The Role of Mental Factors for the Design of a Virtual Memory Palace

Emergent Research Forum

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Abstract

The mnemonic strategy called Method of Loci has been studied for several decades, not only from educators but also by neuroscientists, psychologists and researchers from the domain of information systems (IS). The idea of the Method of Loci is to mentally place the learning content in a familiar environment. This procedure fosters an association process that combines specific items with spatial cues or places. Due to this association, it is easier to recall the information later. Researchers started to evaluate the potential lying in the idea to support the Method of Loci with a virtual environment as a template for the users mental Memory Palace. This research approach intends to optimize the design of a so called Virtual Memory Palace by evaluating the users’ mental factors spatial ability and creativity. It is hypothesized that these factors allow a user-centric and therefore optimized design in order to foster the methods effectiveness.

Keywords

Memory Palace, Method of Loci, Virtual Reality, Creativity, Spatial Ability.

Introduction

This research approach addresses practitioners and researchers in the domains of human-computer interaction and education. A traditional memory palace (not virtually supported) is based on an ancient learning method that helps the user to memorize a vast amount of information. This strategy is called the Method of Loci (MOL)(Putnam 2015). Applying the MOL means to mentally walk through a familiar environment and place the to-be-remembered items at certain locations (lat. locus, pl. loci). In a practice phase, the user repeats this procedure, but only in mind. Later, when the user wants to recall the learned content, s/he walks through the environment again and “picks up” the earlier placed items. Finally, recalling the information is significantly easier than rote rehearsal. The MOL belongs to the mnemonic strategies. These strategies are based on the idea of remembering a certain learning content by creating mental associations to other, easy-to-remember entities. For instance, images, sounds, abbreviations or spatial cues (see MOL) could serve as an adequate entity to build an unusual and therefore long-lasting association (Yates 1999). Especially in an educational setting, mnemonic techniques are useful to achieve the first level of learning (“remembering”) as described in Krathwohl’s reworked taxonomy of Bloom’s learning domains (Krathwohl 2002). McCabe (2011), Hartwig and Dunlosky (2012) promoted the integration of mnemonics in the students’ curriculum. They found these methods to leverage the probability to successfully perform in college (Hartwig and Dunlosky 2012; McCabe 2011). In addition to that, Putnam (2015) emphasized the positive influence of mnemonic strategies on the students motivation to learn. Moreover, he argued that the time that could be saved by using mnemonics for basic principles, results in more time available for the students to focus on higher order learning. However, the idea of using mnemonics in class was already introduced by Levin and Levin (1990). Authors conducted an experiment including pictorial compositions (called mnemonomies) to illustrate complex botanical, hierarchical relationships in a classification system. Results showed that the group that learned by the help of the mnemonomies outperformed a group using no specific learning method. However, Putnam (2015) stated that mnemonics are not integrated in the teaching community yet.
Within the last two decades, researchers from the fields of information systems, psychology and neuronal sciences investigated the possibility of supporting the application of the MOL with the help of virtual worlds and environments (Fassbender and Heiden 2006; Huttner and Robra-Bissantz 2017; Jund et al. 2016; Legge et al. 2012; Mann et al. 2017). The basic idea is to give the user a virtual template for her/his memory palace to facilitate the training of the MOL. After exploring and memorizing the architecture and the learning content (loci) in the virtual environment, the user should be able to recall the learned items by mentally traversing the palace again. In the following sections this concept will be referred to as a virtual memory palace (VMP). The VMP represents a promising way to foster the students career, since it can serve as a training device and therefore lowers the hurdle to learn the MOL. In order to ensure a high user acceptance, it is important to evaluate critical design aspects of the VMP which will be the subject of this research approach.

Related Work

As explained in the previous section, researchers started to combine the ancient MOL with modern technology to investigate a variety of aspects. Studies included a comparison between the traditional MOL and a VMP based MOL, the measurement of long-term memory effects or a setting in the augmented reality. In the following, a short description of related work will be given. Storkerson and Wong found to be the first researchers that had the idea of facilitating mnemonics, e.g. the MOL, by using hypermedia. In 1997 they argued that an increased level of intelligibility would stimulate the memorization in a spatial context (Wong and Storkerson 1997). Three years later, Hedman and Bäckström performed an experiment with the first VMP that was built to support students in a philosophy course. Although inspired by a traditional museum, their VMP design did not implement particular principles. The loci were built as plain text fields on the walls. In an experiment authors did not find any significant advantages of the VMP based MOL over a conventional learning technique. Participants of the study suggested the implementation of interactive 3D loci. (Hedman and Bäckström 2000)

In 2006, Fassbender and Heiden assumed that a VMP facilitates the application of the MOL as the user has to put in less mental effort due to the visually presented template of the palace. The overall appearance of their VMP was based on the stereotypical image of a medieval castle. Emphasizing the importance of an unusual and unique loci design, the loci were implemented as animated 3D objects and equipped with responsive sound effects. As soon as the participants approached the loci, certain sound effects were triggered to facilitate the memorization process. Results implied that the participants long-term memory had improved. Additionally, authors described six vague design principles that should be implemented when building a memory palace/VMP. For instance, the environmental light should not be too dark or too bright, places should not be too spacious or too narrow. Hence, the design aspects of a VMP seem to play a relevant role in terms of the method's effectiveness. (Fassbender and Heiden 2006) However, these design principles seem quite loose. A need for further design oriented research is identified at this point. In 2012, Legge et al. (2012) conducted an experiment involving 142 participants that were assigned to three groups. Authors compared the traditional MOL and the VMP based MOL. A control group with no specific learning strategy was outperformed by both the MOL and the VMP group. There were no significant differences found between the MOL and VMP group. In contrast to other experiments, Legge et al. did not implement the loci. The to-be-remembered items were presented after an exploration phase. Hence, participants navigated through the virtual environment and memorized the architecture as a template for their memory palace. Then they were told to memorize several lists of words with the help of the MOL. Consequently, subjects had to use their own creativity to visualize an unusual locus for each to-be-remembered item.

Four years later, Jund et al. (2016) experimentally compared two different frames of reference in a VMP setting. The recall performance of two groups revealed that an egocentric frame outperforms an allocentric condition to ensure that the subjects receive all relevant spatial cues. (Jund et al. 2016) Huttner and Robra-Bissantz introduced and analyzed the influence of immersion on the application of a VMP. Immersion describes the perception of being in a certain place, although one is physically in another (Witmer and Singer 1994). Results implied a positive influence of higher immersion (Huttner and Robra-Bissantz 2016; 2017) on the VMP based MOL, which was also supported by other authors (Jund et al. 2016; Mann et al. 2017). Following a similar approach, Mann et al. evaluated the recall performance of four groups in total, including a control group, one using the traditional MOL and two groups using a VMP. While one VMP group used a desktop, the other one was put into a Cave Automatic Virtual Environment (CAVE). This is
basically a small room in which all four walls are used as a projection canvas for the VMP in an egocentric frame of reference. As expected, results showed a superiority of the VMP groups over the control and traditional MOL group. (Mann et al. 2017) In 2018, Huttner et al. conducted an experiment and analyzed the loci design. Authors created a VMP that contained, depending on the group, either text-only or image-text loci. The learning success was significantly better in the image-text group. (Huttner et al. 2018) Summarized, up until this point studies focused on technology-centric design aspects such as variations of the VMPs and the MOL as such (allo- or egocentric view, design of the loci, degree of immersion, etc.).

**Theory & Research Question**

As seen in the previous section, a VMP can be seen as a training device for the user to get familiar with the MOL. However, this approach focuses on a user-centric perspective. It seeks to identify relevant mental factors and explain their role with regard to an optimized design in order to enhance the effectiveness of a VMP-based MOL. Note that in this study, the VMP design refers to two central aspects: the complexity of the architecture and the unusualness of the loci imagery.

The designer of a traditional memory palace has to put in creative effort to visualize the loci (Levin et al. 1980). That also applies for a VMP, but in this case the designer and the user of the memory palace are not necessarily the same person. Hence, the designer creates and defines to what degree the users will have to employ their own creativity. For instance, if a VMP is designed for a course of “Hardware in IT”, one locus could be a hard drive lying on a desk. The visualization of this hard drive can be done in manifold ways since in a virtual world there are hardly any technical restrictions (apart from the devices computing performance obviously). The richness of the hard drive’s design may vary in terms of details, it could be a text-only item, an image or a complex 3D model, maybe even animated, interactive or responsive to the users actions. For example, if the locus is a text-only item placed over the desk, then the user should make up an imagery in her/his mind including the hard drive in an unusual context. So the creativity required on the user’s side would be higher compared to a locus where the hard drive is already visualized in a sophisticated and complex manner.

Taking a closer look into the functionality of the traditional MOL (without a virtual template), it becomes clear that the user has to put in a certain mental effort to successfully apply the method. As described above, the user is meant to mentally walk through a familiar environment, especially in the training phase. In earlier studies, this training phase took between a few hours and two days where participants had to repeat this mental navigation process again and again (Brehmer et al. 2007; Roediger 1980). Professional memorization competitors need thousands of hours of training (Putnam 2015). To do so, users need patience, endurance, and spatial ability. Spatial ability describes the capacity to memorize, recall, and understand spatial relations among objects (Russo et al. 2017). It consists of several abilities like spatial perception, visualization, mental folding or mental rotation (Donnon et al. 2005). Furthermore, according to the current understanding of the cognitive memorization process, spatial ability is responsible for the information encoding procedure (Mann et al. 2017), especially in a multimedia learning environment (Park et al. 2016). Maguire et al. (2002) analyzed people's neuronal activity by brain imaging and neuropsychological measurement methods. Results imply that participants with good memory have a higher brain activity in regions that are responsible for spatial tasks. Therefore, authors stated that the effectiveness of the MOL is driven by a natural human tendency to use their spatial ability for memorizing and recalling information.

Hence, spatial ability plays a central role in the application of the MOL. This might imply that the degree to which the user is able to think in a spatial context determines how easy it is for him/her to apply the MOL successfully. For instance, if a someone uses a specific VMP to apply the MOL, the design of the VMP is probably predefined (excluding the case of a configurator-based system). Assuming this user has a quite low spatial thinking ability, but the architectural design of the VMP has a high complexity in terms of space, rooms, corners, hallways, and so on, the users spatial ability is overstrained. Memorizing the architecture becomes too difficult and the hurdle to train the VMP-based MOL is too high or the effectiveness of the VMP-based MOL should drop. Effectiveness in this context involves factors like user acceptance (e.g. perceived ease of use or perceived usefulness (Davis 1985)) or learning success (Huttner and Robra-Bissantz 2016).

Just like in any other mnemonic strategy, the effectiveness of the traditional MOL depends heavily on the user's creativity (Roediger 1980). Furthermore, Roediger (1980) concluded that the only factor that
prevents a learner from applying an efficient mnemonic system is his own creativity. As explained before, the user has to create unusual mental imageries for the loci (Yates 1999). This will foster the discriminative power of each locus and improve the mental association process with the to-be-remembered item. In contrast to the traditional MOL, the concept of a VMP implies that the user’s creativity is not challenged to this extent. Since the memory palace is virtual, it is already visualized. In fact, it has been found that the learner benefits more from a self-created mnemonic compared to an imagery that is given by the experimenter (Bobrow and Bower 1969; Bower and Winzenz 1970; Garten and Blick 1974; Pelton 1969). Nevertheless, this requires a certain level of creativity. If the learner is quite young (Rohwer Jr 1970) or finding an appropriate imagery for a certain item is too difficult (Kibler and Blick 1972) then offering a predefined locus should result in a better retention (Bellezza 1981).

Summarized, the VMP designer and the user have to employ their creativity to build an unusual, easy-to-remember locus. Hence, if the level of unusualness of the predefined locus design does not fit the user’s creative potential, an optimal locus design will probably not be achieved in the users mind and reduce the effectiveness of the VMP based MOL. The two mental factors spatial ability and creativity could be identified as probably being crucial for an user-centric VMP design. Hence, the following question shall be addressed in the upcoming research phase: Do the mental factors spatial ability and creativity affect the VMPs effectiveness?

Research Methodology

This research follows the design science research methodology (DSRM) proposed by Peffers et al. (2007). According to this process, this research proposal represents the second step. The problem and the motivation are described, so the current activities focus on deriving insights about a better solution for a VMP design. Therefore, a pilot study is being conducted as a controlled experiment. More than 30 participants are being tested to examine the effects of their mental factors (creativity and spatial ability) on the intention to use a VMP and their learning success. Note that at this point, the VMP represents the artefact in the DSRM. It is implemented using the Unity 3D engine and will be a virtual reality (VR) application for an android smartphone. The VMP is then used by putting the smartphone into a VR goggle (e.g. Google Daydream). Participants will start at the entrance of a ground floor apartment and will then be able to explore the VMP from an ego perspective. A Bluetooth game controller will be used to walk in the virtual world. Altogether, there will be 40 loci placed in the VMP as suggested by Ross and Lawrence (Ross and Lawrence 1968).

First, a correlation analysis and a two-factor ANOVA will be done to model the relationship between the two mental factors and the effectiveness of the VMP based MOL. Then, variations of the VMP design (complexity of architecture and loci design) will be experimentally compared in order to conceptualize and implement an improved artefact.

Expected Contributions

The study’s contribution is multifold at this point. First of all, it reveals new insights into the scope of the application of a VMP as a helping device to learn the MOL. Since the concept of a VMP is quite young, the study also contributes to the research stream of computer supported mnemonic strategies, especially considering mental factors as determinant for the interface design.

REFERENCES


