Enhancing Password Recollection Performance using Augmented Reality with the method of loci

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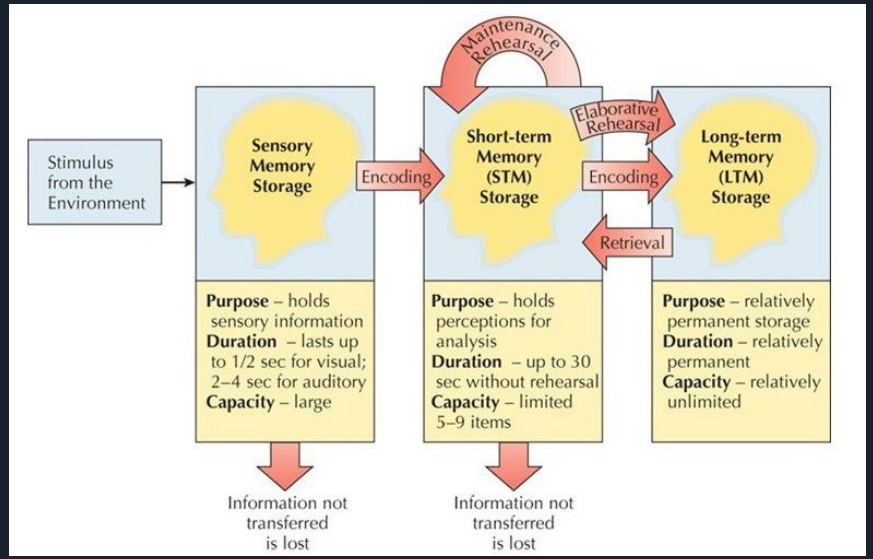
Human memory



Three stages of memory

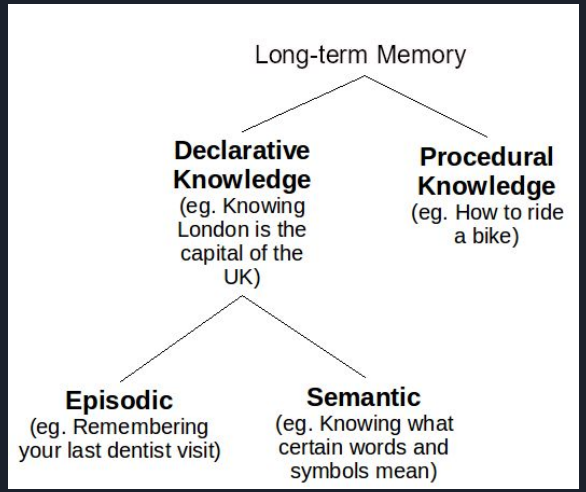


Image Courtesy of Ji Yang, TOWARDS COGNITIVE ASSISTANCE WITH WEARABLE AUGMENTED REALITY, 2016

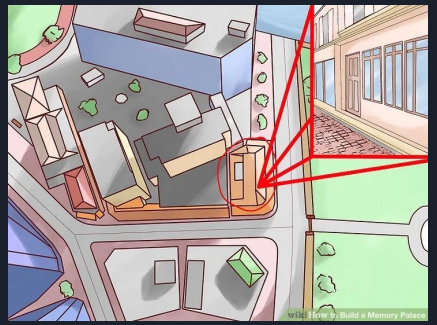
Associative memory

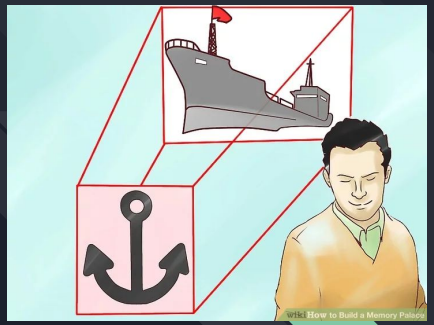
The ability to learn and remember the relationship between unrelated items. This would include, for example, remembering the name of someone or the aroma of a particular perfume.[1]

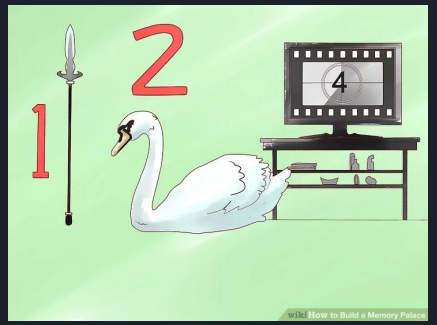
Associative memory is a declarative memory structure and episodically based.[2]

1. Suzuki, Wendy A. (February 2005). "Associative Learning and the Hippocampus". Psychological Science Agenda. American Psychological Association.
2. Dennis, Nancy A., Indira C. Turney, Christina E. Webb, and Amy A. Overman. "The Effects of Item Familiarity on the Neural Correlates of Successful Associative Memory Encoding". Cognitive, Affective, & Behavioral Neuroscience 15.4 (2015): 889-900.

Method of Loci







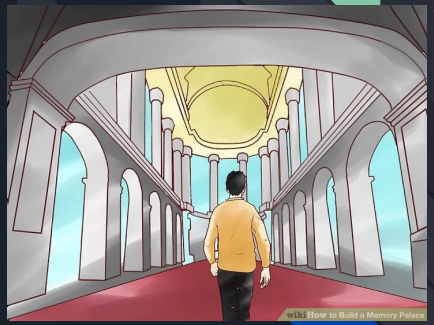
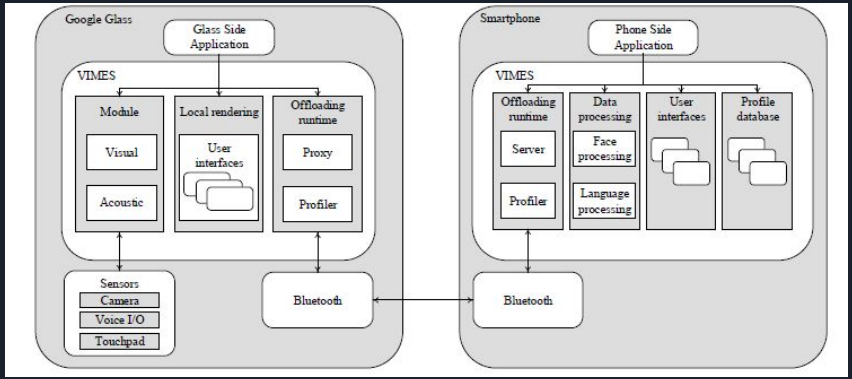


Image courtesy of WikiHow

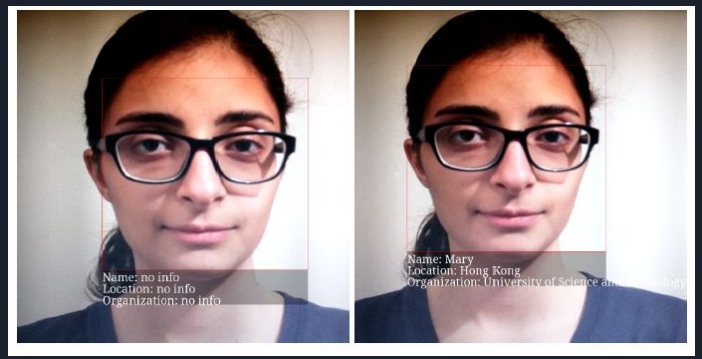
Motivation

How can AR enhance human memory?

Related work



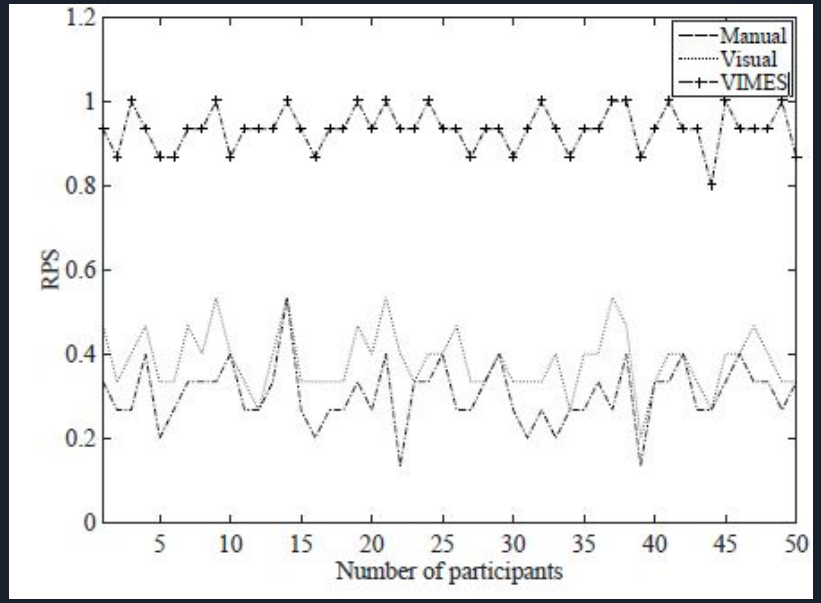
VIMES Interface



User interfaces (a) before and (b) after adding Mary's personal information to the database.

TOWARDS COGNITIVE ASSISTANCE WITH WEARABLE AUGMENTED REALITY, 2016

Related work

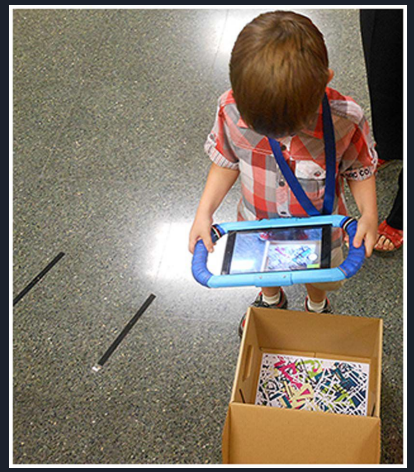


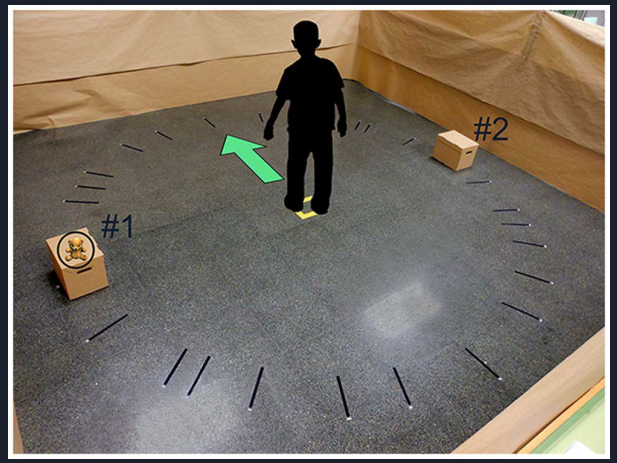
Distribution of Recall Performance Score

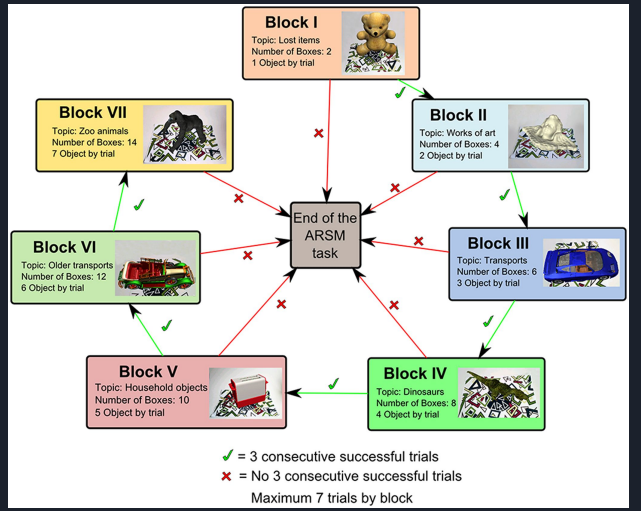
Memory Experience	VIMES	Manual Recall
Vividness	4.1 (0.35)	3.0 (0.71)
Coherence	4.0 (0.43)	2.7 (0.67)
Accessibility	3.8 (0.58)	3.0 (0.83)
Visual Perspective	4.1 (0.39)	2.9 (0.75)

Users' Rating of Memory Experience of 50 Participants

Related work



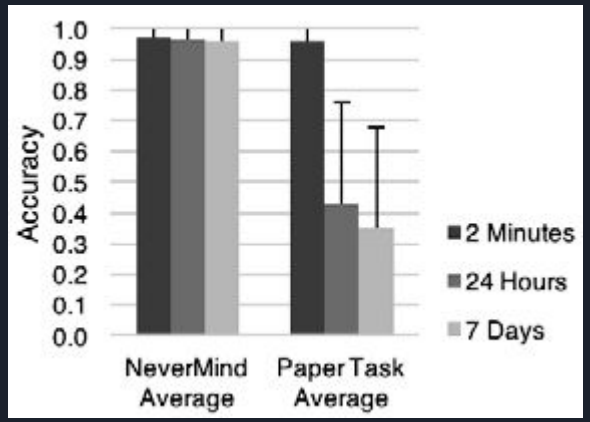




Augmented Reality for the Assessment of Children's Spatial Memory in Real Settings, 2014

Related work

Nevermind Interface



Recall accuracy for the experiment task using NeverMind compared to the paper based task

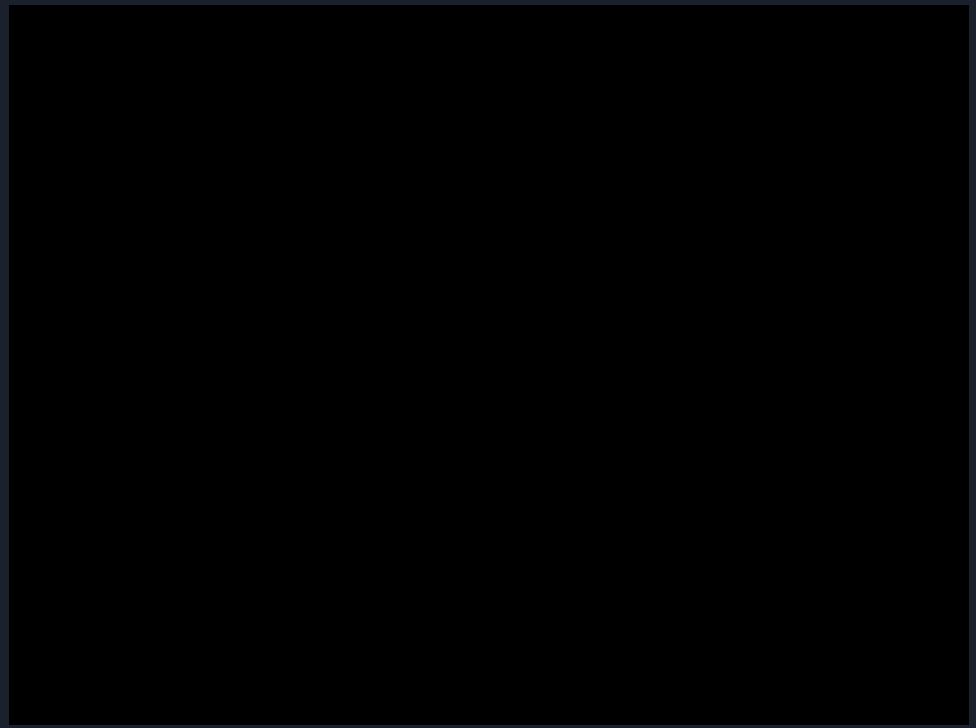
NeverMind: Using Augmented Reality for Memorization, 2016

Previous work from Graphics lab

Methodology

Microsoft HoloLens

Spatial Mapping



The Experiment

Participants

Total number: 90

Groups: 3，30 participants per group

Source: university student with age from 18 to 25 years old

Experiment Design

Participant groups

1. Control Group (using traditional repetition method)
2. Group of the *method of loci*
3. Group of AR-enhanced *method of loci*

Password generator: generate passwords that make use of all 0-9 digits in a given task for all groups for unbiased results

Procedure

1. Memorization Stage (10 minutes, five 10-digit passwords)
2. Cognitive Task Stage (read 10 random 15-digit passwords aloud)
3. Recall Stage (try to recall original passwords and type into an iPad after the memorization process)
4. Recall after 24 hours

Evaluation

Objective Evaluation

Recollection Accuracy with Metrics:

1. Levenshtein distance
2. Damerau-Levenshtein distance

*Maximum Recollection capacity (extra)

Subjective Evaluation

1. Did the AR-enhanced interface work as you expected?
2. Do you think the AR-enhanced interface helped you perform better?
3. For the AR-enhanced interface, please indicate your level of mental stress?
4. For the AR-enhanced interface, please indicate your level of physical stress?
5. How intuitive was the AR-enhanced interface?
6. Do you have any other feedback on the experiment?

Extra test (work in progress)

In the current experiment, we have test the performance on recollection of password of certain length and number, we plan to test the upper bound for participants to remember using our interface.

We plan to see if additional audio information for the AR-enhanced method of loci will further help improve the performance or ease the memorization process.

Do alphanumeric passwords

Include additional information such as orientation cues (compass displayed in user's FOV) in AR, visualize arrows for shortest path dynamically, and measure how much overall time it takes.

Objects memorization

Future work

Help remember words in sequence or objects in sequence. In case of objects, the system could perhaps generate more vivid animations and visualizations to help the participants form stronger memories.

Possible direction of improvement in real-life application scenarios:

1. Most familiar locations for individual users for more effective memorization
2. Storation of different loci with corresponding spatial map
3. User defined items for memorization and off-line association editing

Citations

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Citations

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