Loci Spheres: A Mobile App Concept Based on the Method of Loci

Jonathan Wieland, Jens Müller, Ulrike Pfeil, Harald Reiterer

Human-Computer Interaction Group, University of Konstanz

Abstract

The method of loci is a technique to memorize large quantities of information by associating the items to be learned with familiar places (loci). The effectiveness of the technique has been well established, but the initial creation of the loci can be a tedious task. With the aim of supporting flexible learning in situ, we introduce Loci Spheres, a novel concept which facilitates the creation of loci using mobile devices. We present three variants which support the technique to varying degrees: spatial loci (uses spatial input) and panning loci (uses panning) to define and navigate the loci, and no loci (baseline condition), where users have to create the loci within their imagination. In an in-the-wild study we investigated perceived system support, usage behavior, and effectiveness of the three variants. With this work we introduce a novel memorization tool which addresses the potential barrier involved in loci creation and provide a set of four design principles on how to leverage the technique with mobile devices in everyday situations.

1 Introduction

The method of loci is an effective technique to support the memorization and retrieval of information. Ancient Roman and Greek rhetoricians applied the technique to remember long speeches (Yates, 1992). The technique first requires the creation of mental images of the items to be remembered and places (loci) where these items are deposed (Yates, 1992). According to Bower (1970) both elements are related as follows:

"When desiring to remember a set of items the subject 'walks' through these loci in their imagination and commits an item to each one by forming an image between the item and any distinguishing feature of that locus. Retrieval of items is achieved by 'walking' through the loci, allowing the latter to activate the desired items."

Several controlled lab studies have established the effectiveness of the technique (e.g., Ikei et al., 2007; Kemp and Van der Krogt, 1985; O'Keefe and Nadel, 1978; Perrault et al., 2015) but also report an initial mental effort when loci are created (e.g., Bower, 1973; Kemp and Van der Krogt, 1985), which can make its application a demanding and tedious task. In this paper we introduce "Loci Spheres," a concept that aims at facilitating the application of the

Veröffentlicht durch die Gesellschaft für Informatik e. V. 2017 in
M. Burghardt, R. Wimmer, C. Wolff, C. Womser-Hacker (Hrsg.):
Mensch und Computer 2017 – Tagungsband, 10.–13. September 2017, Regensburg.
 https://doi.org/10.18420/muc2017-mci-0235

technique for learning purposes (e.g., as proposed by Bellezza, 1981). The concept makes use of smartphones' photo sphere feature, which allows the user to capture their environment as a 360° photo sphere. Combined with the spatial input feature, it creates the illusion of the captured scene surrounding the user and thus affords a vivid experience. Loci Spheres extends the mere viewing of the captured environment, because the user can define the loci therein and associate the items to be learned to the loci. Thereby, Loci Spheres supports the user in creating and exploring their loci from any physical context.

2 Related Work

Our work is based on the two strains of research, *basic research of the method of loci* and *application of the technique in human-computer interaction*.

Yates (1992) provides an extensive overview of mnemonic techniques (from Mnemosyne, the name of the ancient Greek goddess of memory (Higbee, 2001)). Determinants of the effectiveness of the technique have been extensively researched in several psychological studies since the 1960s under controlled lab conditions (e.g., Ikei et al., 2007; Kemp and Van der Krogt, 1985; Perrault et al., 2015). Ross and Lawrence (1968) found that the learning technique facilitates exceptional memory performance in terms of long term memory and that the concreteness of the visual stimuli had no significant effect on recall performance. The effectiveness of the method in comparison to other mnemonics was confirmed by Roediger (1980). Bower (1970) identified a set of nine distinct components that are crucial to the application of the technique, e.g., that loci have to be available to the learner at the time the items are studied. When defining the loci, he suggested to choose geographical locations as they can be visualized easily. He also emphasizes that the mental creation of locations is a demanding task and crucial to the technique's effectiveness. McCabe (2015) identifies this mental hurdle as the reason why many students do not apply the method. Kemp and Krogt (1985) investigated how visual stimuli of loci shape recall accuracy. They found that recall accuracy was significantly lower when visual stimuli were visible during memorization and invisible during recall. Bellezza (1981) notes that the application of mnemonic techniques is largely limited to professional stage performers, but they might be promising tools for educational purposes such as the learning of second-language vocabulary. O'Keefe and Nadel (1978) analyzed the method of loci in terms of the relationship between the hippocampus (the psychological representation of space) and context-dependent memory. They reported that "the facilitative effects of the 'method of loci' can be seen to derive from the ease with which the overall spatial image can be reconstructed."

There is only limited research that has studied the method of loci in an HCI context. Perrault et al. (2015) used the technique to associate computer commands with physical objects in a room and showed that command selection using the method of loci outperformed a mid-air marking menu. Ängeslevä et al. (2003) introduce Body Mnemonics, a concept for mobile devices that uses the body space to associate and store information. Motivated by the assumption that mnemonic techniques are powerful yet hard to apply, Ikei et al. (2007) introduced the concept of Spatial Electronic Mnemonics which applies the principles of the method of loci and the peg technique (see e.g., Bower (1970)) with mobile display technologies. In a controlled lab experiment, participants had to memorize a set of numbers. In one condition participants were provided with a single-eye head mounted see-through display that showed the items to be learned (both the number and its associated image). Participants could define loci in their environment and map the associated images to them. In the second condition, participants applied the technique without any electronic support. Participants could retrieve significantly more items when using the electronic device. Furthermore, participants reported that memorization was easier when the item-loci associations were provided. Krauss (2014) introduced LocoLoci, a mobile app that allows the users to define loci on photos they had taken with the smartphone camera. An experiment with 12 participants showed improved user experience, but did not reveal a difference according to recall accuracy when LocoLoci was provided as a supportive tool for the memorization of information. As a possible conceptual extension, he suggested using panorama or 360° photos.

While generally accepted as an effective technique, the application of the method of loci can be a demanding and tedious task due to the initial mental effort during loci generation. Moreover, there have been only few attempts to faciliate the technqiue with the help of digital technologies. With our work we extend and contribute to these different strains of research by addressing the potential barrier involved in loci creation. We introduce a mobile tool that supports the creation of loci by providing the user a visual representation of the loci environment (such as demonstrated by Krauss (2014) and Ikei et al. (2007)). Based on the findings by Kemp and Krogt (1985) (recall accuracy decreases when loci are visible during memorization) and Bower (1970) (the effectiveness of the technique depends on cognitive constructive activity) we expect the following tradeoff: *"Loci Spheres reduces the mental effort during the memorization but also reduces the effectiveness of the technique (assuming that Loci Spheres is not provided during retrieval)."*

3 Loci Spheres

For the design of Loci Spheres we derived a set of design requirements from related work. In general, retrieval of items, i.e., the act of remembering, assumes the existence of the loci, mental images of the items to be learned, and the associations between the mental images and the loci. For loci creation and retrieval of items, we provide two distinct modes: "loci creation" and "item retrieval."

Successful retrieval of items presupposes that the user has defined and learned the exact loci and the traveling paths between them. During the creation of loci, the scene that contains potential loci should therefore be visible to the user. Once a suitable locus has been defined for an item, the combination of loci and item should also be visible. In addition, the path containing and connecting the loci should also be visible to reduce the mental load involved when the user tries to memorize the order of loci ("loci creation"). If the combination of a locus and the mental image of the item cannot be memorized well, the user needs to be able to redefine that locus. Once the loci have been defined, the user should be able to explore their loci to activate the associated items (Bower, 1970) ("item retrieval"). To better support self-assesment, the system should prompt the user to recall the item that has been associated with the current locus and provide associated feedback. Thereby users can identify and redefine problematic loci.

We implemented two design variants that follow the principles of the loci spheres concept. The two implementations – *panning loci* and *spatial loci* – differ in the way the loci are navigated. This way, the effect of the interaction technique (panning vs. spatial input) could be investigated. To draw comparisons with the classical version of the method of loci we also implemented *no loci*, which does not contain visual stimuli in the form of the loci. Thus, using *no loci* requires users to refer to their imagination in order to apply the method of loci.

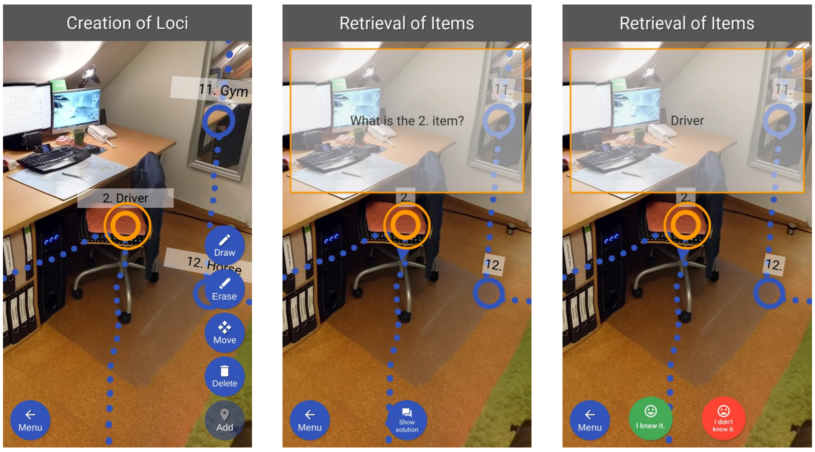

Figure 1: Visualizations of spatial loci *and* panning loci. *Left: Creation of loci, where loci and association are created. Middle and right: Retrieval mode where users can assess their recall accuracy.*

Design 1: Spatial Loci. In the "loci creation" mode (see Fig. 1, left), users can select any spherical image as their loci scene. By moving the device concentrically around them in physical space, users can navigate through the Loci Sphere. An orange circle in the center serves as a pointer. To define a locus at the current pointer position the user presses the "Add" button at the bottom right of the screen. The locus then appears according to the pointer position (e.g., in Fig. 1 the user has just mapped the item "driver" to the chair). A locus turns orange if the pointer hits it. Loci marker are labeled with the names of the item and their ordinal numbers within the sequence of items to be learned. To redefine a locus the user has to point at the particular locus and either delete and position it elsewhere (using the "Delete" and "Add" buttons) or displace it using the clutch functionality provided by the "move" button. A path through the loci can be defined (see Fig. 1, left, dotted line) using the "Draw" and "Erase" buttons. Drawing a path is also performed using spatial input. During the *item retrieval* (Fig. 1, middle and right column), the user can assess their memory capabilities. In this mode, the path, the loci, and their sequence number are visualized. Items are prompted in a defined order and a little arrow at the pointer circle indicates the subsequent locus. When the user points at a locus, an overlay appears and requests the associated item. Via the "Show result" button in the center of the bottom (Fig. 1, lower middle) the user can display the solution. Then, the user can indicate whether her/his retreived item was correct (via the buttons "I knew it" and "I didn't know it.") Depending on the user's indication, the current locus marker then turns green (item correctly recalled) or red (wrong/no item recalled) to provide the user feedback. Like in the "loci creation" mode a locus turns orange if it has been selected. In addition, haptic feedback is provided when a locus is hovered by the pointer circle. To reduce jittering caused by spatial input during loci acquisition, users can activate *locus snapping* which couples a locus near to the center.

Design 2: Panning Loci. The visualization in the *panning loci* version consists of a spherical photo similar to the *spatial loci* design (see Fig. 1), but navigation is performed via panning.

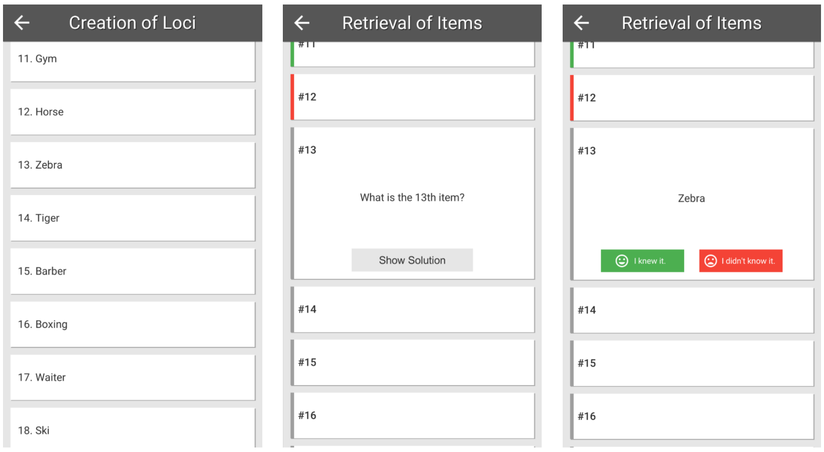

Figure 2: Visualizations of no loci. *Left: Creation of loci, where loci and associations are created. Middle and Right: Retrieval of items where users can assess their recall accuracy.*

Design 3: No Loci (Baseline). As a baseline condition, we designed a version without any visual loci support. Thus, the no loci concept requires the user's imagination to establish both the mental images of the items to be learned and the loci. In the *loci creation* mode (see Fig. 2, left), a list which contains all items to be memorized is displayed. The list can be navigated using panning. Like in the two Loci Sphere designs, the items are annotated ordinally. The *item retrieval* mode (see Fig. 2, right) also shows the list, but the items to be learned are not visible. Like in the Loci Spheres conditions, self-assessment and feedback is provided to make the user aware of the learning progress and of potentially problematic loci-item associations.

4 Study

We ran a 4-day in-the-wild study with the design variants (*no loci, spatial loci,* and *spatial loci*) being the independent variable and *perceived system support*, *usage behavior*, and *effectiveness* being the dependent variables. In the study we addressed three research questions (RQs):

RQ1 Do the two designs, *spatial loci* and *panning loci*, facilitate the application of the loci technique when compared to the *no loci* condition?

RQ2 Does the design influence the way people use the app in their daily lives?

RQ3 Does the design influence effectiveness in terms of recall accuracy?

Using a between-subjects design, each of the 24 participants (4 females, 20 males) was randomly assigned to one of the three study conditions, i.e., three groups with 8 participants each were formed. The mean age was 26.7 years (SD = 4.49, min = 19 years, max = 39 years). 17 participants were students, 6 employees, and 1 was an apprentice. 21 participants reported that they had to memorize learning items on a regular basis. Participants were allowed to use their own smartphones. We used a framing to guarantee operational capability. The study period covered 4 days which included a weekend. Participants were invited to our research lab twice: once at the beginning of the 4-day testing period (instruction meeting) and once at the end of the period (final meeting, at approximately the same time of day as the instruction meeting took place). In the instruction meeting, participants were welcomed and asked to fill out a demographic questionnaire. All participants were then provided with a standardized instruction to the method of loci and a set of best practices based on Bower (1970). Then the assigned app version was installed on the participants' smartphones. Participants were then tasked to memorize a pre-installed set of 40 items in their given order. We used the same set as used by Perrault et al. (2015). As part of the instruction, we recommended that each participant allocate a learning time of at least 10 minutes per day. Finally we made an appointment with the participants for the final meeting. The introduction meeting took $\approx$ 30 minutes. After 4 days participants were again invited to our research lab for the final meeting. To assess recall accuracy they were first tasked to write down as many items as they could remember in the correct order on a plain sheet of paper. Participants were not allowed to use the app when recall accuracy was assessed. Then we asked about their usage routines in a semi-structured interview. Afterwards, the interaction log and photos that participants used as loci environments were saved and the app was uninstalled. Finally, participants were informed that they would receive an online questionnaire one week afterwards (no information was given regarding its content to minimize the risk of participants continuing the memorization task). The final meeting took $\approx$ 30 minutes. One week afterwards, the online questionnaire was sent to all participants to assess the number of recalled items and the number of correctly ordered items. Participation was on a voluntary basis.

5 Results

Results are reported and summarized based on the RQs. Due to the limited number of samples (8 per condition), we used the non-parametric Kruskal-Wallis test for analysis of significance and report the medians. Results are marked with the subscript $_{SP}$ for the *spatial loci*, $_{PA}$ for *panning loci*, and $_{N}$ for the *no loci* condition. For statistical significance we assumed a $p < .05$. For pairwise post-hoc comparisons, we used the Mann-Whitney test assuming a statistical significance for $p < .016$ applying Bonferroni correction.

RQ1 Perceived System Support: RQ1 was assessed via a concluding, semi-structured interview, where participants were asked to rate the system support they perceived using their assigned design (where 0 means "no support at all" and 10 means "ideal support"). *Spatial loci* had the highest ranking followed by *panning loci* and *no loci* (see Fig. 3). The distributions of the ratings were significantly different (Kruskal-Wallis, $\chi^2(2) = 15.21$, $p < .001$). A post-hoc Mann-Whitney test indicated that *no loci* was ranked lower than both *panning loci* (U = 0, $p < .001$) and spatial loci (U = 3, $p < .001$).

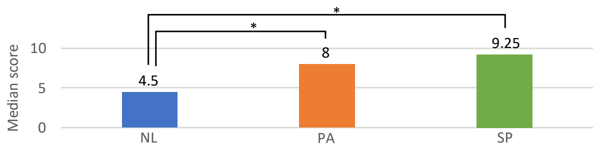

Figure 3: Median score for perceived system support where 0 means "no support" and 10 means "ideal support."

RQ2 Usage behavior: RQ2 included the analysis of app usage time and usage patterns within the two modes. It was assessed using data from the concluding interview and interaction logging. Regarding overall app usage time, participants using spatial loci spent the most time using the app ($Mdn_{SP} = 73.3$ min.) and opened it most often ($Mdn_{SP} = 27.5$ times), followed by panning loci ($Mdn_{PA} = 55.97$ min., 21 times), and no loci ($Mdn_{N} = 47.9$ min, 21.5 times.). A Kruskal-Wallis test did not indicate significant differences between the distributions. Regarding the context of app usage, all participants reported that they used the app at home. Most participants reported trying to retrieve the items while lying in bed ($N_{SP} = 2$, $N_{PA} = 3$, $N_{N} = 6$) and other personal environments. Several participants using spatial loci reported regular retrieval of items while sitting on a swivel chair ($N_{SP} = 5$). App usage in public was performed by participants using no loci ($N_{N} = 3$, in the library, in the dentist's waiting room, at the bus stop) and panning loci ($N_{PA} = 2$, "on the ferry", "during a bus ride"). Participants using spatial loci never applied the mode in a public environment as they thought that spatial input might look strange for passersby (e.g., it became a "social killer") ($N_{SP} = 2$) or because it turned out to be impractical in some situations ("on the toilet", "in the back seat") ($N_{SP} = 2$). In conclusion, participants who used *spatial loci* spent most time using the app. Yet, one needs to take into account, that the app usage time does not necessarily equal the time participants were engaged with the task: In particular, participants using *no loci* might have applied the technique without using the app due to the limited support that this version provides. Regarding the creation of loci, reports from participants using *no loci* indicate a large variety of the interpretations of the technique and how they applied it (e.g., using movie scenes in their temporal order or several spatially distributed places connected by a route as locations), whereas the two Loci Sphere designs determined the application of the loci technique. Using spatial loci seemed to be inappropriate in some situations either because of practical reasons or because participants felt uncomfortable with spatial interaction in public places.

RQ3 Effectiveness: Recall accuracy was measured twice: after the 4 day app usage period (immediate recall accuracy) and one week afterwards (long term recall accuracy). For recall accuracy we differentiated between 1) the total number of items ($N_{max} = 40$) participants were able to recall and 2) the number of items that were put in correct order (correct succession of two items were counted, thus $N_{max} = 39$). RQ3 was assessed using interaction logging and a recall test (pen and paper for the immediate recall test and an online questionnaire for the assessment one week afterward the test period). Immediate recall accuracy was highest when participants used *no loci* in terms of the total number of recalled items (see Fig. 4, left). A Kruskal-Wallis test did not reveal significant difference between the distributions. Regarding the correct order of items, participants using *no loci* recalled the most items (see Fig. 4, left). Distributions were significantly different (Kruskal-Wallis, $\chi^2(2) = 6.07$, $p < .048$). However, pairwise comparisons using Mann-Whitney revealed no statistically significant differences between individual conditions after Bonferroni correction (U = 11, $p < .028$). The questionnaire which was sent one week after the study period had finished was answered by all participants who had used the *no loci* condition, 7 who had used *spatial loci*, and 5 who had used *panning loci*. Participants using *no loci* and those using *spatial loci* were able to remember most items (see Fig. 4, right). Regarding the correct order of items, participants using *no loci* were able to remember the most items (see Fig. 4, right). Kruskal-Wallis test revealed no significant differences in the distribution of the total number of recalled items or of their correct order. This may be due to the limited sample size in the panning loci condition.

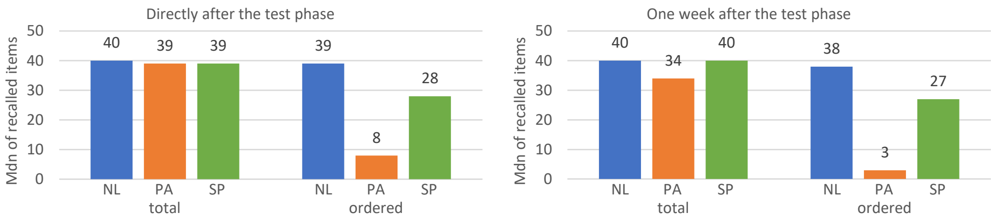

Figure 4: Results of the recall test directly after app usage (left) and in the online questionnaire one week later (right).

6 Discussion and Design Recommendations

As an overall result the *Loci Spheres* concept has been proven to be a practical and promising approach to memorize large quantities of information in situ. In accordance with prior studies, our results show the effectiveness of the method of loci and that mobile devices in general can serve as a tool to support the memorization of items in everyday situations. Our results also revealed differences among the three provided concepts with respect to participants' perceived system support, usage patterns, and effectiveness. The results and their discussion, however, need to be seen in the context of the limited number of participants and further limitations: Due to the in-the-wild design of the study, participants from either of the loci conditions may have also applied the technique without the app. In addition, two limitations refer to the online questionnaire that was sent to the participants one week after the test phase: First, not all participants filled out the questionnaire, resulting in a limited number of samples. Secondly, even though we tasked the participants not to use additional learning aids, such as written notes, they may still have done so and referred to them in the online questionnaire.

Results of our study revealed that the loci sphere concepts provide a significantly increased perceived systems support and thereby reduce the initial mental effort during memorization. A significant effect in terms of effectiveness could not be revealed, similar as in Krauss (2014). Therefore, the hypothesized tradeoff between a lower initial mental effort and the effectiveness of the technique could not be proved. This is not in conformance with other literature (Bower, 1970; Kemp and Van der Krogt, 1985), that states that the effectiveness of the technique depends on the cognitive constructive activity. The reason for that may be found in the limited number of participants. Based on the results, the following design recommendations discuss, how the memorization utilizing the method of loci could be further supported:

I. Provide a low threshold: Results from the interviews show a clear tendency for the use of Loci Sphere concepts compared to no loci. This is reflected in the significantly higher perceived system support for the Loci Sphere concepts (see Fig. 3) and further supported by participants' statements describing the novel (*panning loci*) and gameful (*spatial loci*) approach that the Loci Spheres provide. In addition, *spatial loci* provides the means to define loci within an egocentric sphere providing a vivid visual and spatial experience. Our findings show that system support, especially for the creation of loci, is highly valued. We therefore recommend, to provide a low initial threshold which could be further reduced by offering the user auditive stimuli in addition to the visual ones, such as ambient sounds that are typical for the chosen loci. Besides, Loci Spheres do not provide any support for the creation of the mental images of the items. This element of the technique could also be supported by offering visual and auditive stimuli (e.g. for the item "driver" the system could offer sounds and images to help creating a mental image of the item). Furthermore, during creation of loci, users could also indicate a memory hook that briefly describes their mental images. The memory hook could then be displayed when the user accesses the retrieval mode for the first time.

II. Gradually reduce supportive stimuli: While visual stimuli can help reducing the initial mental load, they can also have a negative effect on recall accuracy as user rely on them when retrieving the items (Bower, 1970; Kemp and Van der Krogt, 1985). Therefore, the design should be adaptive in the sense that it reduces the provided stimuli gradually, dependent on the users' retrieval success. For example, if the user needs to be able to memorize a given set of items, the systems offers the full support at the beginning. As soon as the user is able to retrieve an item, its memory hook should disappear. If the user retrieves the correct item without the memory hook, remaining stimuli should also be removed. As soon as the user is able to retrieve all items, all stimuli indicating the order of items should be removed (i.e., the number labels of the loci, the paths between them, and the arrow which indicates the next locus). In the final stage of the process, all stimuli are removed. Gradual reduction of stimuli, however, must not be experienced as a reduction of the gameful experience. Following the principles of gameful design, reduction should be accompanied by a rewards system, such as highlighting the achievements during the learning process.

III. Provide sufficient scope: One limitations of the Loci Sphere concepts was found to be the number of loci that it supports. Participants made us aware that the capacity of distinguishable loci was limited to $\approx$ 40-50 items due to static spherical visualization. As Loci Spheres requires the mapping of all loci onto one spherical photo, they partly also felt restricted in the process of loci creation and stated it to be cumbersome if they had to place loci too close to each other. Participants using no loci did not experience such boundaries and could move freely in their imagination, providing an arbitrary big space to map loci. Providing sufficient scope could be achieved by allowing the user to capture not just a spherical panorama but a walkable scene. Alternatively, linkage of multiple loci environments (e.g., at home and in the garden) could also be offered to provide to extend the capacity of distinguishable loci.

IV. Provide alternative input: Some participants who used spatial loci reported that they felt uncomfortable using the app in public situations due to practical and social reasons. In contrast to that, *panning loci* and *no loci* were freely used in all sorts of public and private situations. As the method of loci depends on frequent walkthroughs of the loci, a burden to use it in public might hamper the success and advantages of the method. Therefore, the concept should allow the user to switch from spatial input to panning in such situations

7 Conclusion

In this work we introduced *Loci Spheres*, a novel memorization tool based on the method of loci. We presented three design variants that support the learning technique to varying degrees. In an in-the-wild study we found that the two *Loci Spheres* conditions provide a higher perceived system support compared to the baseline condition *no loci*, in which no visual stimuli were provided. Based on our findings we contribute a set of four design principles on how mobile devices can help to leverage the method of loci in everyday situations.

References

Ängeslevä, J., Oakley, I., Hughes, S., & O'Modhrain, S. (2003). Body mnemonics portable device interaction design concept. In *Proceedings of uist* (Vol. 3, pp. 2–5).

Bellezza, F. S. (1981). Mnemonic devices: Classification, characteristics, and criteria. *Review of Educational Research*, *51*(2), 247–275.

Bower, G. H. (1970). Analysis of a mnemonic device: Modern psychology uncovers the powerful components of an ancient system for improving memory. *American Scientist*, *58*(5), 496–510.

Bower, G. H. (1973). How to uh remember. *Psychology Today*, *7*(5), 63.

Higbee, K. L. (2001). *Your memory: How it works and how to improve it*. Da Capo Press.

Ikei, Y., Ota, H., & Kayahara, T. (2007). Spatial electronic mnemonics: A virtual memory interface. In *Symposium on human interface and the management of information* (pp. 30–37). Springer.

Kemp, S. & Van der Krogt, C. D. (1985). Effect of visibility of the loci on recall using the method of loci. *Bulletin of the Psychonomic Society*, *23*(3), 202–204.

Krauss, D. (2014). Human memory support via digital association chains. Retrieved from http://dx.doi.org/10.18419/opus-3296

McCabe, J. A. (2015). Location, location, location! demonstrating the mnemonic benefit of the method of loci. *Teaching of Psychology*, *42*(2), 169–173.

O'Keefe, J. & Nadel, L. (1978). *The hippocampus as a cognitive map*. Oxford: Clarendon Press.

Perrault, S. T., Lecolinet, E., Bourse, Y. P., Zhao, S., & Guiard, Y. (2015). Physical loci: Leveraging spatial, object and semantic memory for command selection. In *Proceedings of the 33rd annual acm conference on human factors in computing systems* (pp. 299–308). ACM.

Roediger, H. L. (1980). The effectiveness of four mnemonics in ordering recall. *Journal of Experimental Psychology: Human Learning and Memory*, *6*(5), 558.

Ross, J. & Lawrence, K. A. (1968). Some observations on memory artifice. *Psychonomic Science*, *13*(2), 107–108.

Yates, F. A. (1992). *The art of memory*. Random House.