

# Effect of 2D versus 3D spatialisation on the identification of everyday sounds : a preliminary study

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## Abstract

The topic of our work is the design of auditory metaphors in computer environment. The aim is to specify how to build auditory metaphors, according to the user's activity and the context of this activity. In that way, we could establish a typology with the use context. In this first experimentation, we want to verify if a sound could be represented within long term memory by a conceptual structure. Subjects listen to 2D environmental sounds and 3D environmental sounds. They have to specify the degree of familiarity, the name of the sound and circumstances in which they have heard the sound.

## 1 Introduction

In order to introduce auditory metaphors in a computer environment, one first has to study of the auditory metaphors, their use and their design.

In computer interfaces, there are three case in which the sound is used.

Firstly, the data auralization or/and the sonification offer advantages when representing information by using the sound parameters. According to Bly (cited [7]), the sound may manage information when this last one is visualised with more than three data dimensions. Though the mapping between data parameters and dimensions of sound seems simple, there are some gaps related to the hardware and software limitations on sound synthesis and processing. In addition, this mapping seems arbitrary; that is to say, there is no semantic links between the sound and its meaning.

Secondly, alarms and musical messages represent another auditory interface supporting interaction with the computer itself. Sounds provide information about the computer system. Blattner and his collaborators [2] have developed a system called Earcons, which was a hierarchical framework of musical messages. For example, Earcons could be used to design auditory maps [3]. Like Sarah Bly's work, the mapping between musical message and its referent is also arbitrary and only symbolic.

Finally, according to Gaver [7], auditory icons use sound "as an integral part of the interface [involving] creating auditory, everyday sounds mapped to computer events by analogy with everyday sound producing events"[7]. There are many applications as SonicFinder [6], ARKola [8], ShareMon [5], and Mercator [12]. These tools are used to support navigation or collaboration in the computer environment. Auditory icons are based on real events and provide a metaphoric or iconic structure for the mapping between sounds and information that the first ones convey. Thus, the auditory mapping is not arbitrary, but based on an analogy with the everyday environment.

In summary, the link or the mapping between sound and information could be symbolic, iconic or metaphoric. The symbolic mapping is arbitrary, the iconic mapping is based on the physical cause and the metaphoric depends on the similarities with the different domains. We could note that the sound is always used to complement visual information. In addition, Ballas [1] stresses on the importance of their function and the use of 3D sounds that could represent natural events in auditory interfaces. In that way, the sound is a powerful media that offers information about our environment.

In the natural environment, we react to many sounds. When we listen to the world around us, we hear it in three-dimension (3D). The everyday sounds offer advantages and potentiality to deliver information in computer environment. Thus, they convey information about real events, which were always known by people. On the basis of this principle, we could sustain the idea that they could be supported as well as the other auditory metaphors.

According to Psychology, the language metaphor is considered to be a rhetoric figure, a meaning transfer by analogical substitution, that is to say, a metaphor states that an object stands for another one on the basis of similarities [13]. In this case, we must specify that when a metaphor isn't a language one, it is an analogy case.

The analogy principle consists in a meaning transfer between a target domain, which was unknown, and a known source domain. In that way, the analogical judgement between the target and the source is based on a certain resemblance. After the detection of the analogy, some object features or proprieties are imported from the source domain to the target one [10, 11, 9]. We could assume they are the same cognitive processes for the auditory metaphors. Firstly, we will verify if a sound could be conceptualised. If there is a semantic network or a conceptual structure for the sounds. Once this is proved, it will offer the possibility to design auditory metaphors, because the mapping between sounds and information and their meaning constitute a structure which could represent a base or a referent for the auditory metaphor. Thus, we could build auditory metaphors, which are more conceptual.

## **2 Experience**

### **2.1 Method**

#### **2.1.1 Subjects**

Forty subjects took part in this experiment. All subjects have a normal audition.

#### **2.1.2 Apparatus**

Computer played the sounds. Four speakers are used in a quadraphonic mode. Two ones are front the subject on his left and his right and the other two are behind the subject on his left and his right. We used a 3D soundcard which was the diamond monster sound. Its one allows the spatialisation of sound. The sounds were played in 2D and 3D and in a dynamic way. In order to play dynamically a sound, the 3D audio card is interfaced with visual basic which applies trajectories to sound. This one is dynamically spatialised and is played in real time. The same forty environmental sounds were used in these two dimensions.

#### **2.1.3 Procedure**

The subjects are placed front the screen and in the middle of the four speakers. A progress bar indicates that the sound will play. This one permits the user to focalise his attention in order to listen to the auditory stimulus. The duration of each sound is 5.5 seconds. After the sound presentation, a response window appears on the screen. The subject has to specify the degree of familiarity, the sound name and the circumstances of hearing. In addition, we have measured the nomination time. This procedure is the same one for all sounds. Twenty subjects performed on the 2D dynamic task and the other twenty subjects performed on the 3D dynamic task.

### **2.2 Data and statistical analysis**

The degree of familiarity, the sound name, the circumstances in which they have heard the sound and the naming time are recorded by subject and for the forty sounds. A variance analysis was performed on the degree of familiarity and on the naming time. A qualitative analysis is actually realising on the sound name and on the circumstances.

### **2.3 Results**

The ANOVA performed on the familiarity degree reveals the presence of a no significant effect of the dimension in which the sound is played (2D vs. 3D). Respectively, the means are 3.251 for the degree of familiarity for the 3D sounds and 3.206 for the 2D sounds. The ANOVA performed on the naming time shows a no significant effect of the 2D dimension (21.69 ms vs. 21.61 ms) the 3D dimension. For the name of the sound, three categories of response are used: the designation of the object, the action on the object or the result of the action on the object. A minority of subjects used the onomatopoeic form to define the sound that they heard.

## **3 Discussion**

These first results show that the subjects have recognised the sounds and have emitted the same familiarity judgement when the sounds are played in 2D or in 3D. According the identification of sound, this one could be related with the work of Bregman [4]. He postulates the existence of schemas in memory, which support the sound identification. There is an auditory pattern which active the schema in memory.

The next work and the further analyse have the aim to prove the existence of a more conceptual structure related to sound. This one is the base of the design of auditory metaphors.

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