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What You See Is What You Know: The Influence of Involvement and Eye Movement on Online Users' Knowledge Acquisition

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News websites have become a major source of information for citizens in Western countries. Although much research has focused on how Internet use affects knowledge acquisition, little is known about how individual websites are used and how that is connected to knowledge gain. This study focuses on how involvement affects attention and how recipients learn from individual website use, integrating theoretical perspectives of multimedia learning theory and the cognitive mediation model. To test our assumption, an eye-tracking experiment was combined with a log file analysis and an online survey. Our results show that users mostly focus on text on news websites, whereas multimedia elements (e.g., pictures or videos) are rarely used. Users' involvement further influences fixations on the central text of a website. Moreover, knowledge acquisition can be explained primarily by the fixation duration on the central text.

Keywords: eye tracking, online communication, cognitive mediation model

The influence of online media on (political) knowledge acquisition is widely debated in communication research. From a theoretical perspective, approaches that assume positive effects of online media on knowledge (Mayer, 2001) can be differentiated from approaches that assume negative effects (e.g., digital divide; Norris, 2001). At the center of the debate is the question whether hypertextuality, interactivity, and multimediality can equally be accessed by all social groups, and whether all citizens are

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equally able to extract knowledge from the wide variety of online information. Empirically, several studies have found strong positive influence of online news use on knowledge acquisition (Dalrymple & Scheufele, 2007; Wei & Hindman, 2011), whereas several others have found small effects (Tran, 2013).

Whether recipients learn from online news depends on at least two different conditions. First and foremost, recipients need to use the information acquired. This is less trivial than it sounds. Although the literature can confidently establish how many citizens use the Internet and which websites they use (Pew Research Center, 2017; Poushter, 2016), significantly less is known about how single-website elements—like text, pictures, videos, and hyperlinks—are used in detail. However, it can be assumed that what is crucial to individual knowledge acquisition is how intensively single elements of websites are used. In other words, multimediality of online news, defined as "presentation of explanations in visual and verbal formats, such as . . . presenting illustrations next to corresponding text" (Mayer, 1997, p. 1), only becomes relevant to knowledge acquisition if multimedia elements are detected and used by the recipients. However, scientific research has seldom focused on how intensively recipients use different website elements.

The second condition to learning from online news is individual preconditions, which determine whether recipients learn from online news. Among the most important preconditions is involvement, defined as the ability and motivation to attentively process and use the content of a message (Petty, Cacioppo, & Schumann, 1983; Yang, 2015). It is assumed that high involvement leads to more intensive processing of information and, subsequently, to a greater likelihood of knowledge acquisition (Eveland, 2001).

This study analyzes whether involvement guides how news on a website is used on a desktop computer, which multimedia elements (besides the central text article) are viewed, and how individual website use affects knowledge acquisition. To do so, an eye-tracking experiment was conducted. Forty-seven participants were exposed to four different website articles on climate change policy, with eye tracking used while the participants viewed news on a website. This article seeks to contribute to understanding individual knowledge acquisition in online environments.

Website Use

The rise of the Internet has changed the way information from news media is consumed worldwide. Today, using the Internet has become normal for citizens in developed countries (Anderson, Perrin, Jiang, & Kumar, 2019; EUROSTAT, 2018). With Internet use becoming part of everyday life, the ways that we search for information, buy goods, or plan holidays have changed.

Major changes have also been seen in the field of journalistic communication and news consumption. "In the U.S., roughly nine-in-ten adults (93%) ever get news online" (Pew Research Center, 2017, para. 1). The most popular online news sources in the U.S. are news websites (33%; Shearer, 2018). In Germany, websites for traditional media play an even more important role (42%) in online news consumption, according to the Reuters Institute Digital News Survey (Hölig & Hasebrink, 2018a). Among the top 10 most-used (per month) websites in Germany, five belong to traditional news media companies (AGOF, 2019).

The change in how news is used goes hand-in-hand with a change in how news is presented. Online news can be presented in a multimedia style that combines texts, interactive images, videos, and hyperlinks. Since the late 1990s, news websites of traditional media companies—like nytimes.com by *The New York Times* in the U.S., or sueddeutsche.de by the *Sueddeutsche Zeitung* in Germany—have integrated more and more multimedia elements (Dibean & Garrison, 2001; Doudaki & Spyridou, 2015; Jacobson, 2011; Menke et al., 2018; Quandt, 2008).

However, although the number of videos, photos, and graphs on news websites has grown and continues to grow, the production of multimedia content for online platforms is not institutionalized in many media organizations (Sehl, Cornia, Graves, & Nielsen, 2019). A recent study by Humprecht and Esser (2018) comparing news websites in six countries shows that news organizations do not reach the fullest potential in use of multimodality, which enables transparent reporting, access to background information, and user deliberation. For example, graphical illustrations of complex processes were only used in 0.7% (Italy) to 6.7% (Germany) of news stories. On the high-reaching websites of international television news services (such as CNN.com, BBC.co.uk, or ARD.de), video messages are usually embedded in comprehensive text, even on the websites of news organizations that typically produce video content instead of text. Contrary to linear television, text information seems to be an essential tool in guiding visual attention online. This is also reflected in online users' behavior. Online users still favor text over video content format, although younger cohorts engage with videos more frequently than with digital texts (Frees & Koch, 2018, p. 407).

Although website owners have broad insights into how their websites are used, not many scientific studies have researched how websites are used. Surveys suggest that audiences may not make much use of most multimedia elements (Chung, 2008; Larsson, 2011). Of these elements, audiences prefer videos, photo slideshows, or audio files. In contrast, more interactive website elements—like user comments and chats—are used less often. These results suggest that Chung's (2008) conclusion may still hold true: "Online audiences are not using interactive features extensively contrary to anticipation by media scholars and the news industry" (p. 672).

A limitation of these findings could derive from their nature as survey data. Because these studies involved self-reporting techniques they might not account for unconscious or automatic affective behavior. Therefore, data from nonreactive methods, such as eye tracking, could provide further insights into how audiences use individual websites. Early research in the field of usability shows that recipients use websites on a desktop computer in an F-shaped pattern (Nielsen, 2006). This means that reading on websites starts on the top left side. While the first few sentences are often read carefully, recipients go on to read only the first few words of the following sentences. While this pattern is still observed for traditional news website layouts and can also be found with mobile screens, changes in layout can encourage users to read text more systematically, on either desktop or mobile screens (Namoun, 2018; Pernice, 2017).

Furthermore, an effect called "banner blindness" has been observed in usability studies (Pagendarm & Schaumburg, 2001). Audiences actively avoid banners on websites; even if important information is presented in banners, recipients tend to avoid looking at them because they are perceived to be advertisements (Benway & Lane, 1998). Growing numbers of website users even install ad blockers to actively avoid banners and ads (Brinson, Eastin, & Cicchirillo, 2018). More recent research has shown that

website users only view banners on the side and top of websites for roughly half a second, even if they had the opportunity to browse freely on a website without a specific task (Resnick & Albert, 2014, p. 212).

In terms of the use of different multimedia elements on news media websites, few studies have been conducted. Holmqvist, Holsanova, Barthelson, and Lundqvist (2003) separate a news webpage into seven different areas of interest (AOIs). Besides the back button of the browser, the scroll bar, and the title header, they distinguish among a navigation area on the left, the middle part containing the central text article, a navigation area on the right, and an ad on the far right side of the website. They show that 59% of the fixation time was spent on the central editorial text in the middle of the website. A "strong preference for text over graphics" has also been found by the Stanford Poynter Institute through gaze entry points on news websites (Lewenstein, 2000, para. 11). These findings have been confirmed by Bucher and Schumacher (2006), who also find a "text-before-picture pattern" for news website-viewing behavior.

The studies presented in the previous section provide some hints on how news websites are viewed by recipients, but they were carried out in the early days of the Internet, when websites did not yet contain many diverse multimedia elements. To be able to make a claim about the use of multimedia elements on modern websites, further research is necessary. Therefore, our first hypothesis is:

H1: Website users mainly focus on the central text of a website.

Knowledge Acquisition in the Online World

One of the main advantages of online communication that has been advocated since the 1990s is the free access to abundant amounts of multimedia information (Dahlgren, 1996). At a broader level, hopes and concerns have been shared regarding the influence of the Internet on democracy. On the one hand, it has been stated that "the Internet is one of the fastest, cheapest, and most reliable channels for distributing political information" (Albrecht, 2006, p. 63). On the other hand, it has also been stated that the immense amount of information is not easy for democratic societies to handle. For example, the "Babel Objection" raises "the concern that information overload will lead to fragmentation of discourse, polarization, and the loss of political community" (Benkler, 2006, p. 214; Hiltz & Turoff, 1985).

These macro-level observations can be applied to the micro level of individual website use. On the one hand, it can be assumed that a multimedia presentation of information simplifies knowledge acquisition, as the same information can be presented in various channels; on the other hand, an information overload can be expected. The central premise for both of these assumptions is the idea that recipients make use of all of the information that is presented to them. In both cases, recipients are assumed to see the information within the certain medium (here, a news website on a desktop computer), and they need to cognitively process the information they see, as explained by the eye-mind hypothesis (Just & Carpenter, 1980).

In terms of what information is seen by website users, two approaches—the bottom-up and the top-down approaches—guide overt attention to information (Kaspar, 2013). The bottom-up approach assumes that visual attention is mainly stimulus driven; thus, multimedia presentation of information guides recipients' attention. According to the bottom-up approach, the use of pictures, videos, or colors to highlight

certain words could influence where users look on a website. The top-down approach argues that motivational factors guide visual attention; thus, emotional factors (Kaspar, 2013) or "attention to task relevant stimuli" primarily guide gaze motion (Orquin, Bagger, & Mueller Loose, 2013, p. 702). Whether users of news websites view multimedia information or primarily rely on textual information might thus depend on the specific situation in which news is used. According to the top-down approach, users would only look at pictures, videos, or other multimedia elements if they intend to do so or if they follow internalized usage habits. Additionally, Orquin et al. (2013) state that "practice increases top down modulation" (p. 702). Because (online) media use is part of many people's daily routine, website use could be guided by top-down attention processes instead of a bottom-up guidance of multimedia elements.

These basic assumptions of a stimulus-driven approach to visual attention can also be expanded into broader theories of knowledge acquisition and learning. For example, multimedia learning theory assumes that "people learn more deeply from words and pictures than from words alone" (Mayer, 2005, p. 31). The theory thus assumes that both visual attention and learning are stimulus-driven processes. Multimedia learning theory is based on three assumptions: dual-channel processing, limited capacity, and active processing.

The dual-channel processing assumption proposes that information can be processed via two channels: a visual channel and a verbal/textual channel. Visual processing is activated when pictures or videos are presented, whereas verbal or textual processing is activated when hearing or reading textual information (Mayer, 2005, 2017). (This assumption is closely connected to Paivio's, 1986, dual coding theory.) The limited capacity assumption proposes that only a limited amount of information can be processed in each channel at a time (Mayer, 2005, p. 36). The active processing assumption proposes that information is integrated into a coherent mental representation, together with previously learned information. Active processing is thus closely connected to the limited capacity assumption because it concerns the selection, organization, and integration of received information (Mayer, 2005).

Based on these assumptions, Mayer (2005) identifies five cognitive processes (see Figure 1). First, a text is processed in the verbal channel. When information is read, the single words are "mentally articulate[d]" (p. 39). Second, relevant images are selected. Because processing capacity is limited, only the parts of the pictures identified as relevant are processed. Third, the words are organized into a consistent representation; for example, causal chains can be mentally formulated. Fourth, the selected images are organized and integrated. This process "reflects an effort to build a simple structure that makes sense to the learner—such as a cause-and-effect chain" (p. 40). Fifth, word-based and image-based representations are connected. "This process occurs in visual and verbal working memory, and involves the coordination between them" (p. 40). This process can be described as cognitive sense-making of the integrated information, where the perceived verbal and visual information are integrated into previous knowledge.

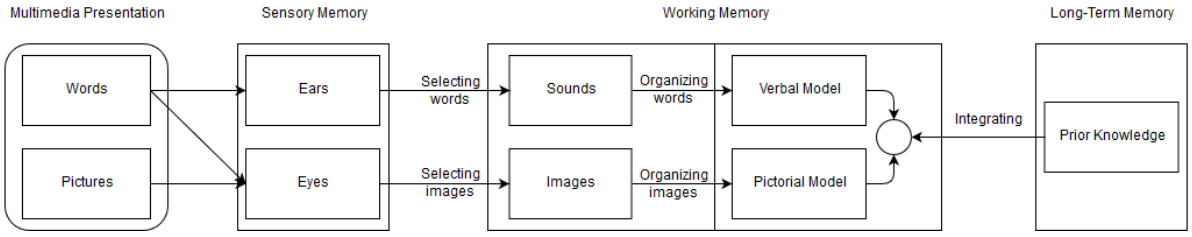

Figure 1. The multimedia learning model. Source: Mayer (2017, p. 405).

Lai et al. (2013) conclude in a literature overview that most studies analyzing the effect of website use on knowledge acquisition have focused on design questions. For instance, researchers have tested how color codings affect multimedia learning (Ozcelik, Karakus, Kursun, & Cagiltay, 2009). In terms of combining text and pictures, Johnson and Mayer (2012) show that text presented together with a diagram has a stronger effect on learning than presenting the diagram after the text. Furthermore, they conclude that "learning was largely text-directed, such that learners in both groups spent much more time looking at the text than the diagrams" (p. 189). Other studies show that illustrations containing irrelevant information hinder learning from the text (Harp & Mayer, 1997, 1998; Sanchez & Wiley, 2006). This effect has been labeled the seductive details effect (Garner, Brown, Sanders, & Menke, 1992).

It can thus be concluded that, just like on the macro level (Benkler, 2006), an information overload can be found on the micro level of smaller scale website use. When the information presented on a single set of websites exceeds individual cognitive capacities, an information overload is generally perceived. When and how recipients perceive information overload depends on individual preconditions, like prior knowledge (Chen, Pedersen, & Murphy, 2017).

Multimedia learning theory mainly focuses on how cognitive processing corresponds with information presentation (bottom-up approach). In contrast, motivational factors are considered by the cognitive mediation model, which directly addresses learning from the news:

> [The cognitive mediation model] proposes that learning from the news is determined through a causal process in which self-imposed learning motivations drive the processing of news information to which individuals are exposed and that this processing to a great extent determines the amount of learning that will occur. (Eveland, 2001, p. 571)

The focal point of the cognitive mediation model is the assumption that motivational factors do not directly determine knowledge acquisition: instead, the learning effect is mediated via factors like attention and news processing (Eveland, 2001, p. 572). The model assumes that attention to news and elaboration on the provided information "covary and have a direct and positive impact on learning of news content" (Eveland, 2001, p. 572).

Like most studies in the social sciences, the cognitive mediation model has been empirically tested mostly by using survey data, primarily self-reported (Beaudoin & Thorson, 2016; Eveland, 2001; Eveland,

Shah, & Kwak, 2003; see also Jensen, 2011). In these studies, news media attention is measured using items asking if participants "pay close attention, some attention, or little attention to stories about national government and politics" (Eveland, 2001, p. 593).

However, attention to news media content can also be measured in a way that is less dependent on self-disclosure. Kruikemeier, Lecheler, and Boyer (2018) used eye tracking to detect visual attention as a mediating effect in learning from news media. They found that news items are read more intensively when they can be actively selected, as on news websites. Furthermore, although recipients read more texts when they read in a newspaper or on a tablet, they read single articles for longer when they read on desktop computers; the selective visual attention leads, in turn, to more learning. Thus, they argue that visual attention should be more intensively researched, as it is a main explanatory factor driving the process of learning from news media content, and they ask future researchers to take into account the influence of design and visual elements (Kruikemeier et al., 2018, p. 8788).

We would like to use this way of measuring attention to news and focus on the intensity of website use. Therefore, in this study, we focus on visual attention as well as the use of hyperlinks on a website. To test individual learning from news websites and to include the influence of the websites' visual elements, we combine the theoretical foundations of multimedia learning theory and the cognitive mediation model. We argue that involvement determines how attention is allocated, which then determines what is learned from the individual use of the website. Our second and third hypotheses state:

H2: High involvement positively predicts the intensity of website use.

H3: Intensity of website use positively predicts knowledge gain.

To address the bottom-up approach of the multimedia learning theory, we specifically test to what extent attention to multimedia elements determines knowledge gain:

H4: The use of multimedia elements positively predicts knowledge gain.

Method

To test our hypotheses, we conducted an eye-tracking analysis and combined it with a log file analysis and an online survey. The data were collected in autumn 2014 at a large German university.

Participants

A total of 50 people participated in this study. The main goal of the study was to test website use and knowledge acquisition of "ordinary citizens"; therefore, the experiment was not conducted with students. Participants were recruited from the population of a German university city by addressing them personally or by announcing the experiment with flyers. We took care to ensure that as many different age and educational groups as possible were represented. Participants were rewarded with an incentive of 15 euros.

Before the stimulus was presented to the participants, the tracking ratio was checked, and the eye-tracking device was calibrated to ensure a valid measurement. The tracking ratio is a percentage value indicating how many (possible) gazes the eye tracker was able to detect. Eighty-nine percent of gazes were recorded (the actual ratio might be higher, because fixations were only analyzed for the stimulus website). All recorded trials of all participants were manually inspected for visible deviations (e.g., if gazes were visibly above or below texts).

The validation was conducted as a calibration task. The participants had to fixate on five points on the screen, one after the other. The validation value can be interpreted as an accuracy value indicating (in degrees) the deviation between the gaze position and the marker on the screen. All validation deviations were below 0.8 degrees (overall mean for horizontal deviations = 0.45; overall mean for vertical deviations = 0.39). Three participants had to be excluded from the data set because of unsatisfactory tracking ratio or validation.

Participants' ages varied between 14 and 68 years (M = 32.66 years, SD = 14.90; median = 27 years); 55% of all participants were male, and 51% had formal education levels at high school or higher. Furthermore, we tested participants' interest in climate change using a 5-point Likert scale, ranging from *very uninterested* to *very interested*. The mean score for the control group was 3.25, and the experimental group had a mean score of 3.13. This difference was not significant (p = .613; see Table 1). With regard to the sociodemographic characteristics, the two groups were equal.

Table 1. Gender, Age, and Education of the Participants (Absolute Numbers).

	Low involvement (n = 24)	High involvement (n = 23)
Female	8	11
Male	15	11
No answer	1	1
<20 years old	6	5
20–29 years old	7	8
30–39 years old	4	4
>40 years old	7	6
Secondary school until the ninth or 10th grade (lower secondary education)	5	5
Secondary school until the 12th grade (higher secondary education)	3	4
Secondary school until the 13th grade (higher secondary education)	11	10
Other	1	1
Still in school	4	3
(Very) uninterested in climate change	3	4
Medium interest in climate change	14	14
(Very) interested in climate change	7	5

Procedure

The eye-tracking study was conducted using an SMI RED eye tracker with a sample rate of 120 Hz, recording 120 data points for gazes per one second. Participants were seated in front of a desktop computer with a 22-in. TFT screen, with a resolution of 1,680 × 1,050 px. Gazes were detected as fixations at a threshold of 80 ms. Log files recording mouse clicks were stored using SMI Experiment center software. The software recorded the exact pixel location where the mouse cursor clicked, thus making it able to detect in what area of a website the user clicked. The online survey was conducted using the Web survey tool SoSci Survey.

Each participant was first instructed on the eye-tracking device, after which the calibration was performed; then, the stimulus material (a news article on a website) was presented. All participants were closely supervised to ensure that they read the information carefully. Any questions were answered by the person conducting the experiment.

After instruction and before showing the stimulus material, the involvement of the participants was artificially manipulated. Two different instructions were presented to divide participants into a low-involvement group and a high-involvement group. Participants in the low-involvement group were asked to use the stimulus website like any other website they would encounter if casually browsing the Internet. Participants in the high-involvement group were told that climate change is an important topic and that they would take part in a survey on climate change after using the website. We manipulated the involvement of the participants by giving different initial instructions. Of the 47 participants, 24 were randomly assigned to the high-involvement group, and 23 participants were randomly assigned to the low-involvement group.

All websites presented a central text article on the topic of climate change, together with relevant hyperlinks, pictures, videos, and interactive images. All participants were informed that they may browse as long as they want and leave the starting page for any other page whenever they want. To do this, the participants could either click on a link in the news website used as a stimulus, or they could manually type a URL into the address bar of the browser. The participants freely browsed up to 17 further websites (M = 7.17, SD = 7.59, Mdn = 4).

Materials

Of the four stimulus websites presented in the experiment, three originated from popular German online news outlets, and one contained a press release from the German Greens political party. These websites were chosen because they all provided a news article on climate change policy in the same context. Additionally, the news websites presented the information in a style that is convenient for casual online users, like the participants of our experiment. The news articles were written in German, the native language of the participants. The layout of the websites, besides individual branding, was comparable. All websites provided a central text with embedded pictures and hyperlinks. Hyperlinks to videos or photo slideshows were embedded next to the central text articles on all websites. Because original news articles on existing websites were used as the stimulus, participants needed to scroll on all four websites. All links on the website were fully active, and the browser's address bar was fully functional. During the trials, mouse clicks were

recorded using SMI experiment center software. After the browser was closed, a new window containing the online survey opened.

Measures

To analyze gaze targets and location of clicks, four AOIs were defined, following the functionality of the stimulus websites. These AOIs were not visible to the participants, and the subsequent division of the Web pages into four distinct areas only occurred for our analysis. These AOIs included the navigation area at the top of the websites, the central text area, the peripheral area, and the comments area. Within the central text area and the peripheral area, textual information (including hyperlinks), pictures, interactive images, videos, and audio files were differentiated. The comments area was divided into a user comments section and a popularity cues (likes, shares, etc.) section. Fixation duration in these areas and sections was recorded as an indicator of attention to the presented information. Fixations on the different AOIs was calculated, along with the number of website elements that were fixated on at least once.

Moreover, the total duration of the trial was recorded. This duration was calculated as the sum of all fixations and saccades on the stimulus website, together with all websites used during the participants' trial. Besides fixations, clicks on any element on the website were recorded, and the accessed websites were manually coded. Therefore, we were able to capture whether these websites also provided information on climate change.

Knowledge acquisition was measured using six recall and recognition items that could be answered using information from the stimulus website (e.g., By how many degrees Celsius has the air temperature increased since the beginning of the 20th century?). The information necessary for answering the question was present in the central text, in multimedia elements (such as videos, audio files, interactive graphics, or pictures), and on websites linked to the stimulus websites that dealt with climate change. For control variables, age, gender, and formal education were measured. Formal education was dummy coded to differentiate participants with high-school and higher education levels from participants with lower education. Additionally, interest in climate change was measured as a control variable.

Findings

Website Use

The individual duration of the full trial varied from 01:04 to 29:43 minutes. Users with high involvement and users with low involvement did not significantly differ in total trial duration. However, low-involvement users (M = 02:39 minutes) left the stimulus website significantly earlier than high-involvement users (M = 05:03 minutes; $t = -2.695$, $p = .010$; see Table 2).

Table 2. Direct Effects of Involvement on Browsing Duration (t tests).

		n	*M*	*SD*	*df*	*T*	*p*	*d*
Total duration of trial	Low involvement	24	0:11:54	0:06:55	45	0.894	.376	0.261
	High involvement	23	0:10:05	0:07:03				
Total duration browsing the stimulus website	Low involvement	24	0:02:39	0:02:14	45	−2.695	.010	−0.786
	High involvement	23	0:05:03	0:03:43				

With regard to the gaze motion of our participants, the first and most immediately striking insight from our study derives from an eyeball inspection of the heat maps provided by eye-tracking technology (see an example in Figure 2). Heat maps visualize how intensely certain parts of a stimulus were viewed, as they provide colored maps showing the duration of fixations. In Figure 2, fixations lasting 100–200 milliseconds are shown in blue, fixations of 300–700 milliseconds are shown in different shades of green, fixations of 700–900 milliseconds are shown in yellow and orange, and fixations lasting 1,000 milliseconds or longer are shown in deep red. Consistent with previous studies (Nielsen, 2006), we find that the websites we presented on a desktop computer were viewed from top to bottom. Our heat maps also display what has been called an F-shaped pattern: Fixation duration was longer at the top of the website and on the left side than on the other areas of the website.

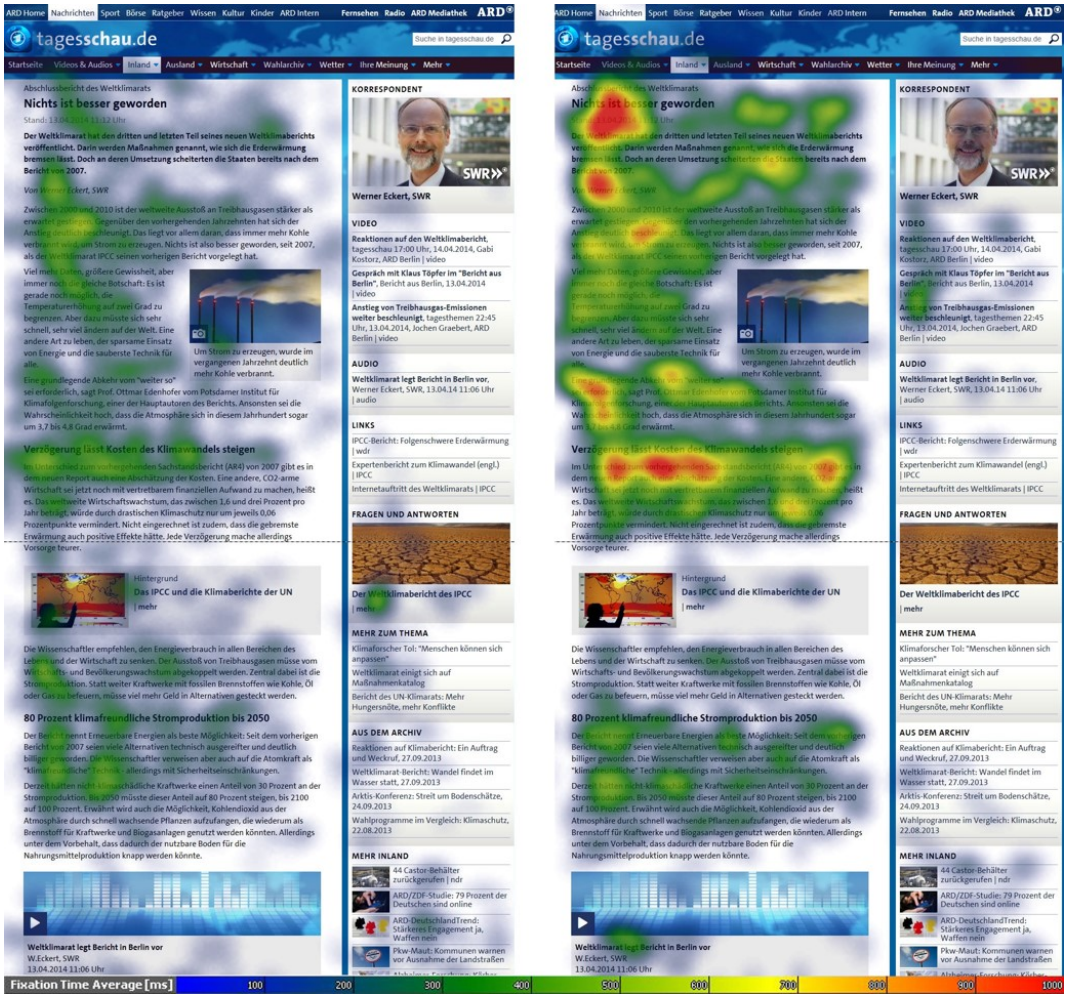

Figure 2. Heat maps of one user in the low-involvement group (left) and one user in the high-involvement group (right).

This first impression is supported by an examination of which AOIs achieved at least one fixation from the participants. Ninety-six percent of all participants gazed at the navigation area (see Table 3); however, even more participants viewed the central text, in the central text area (98%). The multimedia elements within the central text area were fixated on by fewer participants (73%–92%). The least viewed element in the central text area was an audio file. Multimedia elements in the peripheral area of the stimulus websites were viewed even less (46%–72%). About 50% of the participants reached the bottom of the websites and looked at user comments and popularity cues. Consistent with previous research, these results suggest that websites are viewed as a text-based medium rather than a picture- or video-based medium (Bucher & Schumacher, 2006; Lewenstein, 2000). Thus, our first hypothesis (H1), stating that participants mainly focus on the central text of a website, is supported.

Table 3. Share of Participants Fixating on Different Website Elements.

	Participants with at least one fixation (N = 47) in %
Navigation area	**96**
Central text area	
Central text	98
Pictures	92
Interactive images	92
Videos	92
Audio files	73
Peripheral area	
Hyperlinks	72
Pictures	70
Interactive images	42
Videos	68
Audio files	46
Comments area	
Comments	54
Popularity cues (likes, shares, etc.)	51

Comparing website use of users with high and low involvement (H2), we find one remarkable significant difference: high-involvement users fixated on the central website article more than twice as long (total fixation duration on central text, M = 02:27 minutes) as low-involvement users (total fixation duration on central text, f = 01:06 minutes; t = −2.260, p = .029). In contrast, we found no significant differences concerning the share of website elements used (p = .069), the number of clicks on hyperlinks (p = .945), the number of additional websites on climate change browsed (p = .367), or the fixation duration on multimedia elements (p = .126). The second hypothesis (H2)—stating that high-involvement users use websites more intensively than low-involvement users do—is only supported for the central website article (see Table 4). When searching for information to answer test questions, users focused more on the central text, but not on multimedia elements or additional websites on the same topic, as compared with users who did not know that they would be asked questions on the information on the website.

Table 4. Direct Effects of Involvement on Website Viewing Behavior (t tests).

		n	*M*	*SD*	*df*	*T*	*p*	*d*
Fixation duration central text	Low involvement	24	0:01:06	0:01:33	45	−2.260	.029	−0.659
	High involvement	23	0:02:27	0:02:29				
Fixation duration multimedia elements	Low involvement	24	0:00:32	0:00:39	45	−1.558	.126	−0.455
	High involvement	23	0:00:50	0:00:41				
Share of website elements with at least one fixation	Low involvement	24	0.70	0.27	34.24	−1.874	.069	−0.547
	High involvement	23	0.82	0.14				
Number of clicks (all areas)	Low involvement	24	1.42	1.06	45	0.069	.945	0.020
	High involvement	23	1.39	1.44				
Number of views of websites on the same topic	Low involvement	24	0.63	1.38	45	−0.911	.367	−0.266
	High involvement	23	1.00	1.45				

Knowledge Acquisition

To calculate the effect of website use on knowledge gain, we asked six recall and recognition questions on climate change that could be answered with information from the central text of the websites; from multimedia elements like videos, audio files, interactive graphics, or pictures; or from other websites promoted as related content on our stimulus website. To analyze the influence of users' involvement and their patterns of website use on short-term knowledge acquisition, we first calculated a simple regression analysis (see Table 5). After formal education, age, gender, and interest in climate change were controlled for, two factors were found to significantly influence knowledge gain. First, the longer users fixated on the central text article of the website, the more questions they answered correctly (ß = .516, $p < .001$). Second, the more websites on climate change users opened during the trial, the more questions they answered correctly (ß = .411, $p < .05$). No significant effect on knowledge acquisition was found for involvement, total duration of the trial, or fixation duration on multimedia elements.

Table 5. OLS-Regression: Influence of Individual Website Use on Knowledge Acquisition.

	Number of questions answered correctly					
	b	*SE B*	ß	*b*	*SE B*	ß
Involvement				−.014 (−.604, .634)	.284	−.006
Total duration of trial				−.044 (−.088, −.003)	.019	−.275
Fixation duration central text				.269 (.091, .376)	.091	.516***
Fixation duration multimedia elements				−.403 (−.869, .415)	.291	−.244
Number of views of websites on the same topic				.362 (.129, .867)	.147	.411**
Formal education (high school yes/no)	−.143 (−.784, .475)	.335	−.064	−.292 (−.876, 253)	.286	−.130
Age	.016 (−.007, .038)	.012	.214	.009 (−.017, .030)	.013	.120
Gender	−.152 (−.977, .753)	.401	−.067	−.276 (−.937, .324)	.330	−.122
Interest in climate change	.012 (−.490, .449)	.229	.008	−.001 (−.394, .411)	.215	−.001
	Corr. R^2 = −.027			Corr. R^2 = .423***		

Note. 95% bias-corrected and accelerated confidence intervals reported in parentheses. Confidence intervals and standard errors based on 1,000 bootstrap samples. *$p \leq .05$. **$p \leq .01$. ***$p \leq .001$.

Although involvement did not directly influence knowledge acquisition, it can be assumed to direct where participants look at on a website. To test this indirect effect, the number of correctly answered questions was integrated as a dependent variable in a mediation model (see Figure 3). This analysis showed an indirect effect of involvement on the number of questions answered correctly, mediated by the total fixation duration on the central text of the website. This effect is stronger than the direct effects in the model (b = 0.41, CI [0.13, 0.94]), and it remains stable when controlling for formal education, age, gender, and interest in climate change (b = 0.36, CI [0.08, 0.83]).

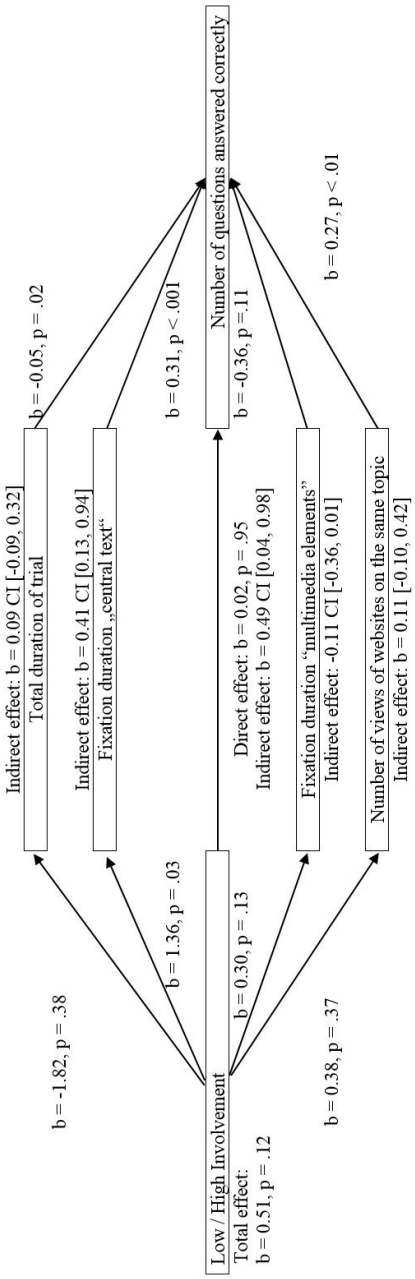

Figure 3. Mediation model: Effect of involvement on knowledge gain. Note. 95% bias corrected and accelerated confidence intervals reported in square brackets. Confidence intervals based on 1,000 bootstrap samples.

Thus, we can conclude that participants' involvement influences their knowledge acquisition indirectly, because involved recipients tend to spend more time reading the central text of the website, which leads to stronger knowledge gain. Thus, our third hypothesis (H3)—that intensive website use leads to stronger knowledge gain—is partly supported, for the use of the central text article. Because the use of multimedia elements does not explain knowledge gain at all, our fourth hypothesis (H4), stating that the use of multimedia elements leads to knowledge gain, must be rejected.

Discussion

The aim of this experimental study was to analyze how multimedia news websites are used and how knowledge acquisition is affected by individual website use. To assess one of the most influential motivational factors, we manipulated participants' involvement and measured its effect on website use and knowledge acquisition. To measure news attention nonreactively, we conducted an eye-tracking study. Insights on individual website use were drawn from an additional log file analysis. Knowledge acquisition was tested using survey items on knowledge about climate change that had been available on the stimulus website.

Our data shows that news websites are still mainly used as a text-based medium (H1). All participants of our study spent most of the time reading the central text of the stimulus website, and several participants did not even briefly fixate on multimedia elements. This was especially true for multimedia elements outside the central text area. This finding is in line with self-reports of media users: 41% of online news users in Germany report using news articles on websites, whereas only 14% report using videos and 6% report using infographics provided with the articles (Hölig & Hasebrink, 2017, p. 37). Additionally, how intensively websites are viewed is only partly determined by the involvement of the users (H2). Although the central text is viewed for a longer time when users are highly involved, other elements (like videos and images) are not fixated on more. This indicates that highly involved participants searched for information within the central text instead of in multimedia elements.

Furthermore, we found a pattern of viewing behavior, which showed that participants go through websites from top to bottom with decreasing attention, leading to the fact that only a minority of the participants took notice of interactive elements (like user comments) at the bottom of the websites. This is a noteworthy finding, as it is often assumed that multimedia and the interactive structure of websites promote knowledge acquisition. In fact, many participants in our study did not seem to make much use of these elements. Thus, when news media organizations provide additional multimedia elements—such as videos or pictures—to their news stories, they cannot assume that this information will be used by the recipients. In the context of using news websites on desktop computers, our results do not indicate a bottom-up guidance of visual attention (Kaspar, 2013).

Previous findings show that attention is best guided when the essential material is highlighted and words are placed directly next to the corresponding images (or parts of images; Mayer, 2017). If news media wanted to cultivate attention to multimedia elements, they could highlight places in the text that refer to additional information in videos and images. Furthermore, media organizations could provide pictures with essential information at the top of the website before the central text begins, instead of using symbolic pictures at the top and essential images next to the central text. Moreover, the order in which

multimedia information is presented could affect attention (Eitel & Scheiter, 2015; Eitel, Scheiter, Schüler, Nyström, & Holmqvist, 2013). Further studies should focus on these aspects, to test under which conditions multimedia elements and text complement each other and which conditions favor visual attention.

Interestingly, the trend of promoting videos on news websites continues (Mitchell & Page, 2014). This is because news outlets are more and more approachable via Facebook. Since Facebook changed its algorithm to provide videos in users' newsfeeds, one can assume that users are becoming increasingly accustomed to consuming videos when consuming news (Bell, 2015). This could, in turn, affect news presentation and news use on websites. Of course, the promotion of videos must be observed with caution and skepticism, because Facebook is suspected of falsely inflating video user numbers (Welch, 2018). Therefore, more noncommercial research is needed on the importance of videos for users seeking news. Further eye-tracking studies should focus on both the use of news on Facebook and the use of website elements on "traditional" news websites.

In terms of the process of learning from news websites, our results indicate a strong influence of reading a website's central article on knowledge acquisition (H3). The longer participants fixated on the central text article, the more they learned about climate change. Moreover, we found an indirect effect of involvement on knowledge gain: High involvement increased the time spent reading the central text article. However, contrary to the assumptions of multimedia learning theory, multimediality does not guide attention and thus does not influence knowledge acquisition (H4). As stated above, we did not find support for the bottom-up approach of visual attention, which states that visual elements guide attention (Kaspar, 2013; Mayer, 2005). Instead, involvement influenced the fixation duration on the central text, which in turn influenced knowledge acquisition. This could have to do with our setting—casual news use on a media website using a desktop computer. These websites were used as a text-based medium by the participants. When seeking to maximize knowledge acquisition, news media could use the central text of a website to directly refer to the information presented in images or videos, or provide guidance tools to direct attention away from the central text to multimedia elements (Amadieu, Lemarié, & Tricot, 2017).

Outlook and Limitations

Our results provide useful insights into how recipients learn from news websites on a desktop computer. They show that involvement alone does not affect knowledge acquisition; rather, involvement affects attention, which affects individual learning. Our results thus confirm the central assumptions of the cognitive mediation model. Furthermore, our results can directly be integrated into broader theoretical concepts that address learning from news media. For example, they could be fruitfully adapted in agenda-setting or knowledge-gaps studies, as they provide insight on how media audiences use information provided on traditional news websites. Furthermore, the results show that multimediality does not lead to more attention and knowledge per se; instead, individual motivational factors influence what is seen and learned. Nevertheless, while multimedia learning theory was developed to explain students' intentional learning, our study focused on news use and a more casual, less intentional knowledge acquisition. Therefore, further studies should be conducted on the differences between the factors explaining intentional versus unintentional learning.

This study has three shortcomings that need to be discussed. First, we focused on short-term effects on knowledge acquisition, and thus possible long-term effects of multimedia learning could not be measured (Schweppe, Eitel, & Rummer, 2015). Second, our study should only be understood as a first insight into how the use of websites affects knowledge acquisition. We could only test our assumptions with a very small sample; however, the effects we found can serve as a starting point for future studies. These effects provide explorative insights into mechanisms that need further investigation. Third, some results of our experiment are limited to news use on desktop computers or laptops. Smartphone use has become one of the main modes of browsing the Internet: In Germany, news use via smartphone has become equally popular to news use via laptops or desktop computers, and it is becoming the dominant device among younger citizens (Hölig & Hasebrink, 2018b, p. 31). Some very basic findings reported here, like the F-shaped pattern of reading online, cannot be generalized to news use via smartphones, because current findings are mixed. New studies find the same pattern for users of mobile devices (Pernice, 2017), but the general layout of websites may strongly influence this pattern (Namoun, 2018) on both desktop computers and mobile screens. In terms of the more complex findings on how the use of online information is connected to knowledge acquisition, this study only adds one piece to the puzzle. Therefore, further research should not only focus on desktop computers and laptops but also extend the scope to the use of smartphones.

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