Effects of infographics on news elaboration, acquisition, and evaluation: Prior knowledge and issue involvement as moderators

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Abstract
This study investigated how infographics may affect individuals’ news processing, focusing on multimodality and interactivity as its signature characteristics. News readers’ prior knowledge and issue involvement, which affect their ability and motivation to process information, were considered as potential moderators. In a 3 (text vs graphic vs text + graphic) × 2 (hyperlinks vs no hyperlinks) between-subjects experiment (N = 360), participants read a news article concerning economic issues. Adding graphics to the news heightened the extent to which they engaged in news elaboration, albeit only among those with higher issue involvement. However, in-text hyperlinks hindered information recall among those with less prior knowledge, creating an information acquisition gap between more and less resourceful individuals. The graphical representation of news appeared to have heuristic appeals to those less involved in and less knowledgeable about the news topic, leading to more favorable news evaluation.

Keywords
Infographics, interactivity, modality, news acquisition, news elaboration, news evaluation

With an ever-growing emphasis on the visual component in news presentation, infographics, loosely defined as a set of technologies that present complex information in an easily accessible manner (Smiciklas, 2012), has become a relatively common element in...
online journalism. In hopes of arousing readers’ interest and promoting their understanding of news, news organizations have adopted a variety of visual elements, such as photos, illustrations, charts, and maps, often to convey statistical figures concerning opinion polls, economic changes, disaster conditions, and the like. Once conceived of as the unique characteristic that sets online news apart from traditional media (Bucy, 2003), hyperlinks are also commonly used in infographics as a means to engage news readers in news acquisition. What seems to fuel such wide adoption of infographics is the belief that it will enhance news readers’ understanding as well as their evaluation of news, but empirical evidence is difficult to find.

To fill this void, the current research investigated how the use of infographics affects individuals’ news processing, focusing on its two most prominent features—multimodality and interactivity. Multimodality refers to a property of the medium that conveys its content using different methods of presentation that appeal to different human perceptual systems, such as text, pictures, audio, and video (Sundar and Limperos, 2013). To be precise, the combination of verbal text and graphics can be seen as multicoval presentation, as they both represent visual information. Still, considering that verbal text and images rely on different kinds of logic for processing (time and sequence vs space and simultaneity) (Kress, 1997) and that they each refer to distinct “means of representation” that are “organized, regular, (and) socially specific” (Jewitt et al., 2001: 5), researchers have often treated their mixture as multimodal presentation (e.g. Kress et al., 2001; Narayanan and Hegarty, 2002; Sundar and Limperos, 2013). By comparing three different modes of presentation (i.e. text-only vs graphic-only vs text-plus-graphic), we aimed to examine the effect of multimodal presentation on news processing, as well as that of graphics, whose use is on the rise as a stand-alone form of infographics.

Another common element of infographics concerns interactivity. As one of the most elusive concepts in the literature on communication technology, interactivity refers not only to computer-mediated social interaction (i.e. interpersonal interactivity) but also to impersonal engagement with media content, such as audio/video downloads and the use of hyperlinks (i.e. content interactivity; Bucy, 2004). In particular, hyperlinks have been commonly implemented as a form of user-to-system interactivity (Bucy, 2004; Eveland et al., 2004; Sundar et al., 2003; Tremayne and Dunwoody, 2001) and are frequently utilized in infographics as a means for the user to access additional information (information-on-demand).

In assessing the effects of multimodality and interactivity on news processing, we extended the previous research on how various features of news interface affect readers’ acquisition of information from news (e.g. Eveland et al., 2004; Openghaffn and D’Haenens, 2011; Sundar, 2000) by investigating the extent to which people engage in message-relevant thinking (i.e. elaboration) as well as their subjective evaluation of the news. By doing so, we aimed to (a) elucidate the underlying process that may account for the difference in news acquisition and (b) uncover the potential discrepancy between news readers’ subjective perception of news and actual information gain, if any. To that end, based on the elaboration likelihood model (ELM; Petty and Cacioppo, 1983), which postulates that individuals’ cognitive ability and motivation determine the degree to which they process a message in an effortful manner, we incorporated news readers’ prior knowledge of the news topic and issue involvement as potential moderators of the effects of infographics.
How multimodality and interactivity affect news processing

Although it seems to be taken-for-granted that the addition of a visual element to the written text will facilitate information processing, two competing views exist as to how multimodality might affect news processing. According to cue summation theory (Severin, 1967), multichannel communications enhance learning as compared to single-channel communications, insofar as (a) there are additional cues provided through each channel (e.g. words and illustrations) and (b) the cues are related or relevant. That is, unless there is complete between-channel redundancy, as when spoken and printed words are provided simultaneously, or interference between channels due to the inclusion of irrelevant information, it is more advantageous to use multimodal presentation to improve information acquisition. The notion that “related cues in two channels should summate and result in a gain” (Severin, 1967: 242) is echoed in dual-coding theory (Paivio, 1971), which proposes two distinct cognitive subsystems specialized for two different types of stimuli: the verbal system for language and the visual system for non-verbal objects and events. In this view, text and graphic are assumed to be processed separately by these independent subsystems, and their combination is likely to facilitate the recall of information, as compared to either mode alone (Paivio, 1986).

At the same time, the limited capacity model of mediated message processing (Lang, 2000) highlights the possibility for less-than-thorough information processing. According to this model, information processing consists of three subprocesses, which collectively determine how well people learn from a mediated message: encoding, storage, and retrieval. In this view, the extent to which the information is encoded, stored, and retrieved depends mostly on the amount of cognitive resources allocated to each subprocess. Given that people can process only a limited amount of information in each channel at one time, the combination of verbal text and pictorial image may deplete cognitive resources available and incur information overload, as people need to decide which information to attend, how to mentally represent it, and how to integrate the verbal and pictorial representations with each other (Mayer, 2005). In fact, cue summation theory also acknowledges the constraints on human processing capacity and notes specifically that the combination of individual presentations in different channels may “cause the system to overload and jam” (Severin, 1967: 241).

Empirical evidence, however, has rather consistently supported cue summation theory and dual-coding theory. When undergraduates read a news story about trade relations between two nations, they recalled better the statistical information contained in the news when it was presented in both text and graphic than in either mode alone (Griffin and Stevenson, 1996). Likewise, adult learners performed the simple procedural task (e.g. a first aid task) better and gave more correct responses to the questions when the learning materials were presented in both text and line drawings than in either text or line drawings (Michas and Berry, 2000). Such advantages of the verbal–visual instruction were observed for other demographic groups with different tasks, such as mentally retarded individuals working on a sorting task (Nailos et al., 1994) and children solving geometric puzzles (Chabani and Hommel, 2014). To further elucidate what accounts for the benefit of multimodal presentation, van der Molen and Klijn (2004) systematically varied the degree of semantic overlap between visual and verbal information in TV news.
They found that TV news was better remembered than its printed version when there was direct text-picture correspondence, while the opposite was true with poor semantic overlap, thus highlighting semantic overlap as a key moderator of the effect of multichannel communication.

Such benefits of multimodal presentation, however, may vary as a function of the news reader’s motivation as well as ability to thoroughly process the news. According to ELM (Petty and Cacioppo, 1983, 1986), there are two distinct routes of information processing: central route and peripheral route. When an individual is both motivated and able to process incoming information systematically, he or she is more likely to deeply engage in message-relevant thinking (i.e. elaboration), taking the central route. On the other hand, when an individual lacks either the motivation or the ability to carefully process the message, he or she is likely to take the peripheral route and shows a lower level of message elaboration. In light of the dual-process model, the current research incorporated two receiver characteristics capturing the reader’s cognitive ability and motivation, prior knowledge and issue involvement, to better understand when and how infographics alters news processing.

First, prior knowledge about the message topic has been found to determine the extent to which an individual is capable of systematically processing the incoming stimuli (Petty and Cacioppo, 1983, 1986). One explanation for the positive effect of prior knowledge on learning concerns the existence of schema. Defined as “domain-specific knowledge structures that allow people to categorize multiple elements of information as a single element” (Kalyuga et al., 2001: 6), schemas can help to interpret and organize the incoming information rather efficiently, thereby reducing the burden on working memory, which can process only a few elements at a given time. Those with more prior knowledge are more likely to have a related schema, which facilitates the encoding of new information. Similarly, based on associative network models of memory, Lang (2000) argues that (a) newly encoded information is more thoroughly stored in our long-term memory when it forms more associations with old information and (b) the more thoroughly the new information is stored, the more readily retrievable it is. If so, those with more prior knowledge should be better able to learn from news, as they possess more old knowledge to which new information can be connected (Tremayne and Dunwoody, 2001). Supporting these views, researchers reported that prior knowledge is a more significant predictor of news learning than other factors, such as education or online news use (Price and Czilli, 1996; Price and Zaller, 1993).

If those with prior knowledge can better process incoming information and learn more from it, the learning-enhancing effect of multimodality may be less pronounced among those already equipped with such resources. With the help of prior knowledge, they may be able to recall the core information from the news even when it is presented through a single channel, leaving less room for improvement to begin with (i.e. ceiling effect). By contrast, those lacking prior knowledge may benefit from the added channel, as it allows a second chance for them to obtain information not completely processed on the other channel. If so, we can expect that an information acquisition gap between more and less resourceful individuals will be lessened in the text-plus-graphic condition.
On the other hand, it may well be that multimodal presentations demand a greater amount of cognitive resources than single-channel communications as they require the integration of information obtained from separate channels, which those with less prior knowledge may not be able to afford. Even if the graphics do not incur extra cognitive work, those with less prior knowledge may have greater difficulty distinguishing relevant and irrelevant information and instead focus more on superficial properties of graphics (Cook, 2006). Consistent with this conjecture, visual annotations were found to impair college students’ foreign language learning among those lacking verbal ability, such that they performed more poorly on the vocabulary test than their more verbally capable counterparts only when visual annotations were present (Plass et al., 2003). If so, an information acquisition gap between more and less resourceful individuals will be widened when graphical elements are added to the verbal text. Given these competing possibilities, the following research questions were proposed:

RQ1a–c. How does the addition of graphics affect (a) news elaboration, (b) news acquisition, and (c) news evaluation, independently and jointly with the reader’s prior knowledge about the news topic?

Second, issue involvement, which refers to “the extent to which the attitudinal issue under consideration is of personal importance” (Petty and Cacioppo, 1979: 1915), is known to heighten an individual’s motivation to systematically process information (Petty and Cacioppo, 1986). If the addition of visual elements arouses interest in the news, less involved individuals who would not pay much attention to the news otherwise may become more attuned to the news and learn more from it, whereas highly involved individuals would dispense a high level of cognitive effort to process the news, regardless of its modality. Even if the use of graphics does not enhance news acquisition, it may trigger a modality-based heuristic, like “coolness” or novelty, thereby eliciting more favorable news evaluations. Again, such an effect is more likely to occur for those who lack the motivation to carefully assess the information and are thus more susceptible to peripheral cues (Sundar, 2008). Albeit plausible, due to the paucity of previous research, the following research questions were proposed in lieu of directional hypotheses.

RQ2a–c. How does the addition of graphics affect (a) news elaboration, (b) news acquisition, and (c) news evaluation, independently and jointly with the reader’s issue involvement?

In addition to information visualization, hyperlinks are commonly used in infographics as a form of user-to-system interaction (McMillan and Hwang, 2002) to enhance readers’ involvement in information acquisition. Hyperlinks enable news readers to control the selection and presentation of news, rather than passively receive it, and such behavioral engagement is an important marker of user–content interaction (Ksiazek et al., 2014). For example, Tremayne and Dunwoody (2001) operationalized interactivity as “message-sending activity by a user (using either a keyboard or a mouse) that results
in a corresponding (and responsive) change in screen content,” and defined interactive Web site structure in terms of the number of user options to alter the content, such as “hyperlinks, search engines, and rollover graphics (p. 116).”

Similar to the provision of graphics, however, the use of hyperlinks may yield divergent effects on news processing. On one hand, interactivity may breed user control over the content as well as the flow of information, thereby fostering message elaboration and information acquisition. Consistent with this view, those assigned to the more interactive website showed better content-specific recall than those assigned to the website with fewer hyperlinks (Tremayne and Dunwoody, 2001). Similarly, Eveland and Dunwoody (2002) found that individuals engaged in higher message elaboration and obtained more content knowledge when they read a news story on the web as compared to print news, although some users who actively engaged in “selective scanning” (Kosicki and McLeod, 1990: 75), picking and choosing among information based on personal criteria, ended up learning less from the news. Albeit in a gaming context, those who actually played the game obtained more knowledge than those who merely watched a replay of someone else’s game play (Ritterfeld et al., 2009), suggesting the importance of behavioral engagement in information acquisition. The use of hyperlinks may also affect individuals’ news evaluation, particularly among those lacking the motivation to thoroughly process the information. Considering that politically apathetic users appraised the target candidate more positively (Sundar et al., 1998) and consumers with lower product involvement rated the product more positively (Kim et al., 2008) when they were exposed to an interactive website than a non-interactive one, the use of hyperlinks may garner more positive news evaluations, especially from less involved individuals who are more vulnerable to peripheral cues.

On the other hand, studies have indicated that hyperlinks may demand a higher level of cognitive effort on the part of the user to navigate information, thereby leading to poorer information acquisition and negative evaluations (Sundar, 2000), if not causing the feeling of being lost (i.e. disorientation; Bucy, 2003). For example, Eveland et al. (2004) found that those exposed to the news website with hyperlinks exhibited a lower level of factual knowledge acquisition than those presented with the identical website without hyperlinks. Interestingly, however, exposure to the hyperlinked news page increased the extent to which people made connections among various news events (i.e. knowledge structure density), although such effect was found only among those who read online news frequently and were thus familiar with how hyperlinks operate. If the use of in-text hyperlinks, a relatively unfamiliar way to read the news, interferes with knowledge acquisition, such effects are more likely to occur for those lacking either the motivation to obtain information or the topical knowledge that can aid their processing of incoming information:

RQ3a–c. How does the use of hyperlinks affect (a) news elaboration, (b) news acquisition, and (c) news evaluation, independently and jointly with the reader’s prior knowledge about the news topic?

RQ4a–c. How does the use of hyperlinks affect (a) news elaboration, (b) news acquisition, and (c) news evaluation, independently and jointly with the reader’s issue involvement?
Method

Participants

A web-based experiment was conducted through an online survey company in South Korea. Email invitations were sent out to the members of its national panel, and a total of 360 respondents (175 men, 185 women) completed the questionnaire online. Among them, 76 (21.1%) were in their 20s, 110 (30.6%) in their 30s, 103 (28.6%) in their 40s, and 71 (19.7%) in their 50s ($M=38.31$, $SD=10.39$).

Procedure

Upon accessing the study website, participants were first presented with questions concerning demographic information, their news media usage, prior knowledge about the focal topic, and issue involvement (see the “Measures” section). They were then taken to the stimulus page to read a news article. Participants were randomly assigned to one of the conditions in a 3 (text vs graphic vs text+graphic) $\times$ 2 (hyperlinks vs no hyperlinks) between-subjects design experiment. After reading the news article, participants were asked to list any thoughts that occurred to them while reading the article and answered a series of questions concerning the news story.

The news article was a slightly modified version of an article that had been published by a major daily newspaper in South Korea (JoongAng Ilbo). Entitled as “Middle-Income Korean Households Grow Poor, Like a Frog in a Boiling Pot,” the original article was based mostly on McKinsey Global Institute’s second report on the South Korean economy (“Beyond Korean Style: Shaping a New Growth Formula”), which highlighted the financial risks of the middle-income class and the unbalanced growth of the big enterprises in South Korea.

For the current research, the title was modified to “In Korea, Middle-Income Households Grow Poor and Big Enterprises Cut Hiring: McKinsey Report” (see Figure 1). Those in the text-only condition were presented with a verbal text describing statistical information in words (e.g. “The percentage of low-income class rose to 20.0% in 2010 from 17.5% in 1990,” “In 2010, housing prices were reported to be higher than the annual income by 7.7 times in South Korea, which was much higher than that of Australia, England, USA, or Canada,” “Between 1995 and 2010, the big enterprises cut hiring at a rate of 2.0% per year”). In contrast, those in the graphic-only condition saw the same information represented in three different types of graphs: a pie chart, a bar chart and a line graph. The text-plus-graphic condition combined both ways of presentation. To ensure that the amount of information was equivalent across conditions, what could not be graphically represented was removed from the original article.

Those in the interactive condition were presented with the first part of a paragraph and were asked to click hyperlinks labeled “Read more …” to view the remaining parts of the story, as commonly seen in infographics implemented by major newspapers. Those in the non-interactive condition, however, were exposed to the full version of the news article at once.
Measures

To control for the factors that might affect news acquisition, participants were asked to indicate their highest degree earned before reading the news article (1 = elementary school, 2 = middle school, 3 = high school, 4 = college, 5 = graduate school; $M=3.89$, $SD=0.54$) and the average amount of time spent reading news online on weekdays ($M=72.43$ minutes, $SD=63.03$).

For prior knowledge, five questions concerning economic issues were asked (e.g. “Which of the following age groups showed the greatest decrease in employment rate in the first quarter of 2013?” “Which of the following is not included in the major economic policies of 2013 that the government announced?” “Which of the following neologisms
refers to the young generation facing unemployment and financial difficulties”), and the number of correct answers was recorded \((M=1.95, SD=1.08)\).

Because the news article touched upon a variety of economy-related topics, such as the share of population by income bracket, the house-price-to-income ratio, and the revenue growth of top 10 large companies, we measured the participants’ involvement in economic issues in general. Specifically, they indicated the extent to which they considered economic issues to be personally relevant, important, and interesting \((1=\text{strongly disagree}, 5=\text{strongly agree})\). The scores were then averaged \((\alpha=.80, M=4.10, SD=0.69)\).

After reading the news article, the participants were asked to list any thoughts that came to their mind while reading it. Two independent coders counted the number of message-relevant thoughts, and the scores were averaged for news elaboration \((\text{Cohen’s Kappa}= .89, M=3.36, SD=2.32)\).

For news acquisition, we employed a recognition test, a commonly used method to quantify the factual knowledge gain from media (Shoemaker et al., 1989). Participants were asked five multiple-choice questions about the information presented in the news story (e.g. “Which of the following correctly describes the changes in the proportion of the middle-income class between 1990 and 2010?” “What percentage of the domestic sales in 2011 is accounted for by the 10 largest companies?” “Which of the following countries showed the lowest price-to-income ratio in 2010?”), and the number of correct answers determined news acquisition \((M=1.82, SD=1.13)\).

Finally, the participants indicated how in-depth, useful, informative, and relevant they thought the news article was (Bucy, 2003), and the scores were averaged for news evaluation \((1=\text{strongly disagree}, 5=\text{strongly agree}; \alpha=.72, M=3.18, SD=0.66)\) (see Table 1 for intercorrelations among key variables).

### Results

To examine how multimodality and interactivity affect news processing, both independently and in conjunction with news readers’ prior knowledge and issue involvement, a series of moderated hierarchical regression analyses was conducted. First, education and online news use were entered in the control block. Next, the main effect terms, graphic \((1=\text{graphic}, 0=\text{others})\), text-plus-graphic \((1=\text{text + graphic}, 0=\text{others})\), and interactivity

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*p <.05; **p <.01; ***p <.001.

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*p <.05; **p <.01; ***p <.001.
Table 2. Moderated hierarchical regression analyses.

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Graphic: 1 = Graphic, 0 = Others; Text-plus-Graphic: 1 = Text + Graphic, 0 = Others.
*p < .05; **p < .01; ***p < .001.

(1 = hyperlinks, 0 = no hyperlinks) as well as prior knowledge and issue involvement constituted the second block. Then, the two-way interaction terms, computed by multiplying two of the four predictors, were added, which was followed by the three-way and four-way interaction terms. Variables were centered before creating the interaction terms, and when higher order interactions were not statistically significant, a reduced model was run (see Table 2).

When the analysis was conducted for news elaboration, two significant interactions emerged involving modality and readers’ characteristics. First, there was a significant interaction between modality (text vs graphic) and prior knowledge on news elaboration (RQ1a), $\beta = -.17$, $t = -2.23$, $p = .03$ (see Figure 2). Specifically, those with more prior knowledge ($M+1SD$) elaborated more on the news story than their less knowledgeable counterparts ($M-1SD$) did, but no such difference was found with the graphic
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Second, there was a significant interaction between multimodality (text vs text + graphic) and issue involvement on news elaboration (RQ2a), $\beta = .20$, $t = 2.79$, $p = .006$ (see Figure 3). More involved individuals tended to show greater message elaboration when the text news was augmented with graphs, but less involved individuals did not show different levels of elaboration whether the news was presented in text alone or in multimodal form. In addition, prior knowledge and issue involvement had a significant interaction on news elaboration, $\beta = .15$, $t = 2.95$, $p = .003$; that is, those with more prior knowledge generated more thoughts relevant to the news story than those with less prior knowledge, but only when they were highly involved in the topic, $b = .80$, $t = 3.14$, $p = .002$. For less involved individuals, prior knowledge had no significant effect on news elaboration, $b = .07$, $t = 0.28$, $p = .78$.

**Figure 2.** Interaction between modality and prior knowledge on news elaboration.

**Figure 3.** Interaction between multimodality and issue involvement on news elaboration.
While interactivity had no significant effect on news elaboration, it exerted significant influence on news acquisition. First, there was a significant interaction between modality and interactivity, $\beta = .22, t = 2.35, p = .02$ (see Figure 4). When the interaction was decomposed, the use of hyperlinks significantly impaired news acquisition for the text-only news, with no corresponding effect for the graphic news. Second, interactivity had a significant joint effect with the participant’s prior knowledge ($RQ3b$), $\beta = .30, t = 3.99, p < .001$ (see Figure 5). Specifically, participants with less prior knowledge showed poorer news acquisition when they had to use hyperlinks than when they did not. By contrast, those with more prior knowledge acquired the news story equally well, whether or not they used hyperlinks. Meanwhile, interactivity had no significant interaction with the participant’s issue involvement on news acquisition, $t < 1$ ($RQ4b$).

Figure 4. Interaction between modality and interactivity on news acquisition.

Figure 5. Interaction between interactivity and prior knowledge on news acquisition.
When the same analysis was conducted for news evaluation, significant three-way interactions emerged (RQ1c and RQ3c), $\beta = .31, t=2.65, p = .01$ (see Figure 6(a)) and $\beta = .24, t=2.16, p = .03$ (see Figure 6(b)). Specifically, more knowledgeable participants rated the news article more favorably than their less knowledgeable counterparts only when they had read the text news without hyperlinks. When the news story contained either graphics or hyperlinks, more and less knowledgeable individuals showed no difference in their news evaluation. In addition, slope difference tests showed that the effect of prior knowledge on news evaluation in the text-only with no hyperlinks condition was significantly different from that in the text-only with hyperlinks condition, $t = -2.47, p = .01$, and the graphic-only with no hyperlinks condition, $t = -2.37, p = .02$. Such results were replicated when the comparison was made between the text-only and the text-plus-graphic conditions, as there was a significant difference between the slopes for the text-only with no hyperlinks condition and the text-only with hyperlinks condition, $t = -2.40, p = .02$.

Moreover, modality (text vs graphic) had a significant interaction with prior knowledge and issue involvement (RQ1c and RQ2c), $\beta = .17, t=2.35, p = .02$ (see Figure 7). When the news article was presented in graphs, only those low on both prior knowledge and issue involvement rated it more positively than the text-only article. Those high on
either prior knowledge or issue involvement did not evaluate the news story any differently, whether the article contained graphical components or not. Slope difference tests confirmed that the slope for those low on both prior knowledge and issue involvement differed significantly from those for others, $ts > -2.42, ps < .02$.

Finally, there was a significant interaction between interactivity and issue involvement on news evaluation (RQ4c), $\beta = -.27, t = -2.19, p = .03$. Those high on issue involvement rated the news story with no hyperlinks more positively than their less involved counterparts, $b = .51, t = 4.79, p < .001$, but the difference lessened when they used hyperlinks to read the news, $b = .18, t = 1.74, p = .08$.

**Discussion**

This study investigated how infographics, a recent development in online journalism used to augment user experience by adopting various modalities and interactive features, may affect the readers’ elaboration, acquisition, and evaluation of a news article. In doing so, competing theoretical possibilities as to how the addition of graphical components (cue summation theory vs limited capacity model) and interactivity (user engagement vs cognitive load) may affect individuals’ news acquisition were entertained. Overall, neither modality nor interactivity in itself significantly altered the way people processed and evaluated the news. Rather, they worked together with news readers’ prior knowledge and/or issue involvement to shape their news experience.

**Theoretical implications**

Graphical representation of information, when used in addition to the text, led the readers to process the news story more actively and engage in higher message elaboration, but such an effect was confined to those highly involved in the issue to begin with. For less involved individuals whose baseline motivation to process the news is relatively low, multimodal presentation failed to stimulate their news processing any further. When used alone, however, graphical representation of the information had a leveling effect on
news elaboration with respect to the news reader’s prior knowledge. That is, more knowledgeable individuals listed more message-relevant thoughts than their less knowledgeable counterparts, but only when they read the text news. When the news was presented in graphs, no significant difference was found in news elaboration between more and less knowledgeable individuals. Rather than aiding the processing of news for those lacking prior knowledge, the visualization of information seemed to constrain message elaboration among more knowledgeable individuals who otherwise would have shown a higher level of message-relevant thinking than their less knowledgeable counterparts.

On the other hand, when the graphs augmented the text news (text + graphic), more involved individuals elaborated on the news to a greater extent than when they read the text-only news, with no corresponding effect for less involved individuals. That is, multimodal presentations can serve as a catalyst to induce more active message processing among those with stronger interest in the topic, if not stimulating cognitive activity on its own. Moreover, the fact that there was no significant difference in more involved individuals’ news elaboration between the text-only and the graph-only conditions suggests that it is the repetition of information, rather than the information visualization per se, that facilitated message-relevant thinking. Interestingly, heightened elaboration among more involved individuals induced by the multimodal presentation did not lead to a better recognition of news information.

Although information visualization failed to enhance news acquisition, it yielded more positive news evaluation, at least among those lacking both the ability and the motivation to process incoming information. Apparently, graphical elements served as a peripheral cue to alter the participants’ news perception, such that only those less involved in and less knowledgeable about the focal topic were susceptible to their influence (Petty and Cacioppo, 1986). By contrast, those equipped with either the motivation to carefully scrutinize the news or the ability to assess its informational value did not rate the news differently, whether the information was presented verbally or visually. This result is consistent with previous findings that the interactivity of a website was positively associated with one’s affinity toward the candidate among politically apathetic participants (Sundar et al., 1998) or the evaluation of the product among those with low product involvement (Kim et al., 2008).

Unlike graphical representation of information, which had limited, yet largely positive, effects on news elaboration and news evaluation, the use of hyperlinks for sequential information presentation had a negative effect on news acquisition, albeit only in conjunction with the participant’s prior knowledge and the modality of news. First, those with less prior knowledge were less likely to obtain factual knowledge from the news when they needed to click the “Read More” buttons to read the full article as compared to when they viewed the entire article at once. By contrast, more knowledgeable participants appeared to better handle the additional demand incurred by the forced mouse clicks and showed a consistent level of news acquisition regardless of the hyperlinks. These results indicate that user-to-content interactivity, at least when operationalized in terms of forced behavioral engagement as in this study, can impair news knowledge acquisition among those with limited prior knowledge. Ironically, however, those with less prior knowledge tended to evaluate the news quality more favorably when the hyperlinks were present than absent, although such a difference was confined to the text-only
condition (see Figure 8). In fact, there was no significant association between news acquisition and news evaluation in general, $r = .08$, $p = .13$, which prompts researchers to look further into the disjunction between actual information gain and subjective evaluation of the news.

From a different perspective, it is noteworthy that more and less knowledgeable participants showed similar levels of news acquisition when no hyperlinks were used, but experienced a gap in news knowledge with the introduction of hyperlinks. That is, the negative influence of the behavioral demand was more pronounced among those lacking prior knowledge about the news topic, such that it ended up creating an information acquisition gap that did not exist otherwise. Just as those with lower cognitive capacity reported a lower level of suspense and less favorable evaluations of the interactive film when they were forced to choose the main character’s course of action (Vorderer et al., 2001), the use of hyperlinks to control the sequential rendition of the news article may have detracted readers’ attention from the news content, which was particularly detrimental for those with less cognitive resources at their disposal.

Interestingly, the negative effect of interactivity that hampers news acquisition dissipated when the news was presented in graphs. Although graphical representation of the news did not enhance information acquisition, it attenuated the memory-impairing influence of interactivity. Considering that the participants in the graph-only condition used the hyperlinks to view the graphs after a short one-sentence description of them, the shift in modality from text to graphs might have rendered the use of hyperlinks more natural. In the text-only condition, however, the participants had to click on the hyperlinks in the middle of the paragraph, which was likely to interfere with their message processing. At the very least, such findings indicate that not only the characteristics of the news audience but also other message features should be taken into account when implementing interactive features to ensure desired outcomes.

Finally, news readers’ prior knowledge and issue involvement jointly affected news elaboration. Specifically, those with more prior knowledge generated more
message-relevant thoughts than their less knowledgeable counterparts, but only when they perceived the topic to be personally relevant, important, and interesting. Alternatively, only when coupled with sufficient prior knowledge, higher issue involvement promoted message elaboration, collectively supporting the basic premise of ELM that predicts the joint influence of cognitive ability and motivation on effortful information processing (Petty and Cacioppo, 1986).

Limitations and future directions

Although the current research was primarily concerned with the effect of infographics on news acquisition, news elaboration was also examined to better understand why such an effect occurs. However, news elaboration and news acquisition showed a rather weak, albeit statistically significant, correlation, $r = .12, p = .02$. What is more, modality and interactivity had divergent effects on news elaboration and news acquisition, casting doubt on the role of elaboration as an underlying mechanism to account for the effect of infographics on information acquisition. Possibly, rather than supporting the acquisition of factual knowledge, news elaboration is more directly related to the degree to which people understand the interconnections among various news events (Eveland et al., 2004) or the socio-political implications of the reported events that cannot be gauged by multiple-choice questions. By conceptualizing news acquisition more broadly to entail such cognitive outcomes, future research needs to shed light on the possible cognitive changes the use of infographics may induce.

Another limitation of the current research concerns the way interactivity was operationalized, that is, those in the interactivity condition were forced to click the hyperlinks to view the remainder of the news article. Not only does such manipulation closely mirror the way interactivity is commonly implemented in infographics but it was also necessary to (a) ensure that those in the interactivity condition actually engage in user-to-system interaction and (b) preclude the self-selection effect. Still, it might actually have lowered perceived user control over information presentation, a core component of content interactivity (Eveland and Dunwoody, 2001). Because we did not measure how much control the participants felt they had over the news consumption process, no conclusion can be garnered in this regard. Notwithstanding, it seems imperative to address (a) how the use of hyperlinks affects perceived user control, or more generally, perceived interactivity and (b) how such perceptions alter the subsequent information processing. Moreover, future research should implement a wide range of interactive features beyond hyperlinks and empirically assess what kinds of interactive features enhance users’ subjective perceptions as well as actual learning.

In this study, we focused on the individual’s prior knowledge and issue involvement as the user characteristics that may modulate the influence of infographics on news experience, but other individual differences may also play a role in that process. For example, Messick (1984) suggested that cognitive style, defined as “individual differences in preferred ways of organizing and processing information and experience,” can alter learning performance, jointly with the presentation mode of information (p. 5). Depending on whether an individual tends to process information in words or via verbal association (i.e. verbalizers) or construct mental pictures when seeing or listening
information (i.e. imagers) (Riding and Cheema, 1991), the effects of graphics may well take divergent forms.

**Conclusion**

Overall, the current results suggest that information visualization serves the purpose of garnering more favorable evaluations from news readers, at least those who are less knowledgeable about and less involved in the focal topic. Although they did not learn any more from the graphic than from the text news, those lacking both the ability and the motivation to systematically process the news were more likely to rely on such a peripheral cue when judging the quality of news. Interactivity, on the other hand, turned out to interfere with less knowledgeable readers’ news acquisition. Although the hyperlinks did not take the participants to an external site and thus were not likely to cause disorientation, they still hindered knowledge acquisition among those with limited domain-specific knowledge. Taken together, these findings indicate that there is no one-size-fits-all answer to the question of when and how to utilize infographics in online journalism, demanding further empirical investigations.

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**Note**

1. Mayer (2005) lists two ways of conceptualizing channel differences, namely, the presentation-mode approach and the sensory-modality approach, and our definition of modality is more closely aligned with the former. We thank an anonymous reviewer for making this distinction between multicolality and multimodality.

**References**


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