Institute for Visualization and Interactive Systems

Universität Stuttgart
Pfaffenwaldring 5A
D–70569 Stuttgart

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Investigating the Effect of Priming on Reading Performance on Electronic Devices

Katrin Angerbauer

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Examiner: Prof. Dr. Albrecht Schmidt

Supervisor: Dipl.-Medieninf. Tilman Dingler

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Abstract

Reading is an activity needed almost everywhere in daily life. Through reading we are not only able to extract meaning from a text, but also to extend our knowledge of the world and to foster other cognitive abilities. In the age of information technology, reading behaviour has been subject to change. With more information made accessible through the internet and e-reading devices, the time spent reading increases. Further, it is reported that reading on computers and other electronic devices tends to be shallower and abilities like browsing over a document to get the gist of its content become more important.

In this thesis we want to investigate the usage of text visualizations to facilitate the reading activities on electronic devices, with special focus on reading comprehension. We want to make use of the memory psychological “priming effect” by presenting the reader with a visualization of the text’s content before the actual reading activity, and thus giving the opportunity to get familiar with the information contained in the text prior to reading. To create those visualizations we developed a first prototype, which is capable of extracting keywords of a text and visualizing them. Additionally, we present certain important design aspects of text visualizations, which were discovered through a preliminary study. The presented concepts were evaluated in a user study and are considered as a starting point for future research. With the contributions of this work we aim to support readers with reading activities. Facilitated reading could help to lower the hurdle to read more and therefore foster the gain of knowledge.

Kurzfassung

Die Fähigkeit des Lesens wird fast überall in unserem Alltag benötigt. Durch Lesen erfassen wir nicht nur die Bedeutung eines Texts, sondern erweitern unser Wissen und andere geistige Fähigkeiten. Im IT-Zeitalter ändert sich auch unser Leseverhalten. Über das Internet und e-Reader sind mehr Informationen zugänglich und so nimmt auch die Zeit zu, die wir mit Lesen verbringen. Lesen auf elektronischen Geräten neigt Studien zufolge außerdem dazu oberflächlicher zu sein und es wird immer wichtiger, den groben Inhalt eines Texts durch Überfliegen zu erfassen.

In dieser Arbeit soll untersucht werden ob Textvisualisierungen in der Lage sind, das Lesen auf elektronischen Geräten zu erleichtern, insbesondere in Bezug auf das Textverständnis. Hierzu möchten wir den gedächtnispsychologischen „Priming Effekt“ ausnutzen, indem wir dem Leser schon vor dem eigentlichen Lesen eine visuelle Zusammenfassung des Inhalts präsentieren. Diese soll dem Leser ermöglichen, sich schon vor dem Lesen mit den Inhalten des Texts vertraut zu machen. Um solche Visualisierungen zu erstellen, wurde ein Prototyp entwickelt, der automatisch die Schlüsselworte eines Texts extrahiert und diese visuell darstellt. Wichtige Design Eigenschaften von Textvisualisierungen werden ebenfalls erläutert. Die vorgestellten Konzepte wurden durch eine Nutzerstudie evaluiert und können Ausgangspunkt für spätere Forschung in diesem Bereich bilden.

Mit den Erkenntnissen dieser Arbeit möchten wir dazu beitragen das Lesen auf elektronischen Geräten zu erleichtern. Unterstütztes und einfacheres Lesen könnte Lesern helfen, mehr zu Lesen und damit schließlich auch den Gewinn neuen Wissens fördern.

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1 Introduction

"The more you read, the more things you will know." (Dr. Seuss)[1]

Writers of children's books like Dr. Seuss would say that reading is some kind of magical power that can take the reader to all kinds of amazing places only by imagining. Reading is one of the first things we have to learn in school and the quote above could certainly be a good motivator for children to do so. But this quote also contains a fact, which can be validated by research. Indeed, there is actually more to reading than just being a technique to extract meaning from a sequence of letters, but also helps us to develop a variety of cognitive abilities such as verbal expression and our understanding of the world.

A book or a piece of text is an excellent contributor to one's vocabulary and knowledge, as written text is far more richer in expression than spoken word or media like television shows. Additionally text can contain rare words that are not commonly used in daily conversation. Avid reading therefore has significant impact on the ability to express oneself [49].

Cunningham and Stanovich [49] even speak of "Matthew Effects" of reading, describing a "rich get richer, poor get poorer"- phenomenon. According to their research comprehension ability and reading volume are in a reciprocal relationship, i.e. the more you know the more you read. For readers with a broader knowledge base reading is simpler [10] and associated with a small amount of effort and a more positive experience, as for readers which struggle to comprehend the text. Positive experience can be a great motivator and so avid readers are in a positive feedback loop, because they also learn quicker and more, than those who read less. Those, who read less, have noticeable differences in vocabulary development, which again is counterproductive to their reading activities [49].

But how can we facilitate reading in an age of information overflow? The Internet makes information accessible and present almost ubiquitously. This development has impact on our reading behaviour as Liu shows [31]: due to the digital environment our reading habits have also have been subject to change. Naturally, with more information available, the time spent on reading increased, specifically the amount of work related reading. On the other hand, reading patterns get more shallow and fragmented as people read in less depth to cope with the high amount of information and only read a text as a whole, if it proves to be relevant. The ability to scan and browse a text for valuable information therefore becomes increasingly important.

This thesis wants to investigate how we can use the possibilities of technology to facilitate and adapt the reading to those developments. More specifically, we want to determine whether visual text summaries can help the reader to understand a text. Here, we want to make use of the memory psychological priming effect by presenting the reader with a visualization of the text's content before the actual reading activity, thus giving the opportunity to get familiar with the information contained in the text prior to reading. The

[1] in: *I Can Read with Me Eyes Shut!*

visualizations we propose in this thesis contain important keywords of the text and visualize those in different forms such as tag cloud or a collection of pictures.
To create those visualizations we developed a first prototype, which is capable of extracting keywords of a text and visualizing them.
Further, we present certain important aspects of text visualizations, which we discovered through a preliminary study and refined in the final user study. In this final user study we evaluated our concepts in a user study and consider them as a starting point for further research.
In short, the contributions of this thesis are:

a. the proposition of four visualization types that could be used to prime the reader,
b. design suggestions regarding those visualizations,
c. a first prototype automatically creating such visualizations and
d. the evaluation of the concepts through a user study.

With these contributions we aim to facilitate reading activities through the use of visualizations. This could help to lower the hurdle to read more and therefore foster the gain of knowledge.

The remaining chapters of this thesis are structured as follows:

Chapter 2 describes the related work this thesis is founded on. **Chapter 3** presents the proposed visualizations that could be used to prime the reader. **Chapter 4** illustrates the procedure and the findings of the preliminary study. **Chapter 5** explains the developed prototype. **Chapter 6** is about the user study conducted to examine the effects of the proposed concepts. **Chapter 7** discusses the results of the study and its consequences for the prototype. **Chapter 8** draws a conclusion and outlines future work. The **Appendix** contains the visualizations of the user study.

2 Related Work

This thesis is founded on research in the fields of Psychology, explores suitable means of information visualisation and thereby aims to support the reader. In this chapter related work is presented that provided scientific ground as well as inspiration for this work.

2.1 The Priming Effect

When a stimulus subconsciously influences the processing of the following stimulus psychologists say a priming effect has occurred. Influencing stimuli, the so-called primes, can have an effect on memory processing tasks [5] and even can go so far as influence our behaviour [6]. For example, social psychology has shown that certain stimuli delivered through advertising can increase the appetite and that some primes can even foster aggression [23]. Behavioural priming is only mentioned for the sake of completeness, in this thesis the priming effect referred to is the effect on memory processing.

A priming effect can be of positive or negative nature and one talks about a positive or negative priming effect respectively. Negative priming effects make processing more difficult, while positive ones make it easier. This facilitation can even be measured via an reduced blood flow in the brain when processing previously primed targets [5].

An important distinction made in memory psychology is the one between explicit and implicit memory. Of explicit memories we are conscious and we are able to explicitly recall them, while implicit memory contains all our subconscious memories. The priming effect does occur in implicit memory, and can be considered as a proof that there exist multiple memory systems. Experiments with amnesiac patients which showed strong impairment on explicit memory tasks, but could perform implicit memory tasks well, underlined that theory [45]. Priming therefore seems to be uninfluenced by age or drugs on the contrary to explicit memory [54].

Priming effects can be observed at a wide range of tasks. Typical implicit memory testing methods, where the participants are primed with stimuli beforehand, are the following (with examples for the prime “apple”)[39] :

a. *word stem completion*, participants have to complete word stems like A P _ _ _

b. *word fragment completion* of _ P_ L _

c. *anagram solving,* task to rearrange “plape” to a sensible word

d. word identification tasks.

Rajaram and Roediger [39] execute the tasks mentioned above with different primes in regard to modality (auditory or visual priming), form (word or picture) and typeface and evaluated which prime achieved the greatest effect. According to their finding within-modality priming, i.e. show visual primes for visual tasks and auditory for auditory ones, was the best in all four tasks.

How long the priming effect is retained in memory depends on the method of priming as well as the task primed for, and can vary greatly, some effects last merely seconds while others last over days [35,53]. Ratcliff and McKoon [41] tried to explain this with different models for short-term and long-term priming effects. Furthermore they state priming effects should not be regarded as a unitary effect but rather as an effect with many faces. It is very difficult to determine how exactly they are caused and influenced as our memory till today remains a very multifaceted construct.

2.2 Reading, Comprehension and Learning from Texts

Depending on the goal we want to achieve with a reading task, we employ different reading techniques. When we are looking for specific information or want to get a quick overview of the text's content, we read in a shallower manner than when we explicitly want to learn and understand the information given more thoroughly.

Thayer et al. [51] distinguished several reading techniques, which are as follows:

a. *scanning,* an activity to locate specific information one is looking for in a text.
b. *search reading* another reading technique to look for information but without a specific target in mind
c. *skimming* follows the text's structure.
d. *receptive reading* involves reading from the beginning to the end.
e. *responsive reading / active reading* , occurs when the reader engages with the ideas presented in the text, for example by taking notes.

The first three reading methods are more superficial ones whereas the last two are more in-depth strategies actually fostering the gain of knowledge.

Liu [31] furthermore mentions the activities of *keyword spotting,* where one browses over the text taking in the important keywords as well as *picture reading*, where the meaning is tried to be extract just by looking at the pictures embedded in a text. These could be seen as examples of the shallower techniques from Thayer et al. [51].

Basaraba et al. [7] stated that the reading skill of a person is influenced by factors like the ability to recognize and process the sound structure of words, the fluency, the vocabulary and his or her reading comprehension abilities. They see reading comprehension as the backbone for the whole reading process.

Comprehending a text is a combination of recalling what has been read and the understanding of the underlying concepts [34]. This process is complex and requires some effort. The reader has to interact with the text on a mental level and connect the information given by the text with his knowledge of the world [1].

Kintsch's "Construction-Intergration-Model" (CI Model) [27,33] assumes that the text representation in memory is structured in three levels, namely the surface level, the text-base and the situation model. The surface level is the most superficial, containing only information about the physical structure of the text. The text-base consists of a collection of small meaning elements, the so-called propositions. It expresses the meaning of single propositions, as well as multiple propositions taken together and mirrors their relationships to one another. The situation model is even more advanced as it integrates the information of the text with the reader's prior knowledge. In the construction phase of this model the reader constructs the text from syntax and semantics and in the integration phase activates the associated concepts in memory. Comprehension according to this model happens when the information extracted from the text combined with the prior knowledge of the reader form a sound mental model of the text. The quality of the structures can vary according to the reader's abilities.

Founding on this early model Basaraba et al. [7] defined three levels of reading comprehension: Literal, inferential and evaluative reading comprehension, which differ in their cognitive demand and their depth of understanding.

For literal comprehension it is sufficient enough to remember what is stated in the text. This level of comprehension is strongly dependent on word level processing skills and the ability to perform word identification tasks. To achieve literal comprehension mostly two strategies are employed: the ability to remember the rough idea stated in a passage or to recognize specific info. It is not enough, however, to keep only the meaning of single, isolated words in mind as their meaning is also determined by their context [7].

Inferential comprehension goes a deeper than literal comprehension as here interpretation of the stated facts is required to get the meaning of implicitly presented information from the text. With inferential reading comprehension the reader is able to perceive the meaning of the connections and relationships of facts in the text. It extends literal comprehension with an additional logical level of interferences. To make such interferences it is necessary to hold some information in the memory in order to process it, which increases cognitive processing demand. Inferential conclusions require reading "between the lines". There are text-based interferences, which help to connect the text structure and knowledge-based ones, which enable the reader to fill "gaps" in the meaning of the text, like the relationship between protagonists or how certain events in the story are connected. How well a person can construct interferences is influenced by factors like processing capabilities, background knowledge and language proficiency [7].

Evaluative reading comprehension is the most complex level of comprehension according to Basaraba et al [7]. It comprises the understanding of the text in regard to the reader's prior experiences. In order to form evaluative comprehension the reader must question and analyse the text in a critical manner, thereby drawing conclusions that may go beyond the text's statements. It seems that these levels of comprehension are dependent on each other, but whether it is really a linear progression, remains yet unclear.

Apart from trying to find an explanation what reading comprehension is and how it works, it is also interesting to look at what can influence it.

One of the most important aspects to name in this context is prior knowledge, which has a great impact on reading comprehension [10]. This knowledge can help to construct an organized schema of the text's information. Furthermore, a certain familiarity with common text structures can also be beneficial for understanding [7].

Being aware of the context instead of just the meaning of single words is also crucial for understanding. Federmeier and Kutas [21] showed that words are often predictable in sentence contexts and that sentence contexts can facilitate comprehension. Bransford and Johnson [9] investigated the role of contextual knowledge. Comprehension according to their findings often results from the context. In their experiments they showed that participants who had to comprehend a text passage without being provided with the appropriate context, did worse in comprehension tests than those who had been provided with the context. Another result of their experiments is that prior knowledge alone is not always helpful for the comprehension process but that it has to be activated first through some kind of stimulus.

Ahmadi [1] investigated the title as potential activator for background knowledge by testing the comprehension on a so-called non-text. A non-text is put together by randomly assembled sentences from different texts and does not contain any sensible information per se, but seems coherent to some extent. Normally "good writing" according to Kintsch fosters comprehension [27], so a non-text should generally receive lower results on a comprehension test. When testing the comprehension on this text, however, Ahmadi noted that when the text was handed out with a title, the title served as a retrieval cue for prior knowledge and the participants retrieved some meaning from the text, regardless from the fact that there actually was none in the text. The title therefore proved to be an influential factor on text coherence and comprehension as it seems to help the activation of certain cognitive schemata.

Text memory and comprehension are often connected. Therriault and Raney [52] specifically examined the relationship between the memory of the "place on the page" and the memory of the sequence of information the text presented. The memory where the information was presented on the page proved to be of little to no importance for comprehension whereas text-sequencing memory and comprehension seem to be related according to the findings of Therriault and Raney.

The logical next step after comprehending a text, is actually learning from it, i.e. to extend one's knowledge.

Kintsch [27] explicitly contrasted remembering and learning. Remembering according to his definition is the process of simply reproducing the information of a text, which requires a shallower form of comprehension. If a reader has effectively learned from a text, he or she can apply the knowledge to other situations as well. In the context of text memory and learning, the importance of background knowledge is emphasized once more. Low knowledge readers and high knowledge readers have different representations of the text in memory. The low knowledge reader has a structure close to the text surface [10]. As a consequence the low-knowledge reader needs retrieval cues to recall what was read and does not learn from the text, while the high-knowledge reader does not necessarily need contextual cues to activate the knowledge needed due to the more advanced representation in memory Therefore the advanced reader can apply the information different situations easily and learns more from the text than a reader with lower knowledge. Thus, the background knowledge to some extent determines the learnability of information. A text is only beneficial for the reader if it is actually in the "learning-zone", i.e. there is neither too little nor too much overlap of the information in the text and the reader's background knowledge

[27]. Learning has occurred, if a reader has been able to build a well-structured representation of the text and connect this representation to the background knowledge he or she possesses [33].

If one aims to facilitate comprehension, this paragraph provides important foundations regarding the basic concepts of reading, comprehension and memory.

2.3 The Chances and Challenges of Reading on Electronic Devices

In 1988 Dillon [18] already reviewed the fundamental differences of reading on paper and reading on screen: reading on screen can be slower, not as accurate and more demanding as reading from paper. Therefore, reading on paper was often preferred.

Today, with new display technologies such as e-ink for e-readers, some report similar reading behaviour on paper and e-reading device in regard of the reading time [47]. Some even say that comprehension is not affected by electronic devices [32], whereas others observe the tendencies to less in-depth reading on screen [31].

Electronic reading material still seems to be perceived as more demanding and long text are still printed out for thorough reading and memorization [31,34]. Morineau [34] described that e-books in contrast to paper books provide no contextual cues for recall, as they do not represent one piece of information but many electronic texts at the same time and consequently do not provide affordances as paper books do.

To overcome the problem of missing contextual cues Li et al. [29] have constructed a e-reader prototype (see Figure 1), which has the aim to support the creation of a cognitive map in the reader's mind. A cognitive map is a mental construct representing the spatial arrangement of objects. This map is used to locate objects or information by the usage of so called landmarks. For texts such landmarks are headings, illustrations or highlighted paragraphs. According to Li et al. there is no direct evidence that a cognitive map of a text supports its comprehension, but Li et al. argue that the more resources are saved on the navigation task, the more are free for comprehension. Contextual cues provided by the cognitive map, however, enable a more profound retention and recall of information. In their prototype a "visual cue map", see Figure 1, was implemented, which is an interactive toolbar, showing the cues the reader has previously created. This prototype aims at improving the navigation and the revision skills of the reader by fostering the construction of a cognitive map.

Colombo et al. [15,16], too, say that e-books offer less tangible experiences and that they can make better use of the technology they are built on. In their research they specifically focus on good e-book design for children. Reading from their point of view should provide user experience. To find out what makes e-books more engaging and how to create an immersive reading experience, Colombo et al. asked children to give design suggestions. Children are observed to select paper books from key features like their cover art or after browsing through the book to get an overview of its content. With e-books such features are not that obvious, better interaction possibilities and more multimedia content are suggested to overcome those shortcomings of e-books. Colombo et al. see book selection as a

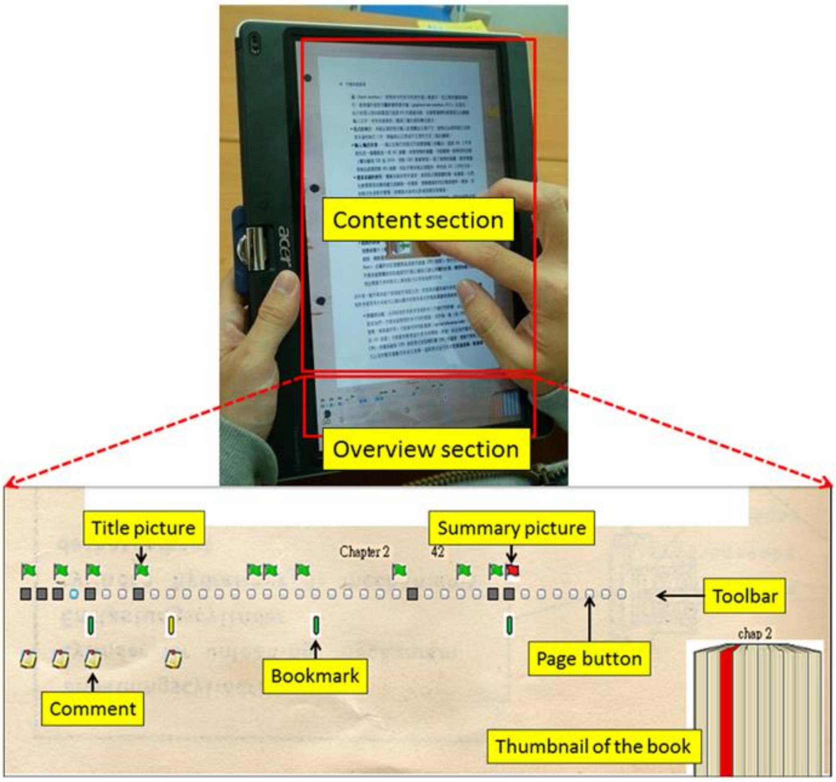

Figure 1: "visual cue map" of a document of taken from [29]

first step towards reading experience. Additionally, reading experience according to Colombo et al. should not only be provided during the reading process itself, but also before and after reading.

Rather than to compensate what the electronic text is missing compared to the paper book Anderson-Inman and Horney [2] stressed the possibilities presented by electronic reading material. Electronic texts have the ability to assist the readers, especially those who learn to read or those with reading difficulties. With additional information integrated in the text, the reading comprehension can be facilitated. They propose a typology for resources supporting comprehension comprising e.g. illustrative resources such as photos or summarizing resources such as concept maps or lists of important features.

Chen et al. [11] aim to improve reading comprehension with their online cooperative reading platform for students, where the students can tag important information on texts they just read, thereby creating their own personal structure of the text (Figure 2). Like the cognitive map system, this approach of support is interactive, i.e. the reader has to be actively engaging with the text. The tagging helps to summarize the information given, lets the reader reflect on the text's structure and is an aid in information location tasks. The system is generally considered helpful, has however, a strong dependence on the reader's prior knowledge. Nevertheless, in the resulting user study Chen et al. reported that the system improved reading efficiency and enabled the reader to grasp the information quickly.

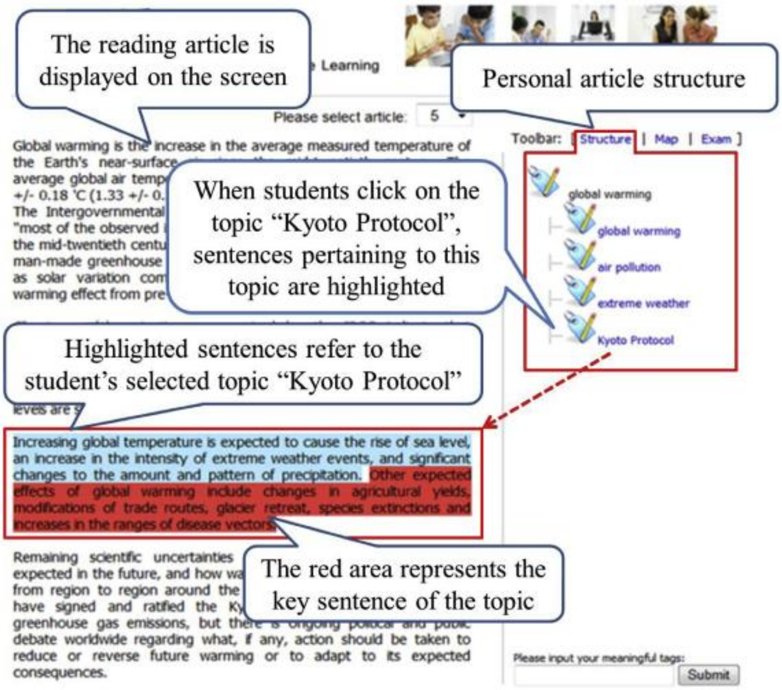

Figure 2: Chen et al.'s prototype taken from [11]

The prototypes of Li [29] and Chen et al. [11] have both their strengths and weaknesses in the interactive nature of the reading support they provide. Actively processing a text leads to better understanding of the text but interaction requires motivation. In the two prototypes readers do only profit from the additionally provided information if they create it themselves.

To simulate “riffling through” and quickly perceiving information the technique of Rapid Serial Presentation (RSVP) can considered to be integrated into electronic documents. Often it is used for example to get an overview over a folder’s content, when all items can be scrolled through in the ‘carousel mode’ in some operating systems [48]. There are various forms and applications as described by Spence [48] , but for reading a sequential RSVP is chosen, where the text is presented word by word, each word appearing on the same spot for the same amount of time on the screen [26], a technique that for example could be applied when speed reading.

Dingler et al. [19] examined such RSVP stimuli as well as kinetic stimuli in form of a moving line that guided the reader’s eye movements in a series of studies. They determined that such stimuli can significantly improve comprehension and reading speed. Participants are reported to read up to 150% of their normal reading speed, when supported with the stimuli. Subjective feedback shows, that RSVP methods are preferred for small screens such as those of smartwatches or mobile phones.

This paragraph has shown that electronic texts have their disadvantages but that there are also a various ways to augment them to the benefit of the reader. In this work the focus lies on text visualizations. Related work regarding visualizations now follows in the next paragraph.

2.4 Approaches to Text Visualization

Visualizations have the potential conveying information quickly and efficiently and generally aim to make the comprehension of aspects easier. The steps till a visualization is created are the following according to Zhang [57]: first determine which form of data is to be visualized, then pre-process it accordingly and extract the relevant information before fitting it to the chosen visualization format. Zhang distinguishes three areas of knowledge management where visualizations are suitable: visualizations for knowledge discovery, knowledge representation and the organization of knowledge.

Collins et al. [14] defined common feature types of text visualizations like semantic visualizations or clustering which are summarized in Figure 3.

Semantics – Visualization reflecting the word meaning.
Clustering – Visualizations grouping words into concepts.
Overview – Visualizations providing an overview over the text.
Zooming- Visualizations supporting different levels of detail.
Frequency –Visualizations showing the frequency of words.
Comparing – Visualizations allowing comparison of different documents.
Search – Visualization enabling to search for words or phrases.
Reading – Visualizations providing means to read the entire text.
Patterns – Visualizations revealing interesting patterns within the text.
Features – Visualizations show special aspects of the text.
Suggestions – Visualizations suggest words/ phrases of interest.
Phrases – Visualization can show phrases combined of multiple words.
All words – Visualization can show all words of the text.

Figure 3: Common feature types in visualizations after Collins et al. [14]

In the following, a few interesting examples of document visualizations is given, each of those implementing various types mentioned above.

The application of text visualizations expands throughout different text forms. Regan and Becker [42,43] explored the possibilities of visualizing data from fictional books. In particular they focus on one fantastical children's book trilogy for which they create visualizations regarding the main characters: the character flower and the character occurrence through the whole trilogy, as seen in Figure 4. The character flower visualizes words that often follow the character name, the nearer dots closer to the centre are unlikely to appear next to other words than the character name, often it are words like the character's surname or words describing the protagonist's character. In the whole text visualization, the rhythm of the characters' occurrence is reflected with different colours for each character. With this visualization one can easily determine for example, if a character is absent or only features less in one volume of the trilogy. Regan and Becker created those visualizations for the fans of the trilogy to augment their reading experience.

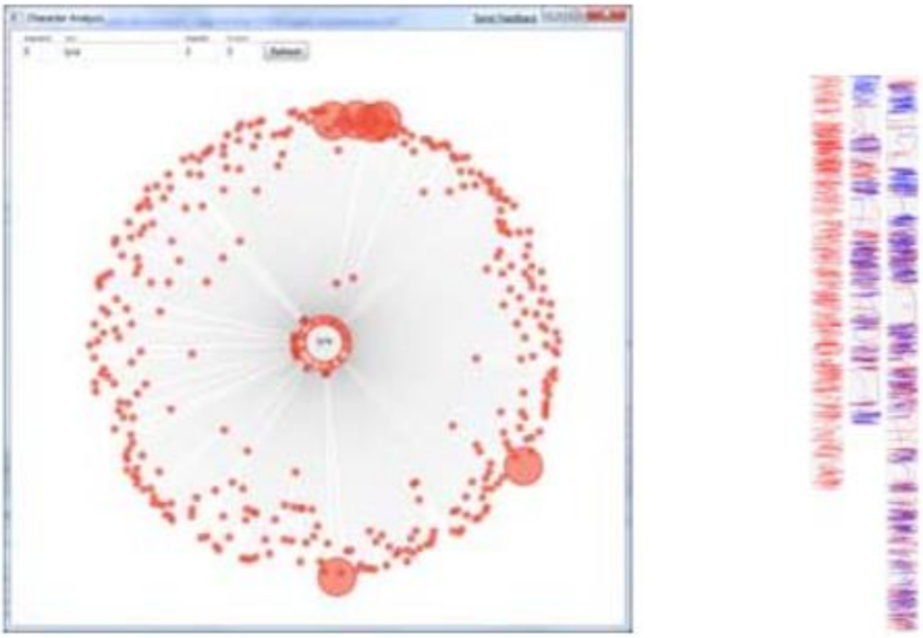

Figure 4: Character Flower from [43] *and whole text visualizations*

Paley [36] introduced a visualization called *TextArc* (see Figure 5), which he describes to be "an alternate view of text". The *TextArc* focusses on the frequency and the distribution of words in a document. Stop words, words that are in general frequent in a language and therefore are often disregarded, in *TextArc* are left in their context. Central for the *TextArc* is the structure of the text, the visualization aims to build around that dimension of a text. This visualization aims to provide a quick feeling for a text, by letting the reader skim the words that are most frequent.

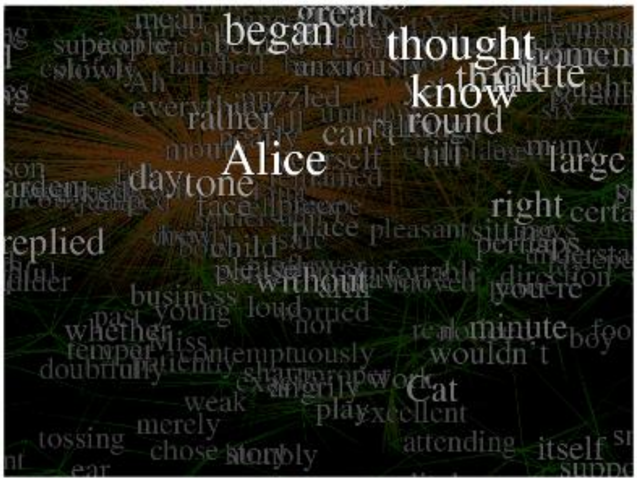

Figure 5: Details of a TextArc, from [36]

Through the interactive *DocuBurst* (Figure 6) visualization Collins et al.[14] wanted to transfer the browsing experience of physical books to digital libraries, by providing interactive summaries. With their visualization they combined word frequency with a human created lexical structure to mirror the semantic content. *DocuBurst* allows the user to zoom in and thus provides visual summaries at various levels of granularity. Regarding the semantical relationship between the words *DocuBurst* focusses on the hyponymy, the "is-a relationship" between words, e.g. the words apple and fruit are in a "is-a relationship". The nodes of the visualization mirror this relationship by getting more specific on the rims of the node, so in our example, fruit would be rather closer to the centre than apple. Collins et al. also decode the relationship between words with using similar colours for words that in the same semantic group.

Figure 6: DocuBurst example from [14]

Similar to *DocuBurst* the *Gist icons* [17] have the purpose of facilitating the search of a document collection by providing shapes for documents according to themes they feature. Documents with related topics are recognizable through similarities in the shapes of their gist icons, which makes the search for related documents easier.

Phrase nets [22] extend the idea of showing semantic relationships by letting the user define the relationship that is visualized. Words are here to be considered nodes and the edges are the connection through the relationship the user defined. Van Ham et al. have the vision to turn books into structured maps with such phrase nets. Possible use cases of these visualizations are to show connections of characters with locations or differences between books (see Figure 7).

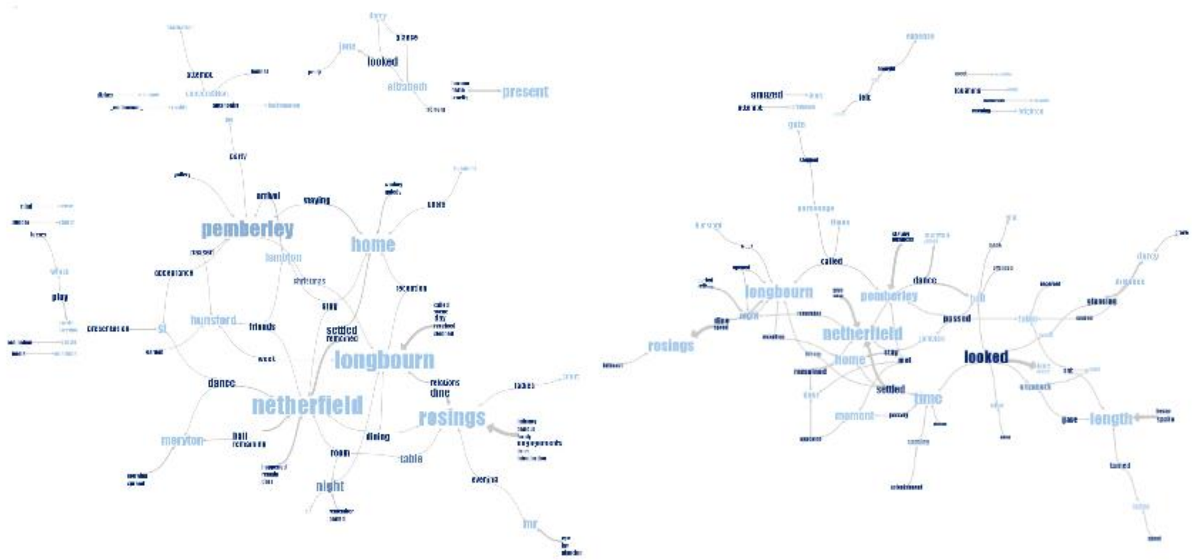

Figure 7: Example of a Phrase Net [22]

Havre et al. [24] did not only focus on the similarity or difference of topics but add yet dimension by aiming to visualize the thematic changes in a collection of documents over time by using a “river” metaphor, each theme occurring in a document collection is visualized as a “current” in a different colour and width according to its importance. With this visualization the user is supposed to get an overview of changing patterns and important aspects over time, an example of a *ThemeRiver* visualization is seen in *Figure 8*.

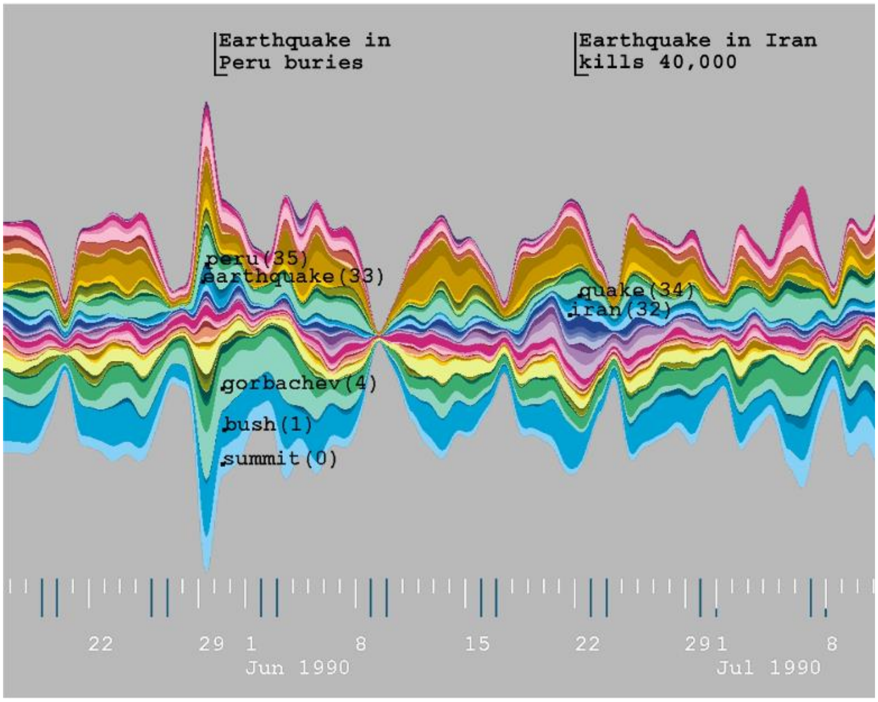

Figure 8: Example of a ThemeRiver [24]

Liu et al. [30] did not concentrate on the semantic relationships or topics but rather on visualizing the emotions contained within a document. With their prototype they want to visualize the affective structure for which they analyse and annotate the document with present emotions. For these annotations sentences are categorized into one of six emotions and then integrated and evaluated for larger units of text. The emotions are colour-coded and succession of emotions can be seen at a documents "affect bar", with which one can also navigate through the document. Liu et al. stated that the affect bar effectively increases navigation speed through a document.

Figure 9: Affect Bar with different colours for different emotions [30]

Strobelt et al. [50] provided a visualization to summarize a document's content and with a Document Card provide a "thumbnail for PDFs". Document Cards visualize the content of a PDF through extracting important keywords and images per section in a fixed size. In the prototype the Document Card is shown as first page of the PDF and also allows interaction possibilities e.g. through links which allow direct navigation to a Document Card element's position in the text.

Augereau et al. [4] approached the visualization of text totally different angle. They do not only take the document itself into account but also how it is read by the user. Through eye-tracking they want to create a “reading life-log” based on the reader’s gaze data. In contrast to a document tag cloud they want to visualize a reading tag cloud, which contains the words the reader has read.

In this work we want to focus on visualizations of keywords such as tag clouds or mind maps, whose characteristics and concepts will be defined later in this document.

2.5 Important Foundations for this Work

The knowledge about priming and reading comprehension we want to use when building our prototype. Comprehension can be facilitate through prior knowledge and its activation through a stimulus [9]. We want to investigate, whether text visualization could be such a stimulus and examine their potential in facilitating reading on electronic devices.

In contrast to the other text visualizations like *DocuBurst* [14] or the “affect bar” proposed by Liu et al. [30], which focus on improving search or interaction with digital documents, our visualization approach will strive to passively improve reading on electronic devices.

The visualizations we want to develop are based on the following characteristics of those which Collins et al. [14] suggested : clustering, overview, frequency, features, suggestions.

Frequency of words is explicitly shown in the proposed tag cloud approach below and clustering occurs in a mind map approach. All proposed visualizations should provide an overview and suggest important information.

With these foundations we hope to develop beneficial concepts and a prototype to support reading on electronic devices.

3 Visualizations

We want to examine the usefulness for reading comprehension for the following four visualization types: tag cloud, mind map, in-text highlighting (also referred to as highlighting) and an image collage approach. In the following, those visualizations are presented and examined closely regarding possible use cases and design principles.

The proposed visualization types then are subject of following studies regarding reading comprehension.

3.1 Mind Map

Mind maps are often used for studying and brainstorming tasks to organize information. They group information into clusters and thereby have the ability to structure it [57]. Structured information is learned better and is processed more efficiently [5,28], thus mind maps could provide a good aid for comprehension. There is a variety of tool support regarding mind map editors like Free Mind[2], but only few approaches to automatically create mind maps like those of Kudelic et al. [28] or Elhoseiny [20].

Our aim is to find out how a structured visualization like a mind map can foster the reader's comprehension. Therefore, we suggest a mind-map like approach that features clustering that gives the content structure and meaning. Regarding the design it should be arranged in a clear fashion and not contain too much information (example see Figure 10)

Figure 10: Mind Map [3]

[2] freemind.sourceforge.net/

3.2 Image Collage

Images serve as good retrieval cues for knowledge and can help to activate prior knowledge [5]. Our form of image collage is composed by searching suiting images to important keywords of a document(e.g. on creative commons image portals) and putting them togheter to an image collage. In following studies we want to determine, whether a visual summary in pictorial form is able to support the reader.

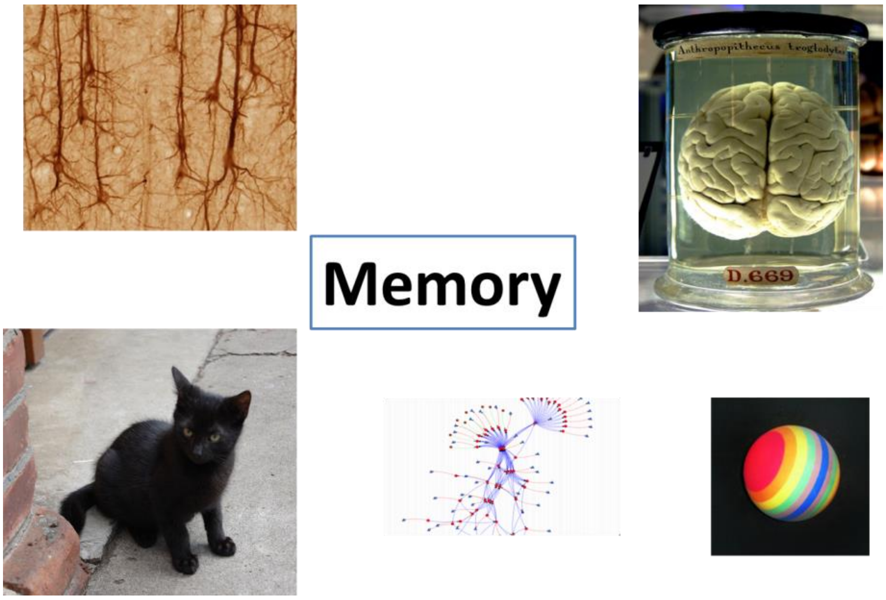

Figure 11: Image Collage [3]

3.3 Tag Cloud

A set of visually presented words is called a tag cloud. This set of words is usually selected by a certain characteristic, which is also reflected somehow in the design of the tag cloud [44]. Xexéo et al. [56] differentiate between summarizing tag clouds where the tags are selected to summarize the content of a collection of tag clouds and differential tag clouds which aim to show want is important or specific for a single document.

According to Rivadeneira et al. [44] tag clouds can be useful for specific search tasks, browsing, impression formation or even recognition tasks. Ideally, tag clouds reflect the gist of a text they represent. Rivadeneira et al. [44] distinguished two important features regarding tag cloud design: The mapping of the text features to some visual property and the word placement. Text feature properties are: font weight, font size and font colour. How the words are sorted (alphabetical, by frequency…) and clustered or how the spatial layout (sequential lines, "bin-packed") is built are variables of the word placement. Different design possibilities were tested by Rivadeneira [44], and they found that layout can have an impact on impression formation.

Schrammel et al. [46] investigated a semantical structuring approach, which can be beneficial for search tasks, but only if the concept behind the semantical structuring is evident for the reader and does not confuse him or her.

Bateman et al. [8] studied the different text features in regard of their potential influence on selection tasks. Font size and font-weight turn out to be most influential in their experiments.

In this work we will focus on tag cloud used to support reading tasks by providing an overview over the text. We propose a simple design, with varying font sizes according to a keyword's importance and a colour scheme that does not distract the reader but fosters readability, like Figure 12.

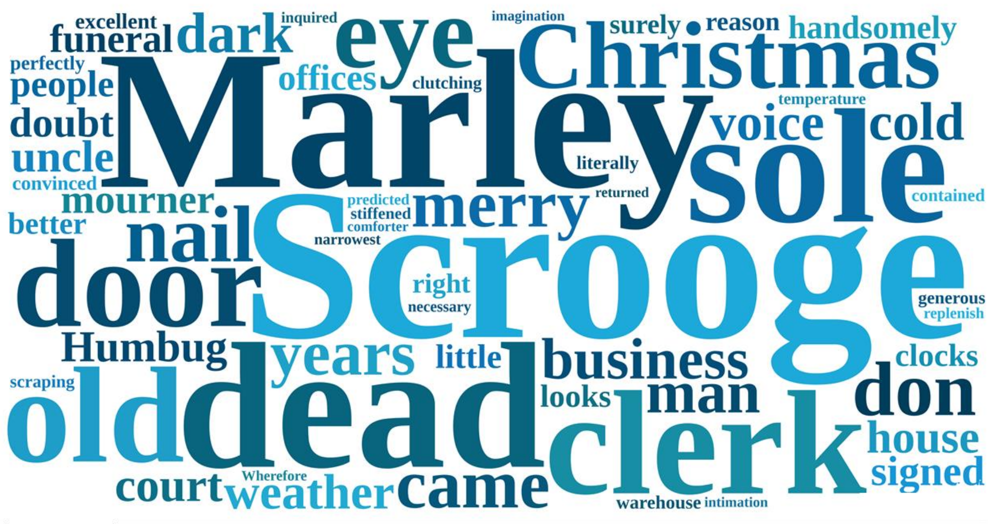

Figure 12: Tag Cloud, (created with Taxedo)[3]

3.4 In-Text Highlighting

On printed text, one often finds in-text highlighting in form of keywords marked with highlighters. There also exists the digital counterpart. With *ScentHighlights* [13] Chi et al. implemented a prototype that highlights sentences if they are related to keywords. The keywords are derived from the user's search input.

We want to investigate an approach where the highlighting is passively done and the text with the highlighted keywords is presented to the reader. The keywords are to be derived with text mining algorithms.

Highlighting can support skimming. When skimming a text, it is useful to be directed to the important parts. In eye tracking studies Chi et al. [12] provided evidence that readers are more likely to focus on the highlighted parts of a text than those without highlighting. They also insinuate that highlighted text could be easier to learn.

Wu et al.[55] showed that highlighting also has positive impact on search performance and reading speed. Colour is suggested as a good highlighting means, but one has to pay attention to the colour choice.

This thesis shall evaluate how highlighting can help the reader and what needs to be considered in the design of automatically highlighted text as seen below in Figure 13.

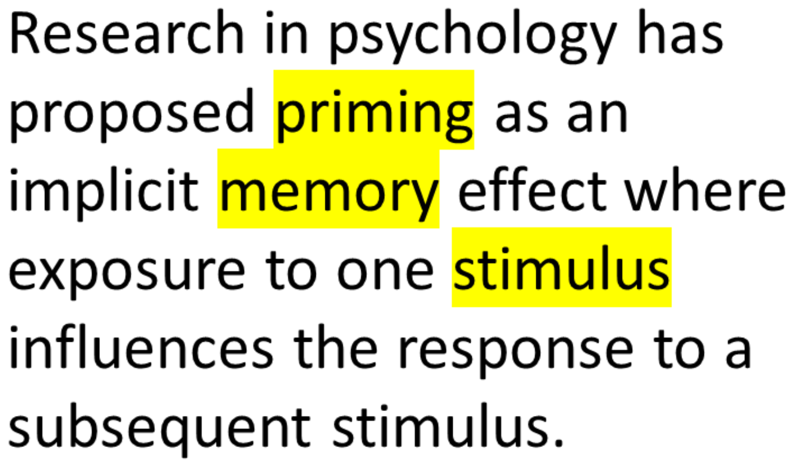

Figure 13: Highlighting

4 Preliminary Study

To evaluate the design of the visualizations proposed in Chapter 3 and to determine how text-visualizations could support the reader before, during and after the reading process a preliminary study in form of a focus group was conducted. This chapter describes the study and the findings from [3].

4.1 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: Business Psychology (one participant), Computational Linguistics (one participant), Computer Science (four participants) and Library Studies (one participant). All of them named German as their mother tongue. Their age ranged between 19 and 24 (M=22.25, SD=1.67). Three of them were female, five were male.

Each focus group was presented four different pieces of texts with a corresponding visualization of the text's keywords. As visualizations for the keywords we used the four kinds described in Chapter 3: tag cloud, mind map, image collage and highlighted keywords.

The original texts and the visualizations were in German. For our initial study the visualizations were manually created, for the tag cloud *Tagxedo* [3]Engine for keyword extraction was used. The photos from the image collage were selected from *flickr* [4]and are under the Creative Commons License[5][58,59,60,61,62].

To broaden the focus group discussion we chose different styles of text: fiction, news, and science. We randomly assigned visualization types to text genres. The mapping was as follows: the tag cloud 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 [3].

4.2 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 and profession.

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[3] http://www.tagxedo.com
[4] https://www.flickr.com/
[5] https://creativecommons.org/licenses/by/2.0/,
https://creativecommons.org/licenses/by/3.0/
https://creativecommons.org/licenses/by-sa/2.0/
https://creativecommons.org/licenses/by-sa/3.0/

To start the discussion some general questions about the participants' reading behaviour were asked, such as how much they read and on which medium.

The main part of the focus group, however, comprised discussions of the four visualizations, which were split into three phases: first, participants were handed the corresponding visualization before reading the actual text. Both visualization and text were printed on paper. For each text, averaging 305 words, the participants had sufficient time to read it. 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 had changed. Finally, the third phase comprised a discussion of the visualization's design aspects. This was done for each of the four visualizations with one different text per visualization. In the concluding discussion the participants were asked to compare the different visualizations and provide further feedback regarding concept and usage context of text visualizations [3].

4.3 Results

In this section we discuss the results of the preliminary study [3], concerning the participants reading behaviour and their comments on the usefulness of the visualizations prior, during and after the reading process.

Reading Behaviour

The reading volume of the participants ranged from *"very little"* to *"very much",* one participant stated to read up to two books per week. Participants said they read on paper books as well as on electronic devices. Paper books were slightly preferred for leisure reading. As reading environment participants most of all mentioned their homes but also the university or public transport. The aim of the reading activity was study purposes, leisure reading or "a means to stay up to date". Most of the participants expressed difficulties when reading scientific texts, especially with long ones, as they were seen as hard to remember.

Pre-Reading Support

The visualizations were perceived as an aid to get the gist of a text. For that purpose 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 caused confusion 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. After the reading phase, however, the participants reported that the initial confusion had cleared up and the visualizations were understood better in retrospect.

In the pre-reading phase, visualizations also helped participants to recall previous knowledge of topics. It was furthermore mentioned that visualizations could also help to decide whether the text was relevant for a certain topic, and thus could be helping the text selection process.

Support during Reading

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 aspects. 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 [3].

Post-Reading Support

All participants stated that they would use the visualizations as a memory aid when they needed to retain the text's content 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 [3].

Comments regarding 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 of the visualizations, 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 considered most useful by the participants [3].

4.4 Design Implications

Participants gave us some direction how automated text visualizations could help before, during and after reading. Summarizing the participants' comments the following design implications can be outlined (c.f. [3]):

- 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.

4.5 Discussion and Directions

Due to the small and biased sample the results of the preliminary study have to be treated with care. A clear preference for a visualization type could not be observed and reading comprehension was not yet measured.

However, participants overall responded positively to the idea of having a visual text summary as reading support and thus showed that the approach of this work is worth further consideration. The focus groups discussions and results also outlined the directions of this work: On the one hand, the means of automatically creating such visualizations should be explored, taking the design requirements above into account. On the other hand, preferences and the actual effects on reading comprehension of the four visualization types mentioned should be studied closely through a more detailed study.

5 Prototype

This section addresses the prototype built to automatically extract important keywords from a text. Its environment, architecture, functionalities and underlying technologies will be explained.

5.1 Architecture and Overview of Functionalities

This prototype consists of two different parts. The first part is a python tool consisting of different python scripts and filling the database with relevant data for the visualization creation. The second part is the integration of visualization functionalities in a literature portal of the Social Sciences, the *GESIS-sowiport*[6], which then use the content of the database to create the visualizations. An overview of the architecture and functionalities can be seen in Figure 14 below.

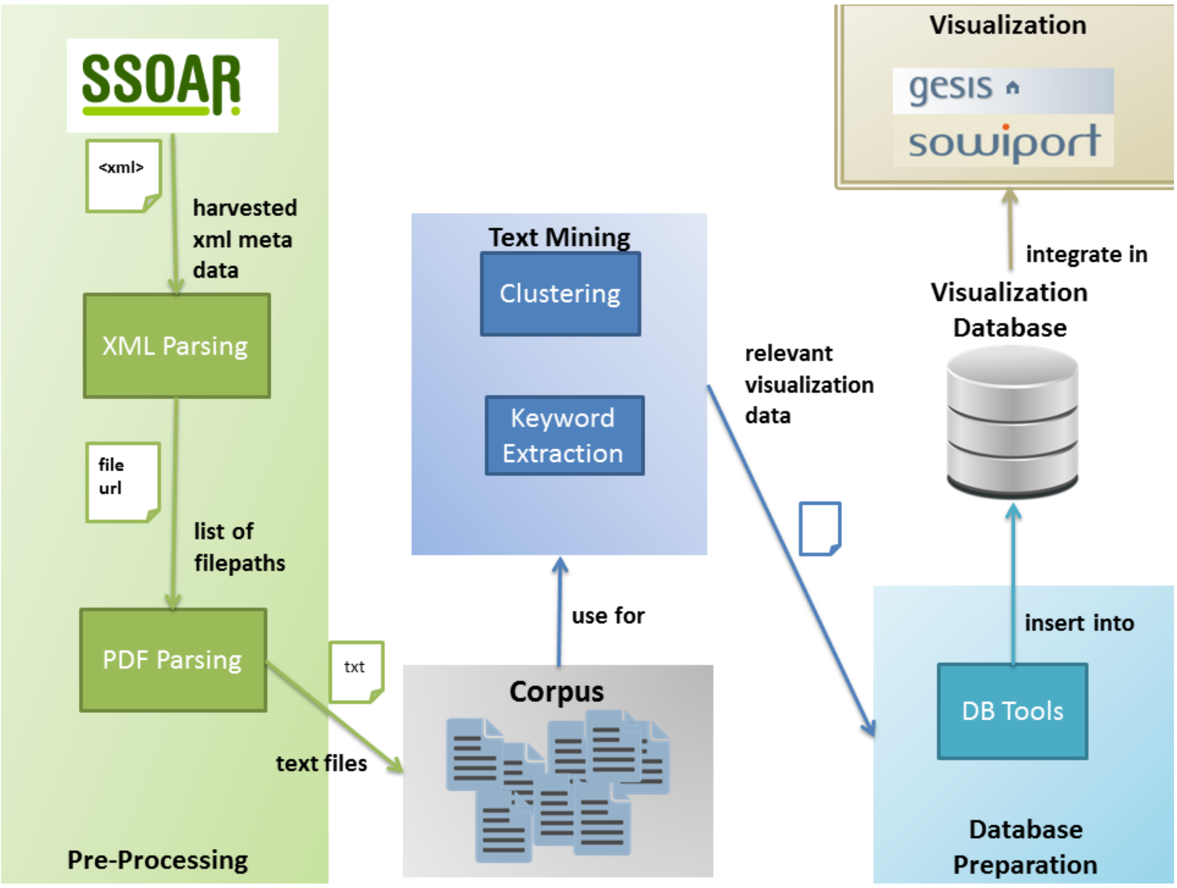

Figure 14: Overview over the prototype's architecture and functionalities

[6] http://sowiport.gesis.org/

The Pre-Processing components are responsible for preparing the corpus for the text mining process. The prototype's corpus is constructed from documents available on the *Social Science Open Access Repository (SSOAR)*[7]. The corpus construction will be discussed in detail in Chapter 5.2. The keywords and other important data needed to create the visual text summaries are extracted in the text mining components (see Chapter 5.3). This data is then stored in the database by the database preparation utilities. The database utilities and the database schema are explained in Chapter 5.4.

The resulting database then is integrated in *sowiport* to create the actual visualizations for the text in the portal via HTML, CSS and Javascript. The sowiport system and the additional integration of the visualization components are described in Chapter 5.5 and Chapter 5.6.

The steps from acquiring the full texts of papers of the SSOAR metadata to the actual visualization in *sowiport* are summarized in Figure 15.

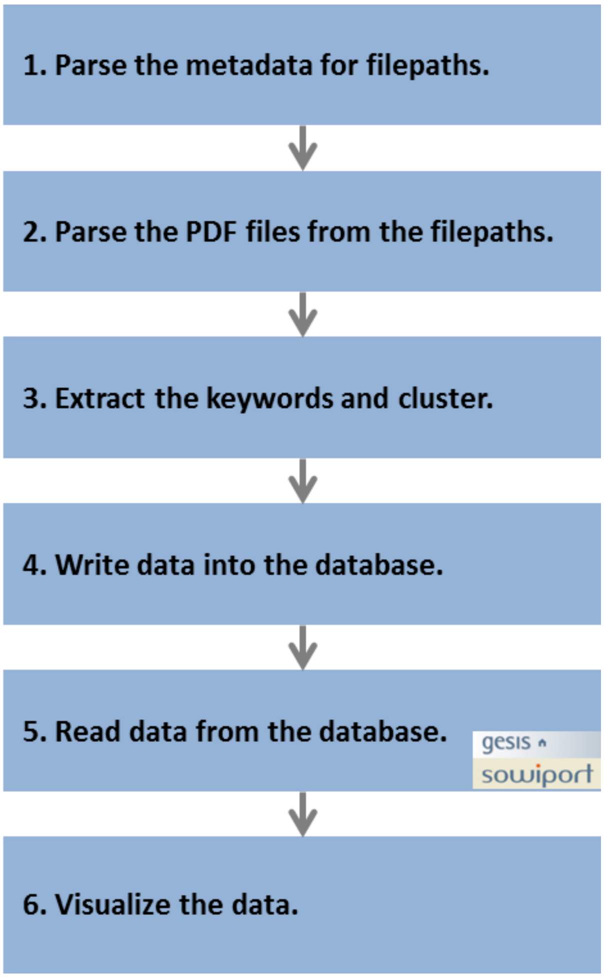

Figure 15: Steps towards a text visualization.

[7] http://www.ssoar.info/

5.2 Pre-Processing the Data

The *SSOAR* is an open access repository which provides *an Open Archives Initiative*[8] *Protocol* for *Metadata Harvesting (OAI-PMH)* interface for metadata access. To get the metadata xml records, we used a python harvesting script provided by the GESIS Leibniz Institute for the Social Sciences.

The resulting xml files follow the standard of OAI 2.0. They contain a `ListRecords` element, which in turn contains multiple `record` elements. Record elements have a `header` and a `metadata` element.

The metadata element has one child element, the so called `dublin_core`. *DublinCore*[9] stands for a metadata specification format, for the description of a resource's metadata. The `dublin_core` element contains children which specify metadata values relevant for this prototype, namely the `uri` of a document, the language it's written in and its `filepath`. Figure 16 shows the structure of a metadata element, with only the relevant child elements for this prototype. Other elements of the xml file are left out to provide a better overview. The xml parser of this prototype extracts these values for further processing. Currently only documents in the English and German language are considered, these languages are determined by the language element.

```
<metadata>
   <dublin_core xmlns="http://www.ssoar.info/OAI/oai_ddb/"
             xmlns:doc="http://www.lyncode.com/xoai"
             xmlns:xalan="http://xml.apache.org/xslt"
             xmlns:xsi="http://www.w3.org/2001/XMLSchema-
             instance"
             xsi:schemaLocation="http://www.ssoar.info/OAI/oai_dd
             b/ http://www.ssoar.info/OAI/oai_ddb.xsd">
      <dcvalue>....</dcvalue>
          ... other metadata in form of dcvalue elements
      <dcvalue element="identifier"qualifier="uri">
      http://www.ssoar.info/ssoar/handle/document/679
      </dcvalue>
          ...
      <dcvalue element="language" language="de">en</dcvalue>
          ... more metadata
      <filepath>
          http://www.ssoar.info/ssoar/bitstream/handle/document/6
          79/ssoar-jswp-2005-1-riemann-
          ethnographies_of_practice__practising.pdf?sequence=1
      </filepath>
   </dublin_core>
</metadata>
```

Figure 16: Exemplary structure of xml OAI metadata tag with relevant elements

[8] www.openarchives.org/

[9] http://dublincore.org/documents/dcmi-terms/

From the URI we extract the unique filename of the corpus documents which always has the following form: `gesis-ssoar-<number value>`. The number value is derived by the number inside the URI. The filepath URL we save for PDF parsing purposes. The form of those relevant elements is also seen in Figure 16)

For PDF parsing we use the *PDFMiner*[10] parsing library for Python. The input for the PDF parsing module the filepath url previously extracted from the xml record. The PDF at the given URL is parsed to a text file with utf-8 encoding and saved at the corpus folder, if it is parsable. If it is not parseable, an error message is displayed and the file URL is saved in a info file for non-parseable documents. This PDF parsing method currently considers everything in a PDF document for parsing. The resulting text files form the corpus for the text mining step.

5.3 Keyword Extraction and Visualization Data Preparation

As a keyword extraction algorithm we use the Term Frequency – Inverse Document Frequency (TF-IDF) approach [40]. The term frequency (TF) captures how frequent the word is within one specific document. The inverse document frequency (IDF) reflects how rare it is in the remaining corpus. High TF-IDF scores of words in a document mean that those words are frequent in this document but not so frequent in the corpus and thus could have the ability to characterize the document. Normally so called stop-words, i.e. words very common in a language are ignored in the calculation process. The formula for TF-IDF calculation is explained below in Figure 17.

In the prototype the python machine learning library *scikit-learn* [37] is used for the calculation of the TF-IDF. Scikit-learn's `TfidfVectorizer` takes a corpus and turns it into a TF-IDF matrix, with a row for each document and a column for each word, which in *scikit-learn* is referred to as feature.

Let i be a word and j a document in which it occurs, further are D the total number of documents and d_i the number of documents where i occurs, then

$\boldsymbol{TF-IDF} = TF_{ij} * IDF_i$, where

$TF_{i,j} = frequency_{i,j}$ (read: frequency of the word i in document j), often normalized with the maximum frequency of words.

and $IDF_i = \log(\frac{D}{d_i})$.

Figure 17: Calculation of TF-IDF after [40].

Before being able to pass data to the `TfidfVectorizer` we prepare the corpus by parsing the documents in the corpus folder from the pre-processing step to a python dictionary of filenames and text content. In the text content unwanted characters such as page num-

[10] https://euske.github.io/pdfminer/

bers or hyphenation is removed. Then this list of text content is used as corpus by the `TfidfVectorizer`.We extend the tokenizing method of the vectorizer by a lemmatization step. In contrast to the stemming approach were only the word stem is kept, lemmatization is the process of bringing a word in its normalized form [38]. Example: if you would stem the word "computers" you would receive the stem "comput", whereas you receive the singular form of "computers", "computer". The `WordNetLemmatizer` module of the Python NLTK[11] is utilized for that purpose.

By default, the `TfidfVectorizer` uses its built-in stop word list of the English language. For the support of the German language we extended this stop-word list with common German words.

When the TF-IDF matrix is constructed, we choose the 100 words with the greatest TF-IDF value and save them in a list for each document.

For the clustering step, we calculate the word's first occurrence within the text for each of those 100 keywords. It is then added to a cluster according to its relative position in the text ($\frac{position}{length\ of\ text}$). Currently the clusters distinguished are:

- beginning: $relative\ position < \frac{1}{3}$
- middle: $\frac{1}{3} \leq relative\ position < \frac{2}{3}$
- end: $rest$

For each document now exist three cluster lists containing their words. With this and the previous mapping of important words, their position and their TF-IDF value, we have now all relevant data to insert in the database (summary see Figure 18)

.

Visualization Data for each document:
- id of the document
- list of keywords
  - with their corresponding TF-IDF
  - with their positions
- list of clusters refering to the keywords

Figure 18: Constructed Visualization Data

5.4 Storing the Data

The previously constructed visualization data is stored in a MySQL database named "Priming". This database is first set up with a database setup module. In this setup module the

[11] http://www.nltk.org/api/nltk.stem.html

database and its table `Visdata` are created. The database and the table use utf-8 as char-set encoding. The table has the fields shown in Figure 19. The field `TextID` contains the filename, the `ClusterID` the name of the cluster, the `Keyword` the keyword value, the `TF_IDF` field its TF-IDF measure and `Pos` the keyword's position.

Name	Type	Collation
TextID	varchar(255)	utf8_unicode_ci
ClusterID	varchar(255)	utf8_unicode_ci
Keyword	text	utf8_unicode_ci
TF_IDF	float	
Pos	int(11)	

Figure 19: Database Table Schema

The table is indexed at the field `TextID` to make queries more efficient. Currently, the DB holds data from approximately 5000 documents which makes 500 000 entries total, but there are plans to expand the data in the future. Figure 20 is a screenshot of an example for a database entry (not all keywords are shown, to keep it easier to view).

TextID ▲ 1	ClusterID	Keyword	TF_IDF	Pos
gesis-ssoar-10036	beginning	production	0.117149	7262
gesis-ssoar-10036	beginning	technological	0.0289021	729
gesis-ssoar-10036	beginning	köhler	0.209307	80
gesis-ssoar-10036	beginning	division	0.0321437	4120
gesis-ssoar-10036	beginning	meil	0.259885	96
gesis-ssoar-10036	beginning	condition	0.0217346	17273
gesis-ssoar-10036	beginning	furniture	0.0227715	94709
gesis-ssoar-10036	beginning	semi	0.0221514	2036
gesis-ssoar-10036	beginning	level	0.0256762	17597
gesis-ssoar-10036	beginning	large	0.0252614	1479
gesis-ssoar-10036	beginning	planning	0.0312397	110082
gesis-ssoar-10036	beginning	small	0.0401818	1469
gesis-ssoar-10036	beginning	requirement	0.024426	41040
gesis-ssoar-10036	beginning	computer	0.0502835	6564
gesis-ssoar-10036	beginning	design	0.0357748	10218
gesis-ssoar-10036	beginning	nbn	0.416413	276
gesis-ssoar-10036	beginning	integration	0.0224096	9371

Figure 20: Example of a Database Entry

5.5 Integration into *GESIS-sowiport*

The database with the visualization data is integrated into the *GESIS-sowiport (sowiport)* literature portal for Social Sciences. It then is used by components responsible for the creation of visualizations. In this paragraph *sowiport* and the newly implemented components are described.

Architecture of *sowiport*

sowiport is based on the VuFind [25,63] resource discovery system for libraries. VuFind is open source and was developed by the Villanova University in 2008, to enrich the community of library software developing. The tool is implemented in Java and php, uses MySQL as database and *Apache solr*[12] as search server. In the processes of designing VuFind, the following design goals were aimed for [25]:

1. Provide a simple search functionality.
2. Enable faceted browsing and filtering of search results.
3. Enable enhancing the portal of the portal's content by additional information
4. Provide social functionalities like personal recommendations.

An overview of the architecture of the VuFind system can be seen in Figure 21. VuFind has an application core containing the controller module as well as all other modules important for the functionality. The application core communicates with the data layer to get all the data needed for the display in the user interface layer. In the user interface layer Smarty[13] templates are used.

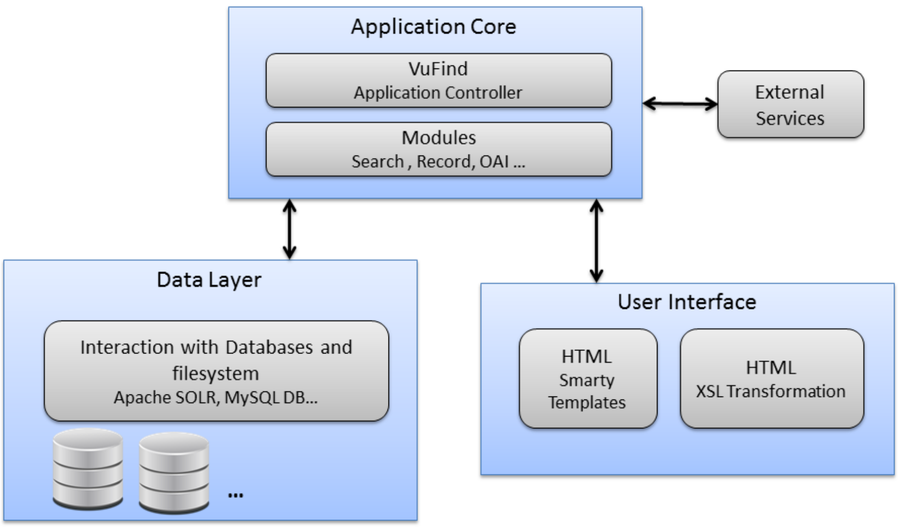

Figure 21: Architecture of VuFind based on [64]

[12] http://lucene.apache.org/solr/
[13] http://www.smarty.net/

sowiport uses this architecture and extends it with additional functionalities and an own interface theme. For the purposes of this prototype the `Record` Module is important. The `Record Module` and its child classes are responsible for displaying the resources (see Figure 22) in the portal. With this prototype this module is extended to display text visualizations in the tab-bar (marked with a red border in *Figure 22*).

Figure 22: Screenshot of a sowiport resource, the tab-bar is marked with a red border

Implemented Visualization Functionalities

The different components of the visualization functionality added to *sowiport* are schematically shown in Figure 23. For the visualization data we added the Priming database which we previously created with the Python Tool to the data layer by specifying its configuration data in the configuration file of *sowiport* and by implementing a so-called "system class" for database access. System classes in VuFind are those classes who provide system-level functions needed by various modules [63]. The `VisData.php` class is used by all visualization modules described later and handles the database access by offering database methods for each visualization type. These database methods structure the data so that the visualization can be created in an easy manner.

The structuring of the data is as follows:

- The method for the tag cloud all information of the keywords is fetched from the database, the keywords are sorted by position
- The mind map method returns the data structured by clusters and which have a name and the keyword data as elements. Here the keywords are also ordered by position
- For the highlighting only the keyword values are fetched.

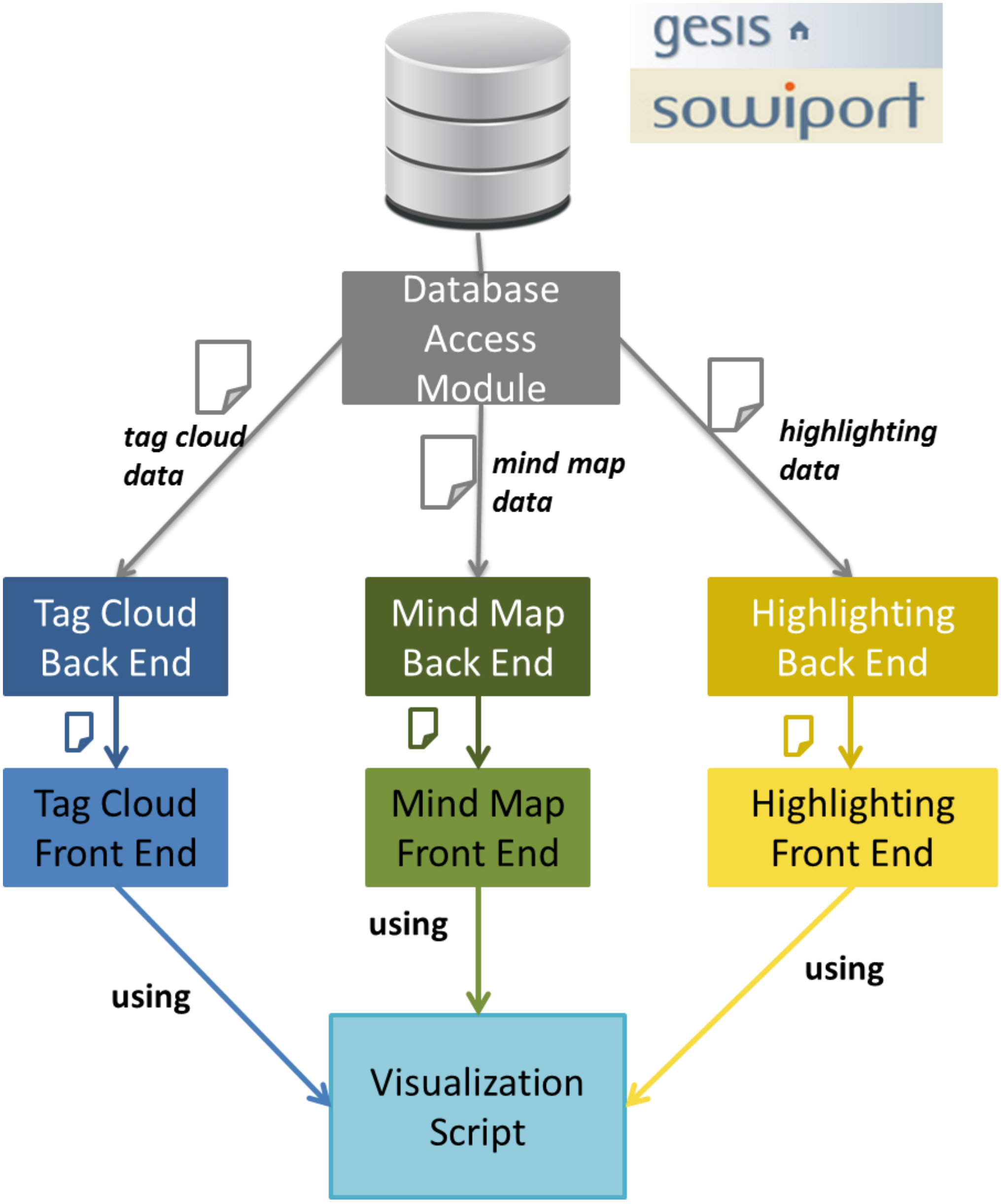

Figure 23: Implemented Visualization Functionalities

For the tag cloud and the mind map visualization, keywords are also sorted in their according importance category, which depends on their TF-IDF value. Currently there are three different importance categories: high, medium and low. They are determined by ordering the keyword's by their TF-IDF descendingly and then splitting them into those three groups depending on their index: The keywords appearing at the top of the sorted list are most important, the keywords at the bottom of the list have low importance and those in between have medium importance.

The tab bar-elements, where the visualizations are supposed to be shown, inherit from the `Record.php` module and as we want each of the visualizations shown in a different tab, we implemented a module for each visualization type. A module in *VuFind* consists of a "back end" php class, and a "front end" Smarty template file. For our three visualization tabs we thus have a php class and a Smarty template for the tag cloud tab, the mind map tab and the highlighting tab. The php classes are responsible for assigning the visualization data to the interface to be displayed. To get this data they each use the method for their visualization provided by the `VisData` class. Each of the Smarty template files is structured specifically for its visualization type and references the Javascript and CSS files for visualization creation, that are explained in detail in the next paragraph.

5.6 Creating the Visualizations

To create the visualizations we use Javascript, Jquery, HTML and CSS. The `visualizations.js` file dynamically creates the visual text summaries from the visualization data which is handed over as parameter to the according method. The corresponding visualization method is called from the front end template files and interacts with the html elements contained therein. The specific styling and design of the visualizations in the prototype is explained below.

Tag Cloud

The tag cloud visually distinguishes the three importance categories by font-size and color. Font-size gets bigger with importance. The colors are fitted into the GESIS color scheme. The tags are ordered ascendingly by their position and thereby aim reflect the text structure to a certain extend. We explicitly avoided random or dynamically changing positioning to provide the potential reader with a sound, recognizable visualization representing a certain document. An example of a tag cloud can be seen in *Figure 24*.

Figure 24: Tag Cloud in sowiport

Mind Map

The mind map visualizes the three clusters of keywords with different colors. In the center is the title of the document. Each element in the mind map has its own “bubble” which varies in size according to the importance of the keyword. Each cluster is limited to ten elements due to visibility issues. Currently the clusters reflect the relative position of keywords in the documents, because of the implementation of the current clustering algorithm in the python tool, which focusses on relative positon. To maintain a structured design of the mind map, we used Flexbox Grid[14] styling resources in the background. Such a mind map is shown in *Figure 25*.

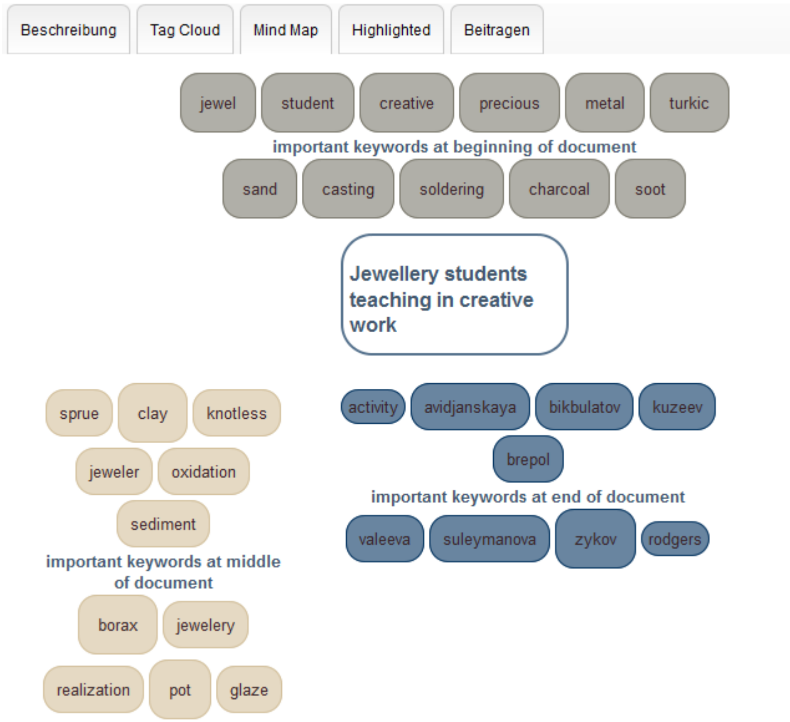

Figure 25: Mind Map Example in sowiport

[14] http://flexboxgrid.com/

Highlighted Keywords

The highlighting visualization concerns the abstract of a text presented by *sowiport*. When creating the visualization, we search whether our list of keywords is used within the abstract and replace all occurrences of them with a highlighted counterpart. For highlighting we use a relatively subtle colour (see *Figure 26*)

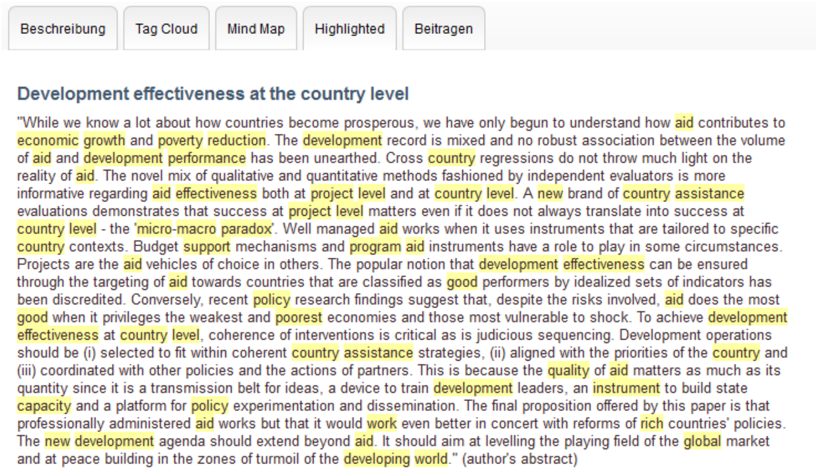

Figure 26: Highlighted Keywords Example

5.7 Future Refinements of the Prototype

The prototype still requires some refinement. Some issues and refinement possibilities are mentioned below. The need for further refinements will be determined in a future field study of the prototype.

Pre-Processing and Text Mining

In the pre-processing phase, the whole PDF file is considered and this leads to some less informative keywords from the reference section. Further one has to deal with parsing and decoding mistakes. The pre-processing should be made more precise in the future, perhaps by only considering the main area with a document's text. To eliminate the "non-sense" keywords, the tokens could be compared to a dictionary first. Performance should be tested with large corpora. The language support for multiple languages should be extended and refined, so that documents of different languages can be considered. Also the clustering approach should be made more semantical, towards a more natural mind map design.

Visualizations and Integration into *sowiport*

The image collage is currently not implemented, as there were difficulties finding an algorithm that intelligently selects a fitting image from search results of open source image sources like *flickr*. This problem should be addressed in the future.

The design of the existing visualizations should be evaluated and improved. One could also think of adding more functionalities around the visualizations providing possibilities for user interaction, such as saving a visualization or editing it.

6 User Study

This section addresses the design and the results of the study conducted to investigate the effect of text visualizations on reading comprehension. The study aims to answer the following research questions:

1. Do visual text summaries have an effect on reading comprehension?
2. What are the subjective benefits or preferences regarding the visualizations?

6.1 Methodology

A user study in a repeated measure design with five conditions was conducted. The study had 70 participants in total. The majority of the participants were university students of different fields of study. Mostly they were from media related studies or social sciences, but there were also participants from humanistic or technical backgrounds. Their age ranged from 18 to 39 (M=22.33, SD=4.18), 43 of them were female and 27 male. They were recruited over university newsletters, social networks and university lectures.

Five different texts are mapped to each of the four visualization and one baseline condition without a visualisation. Here, all types of visualizations were prepared for each text, so that the visualization could be evaluated independently from the text. There were five different groups with different text-visualization mappings to which participants were randomly assigned. Participants had to read all five texts, which were also presented in a randomized order for each participant to eliminate side effects of fixed text order. With this design we strived to eliminate confounding influences and aim for a high internal validity.

Group 1	Group 2	Group 3	Group 4	Group 5
Text 1	Text 1	Text 1	Text 1	Text 1
Text 2	Text 2	Text 2	Text 2	Text 2
Text 3	Text 3	Text 3	Text 3	Text 3
Text 4	Text 4	Text 4	Text 4	Text 4
Text 5	Text 5	Text 5	Text 5	Text 5

The text order was balanced.

Legend:

visualization 1	without visualization	visualization 3	visualization 3	visualization 4

Figure 27: Text-Visualization Mapping of the Questionnaires

6.2 Apparatus

As reading material five standardized texts from the Institute for German as a Foreign Language (TestDaF) with comprehension questions were chosen. For those texts we generated the keywords with the prototype. For the visualizations we used the keywords of the prototype. The mind map and the image cloud were only based on the keywords but created manually. For the mind map we used the mind mapping tool Free Mind[15] and for the image collage we searched for suiting pictures under a creative commons licence. As a survey tool we used *Limesurvey*[16].

6.3 Procedure

The study took place in a computer lab at the university, where multiple people could take the test at the same time, but could be supervised in case of questions.

First, the purpose of the study was explained and each of the participants signed a form of consent, were they also agreed to participate in a subsequent study investigating the effect visualizations have on memory. Then they were handed a piece of paper with the url of the questionnaire, which they could fill out at one of the workstations in the lab.

The questionnaire itself contained a block with demographic questions, inquiries about the reading behaviour, as well as each of the five texts with corresponding comprehension questions, questions about each of the text visualizations and a comparison of the four visualizations and concluding feedback.

Demographic data we collected were: age, gender and profession. Furthermore, we asked whether German was the mother tongue of the participants. The participants had to judge their reading behaviour and chose one of these statements: “I read little”, “I am a casual reader”, “I am an avid reader”. We also wanted to determine popular reading media among the participants (paper, digital devices like PCs, tablets, e-readers or others).

After the block of demographic questions came the visualization and text related questions. If the text was mapped to a visualization type, we showed the visualization before the reading task and instructed the participant to look at it closely for a minute. Then the participant was asked to guess what the text could be about. After that, the text was to be read, for which the participant could take as much time as needed. Having read the text and before the ten comprehension questions in form of multiple choice, the participant was asked to evaluate the visualizations according to the following characteristics on a scale from “I disagree”(1) to “I strongly agree (5)”:

1. The visualization helped me to understand the text.
2. The visualisation helped to get the gist of the text.
3. The visualization reflected the content of the text comprehensively.
4. The visualization provided an overview of the text structure.

[15] freemind.sourceforge.net/
[16] https://www.limesurvey.org/

At the end of the questionnaire we gave the opportunity to give feedback on the visualizations and pick a favourite and a least favourite one regarding helpfulness as well as design. The last question aimed at the use cases of such visual text summaries and asked which types of text (non-fiction, fiction, web pages and other) the participant would like to have visualized.

6.4 Results

In this section the results regarding the reading behaviour, the subjective feedback and rating as well as the effects on reading comprehension collected by the conducted user study are presented.

Reading Behaviour

When questioned about their reading behaviour 30 of 70 participants stated they were avid readers, 37 said they read occasionally and three answered they read little. Regarding the medium or the device on which they read, 65 participants read on paper, 52 on the computer, 24 on tablets, seven on e-readers and seven on smartphones (see Figure 28).

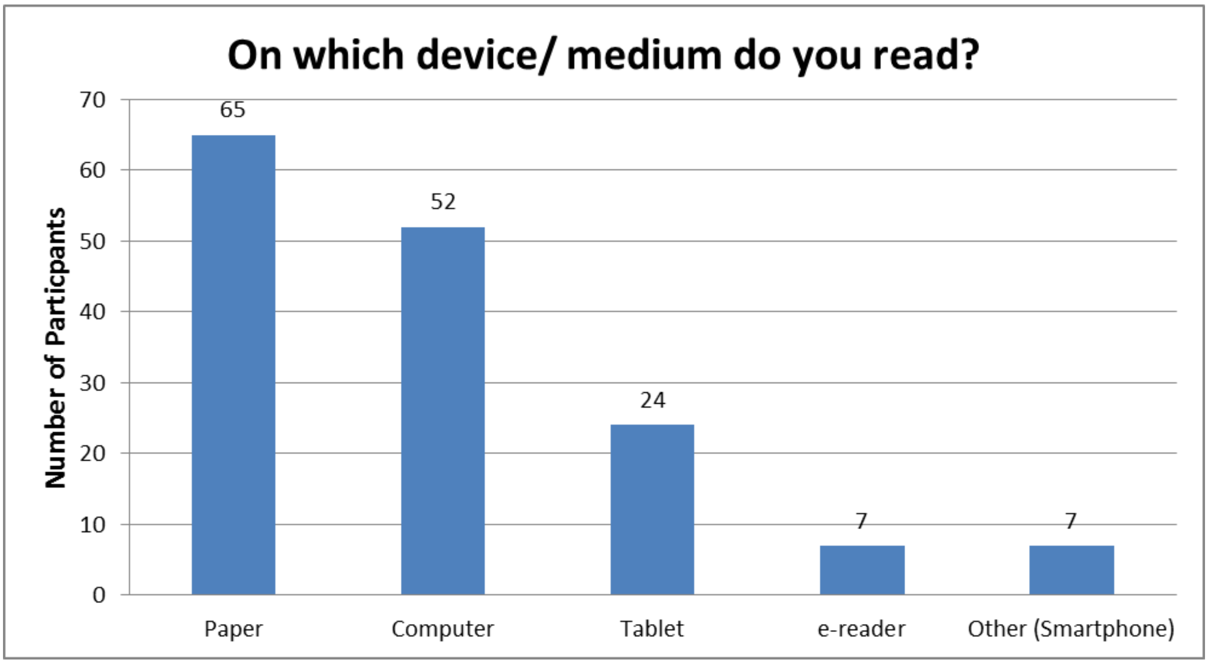

Figure 28: Reading devices/ media of the participants

Subjective Feedback

For the statement *"The visualization helped me to understand the text."* the tag cloud received a mean of 2.83 (SD=1.27) and a mode of 4. The mind map had a mean of 3.14 (SD=1.25) and a mode of 4 for this statement. The highlighting received a mean of 2.93

(SD=1.12) and the mode was 3. The mean for the image collage for this question was 2.96 (SD = 1.16), the mode was 4. The results are visualized in *Figure 29,* where the median and the mean are marked. No significance was found between conditions with $X^2(2) = 4.7, p = .195$.

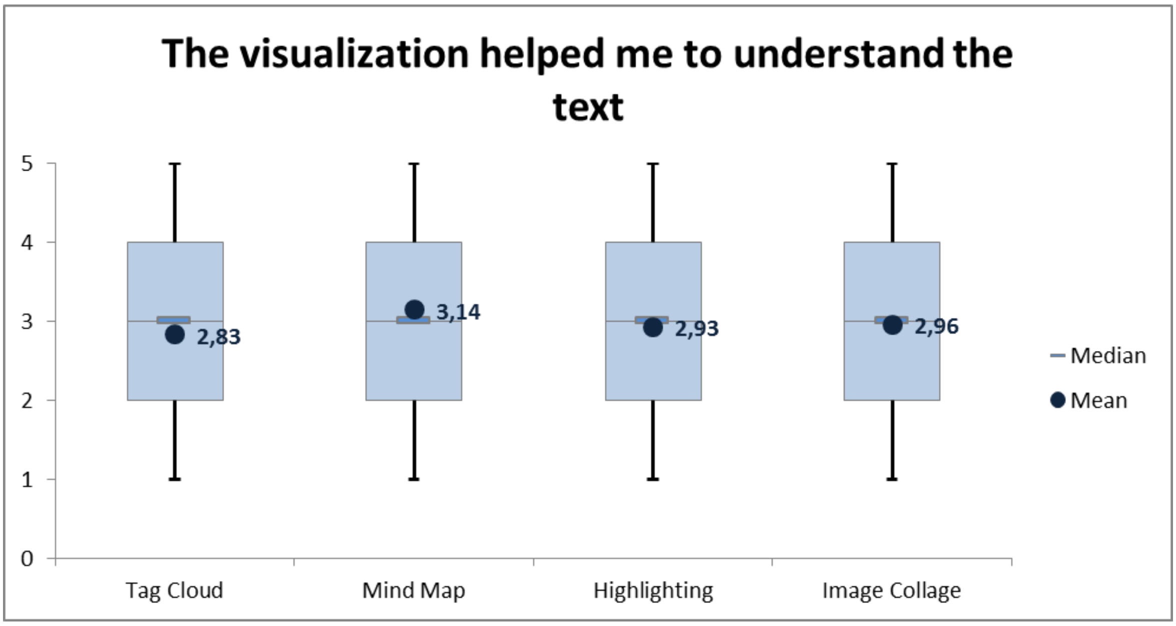

Figure 29: Results for "The visualization helped me to understand the text."

The tag cloud was rated with a mean of 3.61 (SD=1.31) and had a mode of 4 for *"The visualisation helped to get the gist of the text"*. The mind map received has got a mean of 3.84 (SD=1.04) and a mode of 4. The mean of the highlighted keywords was 3.56 (SD=1.31) and also a mode of 4. For the image collage a mean of 3.19 (SD=1.15) and a mode of 4 was received. More details are shown in *Figure 30*. The Friedman test showed a significant difference between conditions with $X^2(2) = 12.051, p < .01$. Pairwise comparison Wilconxon signed rank test showed that participants preferred mind map (M = 3.84) over image collage (M = 3.12),$T = 1028.0,\ p < 0.05$. No significant differences were found for the remaining tests.

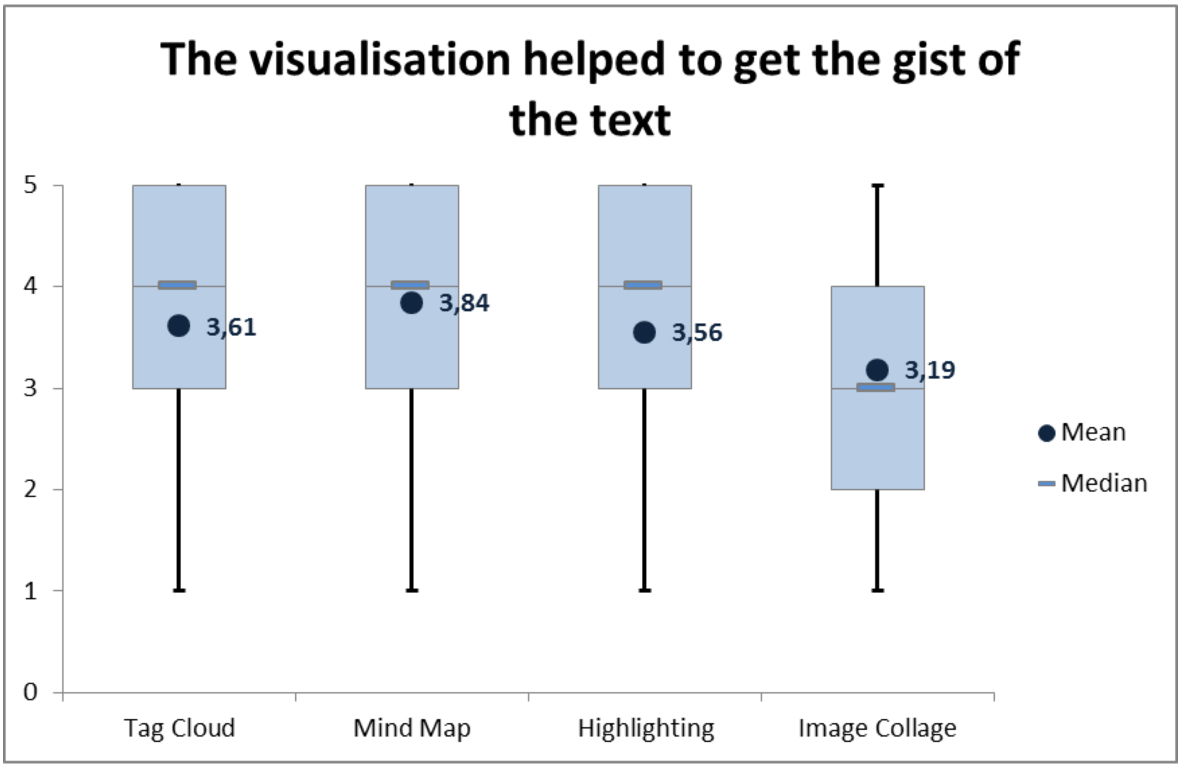

Figure 30: "The visualisation helped to get the gist of the text"

Regarding the statement *"The visualization reflected the content of the text comprehensively."*(as visualized in Figure 31) the tag cloud had a mean of 2.83 (SD=1.24) and a mode of 2. Here, the mind map achieved a mean of 3.23 (SD=1.17) and mode of 4. The highlighting was evaluated with a mean of 2.91 (SD= 1.23) and a mode of 2. For the image cloud the rating was in the mean 2.74 (SD=1.23) and a mode of 3. The Friedman test showed a significant difference between conditions with $X^2(2) = 10.137, p < .05$. However, pairwise comparison did not yield any significance.

The evaluation of *"The visualization provided an overview of the text structure*." (see also Figure 32) resulted in a mean of 2.71 (SD=1.26) and a mode of 3 for the tag cloud. The mind map was rated with a mean of 3.30 (SD=1.33) and had a mode of 4. The highlighting received a mean of 3.14 (SD=1.25) and a mode of 4. For the image clouds the mean was 2.52 and the modus 2. The Friedman Test showed a significant difference between conditions with $X^2(2) = 21.106,\ p < .01$.Pairwise comparison Wilconxon signed rank test showed that participants preferred mind map (M = 3.3) over tag cloud (M = 2.71), $T = 345.0, p < .05$, and mind map (M=3.3) over image collage (M=2.52), $T = 1195.0, p < .01$. No significant differences were found for the remaining tests.

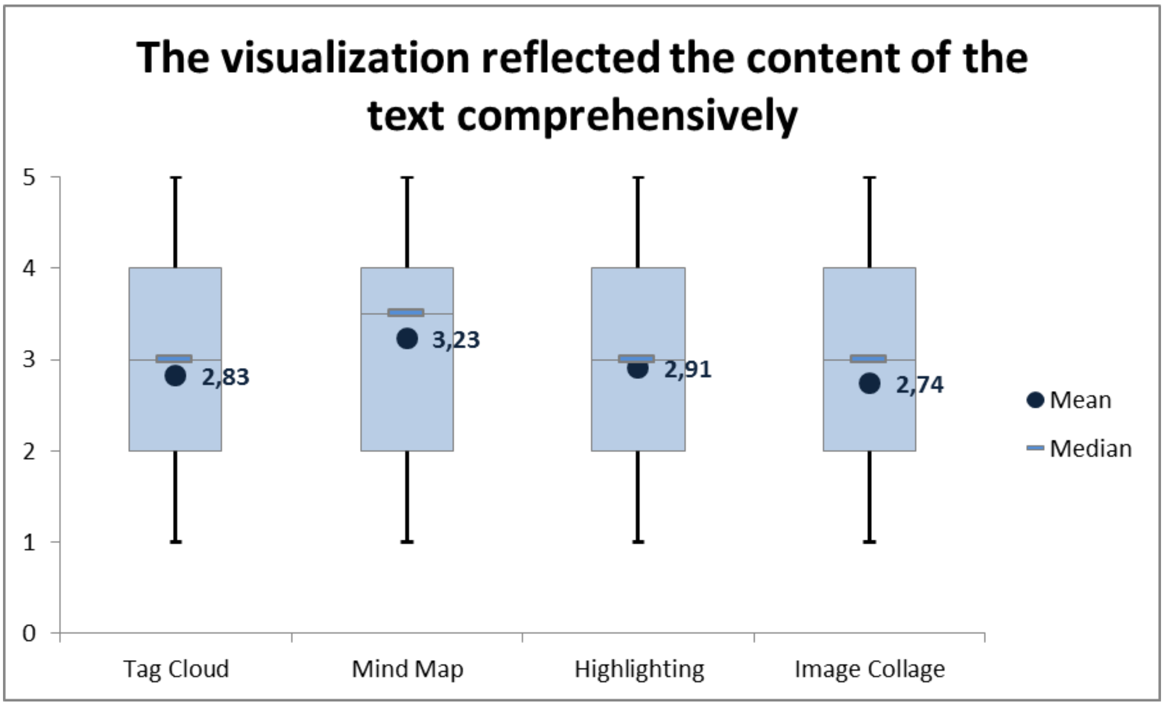

Figure 31: The visualization reflected the content of the text comprehensively

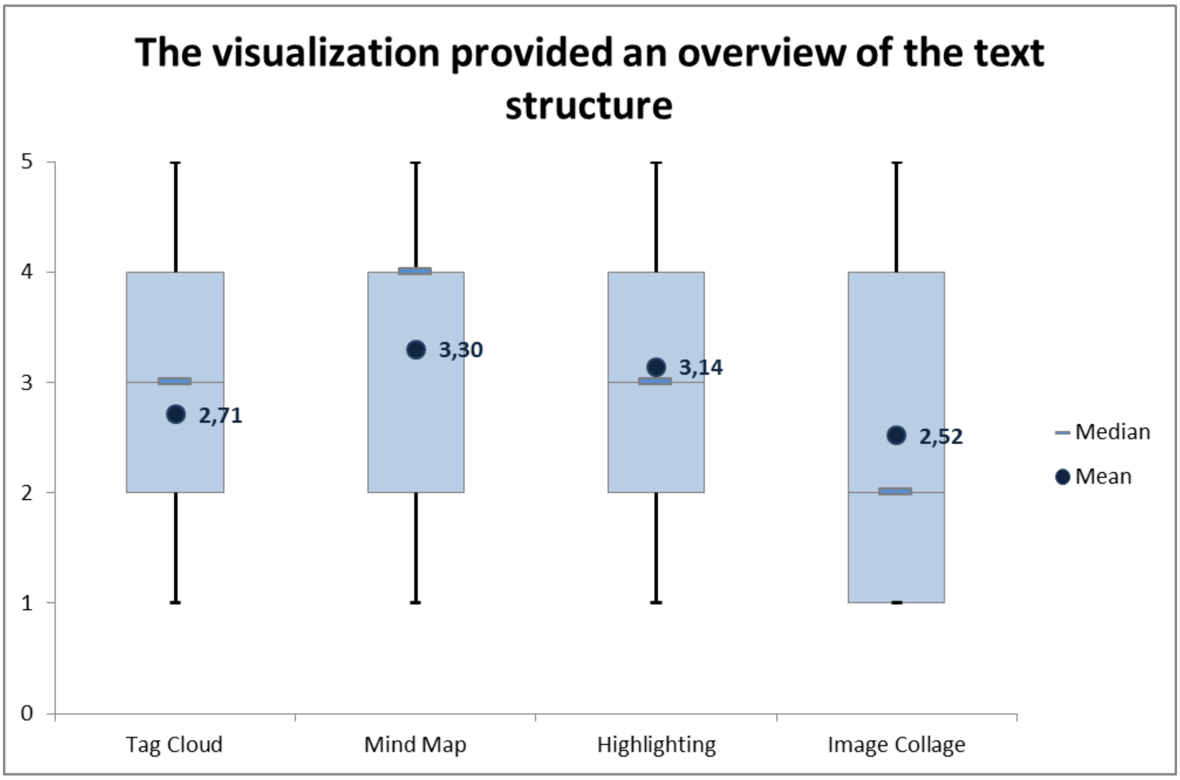

Figure 32: "The visualization provided an overview of the text structure."

Subjective Rating of the Visualizations and Preferences for Visualizations

We asked the participants to rate the visualizations, regarding the helpfulness and the design, letting them select which visualization they liked the most or the least for the given criteria. Results are visualized in *Figure 33* and *Figure 34*. Two participants selected the same in the least and most appealing design category, thus their data could not be counted. Likewise, seven participants made the same selection in most and least helpful, those too, are not considered.

16% considered the tag cloud most helpful, while 29% considered it least helpful. The mind map was rated most helpful by 29% and least helpful by13%. For 33% the highlighted keywords were most helpful, for 19% they were least helpful. The image collage received the rating “most helpful” from 21% participants, and “least helpful” from 33%. 2% considered none of the visualizations most helpful, while 6% considered none of the visualizations least helpful.

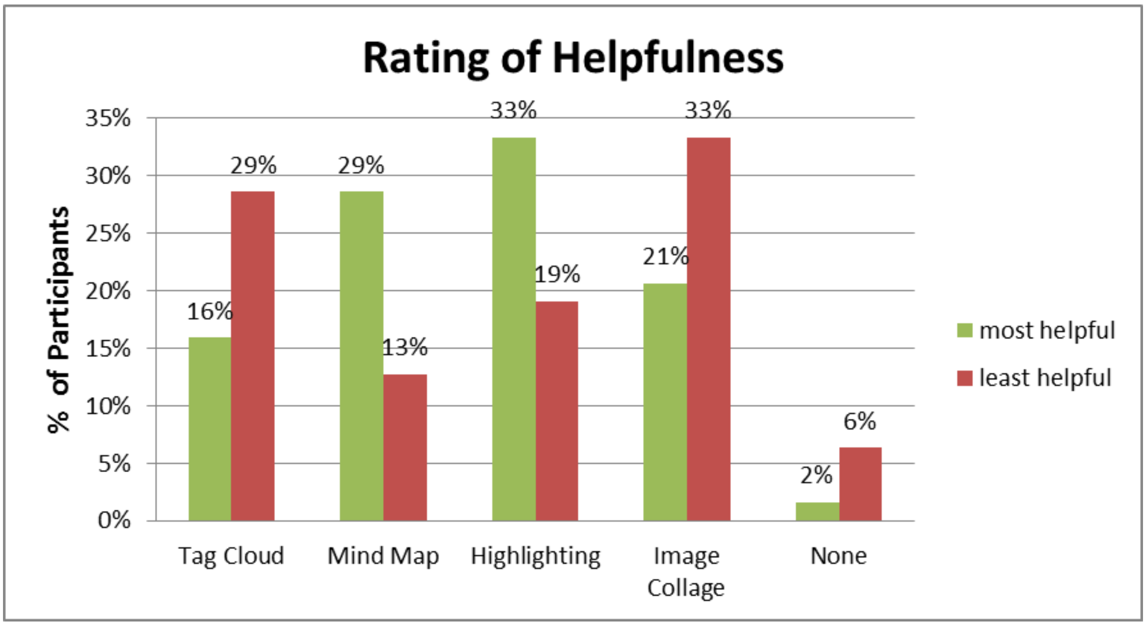

Figure 33: Rating of Helpfulness

Regarding the design of the visualisation the tag cloud was considered most appealing for 26% and least appealing for 21%. The design of the mind map received 16% “most appealing” and 25% “least appealing” votes. Highlighted keywords were considered most appealing by 6% and least appealing by 43% The image collage was rated “most appealing” by 47% and considered as least appealing by 9%. 4% rated none of the visualizations most appealing, while 3% considered none least appealing.

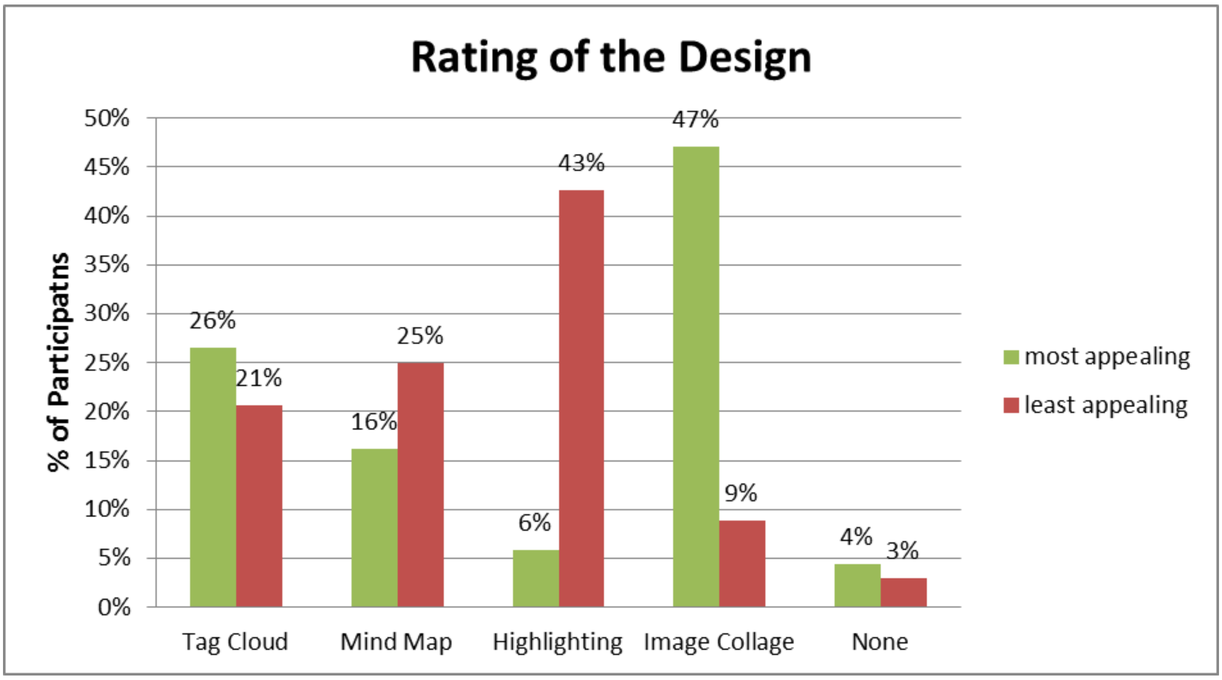

Figure 34: Rating of Design

When asked for which kinds of text they would like to have visualizations for, 63 participants wanted visualizations for non-fictional texts, 28 wanted web sites visualized and eight fictional texts. Additionally mentioned were lecture notes or manuals.

Effects on Reading Comprehension

The tag cloud had a mean of 7.50 correctly answered questions (SD=1.83), the mind map one of 7.29 (SD=1.77),the highlighting one of 6.99 (SD=2.06) , the image collage had a mean of 7.10 (SD=2.08) and the baseline without any visualization received a mean of 7.30 and SD of 1.66.
There seems to be a noticeable difference between tag cloud and highlighting with highlighting resulting in slightly worse comprehension. However, a Friedman test did not yield any significances between the five conditions, $X^2(2) = 3.42, p = .49$.

6.5 Limitations

Potential biases or limiting influences on the results could stem from the sample which is not representative, as the majority are university students and the text selection with their corresponding comprehension questions.

7 Discussion

The results of the user study are discussed and put in context, in consideration of the limitations and the participants' comments. Further, consequences for the prototype are to be drawn.

7.1 Findings of the User Study

In this paragraph the results of the user study are discussed and evaluated. Additionally we want to refine our design implications of our previous work [3] and state some subjective benefits participants mentioned.

Effects on Reading Comprehension

By testing the participants with comprehension question for each text we wanted to measure the influence of the text visualizations objectively. However, we were not able to find any significant differences between the five conditions. This could be due to the differences regarding the difficulty of the texts and their comprehension questions. Comprehension does depend on the type of text and on the text structure. If the text itself has a good and clear structure and writing, it is generally better understood c.f. Kintsch [27]. One participant stated that *"I think it also depends on the type of text. [One text] was better to recall than the others because it was not structured like a 'typical' non-fiction text",* another also stated that *"[the same] text was the easiest."* This inequality of text comprehensiveness could have influenced the results. The comprehension questions also varied in their difficulty, sometimes it seems they were more general, while other questions were more specific and thus more difficult. Further the comprehension results could also be by guessing the right answer. In future studies texts that are more similar in regard to their structure and difficulty should be used. One could also think about measuring the reading comprehension in a way to limit guessing.

Subjective Feedback

No visualization seemed to be significantly different than the others regarding the helpfulness in regard to text. Here there is to say, that the amount of neutral votes perhaps could have influenced the lack of significance. Many participants selected the neutral option, perhaps because they have difficulty in evaluating their understanding as such.

Regarding the statement *"The visualisation helped to get the gist of the text"* the mind map was significantly favoured over the image collage. Mind map and image collage follow two different approaches of transmitting the gist. The mind map uses a very explicit approach by directly showing relationships of keywords and thus potential topics, while the image collage presents the content implicitly through pictures that first have to be interpreted by the reader. This interpretation step often seems to *"blurry", "ambiguous"* and *"confusing"* for the reader. The mind map on the other hand has *"the ability to "reflect the text systematically"*, which seems to be more beneficial for the users. The other approaches of visualizations seem not so contrasting to one another regarding that aspect, as an image collage and mind map, participants e.g. remarked that *"tag cloud and highlighting are similar"*, which could be the reason why there were no significances observable.

Though no significance pair-wise significance was found regarding the comprehensive reflection of the text, it seems like the mind map is slightly better in that category. Various participants also praised the mind map for *"summarizing the text best"* or *"containing the most information"*. However, this assumption is only hypothetical and should be treated with care.

The significantly better results of the mind map regarding the text structure were to be expected. In a mind map the structure seemed most obvious in contrast to other more unstructured appearing visualizations like a tag cloud or a image collage. Participants especially stressed the good structure of the mind map: *"is well structured"*, *"provides the best overview over the text"*, *"mirrors hierarchies and connections"*. Regarding the tag cloud or the image cloud it on the other hand it was often remarked that *"the tag cloud was not easy to view" or "[In the tag cloud] the words were not connected through sensible relationships, the context was missing completely."* or, concerning the image collage: *"[the image collage] would be more helpful if it would be structured somehow"*. The highlighting is not significantly different than the mind map regarding this question. This could be, because, the highlighting, too, could have the potential to show the text's structure, according to the participants' comments:*"[The highlighting] puts the keywords into context"* and *"you recognize the structure of the text through the highlighted keywords"*. However, this potential was not as clear and apparent as in the mind map, which could be why there are no significant differences between image collage and highlighting or tag cloud and highlighting as there are for the mind map.

Subjective Rating of the Visualizations

The comments of the participants about the visualization rating concerned the general benefit gained by the visualization, design and comments on the text. These comments are presented now for each of the visualizations.

Participants rating the tag cloud most helpful or most appealing mentioned that this visualization type *"directly reflects the structure of the text and the importance of the words through size, color and order of the keywords"*. This they found beneficial for getting an overview or recalling the information. One participant even stated that the not so evident connection of information motivated to form own connections between the words. This lack of connection, however, was also remarked negatively. Those who rated the tag cloud as least helpful or appealing found the tag cloud hard to understand, confusing or even not motivating. They said they were confronted with *"too much information"*, which was not structured. Some participants seemed not to grasp the underlying design principles of the tag cloud, which could be related to unfamiliarity of tag cloud visualizations in general.

Positive comments about the mind maps pointed out the hierarchical structuring of the visualization itself and that it mirrors the structure of the text. Participants, who ranked the mind map most helpful or found it easy to understand, stated that held a lot of information and fostered comprehension. People rating the mind map least helpful commented that the connections of the keywords in the mind map are sometimes difficult to understand and confusing. Some criticized, that the information was not presented in the same order as in the text. The interleaving and vast forms of the mind map caused visibility problems for some *(“It takes up too much space”*). On more superficial level it was remarked that the design was rather plain.

The highlighted keywords were seen *“as a comprehensive reflection of the text”* that “make the important words stand out” according to the some participants who rated the highlighted keywords most helpful. They further stated that the highlighting were a good preparation for the text, supported skimming and that the highlighting helped to recall the text. That the words here are presented directly in the context of the whole document was remarked positively by some, other however found it irritating and not easy to browse through.

Images in the image collage were said to *”foster imagination”* and be *“more expressive than words”* by those who rated it helpful. Some even commented that the pictures motivated to read the text. Negative ratings often had comments like “the pictures leave too much room for interpretation”, “convey too little meaning” and “are distracting”. The design of the image collage was rated positively on more superficial reasons like “colourfulness” or the aspect that *“pictures in general are more interesting to look at”*.

Some participants would not select a specific visualization as most helpful, because they thought *“the helpfulness depends not only on the visualization type but also on the text type”*.

While the decision on helpfulness mostly was founded on subjectively perceived benefits and important design principles, the decision of appealing design was often influenced by more concrete properties like colour. Helpfulness was not considered in the design rating as the inverse results, especially those of the image collage, show.

Summary of Participants Comments and Refinement of Design Implications

Summarising the comments and the ratings, subjective “least helpful” or “most helpful” decisions where often justified by the design of the visualization. Properties that could often influence that decision are visualized in Figure 35. Some of those design implications are consistent with those already mentioned in the preliminary study [3] and provide some refinements. However, these design implications base on subjective feedback so far and should be further evaluated regarding their objective helpfulness in future studies.

Characteristics of “helpful“ visualizations	Characteristics of “non-helpful“ visualizations
1. They focus on **important aspects** of the text.	1. They confront the reader **with too much information**.
2. Their concepts are **clear** and **not too complicated** to understand.	2. They **confuse** the reader, use **too complex** underlying concepts.
3. They are able to provide an **overview of the text**.	3. They are **not able to reflect the text‘s content**.
4. They provide **sequential ordering** and mirror the **text‘s structure**.	4. The **text‘s structure is not considered** in the design.
5. They are unambiguous.	5. They create **wrong impressions** and leave too much room for interpretation.
6. Their design is **structured** and perceivable quickly.	6. Their design is **unstructured** and **not easy to view**.
7. They are designed to capture one‘s **interest**.	7. Their design is perceived as **non-motivating**.

Figure 35: Characteristics of helpful vs. non-helpful visualizations

When helpful, the participants mentioned the following subjective benefits were often throughout the visualization forms:

- Visualizations could help to single out important aspects.
- The gist of the text can be understood through visualizations.
- Visualizations aid to quickly perceive structure and content.
- Visualizations make the important aspects potentially more present in one’s mind and help to remember the information.

These are the benefits we designed the prototype for, however, they are only subjective statements and thus, their actual effects should be investigated further through objective measures in future studies.

7.2 Consequences for the Prototype

This paragraph focusses on the consequences of the study results on the prototype, particularly the visualization data creation and the visualizations itself.

Visualization Data Creation

The prototype should be refined regarding the semantical clustering, to provide more meaning in the automatically created mind map approach as it seems to be a visualization subjectively favoured by the participants. Challenging, however, remains to find a semantical structure that is not too difficult to understand for the reader, as this would be counterproductive, as Schrammel et al. stated [46].

Concerning the image collage it still seems crucial to find the "right" pictures for the visualization to work. However, this definition of "right" is another challenge we have to face. Perhaps similar approaches to those of *Document Cards* [50], where relevant images are extracted directly from within the text, or of Kudelic et al. [28], who involve the user in the image selection process by providing him with a list of fitting pictures and asking for the selection of the image the user likes best, could be pursued.

Visualizations

The design of the visualizations should be considered to be refined and improved. Particularly the design of the tag cloud should be made more structured and easily viewable. Some participants suggested a mixture of tag cloud and image collage. Such hybrid visualization forms could be explored.

8 Conclusion and Future Work

In this work we explored the potential of text-visualizations as reading support. We proposed four visualizations and could derive important design aspects to consider when designing visualizations to foster reading comprehension. Our first prototype is able to extract important keywords from text and visualizing them.

Though our current study results have not yielded significant results regarding the reading comprehension, we are positive, that text visualizations can help the reader with his or her reading activities. Subjective feedback has hinted the benefits of reading support of visualizations and we want to investigate those potential benefits and especially want to focus on the effects on comprehension and memory. However, results have provided us with useful subjective feedback, which can be used as orientation for future studies

Our prototype has basic functionalities for visualization creation but still requires some refinements regarding the visualization data creation, especially in the clustering approaches. Also performance should be tested with very large corpuses and the prototype should be extended to provide more extensive and precise language support. In a future field study we want to evaluate the current state of the prototype and determine further room for improvement. In this field study the different usage scenarios of text visualizations could be investigated by carrying out surveys among the users of *sowiport*. Also further design refinements could be derived in these future field studies.

As our participants confirmed reading on electronic devices has and will become increasingly common. One could also imagine of using the prototype's technology in other settings such as e-book readers or websites. We plan on implementing a browser plugin that dynamically creates visualizations based on the content on of a website. This could make the information contained in websites quicker and easier to comprehend. This could help the reader to quickly find, understand and remember the information he or she was looking for.

With this work we hope to provide a starting point to the exciting and important field of research on facilitating reading on electronic devices with the aid of text visualizations.

A Appendix

The appendix contains all visualizations used in the study mentioned in Chapter 6.

Visualizations Text 1

Die Sammelleidenschaft beim Menschen

Evolutionsbiologen beschäftigen sich seit geraumer Zeit mit der Sammelleidenschaft des Menschen. Der Mensch sammelt die unterschiedlichsten Gegenstände, unabhängig von ihrem materiellen Wert. Selbst Schlüsselanhänger, Gesteinsproben oder Murmeln können den Sammeldrang wecken. Keineswegs stellt das Sammeln lediglich das Anhäufen nutzloser Gegenstände zum Zeitvertreib dar, wie gemeinhin angenommen wird. Vielmehr kommt dem Sammeln in vielerlei Hinsicht eine wichtige Rolle zu. Wie kommt also diese Sammelleidenschaft zustande, und welche Funktion hat sie?

Die Sammelleidenschaft kann am stärksten in der Kindheit konstatiert werden, in einem Alter also, in dem Nützlichkeitserwägungen noch keine Rolle spielen können. Kinder beginnen in der Regel schon früh, oft unvermittelt und intensiv mit dem Sammeln. Das Sammeln bestimmter Gegenstände muss also schon in der Kindheit etwas außerordentlich Wichtiges sein. Es ließ sich beobachten, dass Kinder beim Sammeln sogar bereit sind, ihre guten sozialen Beziehungen zu gefährden. Das unterscheidet das Sammeln vom Spielen: Ein Spiel wird zwar sehr intensiv betrieben, wird aber auch rasch wieder beendet, während das Sammeln oft über Monate und Jahre, nicht selten ein ganzes Leben lang, anhält.

Figure 36: Highlighted Keywords Text 1(excerpt), text was taken from:[65]

Figure 37: Tag Cloud Text 1

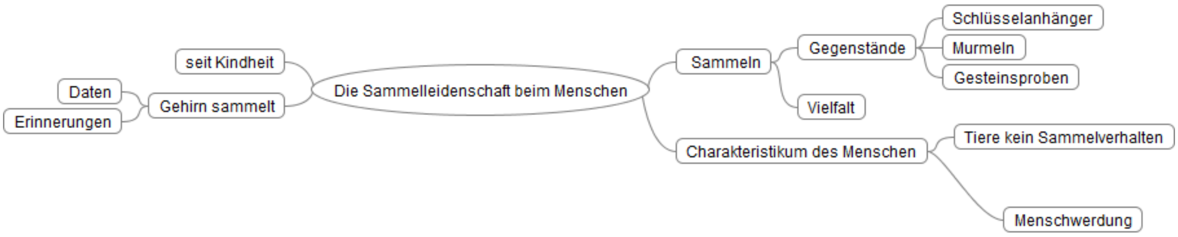

Figure 38 : Mind Map Text 1

Figure 39: Image Collage Text 1[66,67,68,69,70,71,72,73]

Visualizations Text 2

Zur Funktionsweise von Werbung

Wie funktioniert Werbung? Dieser Frage geht unter anderem die Sozialpsychologie nach. Sie kommt dabei zu interessanten Ergebnissen über die Voraussetzungen für erfolgreiche Werbestrategien. So belegen mehrere wissenschaftliche Studien, dass die Stimmung, in der man sich befindet und die Emotionen, die durch Werbebilder und Texte vermittelt werden, die Wirkung von Werbung verstärken können. Auch das Bild einer bekannten Persönlichkeit oder Markennamen können Menschen zum Kauf eines Produktes veranlassen. Doch warum ist das so?

Ein Grund für den Erfolg von Werbung ist vermutlich, dass Menschen in Situationen, die ihnen unwichtig erscheinen, Entscheidungen aufgrund einfacher Signale treffen, anstatt nachzudenken und abzuwägen. Wie wenig sie dabei auf den sachlichen Inhalt eines Überzeugungsversuchs achten, veranschaulicht folgendes Experiment am Kopiergerät einer Universitätsbibliothek: Ein Forscher ging auf Studierende zu, die gerade kopierten, und bat diese, ihn vorzulassen. Die Bitte wurde in drei Testphasen unterschiedlich formuliert. In der ersten Phase wurden die Personen am Kopiergerät gefragt: „Entschuldigung. Ich habe fünf Seiten. Darf ich den Kopierer benutzen?“ In der zweiten Phase wurde die Bitte mit dem Zusatz „weil ich in Eile bin“ begründet. Wie erwartet, willigten mehr Personen ein, wenn die Bitte gerechtfertigt wurde (90 %), als wenn die Rechtfertigung ausblieb (60 %). In der dritten Testphase wurden die Personen am Kopiergerät folgendermaßen angesprochen: „Entschuldigen Sie. Ich habe fünf Seiten. Darf ich den Kopierer benutzen, weil ich einige Kopien machen muss?“ Bei aufmerksamer Lektüre fällt auf, dass hier gar keine Begründung dafür gegeben wird, warum die Studierenden den Forscher vorlassen sollten. Erstaunlicherweise gaben dieser Version der Bitte aber 93 % der angesprochenen Personen statt! Die inhaltliche Begründung scheint also nicht ausschlaggebend für den Erfolg zu sein.

Das Experiment verdeutlicht, dass Menschen, wenn sie nicht an Details interessiert sind, oberflächliche Hinweise nutzen, um rasch zu einer Beurteilung oder Entscheidung zu gelangen. Im geschilderten Experiment war es das Wort „weil“, das den Versuchsteilnehmern eine Begründung signalisierte. Die Aussage nach diesem Signalwort wurde somit ohne weitere Überprüfung als Begründung akzeptiert. Ähnlich können in der Werbung von einem Experten oder Prominenten vorgebrachte Argumente für den Erwerb eines Produkts sprechen, ohne dass wir über die Argumente als solche, über ihre Stichhaltigkeit und logische Einbindung nachdenken. Ohne diese Hinweise, mentale Abkürzungen genannt, wäre man in vielen Situationen aufgrund der Fülle an einströmenden Informationen überfordert und unfähig, zu Entscheidungen zu gelangen. Mentale Abkürzungen erlauben daher schnelle und in der Regel effektive Reaktionen. Würde man z. B. im Supermarkt alle Vor- und Nachteile der unterschiedlichen Marken abwägen, so nähme die für einen Einkauf aufgewendete Zeit erheblich zu.

Figure 40: Highlighting Text 2, text was taken from:[74]

Figure 41: Tag Cloud Text 2

Figure 42: Image Collage Text 2,images from: [75,76,77,78,79,80,81,82]

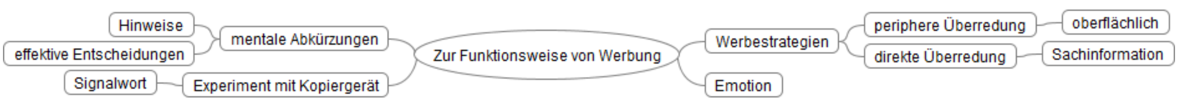

Figure 43: Mind Map Text 2

Visualizations Text 3

Lernen: Lust oder Last?

Manche Hirnforscher gehen heute davon aus, dass der Mensch über eine Art „Kapiertrieb“ verfügt. Das würde bedeuten: Außer den angeborenen Trieben wie Essen oder Fortpflanzung hat die Natur den Menschen noch mit dem Lerntrieb ausgestattet. Demnach wäre der Mensch von Geburt an bestrebt, Einzelheiten zu einem Ganzen zu fügen und neue Verknüpfungen zu erkennen – also zu lernen. Beim Lernen werden im Gehirn sogenannte Botenstoffe ausgeschüttet, die einen chemischen Ablauf auslösen, an dessen Ende im Körper ein Glücksgefühl entsteht. Lernen kann demnach Vergnügen bereiten. Die Lern- und Gehirnforschung hat herausgefunden, dass ein wichtiger Aspekt beim Lernen eben dieses Glücksgefühl ist, das sich automatisch bei Lernerfolgen einstellt. Die Forschung konzentriert sich heute auf den Vorgang des Lernens und auf den Antrieb, der zu Lernerfolgen führt. Viele Wissenschaftler vertreten inzwischen provokativ die These, dass jemand, der von der Arbeitsweise des Gehirns nichts versteht, auch keine Ahnung davon haben kann, wie Kinder am besten lernen. Sie fordern deshalb eine stärkere Berücksichtigung der wissenschaftlichen Erkenntnisse aus der Hirnforschung bei den Lernprozessen und im Lernalltag an den Schulen.

Allerdings liefert die moderne Gehirn- und Lernforschung in vielen Fällen oft nicht mehr als eine Bestätigung längst bekannter pädagogischer Weisheiten. Das Ergebnis der Wissenschaftler, dass Lernen mit Lust verknüpft sein kann und angenehme Erlebnisse besser als unangenehme erinnert werden, erkannten Pädagogen schon vor über dreihundert Jahren. Eine weitere Erkenntnis der Forscher ist, dass in den ersten Lebensjahren die Grundlagen für spätere Lernerfolge gelegt werden. Diese Weisheit findet sich zum Beispiel in dem altbekannten Spruch: „Was Hänschen nicht lernt, lernt Hans nimmermehr.“ Auch eine andere wichtige Botschaft aus der Lernforschung ist alt: Informationen werden dann am effektivsten verarbeitet, wenn sie auf möglichst vielfältige Weise – z. B. gesungen, gereimt, gemalt – alle Sinne anregen. Diese Einsicht entspricht genau dem, was Lehrer bereits vor über zweihundert Jahren forderten, dass nämlich Lernen mit Kopf, Herz und Hand erfolgen müsse. Die modernen wissenschaftlichen Erkenntnisse in Bezug auf das Lernen sind also nicht so neu, wie sie vielleicht auf den ersten Blick erscheinen. Und sie entsprechen im Wesentlichen den Vorschlägen, die Pädagogen seit Jahrzehnten machen. Die geforderten Reformen an der Schule sollten folgende Aspekte betreffen: Anstatt den Schülern möglichst viel Lernstoff einzutrichtern, sollten sie zum eigenen Problemlösen angeregt werden. Ferner sollten Schüler im Selbstversuch die Grenzen von Erfolg und Misserfolg ausprobieren können. Daneben sollte ganz besonderes Gewicht auf die Entwicklung von Lernstrategien gelegt werden. Denn bereits in einer frühen Phase, das heißt im Vor- und Grundschulalter, können Kinder lernen zu lernen. Eine weitere Forderung ist, dass bereits in der Grundschule klare Leistungsstandards und Grenzen gesetzt werden. Außerdem sollte bei der Vermittlung des Lernstoffes unbedingt darauf geachtet werden, dass die Gehirne der Schüler zwar angeregt, jedoch nicht mit zu vielen Reizen überlastet werden. Auch wenn die Kinder aus ihrem Alltag genau an diese Reizflut durch Video, Fernsehen oder Computer gewöhnt sind, kann sich ein Zuviel an Eindrücken negativ auf das Lernen auswirken.

Figure 44: Highlighting Text 3 (excerpt) text from:[83]

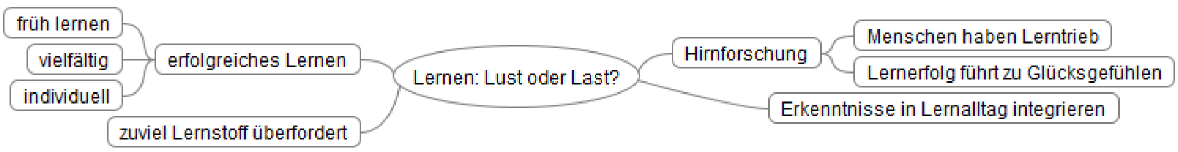

Figure 45: Mind Map Text 3

Figure 46: Tag Cloud Text 3

Figure 47: Image Collage Text 3, pictures from:[70,84,85,86,87,88,89,90]

Visualizations Text 4

Nüsse: Harte Schale, gesunder Kern

Die meisten Nussarten, die wir heute kennen, stammen ursprünglich aus Asien und kamen über Indien in den Vorderen Orient. Griechen und Römer brachten sie nach Europa, wo sie die mittelalterliche Küche bereicherten. Heute werden Nüsse fast überall angepflanzt.

In Deutschland werden Nüsse vor allem zur Weihnachtszeit gegessen. Doch sollte man sie wegen ihrer ausgezeichneten ernährungsphysiologischen Eigenschaften auch das ganze Jahr über zu sich nehmen und zwar am besten unverarbeitet, denn beim Kochen und Backen werden Vitamine zerstört. Zwar essen die Deutschen im Durchschnitt jährlich 3,7 Kilogramm Nüsse, doch kennen die wenigsten ihren hohen gesundheitlichen Nutzen. Das war einmal anders. Neben Wurzeln, Beeren und Pilzen gehörten Nüsse in vielen Weltregionen über Jahrhunderte zur Grundnahrung des Menschen. Ernährungsexperten bescheinigen den Nüssen enorme Qualitäten. Nüsse enthalten zwar viele Kalorien, doch sind sie gerade wegen ihrer wertvollen Fette und Öle nicht hoch genug einzuschätzen. Denn nicht nur, wie viel Fett man zu sich nimmt ist für die gesunde Ernährung entscheidend, sondern vor allem auch welche Fette man isst. Rund 80 Gramm Fett sollte man täglich verzehren.

Darunter sollten so wenig gesättigte, also tierische, Fette wie möglich sein. Einfach ungesättigte Fettsäuren hingegen, die in Nüssen und in anderer pflanzlicher Kost reichlich vorhanden sind, sollten den größten Teil der Fettzufuhr ausmachen. Denn die ungesättigten Fettsäuren senken den Cholesterinspiegel und beugen so Krankheiten vor. Eine kalifornische Studie ergab, dass der regelmäßige Verzehr von Walnüssen die Cholesterinwerte in zwei Monaten um bis zu 16 Prozent senken kann. Außerdem dienen Walnüsse als Stärkungsmittel z.B. nach einer Krankheit und sind für Personen, die an Nervenentzündungen und Rheuma leiden, empfehlenswert. Auch für Kinder im Wachstumsalter ist die Walnuss hervorragend geeignet, denn sie reguliert die Drüsentätigkeit.

Nüsse enthalten auch viele B-Vitamine, die in größeren Mengen sonst nur in Fleisch und tierischen Produkten vorkommen. Und sie liefern ebenso hochwertiges Eiweiß wie Fleisch. So haben drei brasilianische Paranüsse dank ihrer Öle und Proteine denselben Nährwert wie ein Steak.

Figure 48: Highlighting Text 4 (excerpt) text from: [91]

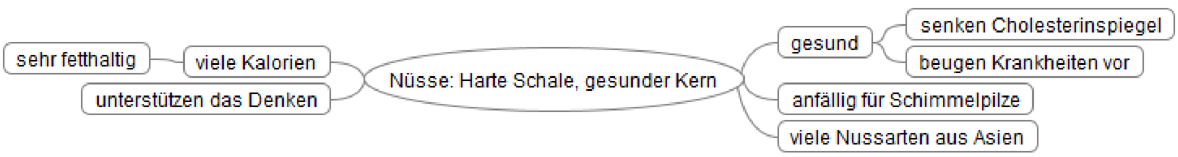

Figure 49: Mind Map Text 4

Figure 50: Tag Cloud Text 4

Figure 51: Image Collage Text 4, pictures from:[92,93,94,95,96,97,98]

Visualizations Text 5

Junge Hose - alte Geschichte

Heute trägt fast jeder Jeans. Viele junge und auch ältere Leute können sich gar nicht mehr vorstellen jemals eine andere Hose anzuziehen. Jeans sind immer noch modern, obwohl diese „Superhose" schon mehr als 140 Jahre alt ist.

Erfunden hat sie Levi Strauss. Als er im Jahre 1848 nach Amerika kam, hatte er sich bestimmt nicht gedacht, dass er einmal eine weltberühmte Erfindung machen würde, die „Blue Jeans", Levi Strauss, der den Beruf eines Schneiders gelernt hatte, war mit 18 Jahren aus Deutschland nach Amerika ausgewandert, um dort, wie viele andere Menschen auch, sein Glück zu suchen. Seine Familie, Vater, Mutter und acht Geschwister, musste er in der Heimat zurücklassen.

Nach einer langen und beschwerlichen Seereise war er schließlich nach San Francisco gekommen. Dort herrschte zu dieser Zeit das Goldfieber. Zu Tausenden kamen die Menschen ins Land, um in den Bergen und Flüssen nach Gold zu suchen. Aber Levi Strauss war nicht nach Amerika gekommen, um nach Gold zu graben. Er träumte davon, einmal ein eigenes Geschäft zu eröffnen, und so begann er, in einem kleinen Laden als Verkäufer zu arbeiten.

Doch eines Tages brach in dem Laden ein Feuer aus, und Levi Strauss verlor seinen Arbeitsplatz. Da gab ihm ein Freund einen Rat: „Geh doch zu den Goldgräbern, die brauchen dich. Du bist doch Schneider, die Goldgräber können ihre Hosen nicht selber reparieren, und Frauen gibt es dort keine.

So zog Levi Strauss los und wanderte zu Fuß in die Berge. In einem kleinen Dorf bei Sacramento baute er sich ein Häuschen aus Holz und begann zu arbeiten. Sein Geschäft ging gut Er kaufte alte Kleider, brachte sie in Ordnung und verkaufte sie wieder mit Gewinn.

Eines Tages wurde ihm zu einem günstigen Preis ein großes Stück sehr fester, blauer Baumwollstoff angeboten. Er kaufte ihn und machte daraus Decken für die Pferdewagen der Goldgräber. Aber niemand wollte sie kaufen. „Decken brauchen wir keine", sagten die Goldgräber, „was wir brauchen, sind Hosen!" Levi Strauss erkannte sofort die Gelegenheit und machte aus dem blauen, festen Deckenstoff Hosen. Das war die Erfindung der Blue Jeans! Sie wurde sofort in ganz Amerika ein Erfolg.

Die Goldgräber kauften diese Hose, weil sie haltbar und praktisch war und große Taschen hatte, in die man sogar Werkzeug stecken konnte. Bald trugen auch Cowboys und Viehhändler diese idealen Hosen.

Als Levi Strauss im Jahre 1902 starb, war er Millionär, und seine Firma war zum größten Kleiderhersteller der Welt geworden.

Figure 52: Highlighting Text 5 (excerpt), text from:[99]

Figure 53: Tag Cloud Text 5

Figure 54: Image Collage Text 5, images from:[100,101,102,103,104,105,106]

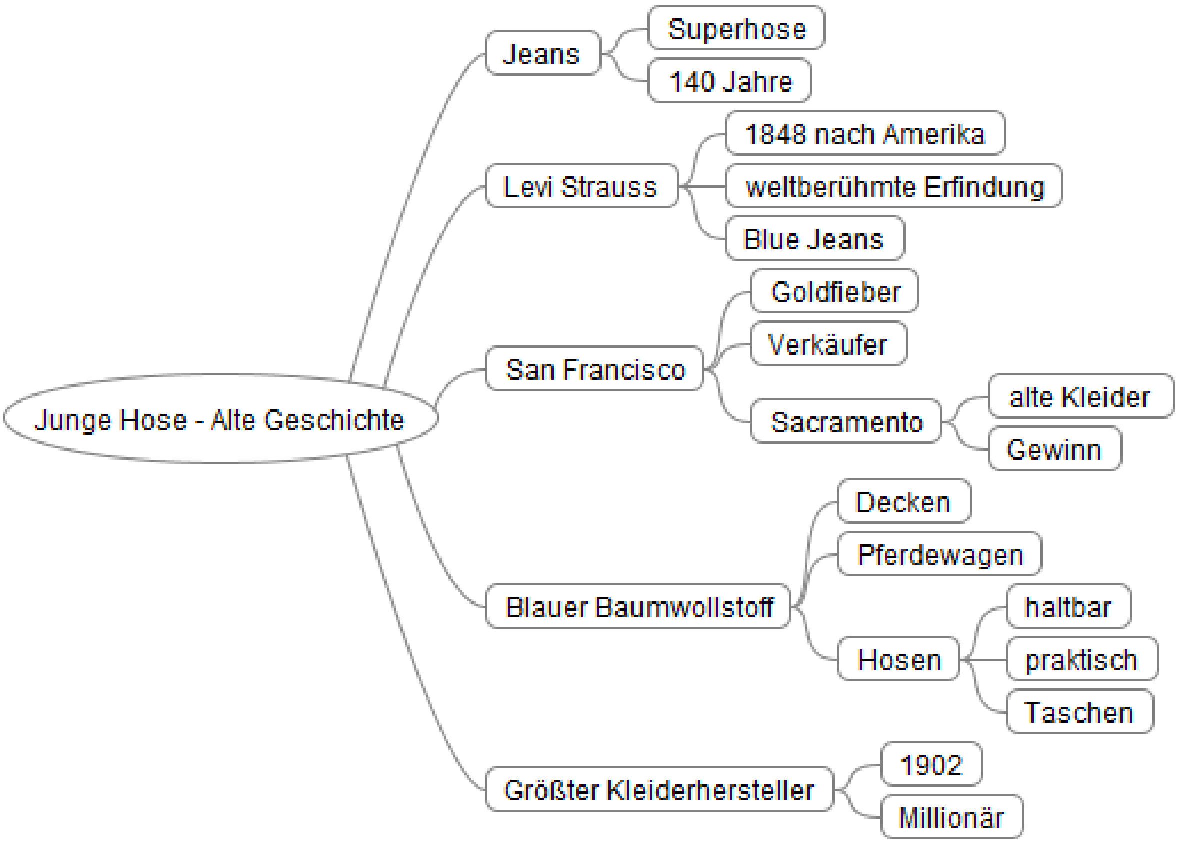

Figure 55: Mind Map Text 5

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