Comparing Different Layouts of Tag Clouds: Findings on Visual Perception

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Abstract. With the emergence of social tagging systems and the possibility for users to extensively annotate web resources and any content enormous amounts of unordered information and user generated metadata circulate the Web. Accordingly a viable visualisation form needs to integrate this unclassified content into meaningful visual representations. We argue that tag clouds can make the grade. We assume that the application of clustering techniques for arranging tags can be a useful method to generate meaningful units within a tag cloud. We think that clustered tag clouds can potentially help to enhance user performance. In this paper we present a description of tag clouds including a theoretical discourse on the strengths and weaknesses of using them in common Web-based contexts. Further recent methods of semantic clustering for visualizing tag clouds are reviewed. Findings from user studies that investigated the visual perception of differently arranged depictions of tags follow. The main objective consists in the exploration of characteristical aspects in perceptual phenomenons and cognitive processes during the interaction with a tag cloud. This clears the way for useful implications on the constitution and design factors of that visualisation form. Finally a new approach is proposed in order to further develop on this concept.

1 Introduction

Ever since social tagging systems began to gain popularity as a tool for annotating web resources, extensive amounts of unordered information have found their way into every day life in Web 2.0 surroundings. In order to differentiate between personally relevant information and irrelevant content, tagging and bookmarking have become a powerful routine among internet users. Essentially, once a selected item of information has been extracted from the enormous set of cumulated web content it has to be captured by the user for later use. An information source which has been tagged once should allow the user to re-find the content easily and at any time, while the meaning of that information in given contexts must remain comprehensible through the meaning of the adequately chosen tag. As people obviously differ in their personal conceptions and derive inter-individually different associations from one and the same information content many tags are dedicated to stand for fewer resources, filling the "tagging space" with more and more personalized keywords.

The need for managing this plenitude of cumulated tagging data, i.e. "folksonomies", provided reason for the emergence of a simple visualization form named the "tag cloud", a visual depiction of user-generated tags, in which words that act like links and connect to subsequent information content. In contrast to their great popularity, however, efforts to understand the underlying cognitive and perceptual processes related to the interaction with tag clouds have so far been moderate. Hence in our work we set the focus on tag clouds as a useful search tool that provides access to large amounts of user-collected data. As contents and resources in folksonomies are subjectively denominated by users without any limitations on vocabulary, a viable visualization form needs to integrate unclassified and difficult to define content into meaningful representations. A few variants have been proposed to enhance the interaction within a search process, e.g. mediating the relevance of the tags by varying visual features such as font size, color and position; or alternating the tags structural arrangement within a tag cloud. Additional innovative approaches have dealt with improvement of data management i.e. consolidation (for example [Viegas2004]). Accordingly, clustering methods have previously been used either to integrate tags into a coherent whole according to their semantic interrelations or to create new visual variants of tag clouds [Hayes2007],[Hassan-Montero2006],[Bielenberg2005]. In our opinion, semantic clustering for arranging tags can be a viable method to generate meaningful units within a tag cloud in order to enhance user performance and augment users' personal gain from the interaction. Facing the potentially great value within information visualization issues, our objective for improving tag cloud representations can be justified by their perpetual popularity as well as by the fact that their typical organisation and appearances have not yet seen much innovative activity.

In a first step, this work provides a detailed description of tag clouds, including an elaboration of the basic concept, common shapes and application methods; this introduction serves to hilghlight some cogent arguments regarding tag clouds practical limitations. Further, we excerpt some essentials from research into visual perception and eye movement, in order to touch on considerations in the discourse on perceptual aspects of the interaction with the tag cloud visualization. Additional attention is then given to the different uses of semantic clustering methods for the meaningful implementation of tag cloud applications, including some of the stringent findings attained with eye tracking methodology. We emphasize the analysis of the cognitive background of the observed behavior related to the interaction with tag clouds. A section is dedicated to illustrating the attempt of a stepwise dissociation of the different attentional and conscious and cognitive stages occurring during a typical interaction. Once the underlying processes have been illustrated we finally discuss some design- and concept-related considerations for the future use of tag clouds as a simple and viable tool for visualizing user-generated annotation content in the Web.

2 Tag Clouds

2.1 The Concept

The concept of a tag cloud is as popular as it is simple to comprehend. A tag cloud consists in an agglomeration of lexical items including words, parts of words, expressions, symbols, and combinations of the latter. All items are usually placed nearby to one another on a dedicated part of the display. Taken together they build a certain form due to their proximity one to each other, such as an angular or rounded shape. An example of a common tag cloud layout as can be found in the Web is presented in Figure 1. Each item, called a "'tag"', represents a hyperlink to a specific informational resource on a Website. Thus users are able to re-find their bookmarked resources through the use of keywords. Furthermore the tags can be used to organize several resources within specific topics.
Tags are usually weighted according to their occurrence and popularity within a representation, whereby the bigger the tag the more it has been frequented by users or the more often it occurs on a website (see Fig.1). In this way tag clouds allow for the easy highlighting of important information among the remaining content, set apart from the typical text-based website appearance. An additional property that can be varied in tag cloud visualizations concerns the order of the tags. Although a few solutions exist for the spatial organization of tags, their arrangement within a tag cloud typically follows an alphabetic order, as is the case for the tag cloud in Figure 1.

2.2 Application

Several web tools exist today (e.g. Tag Cloud Generator, TagCrowd [1]) that let users built their own tag cloud. Thus they can organize personal web space and provide a quick overview or a first orientation for insight-seeking visitors. Due to their great popularity tag clouds remain a widely used tool among internet and social media users for the visualization of metadata. More concretely, tag clouds can be used in several contexts: firstly, when a website owner wants to visualize the main topics on his site, he can use a tool to process the most frequented terms as weighted tags in order to form a cloud. In this case visitors are supposed to get an idea of "aboutness" of the website content. Secondly, many web services exist which allow users to individually bookmark information content using self-created keywords. These keywords support them in their ability

[1] http://www.tag-cloud-generator.com, http://tagcrowd.com

to accurately organize relevant data. These user-generated tags can then be embedded into a graphical frame, i.e. a tag cloud within the users personal profile. A tag cloud can also serve as a categorization method for special content items where the font size of each tag reflects the quantity of subsequent content items in a given category. Keeping in mind these different tasks where tag clouds can be involved, user-related factors such as individual skills and familiarity with this kind of tool will always have an impact on the resulting performance during an interaction. It is therefore important to consider that different search scenarios exist, originating from personal search intentions in various search contexts. Different browsing contexts depend on the goals and intentions of the users, which lead to different browsing behaviors. We will discuss the significance of these scenarios later in this work.

Fig. 1. Example from a TagCrowd [1] tag cloud

2.3 Practical Limitations

The initial idea behind this tool was to provide uncoded and intuitively comprehensible keywords that help to better organize and to refind miscellaneous web content (see Fig. 1). Beside their ease of use, tag clouds are perceived to loosen the appearance on a website as usually dominated by primarily text-based contents. In practice, however, the operability of tag clouds suffers from obvious limitations. First of all, tag clouds have to deal with weaknesses concerning the quality and syntax of folksonomies [Mathes2004]. An important issue concerns the lack of vocabulary control within social tagging data, where identical words leading to similar resources are written differently and so the variety and plenitude of redundant annotations continuously grows every day. Often contents are tagged by symbols or codes that cannot be comprehended by uninvolved people, but allow others to remember and re-find certain information via the use of these mnemonic tricks. As already mentioned, people have varying abstract concept understanding for everything they perceive. Each individual derives different associations from one and the same informational content. Hence efforts to generate meaningful ontological organizations from user-generated social tagging data often run up their limits. Users obviously like to make efficient use of this tool. Hence when reflecting on ways to optimize tag clouds, restrictions related to vocabulary control can not be up for discussion.

Another observation concerns the interaction with a tag cloud which is often limited. Former studies have shown that usually tags with larger font size are frequented over a longer time than are smaller tags [Halvey2007],[Shepitsen2008]. As the most frequented tags are displayed with larger font size, tags with smaller size become redundant. The result is that the perception of a tag cloud is dominated by a few number of very large tags, where the smaller tags earn much less attention from the users. For the insight-seeking user the interaction with a tag cloud visualization often ends here without having exploited the full informational content. Now, one can raise the question if the systematic variation of the visual features runs the risk of becoming counterproductive for a sensible interaction, when the larger tags systematically distract from the remaining content. In this context the advantages of just weighting tags following their popularity remain to be discussed [Hayes2007].
The variation of the font size provokes further inconsistency. In many tag cloud visualizations the appearance is affected by the occurrence of some areas of white space between the lines (see also Fig.1). As the bigger tags need more space than do the smaller, much space is utilized when a line contains only one big tag but many tags with small font size [Kaser2007]. The waste of empty space on a website not only disturbs the appearance of the tag cloud itself but also leads to issues dealing with page layout and design aspects. Influence of white space on perceptual factors will be discussed in a subsequent section.
We can assert at this point that the manipulation of the visual features has a major impact on the appearance of a tag cloud. Although the variation of the tag font size is predominantly used other ways should be elaborated. To do so the principles of human visual perception in relation to tag cloud "reading" and similar tasks must first to be outlined.

3 Basics on Visual Perception

A classic approach to how visual information is processed by the human has been delivered by Ann Treisman [Treisman1980]. In the feature integration theory she claims for the existence of a pre-attentive subsystem, which at the earliest stage of visual processing decomposes a visual stimulus into its elementary features [Treisman1980],[Duchowski2002]. At a more focused attentive level, then, these independent basic features are recomposed in order to obtain an integrated per-

ception of an object and the world. Pre-attentive vision is supposed to happen around 200 ms after stimulus onset and can be manipulated by pre-attentive cues such as color, size, or proportion difference of objects [Bruce2006].
As tag clouds provide quick access to information without the demand of great mental efforts, special interest is dedicated to those moments of early processing before complex cognitive activities of reasoning are engaged. In order to quantify visual perceptual processes physiological parameters can be derived from the recording of eye movements during a given task.

3.1 The Eye Tracking Approach

Usually when interacting with visual interfaces what we perceive from the outer world is principally determined by what our eyes capture for us. The systematic observation of eye movements potentially offers a viable approach for the derivation of physiological correlates of visual perception and processing in a non invasive manner. Relevant metrics for measuring gaze behavior are frequency, duration and spatial distribution of fixations and saccades.
The recording of eye gaze is considered as an empirically approved method to derive important aspects for the understanding of visual perception. In relation with our current research interests the main intention is to compare the visual perception of tag clouds with processes running during other visual tasks. Also different patterns of visual inspection behavior that exist for different visual stimulation variants can be identified. In respect to findings on the basic characteristics of eye movements in information processing selected patterns shall be briefly described in the following section.

3.2 Perceptual Aspects in Similar Tasks

Tag clouds have to be processed by capturing the lexical characters and similarly integrating the formal aspects of their graphical frame. This is why the perceptual aspects of related tasks such as reading text and anticipating the meaning of graphically presented information will be outlined.
A major part of the eye movement research has been extended from initial examinations of reading behavior, and many studies have dealt with the visual perception of textual information. Apart from the individual factors of intention, motivation and strategy, eye movements are affected by textual and typographical variables such as the manipulation of various visual features. When *reading text*, indicators for visual processing are the so-called fixations, saccades, or scanpaths [Rayner1998]. Saccades are the rapid eye movements that the eyes perform during a visual task lasting between 20 and 35 milliseconds (ms). More exactly, during the activity of reading, a saccade of $2°$ has an average duration of approx. 30 ms [Rayner1998]. Eye fixations occur between the saccades when the eyes remain relatively still during a time window of 200 to 300 ms. Depending on the context, fixations are meant to represent the critical moments for the synchronization of perceptual and attentive processes, from physical input

at the sensory receptors of the eye to the encoding and integration of information.

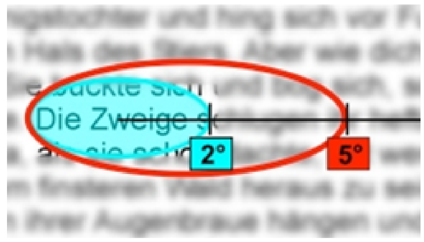

Fig. 2. Visual field during a reading activity; foveal vision (turquoise), parafoveal (red)

The *perceptual span* is the region from which useful information can be captured during an eye fixation [Rayner1998]. During reading this region is known to reach not more than 3 to 4 letters from the beginning of the actual fixation point to the left and about 13-14 letters to the right (parafoveal vision)(see Figure 2). For a mean saccade size the *perceptual span* is said to correspond up to 7 to 9 letter spaces. More concretely, the maximum acuity of the eye can be attained in the central 2° of vision (foveal), whereas acuity shrinks in parafoveal vision and even more in its periphery, as is illustrated in Fig. 2.
Worth noting is that during saccades no encoding activity is supposed to happen. The so-called regressive saccades (back-tracking eye movements) can serve as an indicator for task complexity and encoding difficulties. Whereas some studies have demonstrated that lexical processing is not suppressed during saccades, others argue that cognitive processes are suppressed (for example see [Irwin1998]). For the current analyses of tag clouds, however, the examination of eye fixations remains our principal indicator for visual processing.
These facts can aid us in finding out about the acuity of tag perceptions within a tag cloud. We are interested in how strong fixations on bigger tags or on semantically charged tags favor or disrupt the perception of neighbored tags (parafoveal field). Of further interest is if tags in the parafoveal field are perceived depending on their semantic content, i.e. if the latter has an influence on the integration of pre-attentive captured information.
For a better understanding of the visual perception of tag clouds, the consideration of the perceptual and cognitive aspects of *graph comprehension* can also be useful. Carpenter and Shah recorded peoples eye movements while they were examining graphs showing complex interactions. They argue for an iterative character of graphical feature identification processing [Carpenter1998]. Due to the increase of online information platforms and newspapers, new paradigms have been generated where people deal with more complex scenes in form of multimodal representations, i.e. when a web page contains text and graphical content. Interestingly, studies showed that when observing selected advertisements (ads) on the Web viewers do not alternate fixations between the text and

picture part of the ads. They rather tend to read the large print, then the smaller print, and then they look at the picture [Rayner2001]. Accordingly, a question of particular interest is how people process a tag cloud, comprised of both textual and graphical information. Overall active tasks such as visual search or reading text seem to generate shorter fixation duration and larger saccades than do passive viewing of natural scenes or simple patterns.
As tag clouds mostly serve for browsing website content or annotated resources, parallels to the behavioral processes during *web search* generally have to be considered. The examination of eye movements in order to understand how users search for information on the Web showed that most people perform a linear strategy during the inspection of search results, in which every result is evaluated in turn before a person proceeds with the list [Kloeckner2004]. The question is now if people adopt similar strategies for browsing tag clouds, or if the graphical context stimulates different patterns.
Finally, we have no doubt that these perceptual, attentional, and cognitive processes for the integration of visually distributed material are influenced by motivational factors during the interaction (e.g. for aborting an unsuccessful search). Of course the context in which a search task is performed has a strong influence on the outcome. Every activity requires energy and demands a certain amount of an individuals cognitive capacities and motivation. According to this, behavioral data should be analyzed in order to extract peoples level of motivation to use the tool (i.e. trying out and continuing to use), and to observe corresponding typical *behavioral tendencies* respectively.
Taken together these findings and in order to better understand the mechanisams of human information processing when handling with tag clouds, open questions exist such as:

- How font size affects the perception of a tag cloud?
- Do semantically relevant tags earn attention within parafoveal vision?
- How both graphical and lexical information is processed within a tag cloud?

Before trying to answer those questions, however, we need to examine the various visualization approaches that use different clustering techniques in order to learn more about perceptions of tag clouds.

4 Layouts of Tag Cloud Visualizations

4.1 State of the Art

Current innovations in the field of information visualization enable the implementation of highly sophisticated techniques based on graph theory, topological algorithms, physical models, geometrical and geographical representations [2]. Existing solutions for visualizing conglomerates of unordered and semantically interrelated data must not only fulfill principal functional requirements but also

[2] VC: http://www.visualcomplexity.com/vc

meet aesthetic demands. Similarly, in addition to the variation of the visual features, solutions with different tag arrangements have been realized.
Work on tag clouds has been done with the motivation to embed the semantic relations between tags into a graphical frame. For example [Fujimura2008] generated an algorithm displaying tag clouds within a topographic image context, where the cosine similarity of tag feature vectors (terms and their weight generated from a set of tagged documents) was used to measure tag similarity. A tag cloud layout was then calculated where the semantic relatedness was displayed as the distance between tags. Others tried to generate map-based visualizations of large collections of geo-referenced pictorial data [Jaffe2006]. Using a summarization algorithm pictures were ranked and organized into a hierarchically clustered structure. Additionally, [Begelman2006] provided a technique to measure similarity among tags in order to use a selected clustering algorithm for adequately displaying semantically-related tags. As contents vary significantly within different contexts, Begelmann and colleagues further advocate the implementation of separate clusters for different communities. They also recommend re-running the algorithm periodically in order to keep the data updated. This observation refers to a phenomenon that has been named ”user drift” i.e. the inconsistency of social tagging data over time [Hayes2007]. A circular cloud layout as opposed to the common rectangular layout of tag clouds has also been proposed [Bielenberg2005].
Furthermore [Kaser2007] discuss the waste of white space in classic tag clouds, in particular as it is found to become problematic in small-display (e.g. mobile) devices. They seek to optimize the tag cloud layout with electronic design automation (EDA) tools. Having inconsistent white spaces between the lines is not as trivial as it seems as - following the proximity law of Gestalt - the white spaces can give impression of grouped lines as entities, which biases the perception in an unintended direction (see Fig.1). Here a robust algorithm could prevent from such side effects.
Some investigations also encountered the phenomenon of a majority of infrequently used tags in a cloud as mentioned before. They partitioned data using content clustering [Hayes2007].
Overall, depending on the nature of the task in question we assume that semantic mapping techniques to visualize tags and their interrelations can be useful, as reading and handling maps is part of most human procedural knowledge and memory abilities.

4.2 Empirical Evidence

Effects of tag position on user perception have not been confirmed yet. However evidence exists that larger displayed tags earn more attention than smaller tags. Fig. 3 shows an example of how the gaze can get stuck on larger tags. Results from eye gaze analysis with tag clouds showed that generally the upper left quadrant of the display is the most frequented [Schrammel2009b]. This trend may be understood by the fact that people in western cultural areas usually read texts from top left to bottom right. Knowing that the bigger tags earn more attention than the smaller ones, tags with small font size positioned in the bottom right quadrant risk being neglected by the users attention. This observation should be a principal motivator for conceptual adaptations in future design considerations.

Fig. 3. Gaze plots showing fixations on tags with large font size

Fig. 4. Targeted search behavior for the target tag "'water"' (alphabetic layout)

Tag clouds with semantically clustered tag arrangements have been implemented by a series of research groups. Semantic relatedness is most often defined by the means of relative co-occurrence between tags (see section 4.1). Whereas some could determine a better search performance of their participants for the interaction with a semantically clustered tag cloud [Hassan-Montero2006], the results in our experiments did not show such an improving effect [Schrammel2009b]. Nevertheless the study showed that semantically clustered tag clouds can provide improvements over random layouts in specific search tasks. Also, semantically structured tag clouds were preferred by about half of the users for general search tasks, whereas tag cloud layout did not seem to influence the ability to remember tags.

Here the quality of the applied algorithm may have an essential role, noting that social tagging data are known to be not clearly definable in their semantic concept. In one case, related tags were situated in the same line of text, whereas our algorithm grouped the semantic clusters over several lines. According to the quadrant effect and reading direction in western cultural areas the use of line-by-line clusters by [Hassan-Montero2006] (i.e. each line contains only items of one cluster) may be more appropriate for the linear-scanning users.
Although our findings did not show any significant differences, we have to underline that search strategies can differ within various search contexts. An opportunistic search where no explicit target tag is searched may engage different patterns than a specific tag search. When looking for a specific tag the alphabetic arrangement may be useful. When searching for any term belonging to a certain topic a semantic layout is thought to be more practicable. Given that the user identifies the semantic arrangement of the tags he can choose from a pool of tags. For the semantic layout, however, specific patterns could not yet be observed or dissociated from patterns in other layout conditions.
Another aim in previous studies was to examine whether users perform characteristic search patterns within a search task. Eye gaze analysis showed that depending on the task users can adopt certain patterns but no traceable strategy within a search process could be determined: some use a *chaotic search* patterns, others perform a *serial scanning* in a "zigzag" pattern (see Fig. 6). Again others alter their gaze behavior during the search process between chaotic searching and serial scanning (i.e. beginning to search chaotically and after a moment of unsuccessful performance proceeding with serial search and so on). Generally search behavior may be influenced by individual factors such as personal levels of impulsivity and accurateness in search tasks. Those users, however, who often alternated their search strategy within one search often took more time to solve it.
Interestingly, serial search is not always performed until the last line of a tag cloud. Some users abandon the serial search for conducting chaotic search again. In this case the same tags are fixated several times. This could be due to reciprocal blocking of memory traces. The trace of tags scanned during one search strategy probably does not include the short memory trace from the other strategy and vice-versa.
According to the scanning phenomenon some authors think that people scan tag clouds rather than read them [Halvey2007]. These perceptual aspects related to processing depth have to be considered in further information visualization discources. Independently from the layout (alphabetic, randomized, semantic) people performed similar gaze combinations for several stimuli right after onset. Considering the existence of *scanpaths*, some users performed for example a "circle loop", or an "S"- scan (see Fig. 5). It is still open if there are characteristic orders of alternating those patterns within one search process, i.e. if inter- and intra-individual regularities in task strategies can be identified. Again, systematic differences due to the various search contexts could not yet be examined.

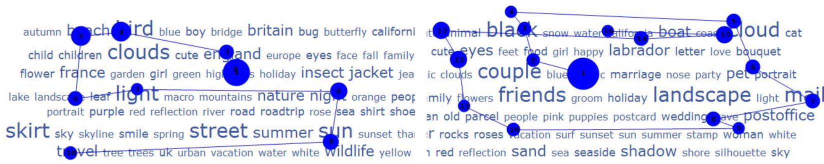

Fig. 5. Example of a "S - scan" (left) and a "right loop" (right) pattern

Fig. 6. Gaze plot for serial search using zigzag pattern (semantic layout); note the upward dislocation of the gaze plot due to unsystematic head motor activity of the participant

Focusing on performance in different layouts, research on the perception of alphabetically ordered tag clouds showed that search processing becomes much more targeted once the user recognizes this principle of organization (see Fig. 4) [Kaser2007], [Schrammel2009b]. An example is shown in Figure 5 where the gaze heads first to a very large tag at the bottom of the cloud. Scanning inverse to reading direction is then initiated until the alphabetic order is recognized. Eye movements turn to the region where the target tag is estimated, following the perceived principle of organisation.
This means that as soon as a structural feature has been identified the search behavior is efficiently adjusted. This observation may lead to the assumption that a better task performance can be achieved if the user is aware of the semantic organisation in a tag cloud. In this case all the more appropriate visual features of tag clouds are required to be well developed for ensuring an enhanced interaction within the latent information, i.e. tagging space.

5 From Perceptual to Cognitive Integration

Essentially a tag cloud consists in a visual representation of data mined content, i.e. information resources reduced to a certain quantity of selected tags. This concept may invite users to search for single items rather than for entities, keeping the perceptual processing more pre-attentive, i.e. lowering cognitive load.

This is in line with approaches from cognitive psychology which underline the fact that attention focus is limited, e.g. naming the spotlight-metaphor within visual attention discourses [Posner1980].
Within neuropsychological research, the postulation of a limited capacity control system (LCCS) of attention has been widely discussed [Eysenck1995]. It is assumed that the information integration begins with pre-attentive appraisal of the visual features, in this case, the font size of the tags. In case of a mismatch, when the larger tags do not meet the search intention of the user, an orientation reaction (OR) occurs. With the OR the user abandons the irrelevant cues to adjust the attention to other targets. In line with the findings on tag clouds, we can assume that a chaotic pattern is initialized by the upcoming OR in succession of the mismatch. Via the LCCS, an effort mechanism is then triggered for a more conscious coordination and comparison of contents in short-term versus long-term memory stores. If the new search strategy also fails (influenced by motivational factors) a new OR is engaged. We further suppose that the motivation to find the target tag by chance (e.g. chaotic browsing) is sometimes higher than the patience to accomplish a certain strategic pattern (e.g. serial scanning).
In general, however, such effort mechanisms are accompanied by higher energy costs in the central nervous system and finally take more time. These considerations taken together could explain why people in previous experiments took more time to detect the underlying hierarchical structure within the tag cloud than they needed to recognize the alphabetical order [Schrammel2009b]. Accordingly people perceived the semantically clustered tag cloud as less helpful than the alphabetic condition.
Hence we suggest that once a cluster has been identified as being semantically related, cognitive load should be relatively low to proceed with search. We can distinguish between first, the cognitive effort needed to comprehend an underlying semantic structure within a visualization form, and second, the search process within a coherent context. In order to attain the latter i.e., to favor the conjunction of semantically related tags into an integrated percept, users simply could be alerted by a note when a tag cloud contains semantic clusters.
Further we claim for the elimination of the artificially generated separations between tags (see section 4.1). White space should only separate tags of different clusters, such as in the form of several "mini clouds". However, the initial conception of tag clouds would then need to be redefined. To encourage the awareness of arrangement structure, future design implications could profit from the physiological phenomenon of context dependency [Eysenck1995]. This refers to the phenomenon that objects with similar attributes are seen as related, i.e. embedded in a common context. In line with the arguments of the Gestalt theories [Eysenck1995], semantic clusters of tags could be visualized with manipulated visual features, such as differently colored tags for each cluster within a tag cloud. An item thus integrated in a certain context - even if not familiar - could initiate contextual cueing processes and provide much more informational content to the user than a cumulated representation of items. By modulating light and color conditions of related tags, entities could be better recognized following the law

of similarity. For the technical implementation of these propositions, however, issues of keeping system load to a minimum have to be taken into account.

6 Conclusion

Based on our experience, we think that semantic clustering methods are useful for classifying annotations in social tagging systems, i.e. tag clouds, as their strength lies in the procurement of meaning on a meta-level, and clustering here meets the needed standards. As the core interest in research lies in the effort to enhance interaction with tag clouds, future efforts should focus on the synchronization of the perceptual user capacities and the conceptual conditions of that visualization form. Summarizing the approaches above, we see potential for improvement of clustering techniques for use in tag clouds. We expect that the cognitive processes of chunking could be engaged through visual stimulation, e.g. becoming clusters signalized as entities. As evidence now exists that performance can be enhanced when the user is aware of the tag arrangement (as for alphabetic layout), design implications could involve the visual accentuation of the clusters. We conclude that this can be solved by triggering the perceptual system on a pre-attentive level.

Although they are not appropriate for all contexts [Sinclair2008], tag clouds still remain useful in their simplicity of visualization, and in their ease of use and manipulation. The interaction with a visualization based on a semantic structure demands semantic processing by the user, i.e. the processing of meaning, which occurs at a higher processing level that of scanning a display for single lexical expressions. In our opinion we cannot expect from users to autonomously search for semantic relations within such a simple visualization form; there must be an indication of the underlying structural attributes. In order to enhance the dynamic character of the interaction, the user could be allowed to vary the number of displayed clusters within a tag cloud, where he/ she could easily switch between the different views. An option to display the evolution of tagging data over time could also provide some additional insight into information content for the interested user. Altogether we hold the position that semantically clustered tag clouds represent a viable visualization form for displaying social tagging data. They potentially enhance users ability to represent knowledge and improve retentiveness of given knowledge. Along with the findings on perceptual aspects, new approaches have been formulated that integrate important factors of visual processing and attention capturing. In this regard, elaboration on the graphical appearance of tag clouds cannot yet be seen as completed, and provides material to further research.

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