



The Impact of Online News Features on Learning from News: A Knowledge Experiment

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Abstract: This study examines the impact of the use of multimedia, interactivity, and hypertext in Internet news reporting on learning from news. A knowledge experiment ($N = 53$) reveals that the use of multimedia, interactivity, and hypertext applications in online news indeed have an effect on recognition and cued recall, taking into account the level of difficulty of news content as well as users' Web expertise. Experienced Web users benefit from online features only if the news content is difficult, whereas the presence of online features results in a drop in inexperienced users' knowledge. Inexperienced Internet users benefit most from online features when the news content is easy, whereas in the latter case the scores of expert users tend to fall. This article provides insight into the way online features impact on the cognitive load and attitudes concerning news content and how these variables might mediate learning from online news. Online journalists could put these findings to their advantage when producing online news stories.

Keywords: Online news, multimedia, interactivity, hypertext, information-processing

Introduction

Today, online journalists produce online news in multiple ways. Thanks to digitization, one can make use of multimedia features (e.g., video, audio, and pictures), interactivity (e.g., users' reactions and polls) and hyperlinks to cover news. Since ever more news consumers mainly rely on online news to get informed (Pew Internet & American Life Project, 2010), the study of how these online features affect learning deserves our attention.

This focus on how people learn from news is far from new. Numerous studies have demonstrated that news consumers tend to misunderstand or forget considerable amounts of information presented by news media, particularly when consuming television news (Graber, 1988; Gunter, 1987; Robinson & Levy, 1986). Many of these studies used surveys to link news exposure to knowledge outcome. Confronted with contradictory and unsatisfactory results, scholars started to focus more on the cognitive processes taking place between news exposure and possible knowledge outcome. Experiments were set up to test the impact of different media on the learning outcome using cognitive theories in an effort to describe what happens in the information processing memory.

In this respect, the Limited Capacity Model of Motivated Mediated Message Processing (LC4MP) by Lang (2000, 2006) has been regularly used as a theoretical framework. This information-processing model proceeds on the assumption that news consumers are information processors with limited cognitive capacities. The processing of news begins at the very moment of exposure to news, including three sub-processes: encoding, storage, and retrieval. During encoding, sensory receptors store verbal, and visual information based on controlled and automatic selection, only transferring some of the information into the working memory. Storage is the process of linking new information to information stored earlier in the human memory, which consists of an associative network with nodes and associations. Retrieval constitutes the reactivation of previously stored information in order to comprehend and store new information bits. The degree to which information is actually processed depends on the cognitive efforts required for the sub-processes effectively resorted to by news users. Consequently, the better these three sub-processes are implemented, the more they will result in acquisition of knowledge. However, if the sub-processes are not fed with adequate cognitive resources, they will not be fully implemented, and acquisition of knowledge will not be ideal. Online news users may choose to allocate fewer resources to the processing than required, or else, the online news message may require more resources than online news user have at their disposal to invest in the task. Since users have but a limited amount of cognitive reserves, complex tasks may cause cognitive overload.

Another central element in Lang's model is the notion of two underlying motivation systems. Each individual has an appetitive system and an aversive system. These systems automatically respond to motivationally relevant stimuli. In short, the appetitive system is activated by pleasant or positive stimuli, while the aversive system is activated by unpleasant or negative stimuli (Lang, 2006; Lang, Bradley, & Cuthbert, 1997). This activation of the appetitive system influences the ongoing cognitive processing: stimuli that are novel or motivationally relevant will be better encoded (Lang, 2006). This focus on motivation is not new. Over time, more and more scholars started to study individual motivations and attitudes towards media as important mediators during the process of information processing (e.g., Blumler, 1979; David, 2009; Eveland, 2004). Motives and attitudes concerning media would not only influence exposure and attention, but also the way the information is processed. Eveland (2001) elaborates on this relationship between motivations, attention and information processing activities in his cognitive mediation model. This model states that motivations for media use stimulate attention to and elaboration of information, resulting in better learning. According to the Elaboration Likelihood Model (Petty & Cacioppo, 1986a, 1986b), people's involvement determines how likely one is to invest in the elaboration of relevant information. Petty and Cacioppo (1979, p. 1915) define involvement as "the extent to which the attitudinal issue under consideration is of personal importance". Following this, highly involved people are more willing to invest cognitive capacities than people with low involvement. Involvement can help users reduce or eliminate unwanted or superfluous information in an effort to facilitate information processing (Coyle & Thorson, 2001; Sicilia, Ruiz, & Munuera, 2005; Widing & Talarzyk, 1993).

With regard to online news, Eveland and Dunwoody (2002) argued that the presence of online key features enriches the search for information online. The level of multimedia, interactivity, and hypertext defines the way in which news consumers can control and scan through the content, choose the format in which information should be presented (Deuze, 2004), use hyperlinks (Eveland & Dunwoody, 2001), and discuss news online (Shah, Cho, Eveland, & Kwak, 2005). Although it is demonstrated that online news users do not always take great advantage of these features (Chung, 2008), they tend to consider the Internet with its specific features as serving more opportunities for gratification than other (traditional) media platforms (Dimmick, Chen, & Li, 2004). Consequently, we assume that when people face multimodal, interactive, and hypertextual news content online, they will perceive their news consumption process as more gratifying than when faced with online news messages lacking these features. The former will result in more positive attitudes and greater motivation that in turn can stimulate learning from news.

This article elaborates on how the presence of online features may impact learning by taking into account the effect on cognitive load and personal attitudes concerning online news content. It presents the results of an Internet experiment designed to measure knowledge acquisition during consumption of online news stories that are to varying degrees embellished with bells and whistles. Most importantly, this study analyses the combined impact of both complexity of the online task and the user's web expertise. This was hardly done before. Taking into account both factors is important because earlier research suggests that the complexity of information-processing of online features may cause cognitive overload which is likely to impede learning.

In the next section, we use the above mentioned insights to focus on multimedia, interactivity, and hypertext as key features of online news (e.g., Deuze, 2003), and to elaborate on how these may affect the information processing of online news.

The processing of online news features

Multimedia

Investigating the cognitive effects of multimedia is subject of a vast number of studies that elaborate on the different modalities in traditional media platforms. Scholars have demonstrated the positive cognitive impact of visuals on learning from television and print news (Brosius, 1991; David & Kang, 1998; Graber, 1990, 2001; Katz, Adoni & Parness, 1977). According to the dual-coding theory (Paivio, 1986) that distinguishes between two cognitive stores (one for verbal and one for visual information) in human memory, the combination of visual and verbal cues stimulates news users to store information in two ways, i.e., verbally and visually. As a consequence, the multimodal news is double-encoded and double-learned, resulting in better news recall (David, 1998; Gunter, Furnham, & Griffiths, 2000; van der Molen & van der Voort, 2000). In addition, it is demonstrated that the positive effect of multiple modalities is strongest when visuals and verbal cues are redundant and reinforce each other. In this case, visuals can serve as an extra retrieval cue to the information stored so that recalling the news becomes easier (Brosius, Donsbach, & Birk, 1996; Drew & Grimes, 1987; Lang, 1995; Reese, 1984; van der Molen & Klijn, 2004; Zhou, 2004). Lang (2000) argued that novel stimuli, like text on a television screen or pictures on a computer screen, can be considered as changes in the media environment that may elicit orienting behavior and automatic allocation of resources to encoding of news.

Nevertheless, it would be too simple to suppose that the use of several modalities will always lead to a thorough processing of information, for we know from the limited capacity model that there are limits to the cognitive efforts required for information processing. Cognitive overload may occur when more cognitive efforts are required than are available: human memory cannot cope with the amount of processing required, thus the information is inadequately processed. This seems especially the case when multiple information cues that are necessary to understand the story are physically separated. When faced with a split-source format news consumers are forced to split their attention between multiple sources of information and integrate these (Mayer, 2005). This mental integration, which is reduced when different modalities are physically and temporally integrated, increases cognitive load and might cause inefficient use of the cognitive resources available in the user's memory (Chandler & Sweller, 1992; Mayer & Moreno, 1998).

With online news it is possible to combine and to vary different modalities, even more so than with traditional media. In addition to text and images, online news articles may also include video footage, sound, slides shows, and informational graphics. Sundar and Limperos (2010) argue that this presence of multiple modalities may have a positive impact on perceptions of and attitudes concerning the online platform in that, for example, websites that provide live video feeds in addition to text are being perceived as more "real" than text-based sites. The authors argue that modalities like pictures and videos can create the experience of being present in distant locations and make a real-life experience possible during online consumption. Following the notion that positive attitudes and motivation have a positive impact on information-processing, we can assume that these modalities can positively influence learning.

The few studies that elaborate on the cognitive effects of multimedia in online news come to contradictory results. Berry (1999) found no significant differences between the retention of content presented in texts and multimedia formats. Sundar (2000) showed that text, and text combined with images, are the best triggers of memory and recognition, and that a more complex combination of different modalities, such as text, photographs, and sound, or text, photographs, and video is actually an obstacle to the processing of news. More recently, studies undertaken by the Poynter Institute (2004) registered the eye movements of 46 persons during online news consumption: it was found that multimedia have an adverse effect on retaining factual information (e.g., of names and place-names), whereas memory retention was better, in comparison with text messages, in the case of information the test persons were not familiar with.

In sum, it can be argued that the correspondence between visual and verbal cues and adequate cognitive load during production, online news embellished with multimedia features might stimulate attention and information processing. In this study's experiment, the ideal online version consists of some multimedia features (two photographs and one video) that correspond well with the text, although unnecessary to fully understand the story.

Interactivity

Building further on the literature (e.g., Cover, 2006; Heeter, 1989; Hodkinson, 2007; Kioussis, 2002; Rafaeli, 1988; Steuer, 1992; Sundar & Limperos, 2010; Wise & Reeves, 2007; Yun, 2007), interactivity is a complex concept that stands for control over content, personalization of content, adaptivity, responsiveness, feedback, openness, user-generated content, and so forth. In general, interactivity can be studied as the main characteristic of online environments with the potential to make the news reader part of the news experience (Deuze, 1999).

Due to interactive features of digital technologies, the media experience transforms from a passive into an active and engaging behavior; media users can engage with content in a personal way (Sundar, 2008).

Features allowing control over content (i.e., controlling selection, order, and presentation style of online news stories) tend to enhance concentration and motivation so that cognitive processes such as news attention and the making of associations between new and previously acquired knowledge happen more efficiently (Eveland & Dunwoody, 2002; Tremayne & Dunwoody, 2001; Wise, Bolls, & Schaefer, 2008). The general belief is that control over content not only attributes to more positive attitudes toward Websites, but also helps users reduce or eliminate unwanted or superfluous information so as to organize the information in a way that facilitates information processing (Coyle & Thorson, 2001; Sicilia et al., 2005; Widing & Talarzyk, 1993). Interactive features that stimulate the user to do something with the content evoke a heightened attention and stimulates the processing of news (Sundar & Constantin, 2004). In addition, findings by Kalyanaraman and Sundar (2006) illustrate that greater levels of personalized content provoke more positive attitudes towards the content itself and affect users' browsing activities (i.e., time spent online, returning to the site and number of searches).

Nevertheless, the large number of articles available and the absence of advising cues, combined with a good deal of control at the users' disposal, implies that online news users are likely to select information within their sphere of interest (Schoenbach, de Waal, & Lauf, 2005). This 'selective scanning' (Kosicki & McLeod, 1990) has positive sides, such as the enhancement of motivation and the encouragement of browsing according to one's own abilities, but it is also a hazardous habit. Some studies have shown that user's control over content negatively affects learning from online news (Southwell & Lee, 2004; Wise & Reeves, 2007). Control over content implies activities like navigating throughout the online environment and selecting a news item from a vast amount of news topics, at the expense of cognitive capacities. Consequently, a possible cognitive overload or disorientation may arise, thus reducing acquisition of knowledge.

The possibility to communicate online with others about a given news item on discussion forums, through email and users' reactions also impacts learning from online news. These interactive features are found to have a positive influence on the amount of time spent on the site and users' ability to recall news (Warnick, Xenos, Endres, & Gastil, 2005). Eveland (2004) contends that having a discussion about a news item may motivate users to invest in information processing. Other scholars (Kwak, Williams, Wang, & Lee, 2005; Lenart, 1994; Scheufele, 2000, 2002) also show that a (political) discussion may have a positive impact on knowledge, assuming that the use of interactive features stimulating online talks about the news may also foster information processing and knowledge acquisition. When using interactive features, news users not only have to think what to write about or respond to, they also have to decide whether or not they want to participate in the first place. We suggest that this self-directed inquiry or 'anticipatory elaboration' (Eveland & Thomson, 2006) positively affects attention to the news, resulting in increased learning. Then again, it is argued that the combined presentation of too many of these interactive features might cause cognitive overload (Warnick et al., 2005).

New media are also characterized by the presence of features that make it possible to rate and review items or stories. It is argued that online users rate content favored by other users as more worthy than those without users' evaluation (Sundar & Nass, 2001). Users now can rate and review for example hotels and books. This kind of information seems very important to other users, even so that users may feel disadvantaged when these bandwagon cues are not available. "This need of a bandwagon to jump on is a classic example of a need facilitated by user interactions with affordances offered by new media and was absent before" (Sundar & Limperos, 2010, p. 16).

In sum, interactive features that stimulate control over content or communication might contribute to increased information processing and news knowledge, as long as they do not lead to a feeling of disorientation or cognitive overload. Therefore, the embellished version in this study's experiment was featured with a limited amount of interactive features (i.e., five users' reactions below the article, a rating feature, and a poll in order to enhance users' interaction and engagement) without, however, provoking cognitive overload.

Hypertext

Since hyperlinks, more specifically navigational hyperlinks, are often considered as a form of interactivity (e.g., Deuze, 2003; Ruel & Wojdyski, 2009; Tremayne, 2008; Yun, 2007), the above insight into the influence of interactive features that enhance control over content also apply for hypertext. Moreover, Eveland and Dunwoody (2001) argue that the linkage of various chunks of text to one another by means of hyperlinks is in fact a copy of the way human memory functions. Both the hyperlink structure and the human memory are characterized by the linkage of several nodes. In human memory these nodes consist of previously acquired bits of information which are interconnected. In online news these nodes are different news messages or chunks of text connected to one another by hyperlinks, which in fact help the human memory by telling it which bits of

information belong together. The similarity between the human memory and the online hyperlink structure, or 'structural isomorphism' as Eveland and Dunwoody (2001) call it, implies that the presence of internal and external links enhances the storage of information and thus stimulates the processing of online news. The presence of hyperlinks may also positively influence the gratifications during online news consumption. The common activity of free navigation has become an important process gratification in the context of new media, to such a degree that the absence of these hyperlinks can lead to complaints (Sundar & Limperos, 2010).

However, here the presence of hyperlinks may cause a cognitive overload as well. If a news user is faced with hyperlinks, he or she will have to find out his or her whereabouts in the complex Web of online news. The larger the number of hyperlinks and the more often one is referred to other messages or other news media, the harder it becomes to find one's bearings. When the user no longer knows where he or she is and how the desired information is to be found, a feeling of 'being lost in cyberspace' (Conklin, 1987, p. 38) might emerge. It is argued that external hyperlinks in particular require additional cognitive efforts on the part of the user to find out where he or she is, which of course may result in cognitive overload (De Stefano & LeFevre, 2005). When hyperlinks cause disorientation, major sub-processes in dealing with news tend to some extent to be neglected, and the absorption of knowledge is adversely affected (Bucy, 2004; Eveland & Dunwoody, 2000; Lee, 2005). This tells us that hyperlinks may enhance increased information processing and news storage, but at the same time it can cause (perceived) cognitive overload, due to a feeling of disorientation.

In sum, the general picture emerging from studies on the impact of multimedia, interactivity and hypertext is that these structural features of online news all have the potential to increase knowledge by stimulating information processing and making news consumption more gratifying, but at the same time may provoke cognitive overload which in turn hinders the learning process.

Based on the above insights and theories about the impact of multimedia, interactivity, and hypertext on information-processing and attitudes, an embellished online version of different news stories was designed to investigate the impact on learning from news as compared to unembellished online versions of the same news stories. In other words, this study investigates the impact of the combined presentation of multimedia, interactive, and hypertextual features on the learning from online news. Since many of the theories and insights stem from studies that investigated traditional media like print and audiovisual media, a further elaboration of the impact of the form of online news is needed. As new media require new literacies, one can argue that new technologies have created a new environment for human thinking and learning and that the question rises whether the existing findings still stand. Taking into account the media logic of the Internet and online news, it may be that some findings with regard to the effect of traditional multimedia do not longer hold when studied in the context of online news. Moreover, this study investigates the possible impact of both the complexity of the online task and the users' Web expertise. Only few studies that elaborated on the impact of online features on learning from the online news included user's expertise and task complexity. This is rather surprising since many of the studies conclude that the complexity of the information-processing of online features may provoke cognitive overload. It is therefore necessary to ask the question if and how news users' digital experience facilitates their information-processing when faced with a difficult task or complex features. In our experiment we want to test how users with different levels of Web expertise cope with the complexity of online media platforms, and if and how they benefit or suffer from the presence of multimedia, interactivity and hypertext.

Hypotheses

This experiment seeks to examine the impact of the combined use of multimodal, interactive, and hypertextual features on learning from online news. To this end online news articles have been reworked: one set consisting of versions with text only (i.e., unembellished version), a second set consisting of versions with the same content as the previous set but with multimodal, interactive and hypertextual applications in a theoretically ideal way (i.e., embellished versions). Each test subject was exposed to four different news stories, two in the unembellished version and two in the embellished version. It is important to note that the content was left unchanged. In other words, factual information in the unembellished version was the same as in the embellished version so that possible differences in subjective knowledge could not be caused by differences in content.

We are aware of the fact that the combined manipulation of three variables in the embellished versions weakens the predictive power of the experiments in that it is rather hard to distinguish between the impact of e.g., multimedia features and that of the two other features. However, this distinction between ideal embellished versions and unembellished versions makes it possible to get theoretical and empirical insights into the different impact of two theoretical end-points on a continuum, i.e., ranging from no features at all to all possible features. The present experiment can serve as a starting point for future research on the impact of specific combinations of

multimodal, interactive, and hypertextual features, the impact of combinations lying somewhere in between those two end-points.

In other words, the rewriting of the news stories took into account the theories described above. Modalities, photographs, and video footage were selected to correspond with the text, although they were not necessary to understand the story. With regard to control over content, test users could navigate throughout the news story. However, they had no control over the selection and order of the news stories presented in the experiment, so as to reduce possible cognitive overload. Moreover, interactivity was stimulated by the presence of only five users' reactions at the end of each story, by a poll, and by a rating feature. With regard to hypertext, only internal links were used in order to avoid cognitive overload due to external hyperlinks. As a matter of fact, this procedure aimed at producing the 'ideal online news message', which is thought to elicit adequate information processing while at the same time not putting a heavy burden on the news consumer who is faced with a straightforward reading task.

H1. Embellished versions lead to more knowledge than unembellished versions.

In an effort to see whether the ideal embellished version still holds when faced with a complex reading task, the complexity of the text is also manipulated together with presentation style as independent variables. Indeed, it is argued that in addition to online features, the vocabulary, and syntax also require mental load (Bradley & Meeds, 2004; Bradley & Shapiro, 2004; Britton, Glynn, Meyer, & Penland, 1982). We assume that a complex text structure might put cognitive load on the news consumer, especially when presented in combination with online features like multimodality, interactivity, and hypertext. In this case the news user must invest cognitive resources to make use of the online features while simultaneously making sense of the textual information, which might lead to cognitive overload. The two levels of form (unembellished/embellished) and the two levels of complexity (easy/complex) were crossed so that four different versions (unembellished-easy/unembellished-complex/embellished-easy/embellished-complex) were presented to all participants, each version representing a different story. We predict the following:

H2. The effect of online features on knowledge will be less positive for complex news stories than for easy ones.

Next, we argue that the level of Web expertise has an impact on the way news consumers make use of online features and, as a consequence, on the way these features may enhance or harm information processing and knowledge acquisition. It has been demonstrated that there is a positive link between Web expertise and the correct use of online applications (Jenkins, Corritore, & Wiedenbeck, 2003) or between Web expertise and learning online news (Eveland & Dunwoody, 2001). A high level of Web expertise can reduce some 'useless' cognitive efforts or, as formulated by Eveland and Dunwoody (2000, p. 236): "As time passes and more people gain access to and make use of the Web on a regular basis, levels of expertise will increase to a high and uniform level, potentially reducing much of the existing cognitive preoccupation with orientation". We predict the following hypotheses concerning the relation between online features and Web expertise:

H3. Both for easy and complex stories, the presence of online features will have a greater positive effect on the knowledge of experienced Web users than on that of non-experienced Web users.

In an effort to provide support for the assumption made earlier, i.e., the combination of online features with difficult text structures negatively affects learning from news caused, at least partially, by cognitive overload, we predict the following:

H4. There will be an interaction between the form of online news and text complexity such that the adding of online features will cause more cognitive load with complex articles than with easy articles.

With regard to the impact of web expertise on cognitive load, we predict that:

H5. Both in unembellished and embellished stories, Web expertise is negatively related to cognitive load.

In order to elaborate on the influence of online features on the gratifications during online news consumption and learning, we investigate the impact of online news features on the users' affective evaluations. We predict that:

H6. News stories will be experienced as more informative, believable, important, enjoyable, and interesting, after addition of online news features.

Method

Design

The design of this repeated measurement experiment was a 2 (form) × 2 (level of complexity) × 4 (story) factorial design, formal features, complexity, and story being within subjects factors. As to formal features, the online stories were presented either in a unembellished (text only) or in an embellished version (text in combination with multimodal, interactive, and hypertextual features). The degree of complexity was also manipulated: news stories were presented either in an easy or complex version. Furthermore, four different stories were selected for manipulation to avoid any story-specific effects during repeated measurements and to make the study more generalizable. The articles selected for this experiment dealt with scientific subjects. The four subjects were the following: the development of a new kind of computer chip, the problems related to the construction of a new moon rocket, the destruction of a satellite, and a new arm prosthesis restoring active feeling. As a result, each participant was exposed to four different stories, each presented in one of the four versions (unembellished-easy/unembellished-complex/embellished-easy/embellished-complex). The order in which stories were presented to the participants was randomized in an effort to control any impact it might have.

Stimulus materials

The formal aspect of the online versions was taken care of by a professional webmaster. Photographs and video footage, while kept in the embellished versions, were removed from the unembellished versions. A number of pictures were replaced with more suitable ones; to some embellished versions few photographs and a YouTube video were added. Eventually each of the embellished versions included two photographs and one video fragment. It is important to notice that this manipulation of formal features did not change any factual information at all and that no further information for understanding the story was provided. Pictures and videos were selected so that they were not necessary to understand the news story. Moreover, questions measuring the objective knowledge were only referring to facts and figures that were presented in the text. For the sake of comparison, both an unembellished and embellished version of one of the four stories are provided in the Appendix (Figure A1 and A2). To manipulate the level of interactivity, a poll was integrated in the embellished versions asking a question in connection with the subject of the article. It was also possible to rate the news story. Moreover, at the end of the text five concocted reactions from readers were inserted. Furthermore, the article was introduced by a brief table of contents containing internal hyperlinks (or anchors) referring to specific passages in the article. The difference between the two versions consisted of the use of modalities (photographs and video footage), interactivity (rating, poll, and readers' replies), and hypertext (internal, navigational hyperlinks) in the embellished version, absent in the unembellished versions.

Similarly, the text complexity of each article was carefully controlled. The texts were rewritten by a professional journalist, producing an easy and a difficult version of each article under study. For the easy versions difficult sentences were rewritten. A narrative structure was also used instead of the typical inverted pyramid structure. Earlier research (Machill, Köhler, & Waldhauser, 2007) has shown that the narrative structure, which chronologically describes the different stages throughout the news story, is more straightforward to follow than the inverted pyramid structure, which places the most important aspects of the article first and then descends in levels of importance to the least important story elements. In the complex versions, by contrast, the inverted pyramid structure was retained and sentences were linked together, making them longer. A number of words were also replaced with more difficult synonyms. A pre-test showed that these interventions and changes in complexity did actually have the desired impact on reading behavior, so much so that there was a significant difference between easy and complex versions with regard to the level of complexity that readers experienced, $F(1, 29) = 36.84, p = .004$ and comprehensibility, $F(1, 29) = 6.13, p = .032$). Again, factual information was held constant during manipulation of complexity so that possible differences in knowledge could not be caused by differences in content.

Measurement

News knowledge was measured by cued recall and recognition, the two most sensitive measures that link the knowledge outcome with the sub-processes of the information processing during news consumption. Recognition can be used to measure the encoding of news, while cued recall is the measure that defines how well the information is stored in memory (Lang, 2000, 2006). Studies have benefited from the use of these measures to elaborate on the information processing (e.g., Eveland & Dunwoody, 2001; Grabe, Lang, & Zhao, 2003; Lang, Bolls, Potter, & Kawahara, 2003). To measure *cued recall*, participants were asked a number of open questions, such as “what are the advantages of the new computer chip”, and were given a sentence in which one or more words were omitted and which they were asked to recollect. A correct answer was given one mark and a cued-recall score was calculated with a maximum of five correct answers. *Recognition* was measured to find out how well the news was encoded by facing the test persons with a number of multiple-choice questions and by

showing them sentences asking them whether or not those sentences occurred in the text. The five questions related to names, dates, and other factual data from the text. A correct answer was awarded one mark, and in this way a recognition score was calculated, with a maximum of five correct answers.

The users' level of *Web expertise* was determined on the basis of the number of years they had been online as well as their familiarity with 11 Internet terms, which were each measured by a 5-item Likert question. The 11 Internet-related items were: Boolean commands, WMP, listserv, browser, bookmark, refresh, download, myspace, slideshow, PDF, and flash (Cronbach's $\alpha = .78$). The mean score of Web expertise was $M = 37.9$ ($Min = 17$, $Max = 58$, $SD = 8.0$). It is argued that the use of self-reports of familiarity with Internet-related items is a valid technique to measure Web-oriented digital literacy as familiarity with Internet-related items is identified as an important predictor of actual online skills (Hargittai 2005, 2009). The scores on the Web expertise scale were dichotomized (highest 50% versus lowest 50%) so that the participants were divided into two groups: experienced ($N = 26$, $M = 43.7$, $SD = 5.20$) and non-experienced ($N = 27$, $M = 31.4$, $SD = 4.95$). Although a dichotomization of scores can arguably cause a loss of statistical power (e.g., Taylor, West, & Aiken, 2006), this technique of using a high-low median split has been applied in many studies (e.g., David, 2009; Morgan & Jorm, 2009). In this study we opted for dichotomatization because of the small sample size of the test persons. The simple classification of the sample into 'high' versus 'low' Web expertise made the data more efficient and more straightforward. As a result, Web expertise was included as a binary covariate.

Following Eveland and Dunwoody (2001), *cognitive load* was measured by four semantic differential items of which two were positively worded and two negatively worded, with each a ten-point rating scale: during reading the article 1) I found it hard to follow the structure of the article; 2) I found that all information fitted well in the story (reversed); 3) I found that the article clearly dealt with the main parts (reversed); and 4) I sometimes felt lost (Cronbach's α was between .69 and .79 among the four versions). In order to measure *users' evaluations* of the test stories, the study reported here used five 10-point scale questions, ranging from (1) disagree to (10) agree. The evaluative measures were: during reading, I found this article 1) informative, 2) believable, 3) important, 4) interesting and 5) enjoyable.

Participants and procedure

The participants in the experiment were 53 communication graduate students from the Catholic University of Leuven, Belgium. The ages varied from 19 to 23, the average being 20; 16 respondents were male and 37 female. It could be feared that the overrepresentation of female participants would bias the impact of Web expertise on knowledge. However, gender and Web expertise were not significantly correlated ($p = .760$) with 56.3% of the male and 51.4% of the female participants considered as Web experts. Each test person was assigned to a computer. Four different news stories were presented, each representing one of the four different versions. After having read each story, the participants' knowledge, cognitive load and evaluations were assessed in a questionnaire. After completion of these tests, students were debriefed and received a present.

Results

Cued recall

As to formal features there was hardly any difference between the cued recall scores of the unembellished versions ($M = 2.80$) and the embellished versions ($M = 2.84$), $F(1, 51) < 1$, $p = .838$. News stories with online applications did not produce higher cued recall of news, independent of the degree of complexity and general Web expertise. Consequently, H1 is not supported. There was no significant interaction between formal features and the level of complexity on recall, $F(1, 51) < 1$, $p = .856$. Therefore, H2 cannot be supported.

With regard to the Web expertise (H3), we found a main effect on cued recall, $F(1, 51) = 7.78$, $p = .007$, $\epsilon^2 = .132$ ($M = 2.50$ for non-experts, $M = 3.13$ for experts). No interaction effect was found with the form of news: $F(1, 51) = 2.71$, $p = .106$, $\epsilon^2 = .050$. Consequently, H3 cannot be supported as far as cued recall is concerned. While not hypothesized, we found an interaction effect between Formal Features \times Level of Complexity \times Web Expertise: $F(1, 51) = 4.31$, $p = .043$, $\epsilon^2 = .078$. Figure 1 shows recall scores for expert Web users as well as for those without expertise. For easy stories the addition of online applications had a different effect, depending on the participants' Web expertise. Test persons with little expertise benefited from the embellished versions, their recall scores for these versions ($M = 3.24$) being higher than for the unembellished versions ($M = 2.36$).

Conversely, for easy news stories the recall scores of test persons with Web expertise were lower when exposed to stories with online applications ($M = 3.01$) than exposed to unembellished versions ($M = 3.48$). The impact of Web expertise is also noticeable in complex stories. Participants with little Web expertise saw their cued recall

scores drop slightly for embellished versions, while those with a good deal of Web expertise saw their average scores rise somewhat.

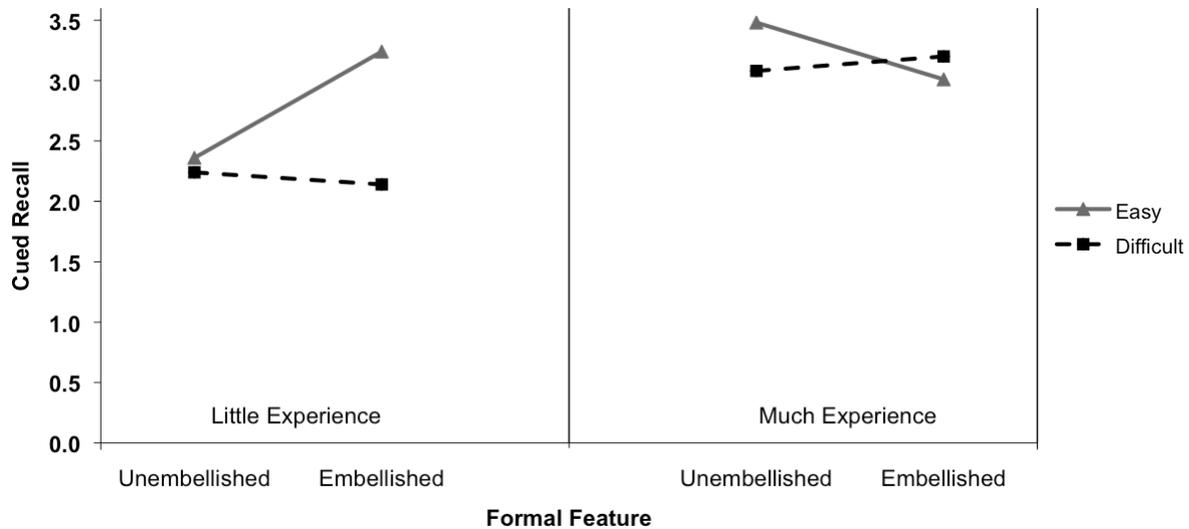


Figure 1. Effect of Formal Features × Level of Complexity × Web Expertise on cued recall of online news.

Recognition

Analysis shows that there was no main effect of form on the recognition of news. The average recognition score of those who were shown an embellished version ($M = 3.77$) was higher than of those who read the unembellished version ($M = 3.67$), but this difference was not significant, $F(1, 51) < 1, p = .476$. Therefore, H1 with regard to recognition is not supported.

With regard to H2, no interaction was found between the form and complexity of online news in that difficult stories in embellished versions were not recognized significantly less than their corresponding unembellished versions, and easy stories were not recognized better in embellished versions than in unembellished versions, $F(1, 51) < 1, p = .680$. As a consequence, H2 is not supported.

With regard to Web expertise, we found no significant main effect on recognition scores, $F(1, 51) = 3.63, p = .062, \epsilon^2 = .07$ ($M = 3.55$ for non-experts and $M = 3.88$ for experts), neither an interaction effect between expertise and form, $F(1, 51) = 1.19, p = .281, \epsilon^2 = .023$. Consequently, H3 cannot be supported as far as recognition is concerned.

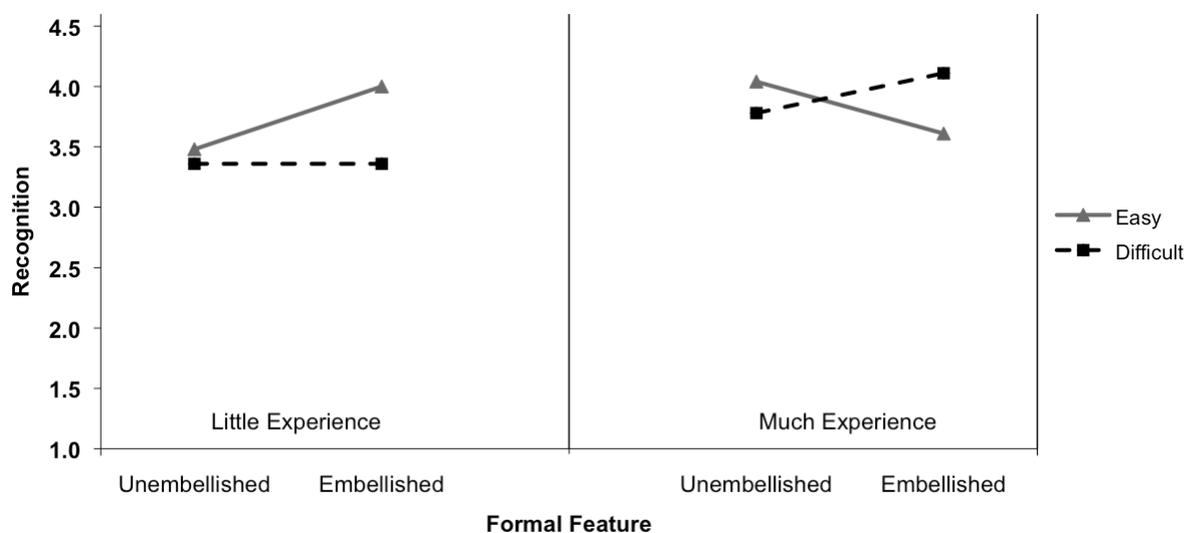


Figure 2. Effect Formal Features × Level of Complexity × Web Expertise on recognition of online news.

Further analysis indicated that Web expertise plays a role during information-processing of online news in that it interacts with both the form and complexity of online news. We found an interaction effect of Formal Features \times Level of Complexity \times Web Expertise, $F(1, 51) = 5.24, p = .026, \epsilon^2 = .093$. The relation between formal features and level of complexity shows a significant difference between participants with a good deal of Web expertise and those with little expertise (see Figure 2). In the case of easy news stories, the addition of online applications to text versions did not have the same effect on the recognition scores of Web users with and without expertise. For participants with little expertise the recognition score climbed from $M = 3.48$ to $M = 4.00$, whereas for Web users with a good deal of expertise, it fell from $M = 4.04$ to $M = 3.61$.

What we found for easy stories also applies to complex ones. The addition of online features had a different effect depending on whether the test persons were experts or not. For participants with Web expertise we found a higher recognition score in embellished versions ($M = 4.11$) than in unembellished versions ($M = 3.78$). For participants with little or no expertise we did not notice any rise in the score, suggesting that these participants did not benefit from a complex text presented with online features.

Cognitive load

We found a main effect of form on cognitive load scores, $F(1, 50) = 21.87, p < .001, \epsilon^2 = .304$. The cognitive load scores of unembellished versions ($M = 19.58$) were higher than those of embellished versions ($M = 16.18$). This is rather surprising since we produced theoretically-ideal versions of embellished articles preventing cognitive load from rising too high, but we did not expect that these embellished versions would produce lower scores of cognitive load than the text-based, unembellished version. In all, it seems that the addition of online news features lowered the cognitive load.

We found no interaction effect between form and complexity, $F(1, 50) = 1.23, p = .273$: complex stories in embellished versions did not cause a significantly higher cognitive load than their corresponding unembellished versions. As a consequence, H4 is not supported.

With regard to Web expertise, there was no main effect on cognitive load, $F(1, 50) = 1.15, p = .288, \epsilon^2 = .023$. Consequently, H5 cannot be supported.

What we found was a three-way interaction effect between Formal Features \times Level of Complexity \times Web Expertise, $F(1, 51) = 5.16, p = .027, \epsilon^2 = .094$. The relation between formal features and level of complexity shows a significant difference between participants with a good deal of Web expertise and those with little expertise (see Figure 3). In the case of easy stories the addition of online applications to text versions did not have the same effect on the cognitive load scores of Web users with and without expertise. For participants with little expertise the cognitive load scores decreased heavily from $M = 20.40$ to $M = 14.12$, whereas for Web users with a good deal of expertise it only fell from $M = 18.70$ to $M = 16.44$. In the case of complex stories, we found the opposite. For Web experts, the addition of online features lowered the scores from $M = 19.04$ to $M = 14.96$, while the decrease of cognitive load for those with little Web expertise was considerably less sharp ($M = 20.20$ vs. $M = 19.20$). It seems that the addition of online features has the greatest positive effect on non-experts exposed to easy news stories and on experts faced with complex news stories.

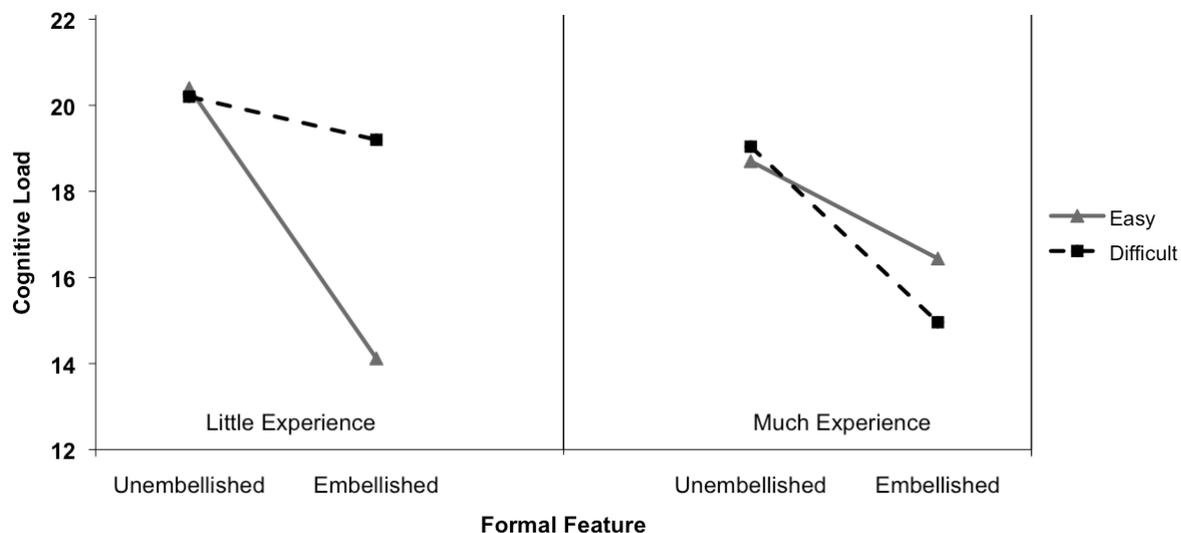


Figure 3. Effect Formal Features \times Level of Complexity \times Web Expertise on cognitive load.

In order to investigate the possible impact of cognitive load on the knowledge outcome, correlations were measured between the cognitive load scores and the knowledge scores in the four conditions. Results show that correlations are all negative, indicating that cognitive load indeed hampers the information-processing and the recognition and recall of news. It should, however, be noted that the scores were relatively low (between $-.15$ and $-.41$) with some of them being non-significant. This may be due to a lack of statistical power (due to the small sample size) or to the intervention of other variables that impact information-processing and that are left unmeasured in this study (e.g., attention and elaboration, see Eveland, 2001).

Evaluation of news stories

H6 predicted that in the news user's experience the addition of multimedia, interactive, and hypertextual features would make the test stories more informative, believable, important, enjoyable, and interesting. In general, embellished versions were rated as more informative, believable, important, enjoyable, and interesting than the unembellished versions (see Table 1). Only the importance rating proved to be significantly different, with embellished versions ($M = 7.15$) rated as more important than unembellished versions ($M = 6.50$) of the same stories.

Table 1
Effect of Addition of Online News Features on Participants' Evaluation of News Story

Variable	$F(1, 51)$	p	ϵ^2	Unembellished	Embellished
Informative	1.11	.297	.02	7.86	8.02
Believable	2.36	.130	.04	7.84	8.13
Important	9.07	.004	.15	6.50	7.15
Interesting	2.45	.123	.04	6.11	6.61
Enjoyable	2.91	.094	.05	5.51	5.95

Note. Values for embellished and non-embellished versions are on a 10-point scale.

Table 2
Interaction Effect Between Form \times Complexity \times Web Expertise on Participants' Evaluation of News Story

Variable	$F(1, 51)$	p	ϵ^2
Informative	< 1	.414	.01
Believable	< 1	.715	.00
Important	< 1	.616	.01
Interesting	5.06	.029	.09
Enjoyable	4.31	.043	.08

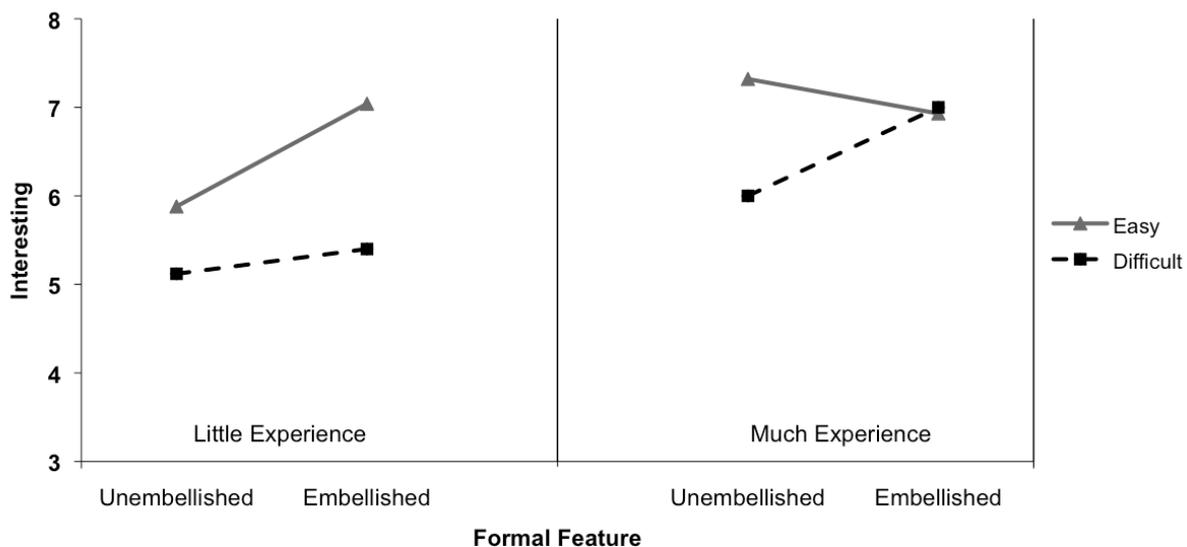


Figure 4. Effect Formal Features \times Level of Complexity \times Web Expertise on finding the news story interesting.

We found an interaction effect between Formal Features \times Level of Complexity \times Web Expertise on participants' evaluation of the story being interesting and enjoyable (see Table 2). Figure 4 shows the ratings on finding the news story interesting for expert Web users as well as for those without expertise. For easy stories the addition of online applications had a different effect, depending on the participants' Web expertise. Test persons

with little expertise benefited from the online versions, rating these versions ($M = 7.04$) higher than the text versions ($M = 5.88$). Conversely, for test persons with Web expertise the ratings were lower if stories were presented with online applications ($M = 6.93$) than in text versions only ($M = 7.32$). The impact of Web expertise is also noticeable in difficult stories. Both experts and non-experts evaluated the embellished complex stories as more interesting than the unembellished stories, but the rise of the experts' scores was more distinct ($M = 7.00$ vs. $M = 6.00$) than that of the non-experts ($M = 5.40$ vs. $M = 5.12$).

The same is true with regard to the rating of the article as enjoyable (see Figure 5). For easy stories, non-experts evaluated the embellished versions as more enjoyable ($M = 6.36$) than the unembellished versions ($M = 5.60$). Conversely, experts found easy stories in text ($M = 7.04$) more enjoyable than in an embellished version ($M = 6.25$). For these users, the addition of online features only makes sense in the case of complex articles in that the evaluative enjoyment scores climbed from $M = 4.86$ (unembellished) to $M = 6.18$ (embellished).

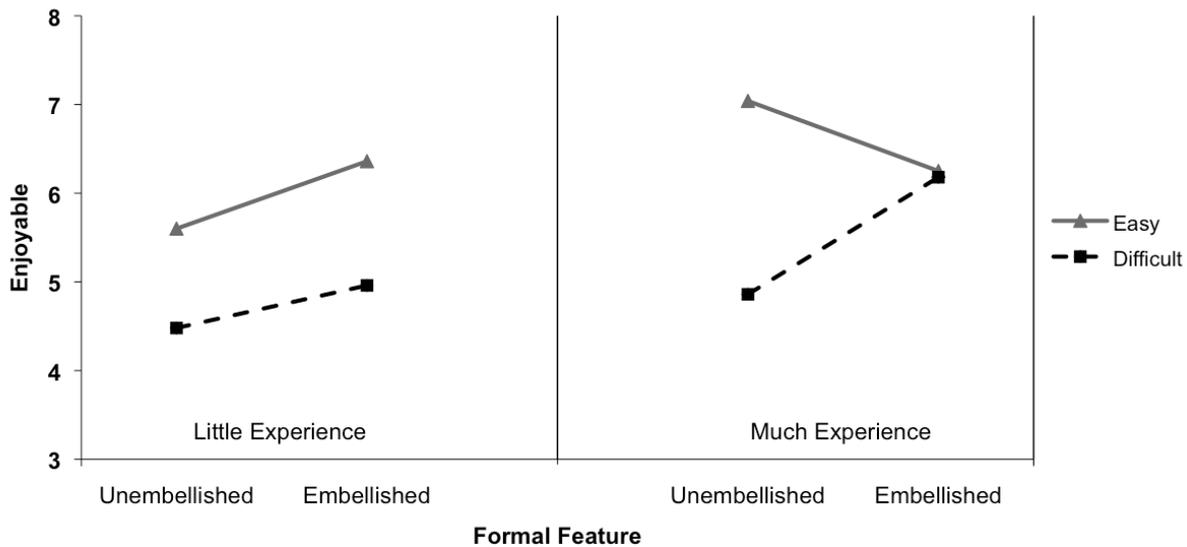


Figure 5. Effect Formal Features \times Level of Complexity \times Web Expertise on finding the news story enjoyable.

Discussion

The knowledge experiment described in this paper confirmed the belief that the addition of multimedia, interactive, and hypertextual applications to news articles indeed has an impact on the objective knowledge of news stories. However, the effect is not the same for each story version and for each kind of news user. Consequently, the main conclusion to be drawn from this experiment is that features of online news need to be studied in conjunction with the level of complexity of the story as well as the Web expertise already acquired by the news users.

The first point studied in the knowledge experiment was the question whether online features have an impact on the objective knowledge acquired from the news story. It is clear from the results that multimedia, interactive, and hypertextual features had no main effect on recognition and cued recall, and that there was no interaction effect with the level of complexity or Web expertise. This was rather surprising since we assumed that especially the combination of online features with a complex text might have made the information-processing much harder. Nevertheless, we found an interesting three-way interaction effect between form, text complexity and user's Web expertise, i.e., the impact of online features combined with the level of complexity was different depending on whether or not news users could rely on a good deal of Web expertise. In easy articles the addition of online applications had a positive effect on the knowledge acquired by news users with little Web expertise, whereas the effect was negative for expert users. Conversely, in complex articles we noticed that the addition of online applications raised the recognition and recall of news reports among readers with Web expertise. By contrast, these additions did not affect the knowledge acquired by inexperienced readers as it even dropped slightly.

In order to elaborate more on this interaction between the form of online news, the text complexity and the Web expertise, we investigated also the test person's cognitive load. Data proved that the addition of online features did make the cognitive load decrease, which make us believe that the manipulation of the test stories resulted in a more or less ideal online version with online features enriching the user's surfing experience but at the same

time not putting a cognitive burden on the user. Another possible explanation can be found in the measurement of cognitive load since it only measured the test person's self-reported cognitive load after each task. Future studies could benefit from including physiological measures such as heart rate and pupil dilation, neuro-imaging techniques or secondary-task measures in order to measure the complex construct of cognitive load in a more objective and direct way.

Again, we found a three-way interaction effect between the manipulated factors, with the cognitive load scores being similar to the knowledge scores. It seems that the addition of online features has the greatest positive effect (i.e., decrease of cognitive load) on non-experts exposed to easy news stories and on experts faced with complex news stories. In other words, non-experts suffered more from complex stories presented in embellished versions than from easy stories in the same version, while experts suffered more from easy stories in embellished versions than complex stories in that same version. This pattern is similar to that of the knowledge scores, indicating that there is a relationship between cognitive load and knowledge outcome.

This finding supports at least partially the assumption of the limited capacity model of Lang (2000, 2006) that cognitive load plays an important role during information processing and that the form of the medium can impact this mental load. The interaction effect makes us believe, however, that future studies towards the impact of online features on cognitive load and information processing should include measures of user's Web expertise and text complexity to address the impact of the medium on learning. It seems that some people might suffer from the addition of online features, but only when they are Web novices and when the text is rather complex. In this case, the online news was too hard to learn. In easy stories the online applications may have stimulated the inexperienced news user to think about the subject, and may have made sure that the information was stored in several ways without putting too heavy a burden on the cognitive system. With expert users the combination of complex articles with online applications did not seem to cause cognitive overload and their objective knowledge actually increased. By contrast, the combination of easy articles with online applications had a negative impact on their knowledge and on the cognitive load scores. We suspect that this negative effect emerged because expert readers did not find it a big enough challenge when presented with online versions of easy stories, and did not have to fully use their cognitive capacities; or perhaps, as argued by Treymane and Dunwoody (2001), the reason is that expert readers did not feel sufficiently involved in simple websites. The pattern of the affective scores provides support for this assumption, as the addition of online features made the complex article much more interesting and enjoyable for the expert users, while the evaluation of the easy article decreased. In this latter case, the news may have been too undemanding or too easy to learn from and expert readers might have had a negative cognitive response to this uncomplicated information. They benefited more from online applications in complex stories, which put their cognitive capacities more to use.

The same patterns of the knowledge scores, cognitive load scores, and evaluative scores can make us believe that there is a relationship between these three constructs, in that positive evaluations make the news user more engaged and active, resulting in a better information processing and better news recall and recognition. With regard to novice Web users, the addition of online features to complex stories may provoke a cognitive burden, while the addition of online features to easy stories makes news items less interesting for Web experts, resulting in worse information processing and lower knowledge scores. Future research should elaborate more on testing the causality of these assumptions.

The abovementioned results provide insight in the way news consumers learn from online news. Media scholars may benefit from taking this study's findings and suggestions into account in order to further elaborate on the complexity of online news media and the way they impact the user's learning. In general, media scholars should elaborate on existing insights and theories regarding multimedia, interactivity, and hypertext in combination with the user's medium expertise. The way news consumers learn from news seems to be at least partially influenced by the way they are experienced with a news medium (e.g., print, radio, television, online) and its accompanying formal features. Future research is needed in order to fine-tune the multiple existing theories in the context of different media environments, starting by including the user's medium expertise and task complexity. In addition, a more refined measurement of Web expertise should contribute to a better understanding of how formal features impact information-processing. Online journalists should take the possible positive and negative effects into consideration before deciding whether or not to add online news features. They should find the tipping point of online news presentation thanks to which human memory is not cognitively overloaded and boredom can be avoided.

Future research could benefit from taking several limitations of this study into account. A pre-test in which the manipulation of the theoretically ideal online version is tested could contribute to a more valid design. In the present study, the manipulations of the embellished versions were done based on findings and theories from previous studies. If we want to make valid conclusions based on ideal embellished versions vs. unembellished versions, a pre-test is needed to find out whether the embellished versions were indeed perceived as more ideal

than the text versions. Follow-up research could include more test versions and more test persons in order to better control for possible effects of test persons' characteristics on online news consumption behavior. Moreover, a follow-up study could benefit from including a think aloud protocol to investigate what people are really thinking when faced with online news. Think aloud protocols are often used in online media research (e.g., Hoppmann, 2009; Treymane & Dunwoody, 2001) to make test persons verbalize their cognitive processes, and can be used during or after a given task (see e.g., van den Haak, de Jong, & Schellens, 2003, for an overview of the differences between both methods). This method could be used to investigate the users' attitudes towards the presented information in order to test for example the earlier made assumption that experienced online news readers are bored when faced with embellished versions of easy stories. In addition, an eye-tracking experiment could provide more insight in what individual news consumers actually do and see on screen when confronted with different versions of online news content. It is clear that these in-depth techniques would address the possible internal heterogeneity caused by the relatively small sample and the different test news items, and could contribute to a better interpretation of the results gathered in this experiment.

References

- Berry, D. L. (1999, August). *Comprehension and recall of Internet news: A quantitative study of Web page design*. Paper presented at the Association for Education in Journalism and Mass Communication, New Orleans, LA.
- Blumler, J. G. (1979). The role of theory in uses and gratifications studies. *Communication Research*, 6, 9–36.
- Bradley, S. D., & Meeds, R. (2004). The effects of sentence-level context, prior word knowledge, and need for cognition on information processing of technical language in print ads. *Journal of Consumer Psychology*, 14, 291–302.
- Bradley, S. D., & Shapiro, M. A. (2004). Parsing reality: The interactive effects of complex syntax and time pressure on cognitive processing of television scenarios. *Media Psychology*, 6, 307–333.
- Britton, B. K., Glynn, S. M., Meyer, B. J. F., & Penland, M. J. (1982). Effects of text structure on use of cognitive capacity during reading. *Journal of Educational Psychology*, 74, 51–61.
- Brosius, H.B. (1991). Format effects on comprehension of television news. *Journalism Quarterly*, 68, 396–401.
- Brosius, H. B., Donsbach, W., & Birk, M. (1996). How do text-picture relations affect the informational effectiveness of television newscasts? *Journal of Broadcasting & Electronic Media*, 40, 180–195.
- Bucy, E. P. (2004). The interactivity paradox: Closer to the news but confused. In E. P. Bucy & J. E. Newhagen (Eds.), *Media access: Social and psychological dimensions of new technology* (pp. 47–72). Mahwah, NJ: Erlbaum.
- Chandler, P., & Sweller, J. (1992). The split-attention effect as a factor in the design of instruction. *British Journal of Educational Psychology*, 62, 233–246.
- Chung, D. S. (2008). Interactive features of online newspapers: Identifying patterns and predicting use of engaged readers. *Journal of Computer-Mediated Communication*, 13, 658–679.
- Conklin, J. (1987). Hypertext: An introduction and survey. *IEEE Computer*, 20(7), 17–41.
- Cover, R. (2006). Audience inter/active: Interactive media, narrative control and reconceiving audience history. *New Media & Society*, 8, 139–158.
- Coyle, J. R., & Thorson, E. (2001). The effects of progressive levels of interactivity and vividness in Web marketing sites. *Journal of Advertising*, 30(3), 65–77.
- David, C. C. (2009). Learning political information from the news: A closer look at the role of motivation. *Journal of Communication*, 59, 243–261.
- David, P. (1998). News concreteness and visual-verbal association: Do news pictures narrow the recall gap between concrete and abstract news? *Human Communication Research*, 25, 180–201.

- David, P., & Kang, J. (1998). Pictures, high-imagery news language and news recall. *Newspaper Research Journal*, 19, 21–30.
- De Stefano, D., & LeFevre, J.-A. (2005). Cognitive load in hypertext reading: A review. *Computers in Human Behavior*, 23, 1616–1641.
- Deuze, M. (1999). Journalism and the Web: An analysis of skills and standards in an online environment. *International Communication Gazette*, 61, 373–390.
- Deuze, M. (2003). The Web and its journalisms: Considering the consequences of different types of news media online. *New Media & Society*, 5, 203–230.
- Deuze, M. (2004). What is multimedia journalism? *Journalism Studies*, 5, 139–152.
- Dimmick, J., Chen, Y., & Li, Z. (2004). Competition between the Internet and traditional news media: The gratification-opportunities niche dimension. *The Journal of Media Economics*, 17, 19–33.
- Drew, D., & Grimes, T. (1987). Audio-visual redundancy and TV news recall. *Communication Research*, 14, 452–461.
- Eveland, W. P. (2001). The cognitive mediation model of learning from the news. Evidence from nonelection, off-year election, and presidential election contexts. *Communication Research*, 28, 571–601.
- Eveland, W. P. (2004). The effect of political discussion in producing informed citizens: The roles of information, motivation and elaboration. *Political Communication*, 21, 177–193.
- Eveland, W. P., & Dunwoody, S. (2000). Examining information processing on the World Wide Web using think aloud protocols. *Media Psychology*, 2, 219–244.
- Eveland, W. P., & Dunwoody, S. (2001). User control and structural isomorphism or disorientation and cognitive load? Learning from the Web versus print. *Communication Research*, 28, 48–78.
- Eveland, W. P., & Dunwoody, S. (2002). An investigation of elaboration and selective scanning as mediators of learning from the web versus print. *Journal of Broadcasting & Electronic Media*, 46, 34–53.
- Eveland, W. P., & Thomson, T. (2006). Is it talking, thinking, or both? A lagged dependent variable model of discussion effects on political knowledge. *Journal of Communication*, 56, 523–542.
- Grabe, M. E., Lang, A., & Zhao, X. (2003). News content and form: Implications for memory and audience evaluations. *Communication Research*, 30, 387–413.
- Graber, D. A. (1988). *Processing the news: How people tame the information tide* (2nd ed.). New York: Longman.
- Graber, D. A. (1990). Seeing is remembering: How visuals contribute to learning from television news. *Journal of Communication*, 40, 134–155.
- Graber, D. A. (2001). *Processing politics: Learning from television in the Internet age*. Chicago: University of Chicago Press.
- Gunter, B. (1987). *Poor reception: Misunderstanding and forgetting broadcast news*. Hillsdale, NJ: Lawrence Erlbaum.
- Gunter, B., Furnham, A., & Griffiths, S. (2000). Children's memory for news: A comparison of three presentation media. *Media Psychology*, 2, 93–118.
- Hargittai, E. (2005). Survey measures of web-oriented digital literacy. *Social Science Computer Review*, 23, 371–379.
- Hargittai, E. (2009). An update on survey measures of web-oriented digital literacy. *Social Science Computer Review*, 27, 130–137.

- Heeter, C. (1989). Implications of new interactive technologies for conceptualizing communication. In J. L. Salvaggio & J. Bryant (Eds.), *Media use in the information age* (pp. 217–235). Hillsdale, NJ: Erlbaum.
- Hodkinson, P. (2007). Interactive online journals and individualization. *New Media & Society*, 9, 625–650.
- Hoppmann, T. K. (2009). Examining the ‘point of frustration’. The think-aloud method applied to online search tasks. *Quality & Quantity*, 43, 211–224.
- Jenkins, C., Corritore, C. L., & Wiedenbeck, S. (2003). Patterns of information seeking on the Web: A qualitative study of domain expertise and Web expertise. *IT and Society*, 1(3), 64–89.
- Kalyanaraman, S., & Sundar, S. S. (2006). The psychological appeal of personalized online content in Web portals: Does customization affect attitudes and behavior? *Journal of Communication*, 56, 110–132.
- Katz, E., Adoni, H., & Parness, P. (1977). Remembering the news: What the picture adds to recall. *Journalism Quarterly*, 54, 231–239.
- Kiousis, S. (2002). Interactivity: A concept explication. *New Media & Society*, 4, 355–383.
- Kosicki, G. M., & McLeod, J. M. (1990). Learning from political news: Effects of media images and information-processing strategies. In S. Kraus (Ed.), *Mass communication and political information processing* (pp. 96–83). Hillsdale, NJ: Erlbaum.
- Kwak, N., Williams, A., Wang, X., & Lee, H. (2005). Talking politics and engaging politics: An examination of the interactive relationships between structural features of political talk and discussion engagement. *Communication Research*, 32, 87–111.
- Lang, A. (1995). Defining audio/video redundancy from a limited-capacity information processing perspective. *Communication Research* 22, 86–115.
- Lang, A. (2000). The limited capacity model of mediated message processing. *Journal of Communication*, 50, 46–70.
- Lang, A. (2006). Using the limited capacity model of motivated mediated message processing to design effective cancer communication messages. *Journal of Communication*, 56, 557–580.
- Lang, A., Bolls, P., Potter, R. F., & Kawahara, K. (1999). The effects of production pacing and arousing content on the information processing of television messages. *Journal of Broadcasting & Electronic Media*, 43, 451–457.
- Lang, P. J., Bradley, M. M., & Cuthbert, B. N. (1997). Motivated attention: Affect, activation, and action. In P. J. Lang, R. F. Simons, & M. T. Balaban (Eds.), *Attention and orienting: Sensory and motivational processes*. Hillsdale, NJ: Erlbaum.
- Lee, M. J. (2005). Expanding hypertext: Does it address disorientation? Depends on individuals' adventurousness. *Journal of Computer-Mediated Communication*, 10, article 6.
- Lenart, S. (1994). *Shaping political attitudes: The impact of interpersonal communication and mass media*. Thousand Oaks, CA: Sage.
- Machill, M., Köhler, S. & Waldhauser, M. (2007). The use of narrative structures in television news. An experiment in innovative forms of journalistic presentation. *European Journal of Communication*, 22, 185–205.
- Mayer, R. E. (2005). *The Cambridge Handbook of Multimedia Learning*. Cambridge: University Press.
- Mayer, R. E., & Moreno, R. (1998). A split-attention effect in multimedia learning: Evidence for dual processing systems in working memory. *Journal of Educational Psychology*, 90, 312–320.
- Morgan, A. J., & Jorm, A. F. (2009). Recall of news stories about mental illness by Australian youth: Associations with help-seeking attitudes and stigma. *Australian and New Zealand Journal of Psychiatry*, 43, 866–872.

- Paivio, A. (1986). *Mental representations: A dual coding approach*. Oxford: University Press.
- Petty, R. E., & Cacioppo, J. T. (1986a). *Communication and persuasion: Central and peripheral routes to attitude change*. New York: Springer.
- Petty, R. E., & Cacioppo, J. T. (1986b). The elaboration likelihood model of persuasion. In L. Berkowitz (Ed.), *Advances in experimental social psychology* (vol. 19, pp. 123–205). San Diego, CA: Academic Press.
- Petty, R. E., & Cacioppo, J. T. (1979). Issue involvement can increase or decrease persuasion by enhancing message-relevant cognitive responses. *Journal of Personality and Social Psychology*, 37, 1915–1926
- Pew Internet & American Life Project (2010). Understanding the participatory news consumer. How internet and cell phone users have turned news into a social experience. Retrieved from http://www.pewinternet.org/~media/files/reports/2010/PIP_Understanding_the_Participatory_News_Consumer.pdf
- Poynter Institute (2004). *Eyetrack III: Online news consumer behavior in the age of multimedia*. Retrieved from <http://www.poynter.org/uncategorized/24963/eyetrack-iii-what-news-websites-look-like-through-readers-eyes/>
- Rafaeli, S. (1988). Interactivity: From new media to communication. In R. P. Hawkins, J. M. Wiemann & S. Pingree (Eds.), *Sage annual review of communication research: Advancing communication science: Merging mass and interpersonal processes*, 16 (pp. 110–134). Newbury Park, CA: Sage.
- Reese, S. D. (1984). Visual-verbal redundancy effects on television news learning. *Journal of Broadcasting*, 28, 79–87.
- Robinson, J. P., & Levy, M. R. (1986). *The main source. Learning from television news*. Beverly Hills, CA: Sage.
- Ruel, L., & Wojdyski, B. W. (2009, August). *Effects of hyperlink density on Web page reading: An eyetracking study*. Presented at the Association for Education in Journalism and Mass Communication (AEJMC) Annual Convention, Boston, MA.
- Shah, D. V., Cho, J., Eveland, W., & Kwak, N. (2005). Information and expression in a digital age: Modeling Internet effects on civic participation. *Communication Research*, 32, 531–565.
- Scheufele, D. A. (2000). Talk or conversation? Dimensions of interpersonal discussion and their implications for participatory democracy. *Journalism & Mass Communication Quarterly*, 77, 727–743.
- Scheufele, D. A. (2002). Examining differential gains from mass media and their implications for participatory behavior. *Communication Research*, 29, 46–65.
- Schoenbach, K., de Waal, E., & Lauf, E. (2005). Online and print newspapers: Their impact on the extent of the perceived public agenda. *European Journal of Communication*, 20, 245–258.
- Sicilia, M., Ruiz, S., & Munuera, J. L. (2005). Effects of interactivity in a web site: The moderating effect of need for cognition. *Journal of Advertising*, 34(4), 31–45.
- Southwell, B. G., & Lee, M. (2004). A pitfall of new media? User controls exacerbate editing effects on memory. *Journalism & Mass Communication Quarterly*, 81, 643–656.
- Steuer, J. (1992). Defining virtual reality: Dimensions determining telepresence. *Journal of communication*, 42, 73–93.
- Sundar, S. S. (2000). Multimedia effects on processing and perception of online news: A study of picture, audio, and video downloads. *Journalism and Mass Communication Quarterly*, 77, 480–499.
- Sundar, S. (2008). The MAIN model: A heuristic approach to understanding technology effects on credibility. In M. J. Metzger & A. J. Flanigan (Eds.), *Digital media, youth, and credibility* (pp. 72–100). Cambridge, MA: The MIT Press.

- Sundar, S. S., & Constantin, C. (2004, May). *Does interacting with media enhance news memory? Automatic vs. controlled processing of interactive news features*. Paper presented at the annual meeting of the International Communication Association, New Orleans, LA.
- Sundar, S. S. & Limperos, A. (2010, June). *Uses & grats 2.0: Do new technologies bring new gratifications?* Paper presented at the annual meeting of the International Communication Association, Singapore.
- Sundar, S. S., & Nass, C. (2001). Conceptualizing sources in online news. *Journal of Communication*, 51, 52–72.
- Taylor, A. B., West, S. G., & Aiken, L. S. (2006). Loss of power in logistic, ordinal logistic, and probit regression when an outcome variable is coarsely categorized. *Educational and Psychological Measurement*, 66, 228–239.
- Tremayne, M. (2008). Manipulating interactivity with thematically hyperlinked news texts: A media learning experiment. *New Media & Society*, 10, 703–727.
- Tremayne, M., & Dunwoody, S. (2001). Interactivity, information processing, and learning on the World Wide Web. *Science Communication*, 23, 111–134.
- van den Haak, M., de Jong, M. D. T., & P. J. Schellens (2003). Retrospective vs. concurrent think aloud protocols: Testing the usability of an online library catalogue. *Behaviour & Information Technology* 22, 339–351.
- van der Molen, J. H. W., & Klijn, M. E. (2004). Recall of television versus print news: Retesting the semantic overlap hypothesis. *Journal of Broadcasting & Electronic Media*, 48, 89–107.
- van der Molen, J. H. W., & van der Voort, T. H. A. (2000). The impact of television, print and audio on children's recall of the news. *Human Communication Research*, 26, 3–26.
- Warnick, B., Xenos, M., Endres, D., & Gastil, J. (2005). Effects of campaign-to-user and text-based interactivity in political candidate campaign web sites. *Journal of Computer-Mediated Communication*, 10, article 5.
- Widing, R. E., & Talarzyk, W. W. (1993). Electronic information systems for consumers: An evaluation of computer-assisted formats in multiple decision environments. *Journal of Marketing Research*, 30, 125–141.
- Wise, K., & Reeves, B. (2007). The effect of user control on the cognitive and emotional processing of pictures. *Media Psychology*, 9, 549–566.
- Wise, K., Bolts, P., & Schaefer, S. (2008). Choosing and reading online news: How available choice affects cognitive processing. *Journal of Broadcasting & Electronic Media*, 52, 69–85.
- Yun, G. W. (2007). Interactivity concepts examined: Response time, hypertext, role taking, and multimodality. *Media Psychology*, 9, 527–548.
- Zhou, S. (2004). Effects of visual intensity and audiovisual redundancy in bad news. *Media Psychology*, 6, 237–256.

Appendix

Toekomstige maanraket heeft de bibber

De opvolger voor de huidige ruimtelandel bestaat alleen nog maar op papier, maar simulaties tonen extreme trillingen.

Ingenieurs van de ruimtevaartorganisatie NASA werken op dit moment aan het gedetailleerde ontwerp van de raket, die in 2015 voor het eerst astronauten moet vervoeren. Het gaat om de Ares 1.

De Ares I is, om te besparen, gebaseerd op Space Shuttle-technologie. De eerste trap van de Ares I is in feite een aangepaste versie van de hulpraketten op poederbrandstof waarvan elke shuttle er bij zijn lancering twee heeft. Boven op de Ares I moet een bemande capsule, de Orion, worden geplaatst. Het geheel van Ares I en Orion moet in het volgende decennium de ruimtelandel vervangen, onder meer om Amerikaanse astronauten van en naar het ruimtestation ISS te brengen. Bij de maanexpedities die de Nasa vanaf 2020 wil gaan ondernemen, wordt de bemanning met de Orion-capsule in de ruimte gebracht met een Ares I, terwijl een veel krachtiger raket, de Ares V, het zware materieel voor de expeditie lanceert.

Maar nu blijken er problemen te zijn. Het is de eerste rakettrap op poederbrandstof van de Ares I die voor de moeilijkheden zorgt. Dat blijkt tenminste uit simulaties op de computer, want in het echt bestaat de Ares I nog niet. De raket zou last hebben van ongewenst krachtige trillingen.

Er circuleerden al een tijdje geruchten over het trillingsprobleem, maar de NASA heeft die altijd ontkend. Pas toen journalisten van het persbureau Associated Press en van de watchdog-website Nasawatch.com de Nasa gingen bestoken met gedetailleerde technische vragen (getipt door insiders) en de wet op Openbaarheid van Bestuur inriepen om documenten te kunnen inzien, gaf de ruimtevaartorganisatie toe dat er moeilijkheden waren.

Berekeningen laten zien dat (normale) trillingen die ontstaan door turbulentie in de uitlaatgassen, de verbrandingskamer van de raketmotor zullen doen meetrillen. Een soortgelijke trilling kan zich voordoen in een auto, als een of ander onderdeel bij een bepaalde snelheid plots fel begint te rammelen. De raketmotor zelf zou tegen die trillingen bestand moeten zijn, maar de hogere trappen van de raket en de erop geplaatste Orion-capsule (en de astronauten zelf) misschien niet.

Michael Griffin, de directeur van de NASA, minimaliseert nu de ernst van de moeilijkheden: 'Ik hoop dat er niemand zo slecht ingelicht was te denken dat we een systeem om de shuttle te vervangen, zouden kunnen ontwikkelen zonder op een probleem te stoten. De NASA heeft een uitstekende ervaring om deze problemen te overwinnen. Ik heb er vertrouwen in dat we deze ook zullen oplossen.'

Interne documenten van de NASA maken al melding van een uitstel van een half jaar tot een jaar voor de eerste proefvluchten van de Ares I-raket. De ingenieurs moeten nu het ontwerp van de raket zo zien te wijzigen dat de trillingen wegblijven, ofwel moeten de trillingen worden gedempt.

Antoon Van Buynder

woensdag 7 mei 09u03

Figure A1. Text and easy version of story 1.

Toekomstige maanraket heeft de bibber

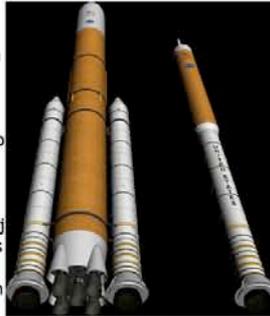
De opvolger voor de huidige Space Shuttle bestaat alleen nog maar op papier, maar simulaties tonen extreme trillingen.

1. [Nieuwe raket: Ares I](#)
2. [Problemen](#)
3. [NASA minimaliseert](#)
4. [Uitstel](#)
5. [Beoordeel artikel](#)
6. [Poll](#)
7. [Reacties lezers](#)

Nieuwe raket: Ares I

Ingenieurs van de ruimtevaartorganisatie NASA werken op dit moment aan het gedetailleerde ontwerp van de raket, die in 2015 voor het eerst astronauten moet vervoeren. Het gaat om de Ares I.

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rechts de Ares I, links de veel grotere Ares V voor vrachtovervoer

Problemen

Maar nu blijken er problemen te zijn. Het is de eerste rakettrap op poederbrandstof van de Ares I die voor de moeilijkheden zorgt. Dat blijkt tenminste uit simulaties op de computer, want in het echt bestaat de Ares I nog niet. De raket zou last hebben van ongewenst krachtige trillingen.

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simulatie van lancering Ares I (geluid start na 35 seconden)

poll

Was het nodig om de Space Shuttle te vervangen door de nieuwe Ares I?

- Ja, want de vorige raketten waren niet meer veilig.
- Nee, mits enkele aanpassingen aan de vorige was deze nieuwe Ares I niet nodig

(continued)

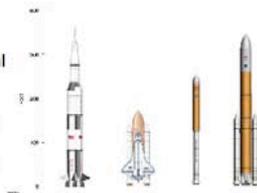
Figure A2. Online and easy version of story 1.

NASA minimaliseert

Michael Griffin, de directeur van de NASA, minimaliseert nu de ernst van de moeilijkheden: 'Ik hoop dat er niemand zo slecht ingelicht was te denken dat we een systeem om de shuttle te vervangen, zouden kunnen ontwikkelen zonder op een probleem te stoten. De NASA heeft een uitstekende ervaring om deze problemen te overwinnen. Ik heb er vertrouwen in dat we deze ook zullen oplossen.'

Uitstel

Interne documenten van de NASA maken al melding van een uitstel van een half jaar tot een jaar voor de eerste proefvluchten van de Ares I-raket. De ingenieurs moeten nu het ontwerp van de raket zo zien te wijzigen dat de trillingen wegblijven, ofwel moeten de trillingen worden gedempt.



Hier zie je de Space Shuttle (tweede van links) die vervangen wordt door de Ares I (tweede van rechts)

Antoon Van Buynder

woensdag 7 mei 09u03

Beoordeel dit artikel:

- zeer interessant interessant matig niet interessant
 helemaal niet interessant

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4 reacties

Jan Defauw uit Beveren

De NASA minimaliseert meestal problemen, maar we weten allemaal hoe het met de Columbus en de Space Shuttle is afgelopen. Ze zouden beter grote aandacht vestigen op deze problemen, daarvoor dienen de computersimulaties immers.

Beledigend? Ongepast? [Meld het ons](#) 21/04/08 12u04

Pieter De Geest uit Kortrijk

Ale, het wordt dus de Ares I in combinatie met de Ares V die als eerste leven in de ruimte zal ontdekken. Ik ben benieuwd ...

Beledigend? Ongepast? [Meld het ons](#) 21/04/08 11u48

Veronique VM uit Wetteren

Wel logisch dat ze verderbouwen op het onderstel van de Space Shuttle, al vraag ik me af of je dan niet de problemen gaat overnemen, zoals nu al blijkt. Hoe dan ook hoop ik dat deze Ares I veiliger zal zijn en dat er dus geen doden meer zullen vallen.

Beledigend? Ongepast? [Meld het ons](#) 21/04/08 11u34

Karel De K. uit Sint-Truiden

Het werd tijd dat ze eens aan een opvolger voor de Space Shuttle gingen denken. Hopelijk krijgt de Amerikaanse luchtvaart een nieuwe boost met deze nieuwe raket

Beledigend? Ongepast? [Meld het ons](#) 21/04/08 11u18

Figure A2. Online and easy version of story 1 (continued).