# Utilizing the Effects of Priming to Facilitate Text Comprehension

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## Abstract
Due to the ever-growing amount of textual information we face in our everyday life, the skill of scanning and absorbing the essence of a piece of text is crucial. We cannot afford to read every text in detail, hence we need to acquire strategies to quickly decide on the importance of a text and how to grasp its content. Additionally, the sheer amount of daily reading makes it hard to remember the gist of every text encountered. Research in psychology has proposed priming as an implicit memory effect where exposure to one stimulus influences the response to a subsequent stimulus. Hence, exposure to contextual information can influence comprehension and recall. In our work we investigate the feasibility of using such an effect to visually present text summaries that are quick to understand and deliver the essence of a text in order to help readers not only make informed decisions about whether to read the text or not, but also to build out more cognitive associations that help to remember the content of the text afterward. In two focus groups we discussed our approach by providing four different visualizations representing the gist and important details of the text. In this paper we introduce the visualizations as well as results of the focus groups.

## Author Keywords
priming; reading interfaces; comprehension;


**Figure 1:** Tag cloud as visualization technique for text priming.


**Figure 2:** Mind map visualization.

## ACM Classification Keywords

H.5.m. [Information Interfaces and Presentation (e.g. HCI)]: Miscellaneous

## Introduction

Reading is an ancient activity traditionally taken up for knowledge gain and pleasure. With the rise of the information age we are facing an abundance of information on a daily basis. With the introduction of multimedia, information is tailored more broadly to our various senses. However, reading remains the primary channel to consume information. The skill to read and absorb information quickly has become vital in both the private and professional sector.

When presented with a text people generally face the two challenges of 1) quickly deciding whether the text is worth reading and 2) comprehending and committing its contents to memory. Therefore, as readers we have different strategies to gain an overview of a text or book, for example by skimming through the text or reading the table of contents first [3]. This pre-knowledge of what to expect from a text before actually reading it has been shown to increase comprehension [2]. What in psychology is called the *Priming Effect* we want to utilize to make readers engage with the content of a text before actually reading it in detail. Therefore, we automatically extract the general essence of a text in form of keywords and build visualizations which are presented to the reader. These visualizations can further be used to support the reader during reading to maintain structural overview. After reading the visualizations may serve as memory aid in form of a summary to retain the text in memory.

In this paper we present four different visualizations to prepare the reader's mind before reading a text. We are building a system that automatically extracts the key content from a text and visualizes the result in these four ways: as 1) a tag cloud (Fig.1), 2) a mind map (Fig.2), 3) an image collage (Fig.3) and 4) an in-text highlighting of keywords (Fig.4). To collect early feedback on the feasibility of our concept we conducted two focus groups investigating the effects of such visualizations on the reader before, during and after reading. We are planning to integrate our system in an ebook reader or application to study its feasibility long-term, measuring usefulness, memory effects and collecting feedback on what type of texts this technique can be best applied to.

## Background and Related Work

The concept of Priming is taken from the field of psychology where it describes an implicit memory effect: by exposing users to a current stimulus a response to another stimulus is triggered in the future [1].

In a series of studies Bransford *et al.* [2] investigated comprehension and recall for text when readers were given relevant contextual knowledge before actually engaging with a passage. Thereby comprehension and recall scores went up as subjects were exposed to context cues before reading the corresponding passage, confirming a positive priming effect.

More generally, Stanovich and Cunningham [6] concluded that the sheer amount of reading alone influences language skills and the size of people's vocabulary. They apply the "Matthew effects" to reading, which - taken from a Bible passage - describes the concept of a rich-get-richer and poor-get-poorer phenomenon. Hence, poor readers tend to expose themselves to less text than their more skilled peers, thereby increasingly corrupting their reading skill level. Hence, it is worthwhile to

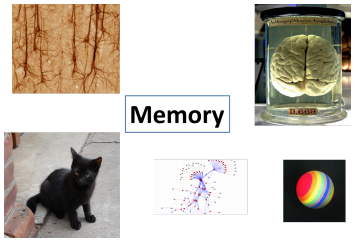


**Figure 3:** Image view visualization (images used are under the CC license).

Research in psychology has proposed priming as an implicit memory effect where exposure to one stimulus influences the response to a subsequent stimulus.

**Figure 4:** Highlighted keywords within a text.

investigate how we can lower the threshold to engage in reading activities and whether we can achieve this by providing pre-summaries of text acting as reading motivation and facilitation.

Some tools to get an overview over a text have been in use for quite long, such as indices, concordances, lexicons and other structured keyword lists. Paley [4] created visualizations as alternative views of entire books exposing frequency and distribution of words on a single page or screen. Paley claims that such visualizations support another level of understanding and help revealing chapters dealing with a specific topic. However, such massive visualizations can be quite overwhelming due to their complexity. Hence, we set out to explore this visualization space in more detail to determine what text types might be more appropriate for using such techniques, what are possible effects on reading comprehension, text discardability and recall and during which reading stage are visualizations most useful: pre-, during or post-reading.

## System

Our system consists of a keyword extraction engine based on the topic models of the open source library scikit-learn [5]. It basically receives a text and outputs a list of most descriptive keywords based on a bag-of-words model. We then take these keywords and visualize them in one of four ways:

**Tag Cloud** A visual cloud (see Fig.1) made up of single words as tags where the font size indicates the importance of that word regarding the text content and where the font color can be used to group tags into semantic units, such as chapters or strings of argumentation.

**Mind map** A visual diagram (see Fig.2) where associated keywords orbit a central topic in the middle. Again, concepts or semantic units can be locally grouped together.

**Image Collage** Items are placed similar to a mind map layout, but instead of words, images represent the content (Fig.3). Therefore our system uses image sources, such as *Flickr*, to request images for each extracted keyword.

**In-text Highlighting** As opposed to the visualizations described above, this technique is not a separate visualization, but can be applied directly to the text. Hence, the extracted keywords are highlighted throughout the text by using a font background color (Fig.4).

## User Study

To collect initial qualitative feedback on our approach we conducted a focus group investigating the effects such visualizations may have on the reader.

*Methodology*

The focus group was conducted in two sessions with four participants each, which lasted about 90 minutes. The participants were university students with different backgrounds between 19 and 24 (M=22,25, SD=1,67), three female, five male. The native language of everyone was German. Each focus group was presented four different texts with one visualization per text. The texts and the visualizations were in German. For our initial study the visualizations were manually created, for the tag cloud we used *Tagxedo* [1]. To broaden the focus group discussion we chose different styles of text, namely: fiction, news, and science. We randomly assigned visualization types to text types: hence the tag cloud

[1] http://www.tagxedo.com

visualized a fictional text, the mind map summarized a news article, the image collage a scientific article and in-text highlighting was used for an abstract of a scientific paper. Discussions were recorded in a written protocol.

*Procedure*
After being introduced to the procedure of the study and the general concept of priming, participants were asked to provide some demographic information, such as age and gender. The main part of the focus group comprised discussions of the four visualizations, which we split into three phases: first, participants were handed the corresponding visualization before reading the actual text. Both visualization and text were printed on paper. After letting the participants read the text discussions started about whether and in what way the visualization facilitated the reading task and text comprehension. In the second phase, participants were asked how helpful the visualization would be after the actual reading of the text (e.g. as a memory aid) and how the perception of the visualization as a summary tool had changed. Finally, the third phase comprised a discussion of the visualization's design aspects. We did this for each of the four visualizations (as depicted in Fig. 1, 2, 3 and 4) with one different text for each visualization. For each text, averaging 305 words, we gave participants sufficient time to read. In the end we asked participants to compare the different visualizations and provide further feedback regarding concept and usage context of such visualizations.

*Results and Discussion*
In this section we discuss the results of the focus group sessions regarding the general concept and the visualizations in order to determine their general usefulness as support before, during and after the reading process.

**Pre-Reading Support** The visualizations were perceived as an aid to get a rough idea of what the text could be about. Here some participants found the mind map or the image view most helpful. It was remarked that the general topic could be extracted from the visualizations. Although the visualizations were generally considered helpful, they sometimes also caused confusion. Especially in the pre-reading phase: when facing unknown text, some content in the visualizations did not make sense for the participants. In some cases the keywords were even found misleading. One participant said that the mental image based on the visualization did not match the actual content of the text. Post-hoc, however, the participants reported that the initial confusion had cleared up and all parts of the visualizations were understood. In the pre-reading phase, visualizations also helped participants to recall previous knowledge of the topic. Furthermore, it was mentioned that visualizations could also help to decide whether the text was relevant for a certain topic, and hence could be used to discard a text before actually reading it.

**During-Reading Support** With the visualizations at hand, participants found it easier to keep an overview of the structure of the text and to single out the important parts. One participant stated that the mind map visualization helped to structure the text while another said the in-text highlighting helped to pay attention to important parts of the text. It was further stated that while skipping through the highlighted text, not only single words, but entire sentences should be highlighted.

**Post-Reading Support** All participants stated that they would use the visualizations as a memory aid when they needed to retain the texts' contents in memory. Particularly, they stressed the usefulness for their studies .

After looking at the visualization again, rough content and some cues could be placed within their context. One participant had doubts about the usefulness of pictures as a memory aid after a long period of time and supposed textual cues would be more helpful. These effects should be investigated in further user studies. Another participant found post-reading support more important than pre-reading support.

**Comments on design and content** An important characteristic often mentioned was the effort with which the meaning of the visualization could be perceived. If a lot of time was required looking at the visualization, it was regarded as less beneficial. Participants said they had to look longest at the tag cloud, whereas the content of the image view visualization was perceived quickest. Design should aim for a *"less cluttered"* approach containing only the most important information.

Generally, the participants wished that visualizations existed for scientific or *"long, difficult texts and lecture notes"* to ease understanding and facilitate the learning process. Visualizations for fictional texts were even considered potentially problematic because they were rather simple to understand and the readers might create their own mental images which did not fit to the given visualization.

During the study no clear preference for one type of visualization could be observed. For each visualization there were positive as well as negative reactions regarding their helpfulness. Especially the use of images as cues was controversial: some participants stated they found images most helpful, while others considered them least informative and preferred textual cues. The design did not seem to be the sole deciding factor for usefulness, but rather content as well as type of the visualization influenced participants' perception. To investigate these additional influences and to compare the usefulness of different designs, we are planning a series of in-depth studies focusing on scientific articles. Visualizations for this text type were stated most useful by the participants.

## Design Implications

Participants gave us some direction how automated text visualizations could help before, during and after reading. Summarizing participants comments we outline the following design implications:

- The reader should be able to get a brief idea of the text. To support this, the general structure of the text should be mirrored in the visualization.
- The visualization should help readers to maintain an overview of the text especially during the reading phase.
- High-quality keyword retrieval is needed for creating visualizations that users can trust, e.g. through appropriate topic model algorithms.
- Too dense and cluttered visualizations should be avoided and keywords should be reflecting the most important aspects of the text, making the visualizations easy to understand.
- Visualizations should support the retrieval process in the post-reading phase. Single keywords as cues can trigger recall of entire text passages and more in-depth details.
- The cues given, particularly images, should be as unambiguous as possible to avoid potential confusion.

- Visualizations should be editable especially when they were used as memory aids so that readers could add their own thoughts.
- Visualizations should not hinder the reading process. Seven participants complained that the bright color of the in-text highlighting approach bothered their flow of reading. Thus, when offering in-text visualizations, they should be designed in a rather subtle way.

## Conclusion and Future Work

We presented a concept to apply the effects of priming to reading activities. Therefore we are building a system that automatically extracts relevant keywords and important details from a text for visualization purposes. We came up with four different approaches to create such visual text summaries with the goal of communicating the gist of a text to a reader. By looking over such visualizations prior to engaging with the text in detail, readers are supposed to get an overview of its contents in order to be able to decide whether to read the text or not and to create mental associations a priori to help foster long-term memorization. We reported findings from two focus groups from which we were able to derive some design guidelines for such visualizations and their usage before, during and after reading a text. We are planning on creating a system that automatically extracts the most descriptive keywords from a text and creates such visualizations, so that they can be used in e-readers and reading applications. In a series of studies we want to investigate users' perception of the quality of the extraction algorithm, the acceptance of such visualizations and their effects on reading comprehension, memory recall and whether they are sufficient to discard a text or read in detail.

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## References

[1] Baddeley, A., Eysenck, A., and Anderson, M. *Memory*. New York: Psychology Press, 2009.

[2] Bransford, J. D., and Johnson, M. K. Contextual prerequisites for understanding: Some investigations of comprehension and recall. *Journal of verbal learning and verbal behavior 11*, 6 (1972), 717–726.

[3] Liu, Z. Reading behavior in the digital environment: Changes in reading behavior over the past ten years. *Journal of documentation 61*, 6 (2005), 700–712.

[4] Paley, W. B. Textarc: Showing word frequency and distribution in text. In *Poster presented at IEEE Symposium on Information Visualization*, vol. 2002 (2002).

[5] Pedregosa, F., Varoquaux, G., Gramfort, A., Michel, V., Thirion, B., Grisel, O., Blondel, M., Prettenhofer, P., Weiss, R., Dubourg, V., et al. Scikit-learn: Machine learning in python. *The Journal of Machine Learning Research 12* (2011), 2825–2830.

[6] Stanovich, K. E., and Cunningham, A. E. What reading does for the mind. *Journal of Direct Instructions 1*, 2 (2001), 137–149.