

## **Learning through different modalities: Comparison between visual stimuli and auditory stimuli through the participants' ability to recall items.**

### **1. Introduction**

This study examines multimodal communication and how the integration of different sensory modalities can ease learning. The aim is to evaluate the recall of items, presented to the participants through visual, auditory and multisensory modalities. The hypothesis is that the subjects exposed to visual stimuli will remember the objects in a more precise manner since the study deals with locations and spatial perception, while the groups that were exposed to auditory stimuli will have lower performances. Moreover, the intent is to verify what researchers are hypothesizing concerning applications such as Virtual Reality, that the strong element of visual stimuli and interactive ability are well suited to educate and train people [1][2][3].

For centuries, there has been a growing interest in how different modalities can influence learning. In the 19th century and early 20th century most studies sought to answer the question of whether people learn and remember better from visual or auditory presentation of material. This has been a core problem also in recent studies. In their research, Bigelow et al. showed that the participants exposed to visual stimuli had a superior performance to participants exposed to auditory stimuli [4]. Other studies found auditory stimuli to be more effective than visual stimuli [5]. In general, the studies do agree that a combination of both visual and auditory stimuli produces the best results [6][7].

### **2. The Experiment**

The experiment has been designed to address learning through different modalities. The interest of this study is to make use of 2D virtual navigation to compare visual and auditory stimuli.

The participants were divided into three groups: one group was exposed to visual stimuli, the second to auditory stimuli and the third group to multi-modal integration of visual and auditory stimuli (audio recording + map).

The visual stimuli consists of a video that navigates the participant through a walk in the Botanical Garden of Padova. The video presents the landmarks as tags on the place or object that the participant has to remember.

The auditory stimuli is a recording of the same path, where the emphasis of the voice is used to mark the landmarks. The landmarks were, in both modalities, accompanied by a number.

The participants of the third group were given the audio recording of the path with the supplement of a map that only displays the numbers associated with each landmark, not the names themselves.

The experiment also aims to verify if the potential differences are ascribable exclusively to the modality in which the environment is presented, or if there are individual differences among the

group of participants, for example if the gender can introduce differences in certain kind of tasks. Individual differences were evaluated through balanced tests, such as sMRT (Vandenberg & Kuse, 1978 [7]), Spatial Anxiety Test (De Beni et al., 2014; originally Lawton, 1994 [8]), Questionnaire Towards Orientation Tasks (De Beni et al., 2014) and the Spatial Orientation Questionnaire (Pazzaglia, Cornoldi e De Beni, 2000).

All the three groups were evaluated through two tasks: “Free Recall” of the items and the “Serial Recall”. In the first task, the participants were asked to recollect and write all the landmarks of the Botanical Garden that they could remember; the order in which they recalled the items was not evaluated. In the second test, the Serial Recall, the list of landmarks was given to them. The task was to sort the landmarks in order of appearance.

### **3 Results and Discussion**

Multivariate Analysis of the data and One-Way ANOVA were conducted. Gender and Learning Method were mainly used as a parameter to evaluate the results, in order to determine if the score is dependent on the stimuli used or the gender of the participant.

The preliminary evaluations of the individual differences of the participants showed that three groups are balanced: gender and visual-spatial abilities of the participants do not introduce significant differences.

The evaluation of the two main tasks showed a significant dependency between the number of items recalled and the stimuli the subjects were exposed to.

The analysis of the Free Recall task confirms our hypothesis: the participants that were exposed to the visual stimuli could recall more landmarks than the participants that were exposed to auditory stimuli or multisensory integration. Moreover, they were more precise in remembering the correct names. In this section, missing plurals or similar mistakes were calculated as errors (e.g. “*Hill Plants*” instead of “*Hills’ Plants*”).

The experiment also confirmed that the group exposed to multisensory modality produced better results than the group that was exposed to auditory stimuli, which achieved the lowest results.

The Serial Recall Task did not show significant differences associated with the learning method used. An interesting finding of the experiment is that the multisensory stimuli group had the highest results in this task.

This study concludes that Virtual Reality for learning could have the potential to create new and better ways to educate and train people. Combining the visual stimuli or multisensory integration of two stimuli, and interactive nature of Virtual Reality might be a more efficient way to learn compared to exclusively auditory learning.

#### 4 References

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