in prioritizing the stability and connectedness of research, and working towards consensus on the understanding of a matter across a field of research. By crossing the intersection with other disciplines, transferring and generating methodological innovation, scholarly work on methodological innovation within journalism studies will become more common.

## Note

1. The studies included are scholarly and peer-reviewed articles from the journalism and communication discipline, published in English. The search term was: ["Psychophysiological responses" AND "journalism" OR "news" OR "Journalism Studies"]. The initial search yielded 22 results, all of which were subsequently screened from their title/abstract and included if they focused on EEG, EDA, eye tracking or facial coding.

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