

Armonis Junior Anilyse, Agathe Muselet, Benoît Quélen, Doriane Thiébaud  
Marine Cadoret, Sébastien Lè  
Applied Mathematics Department, Agrocampus Ouest, Rennes, France

## Context

Phone companies lead studies to evaluate the perception of mobile loudspeakers through the use of classical sensorial analysis. Meanwhile, the loudspeakers studies have a particularity: they can be rated only through musical extracts.

Nine devices, which represent the mobile loudspeakers currently available on the market, were selected.

Three short musical clips are chosen to represent any kind of music.

The classical method requires a long time to train an expert panel and to select a set of verbal descriptors chosen by the judges.

### Can we reach some results using a holistic approach and a panel of 43 non-initiated judges ?

As the studied products are not habitual for sensorial approaches, we want to check the reliability, the interpretability and so the feasibility of the holistic approaches.



## Sorted napping [1]: an easy and fast protocol to realize

A three steps protocol:

- judges have to display the different phones on a map according to their perception of the sound differences
- then they group the phones
- they can attribute words to the groups

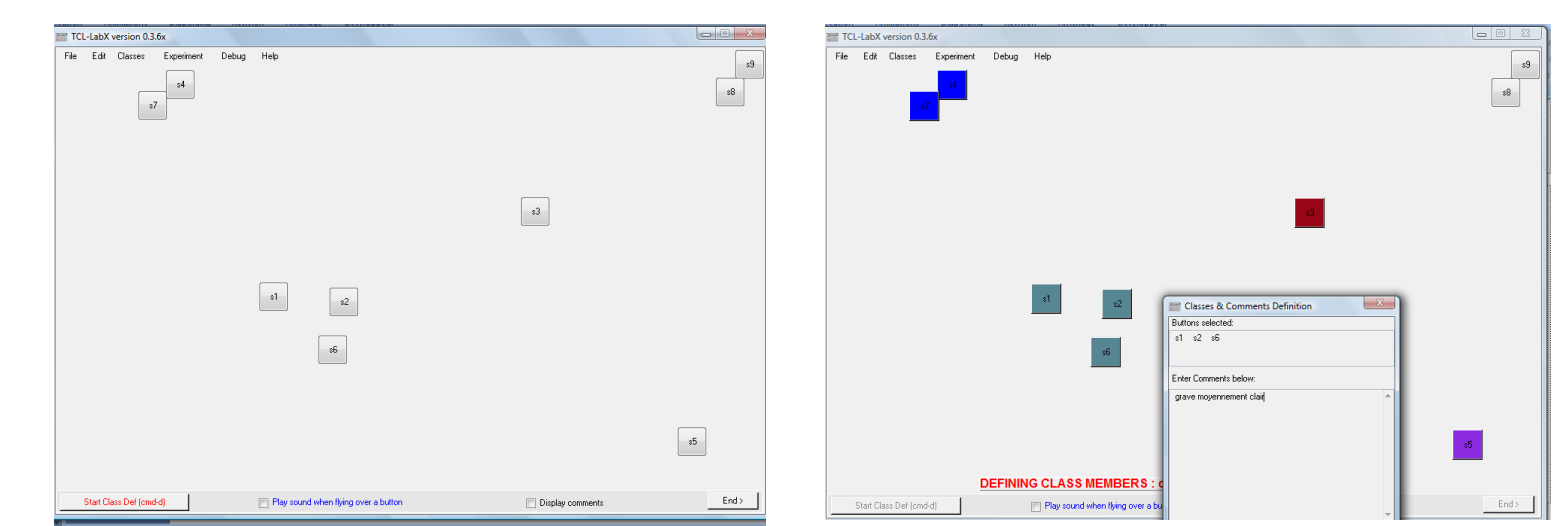
In order to make easier the protocol, we use a computing napping, thanks to a free software TCL-LabX [2].

Judges can listen the sound while they are moving it on the screen, just by clicking on it.

Each judge has to realize 3 sorted napping: one for each clip → a mean of 10 minutes per clip

→ The dataset is divided first in three blocs for the three musical abstracts and then each bloc is divided in forty-three for each judges and finally each judge as coordinates data and categorized data. The data is analyzed by HMFA.

Extract of the software TCL-LabX



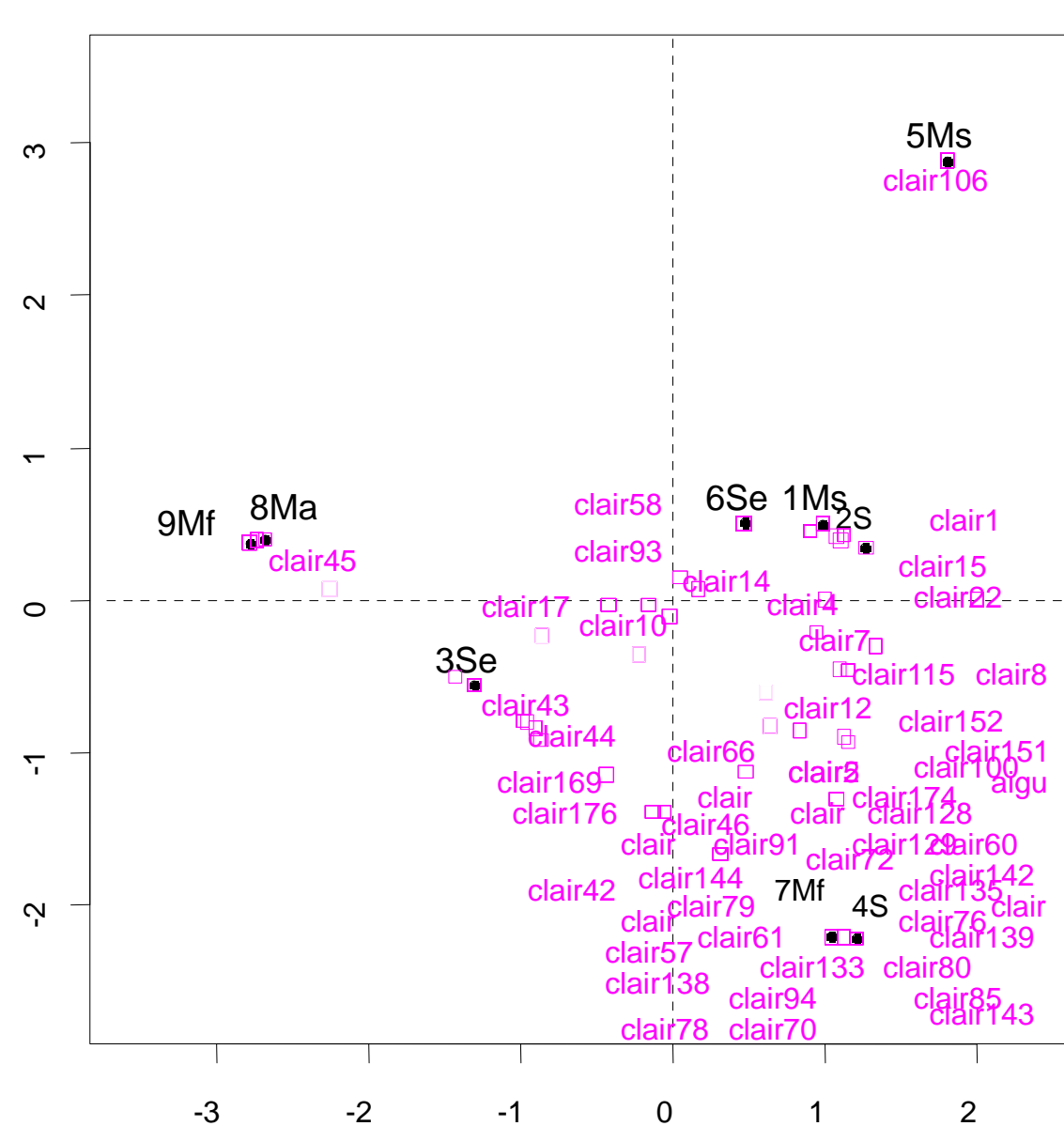
## Reliability of the results

### From descriptors study:

Judges use a wild variety of descriptors, some were very personal and are hard to understand, but some descriptors are used by a lot of judges: "treble", "metallic", "clear", "bass", "smothered"

A same word used by several judges are located on the same part of the plan: judges are consensual on these descriptors.

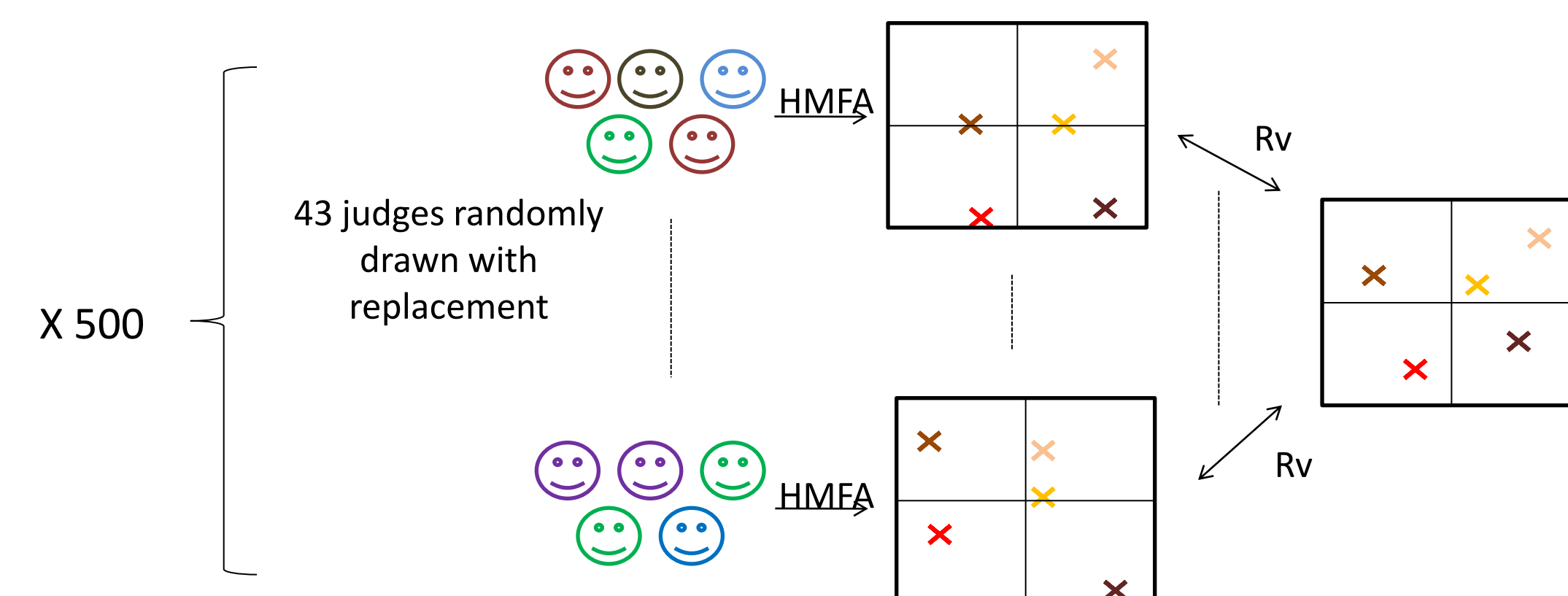
Representation of loudspeakers and of the word "clear"



← The attribute "clear" is consensual

### From resampling method:

We use a bootstrap method to compare the results of our reference panel with the results of virtual panels. We calculate 500 times the Rv coefficient between the virtual and the reference plane.

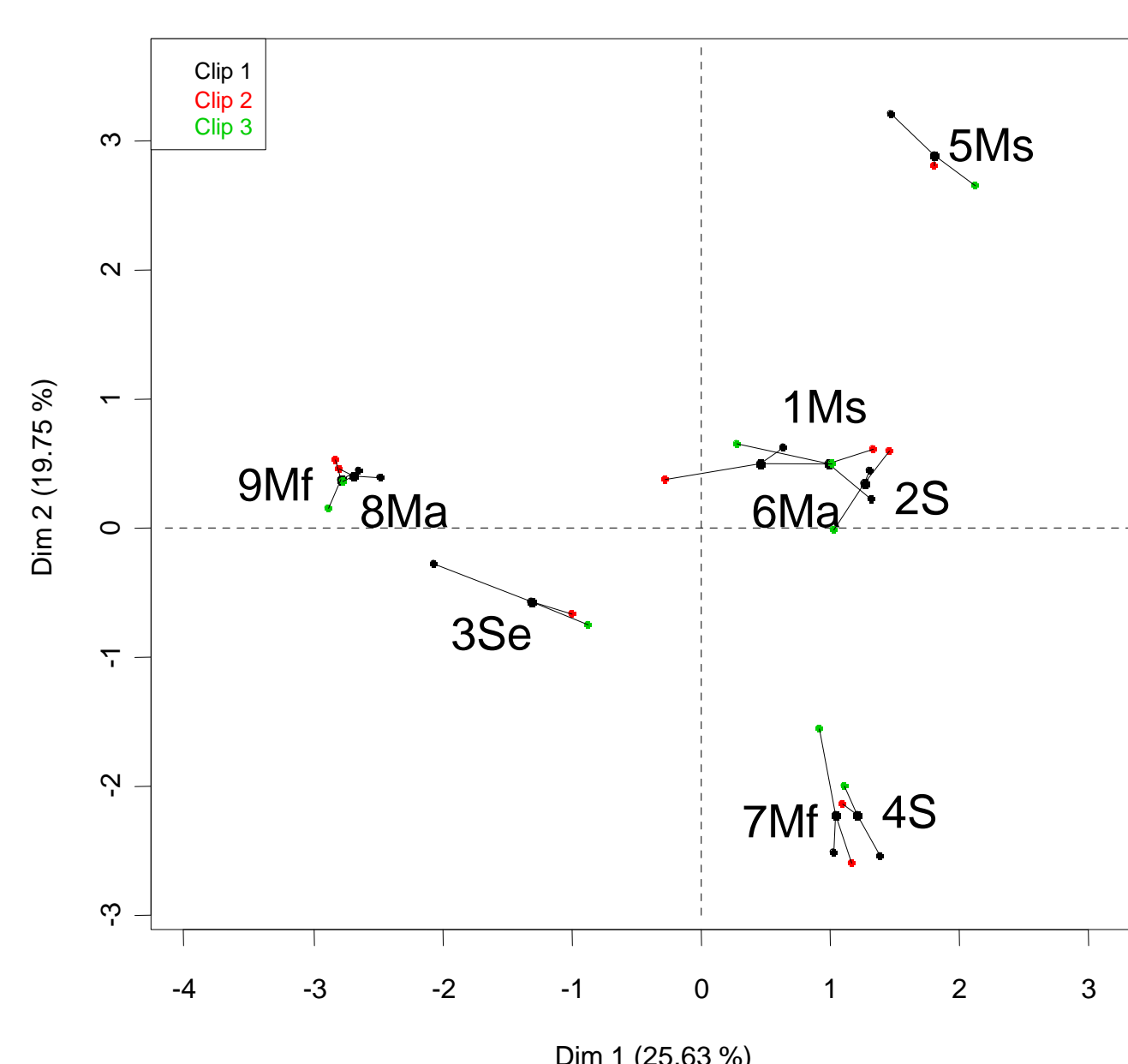


We find a mean Rv coefficient of **0.9938**: with an other panel we would have very closed results.

→ The both approaches show the reliability of the results. We can now interpret them.

## Interpretation

Superimposed representation of the partial clouds



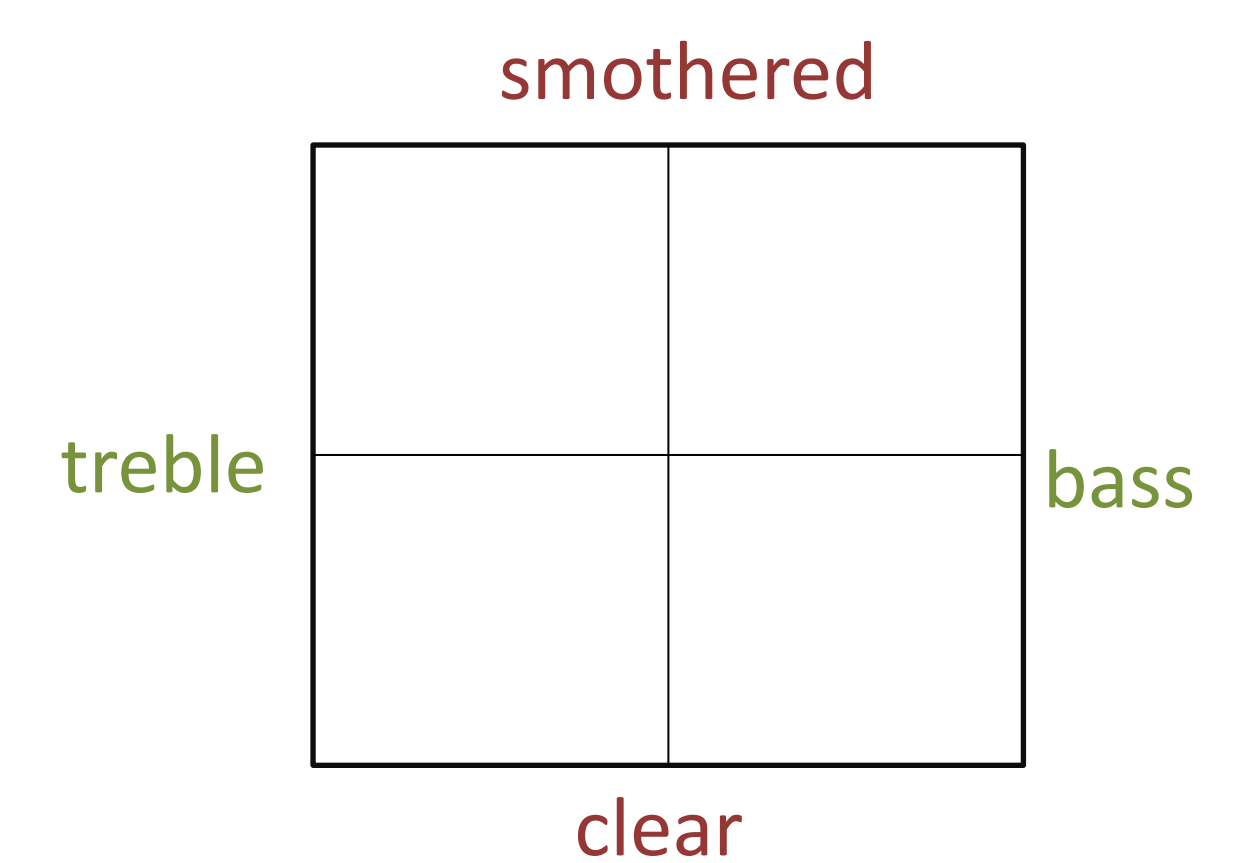
Loudspeakers are well discriminated on the plane 1-2

### 1) Signification of the axes:

- axis 1: opposition treble (phones 8, 9) and bass (phones 5, 4 and 2)
- axis 2: opposition between smothered (phone 5) and clear (phones 4 and 7)

### 2) Partial points are closed to the mean points:

- judges are repeatable from on musical extract to another



## Conclusion

- Sorted napping seems to be well adapted to work with sound stimuli in this example. Our results are both reliable and interpretable.
- We can see that the most important aspects of the sound stimuli for the judges are the frequency (bass and tremble) and the clarity.
- This method has the advantage to be easily set up and to be within the reach of non-initiated judges.