



# The effect of visual and informational complexity of news website designs on comprehension and memorization among undergraduate students

Nidal Al Said<sup>1</sup> · Khaleel M. Al-Said<sup>2</sup>

Received: 8 September 2020 / Accepted: 12 January 2021  
© The Author(s), under exclusive licence to Springer-Verlag London Ltd., part of Springer Nature 2021

## Abstract

The importance of web designs for commercial and informational use has been a focus of research for over a decade and a half. At present, findings concerning the influence of news website designs on the perception and recall of information are rather contradictory. This study aims to identify how the basic web designs aesthetically affect users. A total of 214 students from Arab universities were shown three news sites with different designs and asked to complete two tests to determine their levels of perception and recall. The results revealed that interactive sites with multiple aesthetic elements representing the message of the news item enable users to perceive and remember the information better. The findings of this study can be useful in creating news website templates that improve user comprehension and recall.

**Keywords** Multimedia · Interactive design · News websites · Communications

## 1 Introduction

It has been nearly 20 years since the research on effective news website designs started (Esau et al. 2017). The proliferation of new technologies and changes in the way of news presentation are the driving forces behind the research trends. As technologies advance, findings displayed in the previous studies will lose their relevance and a need for an update thus will rise (Zha 2018). In recent years, attention has been drawn to the visual communication supporting the functionality of the website. Many researchers highlight the important links between web design and neurophysiology of attention and memory (Hamlyn 2017; Riaz et al. 2018).

It is impossible to unambiguously separate the structure of information from the way it is provided. Presentation adds speed to the visual perception of users and thus enables them to evaluate information over a short period of time

and decide whether it is worthy of a closer look. And this is when the two main problems arise: how can we make users read to the end of a news item or learn more about the topic discussed? How to organize the presentation of a news story to deliver it in the shortest way possible? A website design serves as a solution to these problems (Um 2017; Zha 2018). The answer to the above questions can be found by resorting to human cognitive abilities such as perception and memory.

The perception of information has a complex nature, which has not yet been fully studied. Visual website designers have been making use of many well-known patterns of human perception for a long time. These patterns have been proven effective in designing news and corporate websites (Yazid et al. 2018; Kalogeropoulos et al. 2019; Vermeer et al. 2020). Among them are *eye movement patterns* (an eye path of the person starts from the certain point in the visual field occupied by the website); *image perception patterns* (images such as human faces, hands, eyes, and people are instantly recognizable); and *color perception patterns* (certain colors elicit different physiological reactions) (Foxall 2017; Bentley et al. 2019).

Human memory has more to do with the emotional rather than intellectual experience. Individuals are more likely to memorize information for the long-term faster when it is fun (Hamlyn 2017; Bentley et al. 2019). Visual perception is also closely related to the presence of emotional markers

✉ Nidal Al Said  
nidalsaid@yahoo.com; n.alsaid@ajman.ac.ae

<sup>1</sup> College of Mass Communication, Ajman University, Ajman, United Arab Emirates

<sup>2</sup> Department of Educational Technology, Faculty of Educational Sciences, Middle East University, Amman, Jordan

and the strength of emotional experience. This is why mnemonic techniques used to facilitate the retention of information mostly involve developing an ability to voluntarily activate emotional perception mechanisms (Hamlyn 2017; Bentley et al. 2019).

The news resources on the web have evolved from simple news feeds and short messages to designs that are more complex, interactive, and user-driven. Thus, the news website architectures can be distinguished by the level of content (this refers to the number of multimedia elements in the layout) and by the level of interactivity. Studies attempting to suggest the most effective web designs for the news portals recognize that indicators such as user acquisition, monetization, the number of visits to purchase, and other metrics featured by the commercial websites cannot be a measure of success of the website design (Park 2020). Factors that shape visitor perception of the news website have been extensively investigated (Conlin and Roberts 2016; Um 2017; Vermeer et al. 2020).

The contradictory results from these studies are reviewed in the following chapter. There is no holistic evaluation of the success of different news website designs in conveying information to users. This research is devoted to the problem of the influence of the design, and not the content of news sites on the perception and memorization of information by users. The processes of perception and memorization, as described below, directly affect the credibility of the news site and the return of the user to this site. The novelty of the presented research lies in the study of artificial approaches to determining the effectiveness of site design by measuring the perceptual effect on the user through the mechanisms of perception and memorization. This study aims to close this gap regarding especially the design of news sites (while commercial and information sites are much better researched) in terms of the impact of visual and informational complexity of design on the quality of perception and memorization of the user. The objective of the study is to compare and establish the level of influence of different types of news site designs on the perception of content and the retention of users accordingly to the level of visual and informational complexity.

## 1.1 Literature review

A descriptive review of the research literature on the topic under consideration included works from 2015 to 2020, which were selected using a cross-selection method for a number of simultaneously assessed factors. These are works with the highest priority of selection on Google Scholar for the search terms “news website design” and “website designs understanding.” Besides, the work had to include the most recent research data not repeated in other, newer studies, or propose new methods and forms of research, or

discover new factors in design research, factors of perception of site design, memorization and behavioral choice of users. We also selected non-specialized works (by countries, markets, topics, etc.), and the most generalized in content, concerning the entire Internet and all users in general.

The most important finding of the web design research is that presentation directly affects the storytelling. The structure of the content and the number of visual elements on the page change the way visitors perceive and interpret news. That is, a straight text can lead to greater disorientation than an architecture with a visual component (Aranyi and Van Schaik 2016). The visual and interactive aesthetics of the website can create an image of a news organization behind the site and capture the attention of a target audience. These functions of aesthetic elements emphasize the importance of the news website design (Platt 2016; Van Damme et al. 2020).

In most studies of the last ten years, multimedia is understood as a representation of information in various forms such as still and moving images, streaming video, background sound records, text, and more (Aribarg and Schwartz 2020). The concept of interactivity is much more complex and deep. Researchers have been arguing about the essence of interactivity for a long time. It was described both as a style of control over the content of interaction and as an ability to influence the way this content is presented. According to these definitions, there are two ways to organize the news website navigation: designers may choose either a click-through (nonlinear) or scroll-through (linear) navigation structure. Ultimately, interactivity is all about creating an interactive experience (McIntyre and Gyldensted 2018).

The focus of comparative research on website designs has long been on linear and nonlinear formats and their impact on user behavior and visitor perception of the website (Sjöblom et al. 2017; Vermeer et al. 2020). The linear web design allows visitors to digest or find necessary information by scrolling through all the web page content without additional interaction. The nonlinear web design is based on the use of multiple interactive or responsive elements that allow visitors to move to a different section of the website or through the page content quickly without scrolling (Sjöblom et al. 2017). From 1998 onwards, scholars engaged in comparative research on website designs received completely different results. Earlier works agree that the linear format of content presentation objectively improves the ability of users to memorize information. It was also established that greater interactivity or engagement (how many opportunities a user has to control information or interact with the site) results in better perception of advertising on the webpage (Aribarg and Schwartz 2020). The increased levels of interactivity on the eLearning websites, however, were found to have a negative effect on learning success. In the early 2000s, this finding was refuted. More and more studies indicate that

high interactivity on the website enhances the learning process, whereas the increased volume of multimedia content improves academic achievements and leads to better perception of the website (Narikbaeva and Savenkov 2016; Bentley et al. 2019; Tsalikova and Pakhotina 2019; Muravyeva et al. 2019). Several researchers associate the above change in the effects of interactivity with the arrival of digital natives, the first generation of people who grew up immersed in a digital environment (Vermeer et al. 2020). Yet, this issue is not fully understood.

Visual complexity is of great importance for assessing the perception of design and its content. King et al. (2020) investigated the effect of visual complexity on a user's first impression, which determines the subsequent reaction to the site and determines the chances of the user returning. Researchers have identified two forms of visual complexity: feature and design complexity. Both types of complexity equally affect the factors of primary perception and further user behavior. Baughan et al. (2020) investigated user preferences regarding the most comfortable level of website complexity for them. It was found that the complexity of the site negatively affects the efficiency of searching and memorizing information. At the same time, user preferences and their initial settings before viewing the site strongly affected performance: those who preferred simple sites did not search and remember well on visually complex sites.

Various methods were used to measure the perception and level of memorization of the information presented on the site as well as to assess the complexity of the design. Baughan et al. (2020), King et al. (2020), and McIntyre et al. (2016) used the Likert scale to subjectively assess the attractiveness of a site by users in terms of ease of perception. These researchers thus received an estimate of visual complexity: more complex sites are less attractive. An objective assessment of memorizing information from the site was obtained using a survey about the content of the displayed material. In this study, we adhered to the same methodology, but the method of McIntyre et al. (2016) changed to use binary questions (Yes/No) with content assessment, which also allowed obtaining an objective assessment of the quality and speed of perception of the content offered by the site.

There are studies devoted to the construction of webpage layouts with the user behavior in mind. Such studies mostly focus on corporate and commercial (selling and advertising) sites. The news websites, however, have a slightly different set of functions, and their success cannot be measured by the same criteria as that of commercial sites (Aranyi and Van Schaik 2016; Park et al. 2020). Nevertheless, multiple attempts to build a sound and engaging website revealed the most important aspect of interaction with the site architecture that is common in commercial and news formats. It is the user experience design. The components of user experience include the perception of instrumental and

non-instrumental qualities of the website and emotional responses. The website elements such as the navigation system should facilitate the enjoyment of visitors from interacting with the site (McIntyre et al. 2016). For this, a variety of user control solutions and content presentation design patterns are applied.

Forerunners of artificial intelligence benefiting from neural networks and machine learning are increasingly being used to fill information sites' content. Such services are most often offered by companies with the most powerful artificial intelligence and their own search platforms, on the basis of which machine learning takes place (Google, Microsoft, Intel, and others) (Amershi et al. 2019). In this case, the content of sites is formed according to the context of the links of thematic words that the user has entered. The design of sites that use AI computing is usually highly intelligent with ample opportunities for user intervention in the formation of the page content, but with an abundance of contextual advertising (Cybenko and Cybenko 2018; Yang 2020).

Any news source is dependent upon user trust. Hence, the challenge of web design is considered in the context of fake news and manipulative tactics that direct readers towards a concrete message. In spite of the fact that most researchers dealing with misinformation focus on the semantic characteristics of fake messages (Geeng et al. 2020; Vermeer et al. 2020), there are individuals pointing out a connection between how misinformation is structured and what impact it has on the reader (Martin 2020). Furthermore, it is possible to generate a believable story using the functionality of the site and then distribute misinformation via trusted channels in order to shape a false belief among citizens (Martin 2020). This once again shows why analyzing the impact of web design on how readers perceive and remember information is so important.

The effect of different types of design of news sites accordingly to their visual and information complexity on the mechanisms of perception and memorization of users is insufficiently studied yet. Corporate and commercial sites attract more attention of researchers. As the null hypothesis of the study, the belief is accepted that the change in the information capacity and visual complexity of web design of a news site while saving the content does not in any way affect the quality of perception or memorization of information by users.

## 2 Methods and materials

The study involved 214 students aged 18–22 who attended Arab universities in the Saudi Arabia and Jordan. All participants were recruited from the cohort of first- to third-year students via Facebook and through advertisements on the University's website. Participants identified themselves

using social accounts, and then teachers confirmed their student statuses. Afterward, all participants were given unique identifiers to conceal their identity during surveying. All participants gave prior consent and indicated their interest in participating in the study. After confirming their student status and obtaining a unique identifier, all personal data related to the identifier of the participants were destroyed and were not stored or used. The identifiers were randomly bound by the machine algorithm and excluded the researchers' awareness of the person codified. Thus, the authors were confident in the proper demographics of the sample, and the participants were guaranteed confidentiality. In order to generalize the sample and ensure that the perception of web design is independent of specific professional experience, the surveyed students were not selected according to the principles of specialty or field of study. Thus, they represent a large selection of faculties and specialties in all areas. The research was carried out for one month (from the proposal to be enrolled to the analysis of survey results). The study was conducted in May 2019 without regard to gender, age, and other social characteristics. The survey was performed online to ensure that students would demonstrate natural reactions to the proposed news items. All completed questionnaires were adequate and thus accepted for further processing.

The research was carried out by the authors of the article directly without the participation of students. Students acted only as survey participants and did not participate in the preparation of research materials or in their subsequent processing. All materials necessary for research, including the sites that were offered for evaluation to the participants during the survey, were created by the authors and their associates. The websites were developed utilizing free online site creation services. During the study, no third-party funds were used, and the study was not paid for and did not entail any financial obligations.

Hereinafter, in order to facilitate understanding, the term "comprehension" is used in the meaning of the ability to recognize a visual image, identify it and recognize it again if it is repeated (Porion et al. 2016). The term "memorization" refers to the ability to re-identify and reproduce previously obtained information (Porion et al. 2016). The term "perception" refers to a complex of neurophysiological activity that allows one to receive and recognize information (Loschky et al. 2020). The proposed meaning of these terms is based on the results and ideas of these sources but is presented in the interpretation of the authors in accordance with the study objectives.

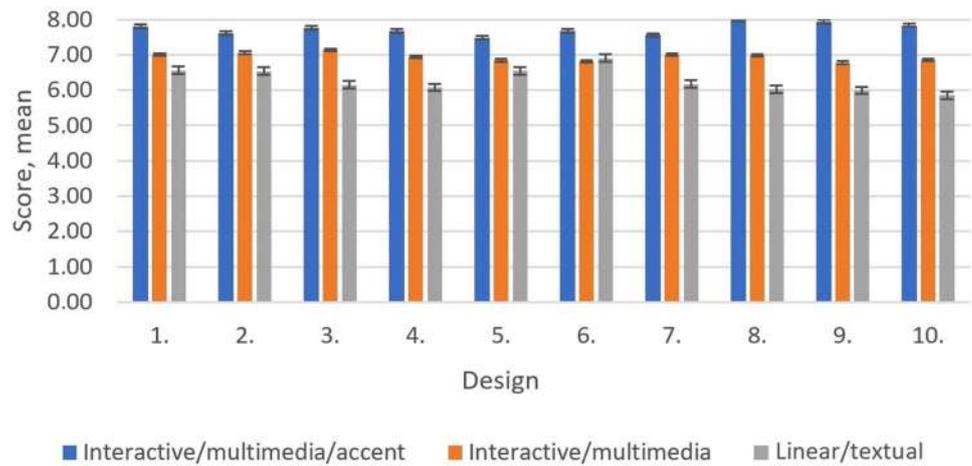
There were three survey questionnaires split into two sections. Each survey was devoted to a single website design, whereas each section represented a group of questions about the content of the news item on a particular site (see Appendix). The surveying process was as follows. Participants

were asked to examine three different website designs for 15 min. Each design was specially created for the purpose of the experiment and demonstrated separately. Afterward, participants were given an electronic survey form to complete. The study was carried out according to the methodology proposed by McIntyre et al. (2016), and the modified approach of Kalyanaraman and Sundar (2006). The slight transformation was done to move away from the subjectivity of site assessment for a number of statements on the Likert scale in the described methods. The respondents were presented with questions related to the content of the site they just viewed, and this allowed them to objectively identify the quality of perception and memorization and not rely on subjective design assessment. The **first section** of the survey measured content perception and comprehension. The subjects were asked ten single-choice questions about topics that were logically or contextually related to materials presented earlier but not directly highlighted in the presentations. For example, for the page shown in Fig. 3 in the Appendix, among others, the following questions were asked: "Is the main article of the page dedicated to street music?" (Yes/No); "Have you seen more than three people in a photo on a website page?" (Yes/No); "Are the theme of music and the theme of vehicles on the site page somehow related?" (Yes/No). For each page presented to the participants, the set of such questions was unique in accordance with the content and design. Each correct answer was worth 1 point. The **second section** evaluated knowledge retention. Likewise, participants were given ten single-choice questions about the content of presentations. Each correct answer was worth 1 point. For example (for the case in Fig. 3): "Are there other examples of street drummers in Las Vegas suggested in the article?" (Yes/No); "Was the latest Ford motorcycle model presented in one of the articles?" (Yes/No); "Did the articles cover areas of New York other than Brooklyn? (Yes/No)". In the statistical analysis of the results, the average scores were calculated cumulatively for the entire sample for every ten responses for each page of the site shown. These average estimates are plotted along the y-axis in Figs. 1 and 2.

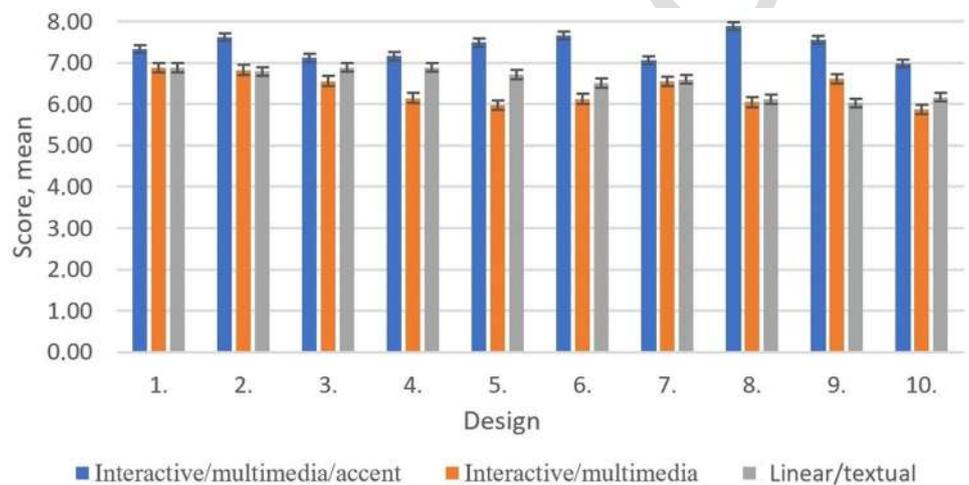
Subsequently, the overall score for each question was calculated by adding up the scores obtained by all participants and dividing the total by the number of scores. This approach was chosen to compare the results of evaluation and assess the validity of surveys. If questions in the test are well selected, then the standard deviation should not be high. Otherwise will indicate that questions in the survey do not truly measure the levels of perception and recall.

Participants were shown three website designs. The **first design** sample employed multiple aesthetic elements such as images, embedded videos, eye-catching headers that act as support for the text. Images were consistent with the text and the heading. It also contained a significant number of user controls. The **second site** structure was similar to that

**Fig. 1** Mean scores on the comprehension/perception test



**Fig. 2** Mean scores on the recall test



of the first option but had aesthetic elements that were not necessarily associated with the adjacent information. The **third website** had a linear framework, and its content was predominantly textual. All sites showed neutral news about the events that could attract student attention. This was done to ensure that all participants are involved with the content presentation and are motivated enough to view and evaluate the information.

### 3 Results

Figure 1 depicts a narrow distribution range of mean scores for each question. Better scores on content perception relate to multimedia-rich interactive designs with consistent textual and nontextual elements. The lowest scores were obtained for questions associated with the linearly organized textual content. This pattern applies to all questions in the section, and the results are statistically significant with a  $p$ -value of 0.02.

The standard deviations for multimedia-rich interactive designs with visuals that either support or do not support the text are 0.1642 and 0.1171, respectively. By contrast, the standard deviation of responses with respect to linear textual format is almost twice as high and equals 0.3346. This is due to a greater distribution of scores. Apparently, participants had some troubles with perceiving the content of linear websites. This phenomenon requires further investigation. Resorting to previous studies (Aranyi and Van Schaik 2016; Bentley et al. 2019), it can be assumed that this case involves a cumulative action of several factors such as the ability of digital natives to grasp information quickly (this is hard when information is presented in a linear manner) and time necessary to understand an exclusively textual message (readers comprehend the news item faster if it contains pictures).

The research results are presented in Tables 1 and 2 with their paired graphical representations in Figs. 1 and 2, respectively.

**Table 1** Mean scores on the comprehension/perception test

	Interactive/ multimedia/ accent	Interactive/multimedia	Linear/textual
1	7.81	7.01	6.56
2	7.62	7.06	6.54
3	7.77	7.14	6.15
4	7.68	6.94	6.08
5	7.49	6.85	6.55
6	7.67	6.81	6.91
7	7.56	7.01	6.17
8	8.01	6.99	6.03
9	7.93	6.78	5.99
10	7.84	6.86	5.86
Standard devia- tion	0.164167936	0.117118174	0.334604244

**Table 2** Mean scores on the recall test

	Interactive/ multimedia/ accent	Interactive/multimedia	Linear/textual
1	7.33	6.88	6.88
2	7.62	6.83	6.79
3	7.12	6.56	6.89
4	7.16	6.15	6.89
5	7.49	5.98	6.72
6	7.67	6.13	6.51
7	7.06	6.55	6.6
8	7.89	6.05	6.12
9	7.56	6.62	6.03
10	6.99	5.87	6.17
Standard devia- tion	0.301568124	0.367054341	0.338197838

Figure 2 shows the results from the recall test, which are somewhat distinct from those of the first test. As in the previous case, results obtained for different design options are statistically relevant ( $p$ -value = 0.03), yet there are very similar responses to questions 1, 2, 8 and 10 covering the accent-free and linear structures. At the same time, the best scores on recalling apply to an interactive design that has meaningful imagery. These results are consistent with other research (McIntyre et al. 2016; Yazid et al. 2018). However, the previous studies did not compare the results of remembering linear and visually accented artifacts. The present research shows that a well-thought-out web page design that enables the most convenient and effective news communication is a better choice than minimalist architectures using linear systems for data presentation.

What is important is that standard deviations obtained with respect to different design options are almost twice as high as those in the assessment of perception. Standard deviation associated with context-adding visuals is 0.3116, with non-related visuals – 0.367, and with linear frameworks – 0.338 2. These results indicate that although the first website format retains the position of advantage over the other two solutions, the second and third designs can be considered equally adequate to improve one's ability to recall information. The influence of website aesthetics stems from short-term and long-term memory mechanisms, which can only be evaluated in laboratory conditions. In the future, it seems necessary to conduct a more detailed study of factors underlying the potential of different website designs to help visitors better remember information that they have read.

For both types of tests, the results of which are shown in Figs. 1 and 2, the differences between the Integrative/media-rich/properly aesthetic design type and two other types in each individual set of results obtained exceed  $p = 0.05$ . Therefore, the null hypothesis of the study must be rejected especially for the Integrative/media-rich/properly aesthetic design type. Towards Interactive/media-rich design and Linear/textual design null hypothesis may be justified.

This research has several limitations. The study focused on a narrow group of people having similarities in age, social status, and education. All participants had high digital literacy levels. Most students belonged to the digital native generation. Hence, there is a need for the validation of results on a broader social group. Furthermore, the study examines the overall impact of the website design and bypasses the influence of its individual components. The work provides no information about the differences between physiological responses of participants and about the characteristics of short-term and long-term memory. These issues should become a subject of future study.

## 4 Discussion

The research on perception is mostly carried out in a laboratory setting. Some studies involve the analysis of surveyed feedback regarding the shown content (Foxall 2017; Amer-shi et al. 2019), and other studies use a machine to examine the work of the nervous system (Hamlyn 2017). Stroud and Van Duyn (2020) have proved that browsing behavior in a specially equipped laboratory environment was consistent with that in real-life conditions. This suggests that the present experiment, which is carried out online, is rather valid.

The results of the research on user perception of news sites indicate that visual adaptation is essential for predicting the level of user satisfaction with the website. Here we mean by visual adaptation the transformation of the site design towards a greater ability of the user to control the

content of the page and facilitate its perception through an increase in the number of graphic elements and the use of special techniques for their placement in the visual field. Adaptation to the aesthetics of the news source affects the impression of the site in the second interaction. Furthermore, satisfaction as it relates to website design also stems from the trust in the news source, which is based on the initial experience of the user (Aranyi and Van Schaik 2016; Jiang et al. 2016). This concludes that features of web design that facilitate the adaptation process keep visitors coming back to the website. More returns lead to higher website credibility. Adaptation is associated with the sense of control and navigation freedom, which corresponds to the level of interactivity. According to the present research, higher interactivity enhances the perception and retention of information.

Several researchers oppose the pragmatic and hedonic approaches to the structure and the content of the site (Sjöblom et al. 2017). As they have shown with their surveys, the most trusted sources bring a greater sense of enjoyment to users. As a result, scholars expressed an opinion that trust is a harbinger and a precursor of a positive impression of the website structure and content (Conlin and Roberts 2016; Aribarg and Schwartz 2020). Note that there are relatively few works to be found about the content of the news websites and their structure, which complicates the overview.

Visual complexity has a strong impact on the subjective perception of the news site. Researchers distinguish between two types of visual complexity: design complexity and feature complexity (Baughan et al. 2020; King et al. 2020). Both types affect the perceptions of visual informativeness and attractiveness, initial impressions, and behavioral intentions of the users. According to the results of the present research, the more visuals and multimedia elements on the site, the higher visual complexity, the greater interactivity. This conclusion is consistent with other works on visual design (Riaz et al. 2018; Baughan et al. 2020; King et al. 2020).

Association between the web interface design and the retention of information is an important research direction. Scholars repeatedly emphasize the predominant role of emotions in long-term memory (Hamlyn 2017; Amershi et al. 2019; Bentley et al. 2019). An emotional connection to the source or topic encourages visitors to return to the source or topic that created a positive emotional experience (Aranyi and Van Schaik 2016; Lam et al. 2020). The format of the site indirectly affects the decision visitors make about continuing to use the site. This indicates that the content delivery expectations underpin the attitude towards the news source. By improving the visual complexity of the site and user engagement, designers help the website owners to predict user behavior. Visitors who see a rich graphics design expect to find a broad spectrum of information, whereas

a high level of interactivity provides users with a greater degree of freedom.

The dark side of visual complexity is that it allows improving the perceived quality of information without enhancing the actual quality of news items (Chyrun et al. 2019; Martin 2020). This feature makes interactive websites with bright and rich designs more vulnerable to the spread of fake news. The attractiveness and the user retention rate of news sources have nothing to do with the quality of posts. Furthermore, sites can use these metrics to manipulate the attention of potential users (Liu and Song 2018; Geeng et al. 2020). This topic is beyond the scope of this research but is worthy of a closer look as one of the most relevant and socially significant issues.

## 5 Conclusion

The work aimed to identify the impact of different news website designs on how well readers understand and remember the content of the news message. The results apply to digital natives and university students. In the future, the study should include other social groups. It was revealed that multimedia-rich interactive sites that mix text with imagery are the best choice if agencies owning a news website wish to improve the reading comprehension of users.

Comparing all studied designs, the best one scored in the range from 7.49 to 8.01 on a ten-point scale, wherein the other two design options scored in the range from 6.85 to 7.14 and from 5.86 to 6.91, respectively. The worst results on the comprehension test were demonstrated by a site with a linear architecture that had no images to support the text. On the recall test, however, the linear format scored similarly to the interactive site with non-related pictures (6.03 to 6.89 vs. 5.87 to 6.88). Thus, the use of multimedia and high interactivity represent a key to better remembering (estimates in the range of 6.99–7.89). The results of the study can be useful practically in creating news website templates that improve user comprehension and recall.

## Appendix

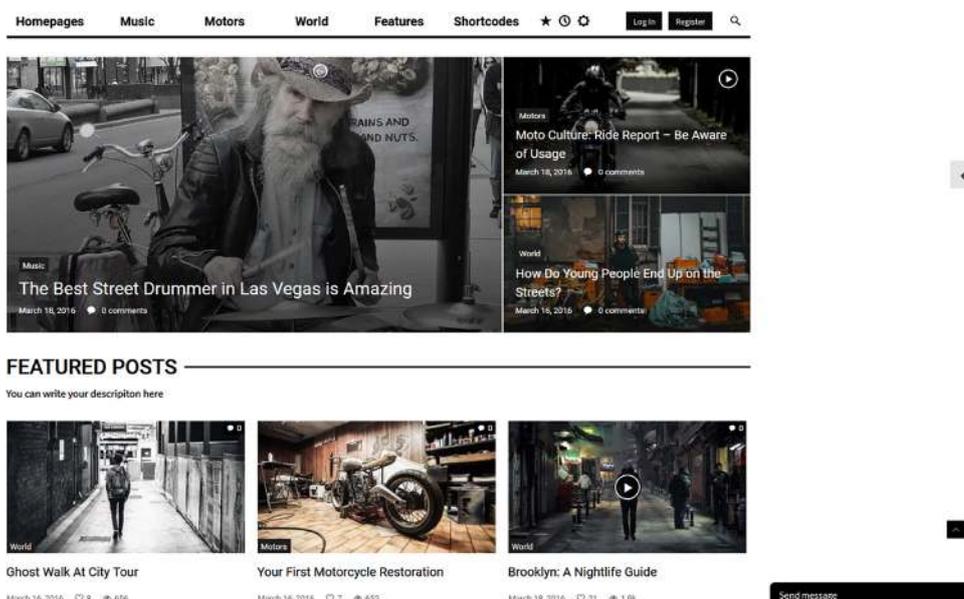
See Fig. 3

Examples of survey questions

The **first section** of the survey:

1. “Is the main article of the page dedicated to street music?” (Yes/No)
2. “Have you seen more than three people in a photo on a website page?” (Yes/No)
3. “Are the theme of music and the theme of vehicles on the site page somehow related?” (Yes/No).

**Fig. 3** Example of site design for the tests



The **second section** of the survey:

1. “Are there other examples of street drummers in Las Vegas suggested in the article?” (Yes/No)
2. “Was the latest Ford motorcycle model presented in one of the articles?” (Yes/No)
3. “Did the articles cover areas of New York other than Brooklyn? (Yes/No)”.

**Funding** This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

**Data availability** Data will be available on request.

## Declarations

**Conflict of interest** Authors declare that they have no conflict of interests.

## References

- Amershi S, Weld D, Vorvoreanu M, Fournery A, Nushi B, Collisson P, Suh J, Iqbal S, Bennett PN, Inkpen K, Teevan J, Kikin-Gil R, Horvitz E (2019) Guidelines for human-AI interaction. In: proceedings of the 2019 Chi conference on human factors in computing systems. Association for computing machinery, New York, pp 1–13. <https://doi.org/10.1145/3290605.3300233>
- Aranyi G, Van Schaik P (2016) Testing a model of user-experience with news websites. *J Assoc Inf Sci Tech* 67(7):1555–1575. <https://doi.org/10.1002/asi.23462>
- Aribarg A, Schwartz EM (2020) Native advertising in online news: trade-offs among clicks, brand recognition, and

website trustworthiness. *J Mark Res* 57(1):20–34. <https://doi.org/10.1177/0022243719879711>

- Baughan A, August T, Yamashita N, Reinecke K (2020) Keep it simple: how visual complexity and preferences impact search efficiency on websites. In: proceedings of the 2020 CHI conference on human factors in computing systems. Association for computing machinery, New York, pp 1–10. <https://doi.org/10.1145/3313831.3376849>
- Bentley F, Quehl K, Wirfs-Brock J, Bica M (2019) Understanding online news behaviors. In: proceedings of the 2019 CHI conference on human factors in computing systems. Association for computing machinery, New York, pp 1–11. <https://doi.org/10.1145/3290605.3300820>
- Chyrun L, Gozhlyj A, Yevseyeva I, Dosyn D, Tyhonov V, Zakharchuk M (2019) Web content monitoring system development. COLINS. Kharkiv Polytechnic Institute, Kharkiv, pp 126–142
- Conlin L, Roberts C (2016) Presence of online reader comments lowers news site credibility. *Newsp Res J* 37(4):365–376. <https://doi.org/10.1177/0739532916677056>
- Cybenko AK, Cybenko G (2018) AI and fake news. *IEEE Intell Syst* 33(5):1–5. <https://doi.org/10.1109/MIS.2018.2877280>
- Esau K, Friess D, Eilders C (2017) Design matters! an empirical analysis of online deliberation on different news platforms. *Policy Internet* 9(3):321–342. <https://doi.org/10.1002/poi.154>
- Foxall G (2017) Context and cognition in consumer psychology: how perception and emotion guide action. Routledge, London
- Geeng C, Yee S, Roesner F (2020) Fake news on Facebook and Twitter: investigating how people (do not) investigate. In: proceedings of the 2020 CHI conference on human factors in computing systems. Association for computing machinery, New York, pp 1–14. <https://doi.org/10.1145/3313831.3376784>
- Hamlyn DW (2017) The psychology of perception: a philosophical examination of Gestalt theory and derivative theories of perception, vol 13. Routledge, London
- Jiang Z, Wang W, Tan BC, Yu J (2016) The determinants and impacts of aesthetics in users’ first interaction with websites. *J Manag Inf Syst* 33(1):229–259. <https://doi.org/10.1080/0742122.2016.1172443>
- Kalogeropoulous A, Fletcher R, Nielsen RK (2019) News brand attribution in distributed environments: do people know where

- they get their news? *New Media Soc* 21(3):583–601. <https://doi.org/10.1177/1461444818801313>
- Kalyanaraman S, Sundar SS (2006) The psychological appeal of personalized content in web portals: does customization affect attitudes and behavior? *J Commun* 56:110–132. <https://doi.org/10.1111/j.1460-2466.2006.00006.x>
- King AJ, Lazard AJ, White SR (2020) The influence of visual complexity on initial user impressions: testing the persuasive model of web design. *Behav Inform Technol* 39(5):497–510. <https://doi.org/10.1080/0144929X.2019.1602167>
- Lam KL, Chan CS, Peters M (2020) Understanding technological contributions to accessible tourism from the perspective of destination design for visually impaired visitors in Hong Kong. *J Dest Mark Manage* 17:100434. <https://doi.org/10.1016/j.jdmm.2020.100434>
- Liu C, Song X (2018) How do information source selection strategies influence users' learning outcomes'. In: proceedings of the 2018 conference on human information interaction and retrieval. Association for computing machinery, New York, pp 257–260. <https://doi.org/10.1145/3176349.3176876>
- Loschky LC, Larson AM, Smith TJ, Magliano JP (2020) The scene perception and event comprehension theory (SPECT) applied to visual narratives. *Topics Cogn Sci* 12(1):311–351. <https://doi.org/10.1111/tops.12455>
- Martin D (2020) Third spaces, sequencing, and intertextuality:(de) constructing misinformation and fake news. In: platforms, protests, and the challenge of networked democracy. Palgrave Macmillan, London, pp 135–156. [https://doi.org/10.1007/978-3-030-36525-7\\_8](https://doi.org/10.1007/978-3-030-36525-7_8)
- McIntyre K, Gyldensted C (2018) Constructive journalism: an introduction and practical guide for applying positive psychology techniques to news production. *J Media Innov* 4(2):20–34. <https://doi.org/10.5617/jomi.v4i2.2403>
- McIntyre K, Barnes SR, Ruel L (2016) The effects of online news package structure on attitude, attention, and comprehension. *Electronic News* 10(3):178–193. <https://doi.org/10.1177/1931243116656718>
- Muravyeva AA, Oleynikova ON, Aksenova NM, Dorozhkin EM (2019) National qualifications system in Russia-an epistemological perspective. *Educ Sci J* 21(4):92–114. <https://doi.org/10.17853/1994-5639-2019-4-92-114>
- Narikbaeva LM, Savenkov AI (2016) Pedagogical system of students vocational ability development. *Int J Environ Sci Educ* 11(9):3013–3024
- Park I, Shim H, Kim J, Lee C, Lee D (2020) The effects of popularity metrics in news comments on the formation of public opinion: evidence from an internet portal site. *Soc Sci J* 1:1–16. <https://doi.org/10.1080/03623319.2020.1768485>
- Platt D (2016) *The joy of UX: user experience and interactive design for developers*. Addison-Wesley Professional, Boston
- Porion A, Aparicio X, Megalakaki O, Robert A, Baccino T (2016) The impact of paper-based versus computerized presentation on text comprehension and memorization. *Comput Hum Behav* 54:569–576. <https://doi.org/10.1016/j.chb.2015.08.002>
- Riaz A, Gregor S, Dewan S, Xu Q (2018) The interplay between emotion, cognition and information recall from websites with relevant and irrelevant images: a neuro-IS study. *Decis Support Syst* 111:113–123. <https://doi.org/10.1016/j.dss.2018.05.004>
- Sjöblom M, Törhönen M, Hamari J, Macey J (2017) Content structure is king: an empirical study on gratifications, game genres and content type on twitch. *Comput Hum Behav* 73:161–171. <https://doi.org/10.1016/j.chb.2017.03.036>
- Stroud NJ, Van Duyn E (2020) Assessing the external validity of using news websites as experimental stimuli. *Commun Methods Meas* 1:1–7. <https://doi.org/10.1080/19312458.2020.1718630>
- Tsalikova IK, Pakhotina SV (2019) Scientific research on the issue of soft skills development (Review of the data in international databases of scopus, web of science). *Educ Sci J* 21(8):187–207. <https://doi.org/10.17853/1994-5639-2019-7-187-207>
- Um NH (2017) The effects of social presence, contextual congruence and source credibility in evaluation of online advertising on news websites. *Int J Internet Mark Advert* 11(1):64–82. <https://doi.org/10.1504/IJIMA.2017.082999>
- Van Damme K, Martens M, Van Leuven S, Vanden Abeele M, De Marez L (2020) Mapping the mobile DNA of news. Understanding incidental and serendipitous mobile news consumption. *Digit J* 8(1):49–68. <https://doi.org/10.1080/21670811.2019.1655461>
- Vermeer S, Trilling D, Kruikemeier S, de Vreese C (2020) Online news user journeys: the role of social media, news websites, and topics. *Digit J* 1:1–28. <https://doi.org/10.1080/21670811.2020.1767509>
- Yang W (2020) Ux design of artificial intelligence news robot. *MSE* 740(1):012135. <https://doi.org/10.1088/1757-899X/740/1/012135>
- Yazid MA, Jantan AH, Abd Ghani AA, Kamaruddin A, Admodisastro N (2018) Accessibility design issues with Malaysian news websites: a case study using a checker and WAVE. *Int J Eng Technol* 7(4):69–73
- Zha Y (2018) *Making the voice: exploring design professionalism in visual information structure of news websites*. University of Lapland, Rovaniemi

**Publisher's Note** Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.