



# Effects of the spatialisation of water-sounds sequences on the perception of traffic noise

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## Introduction:

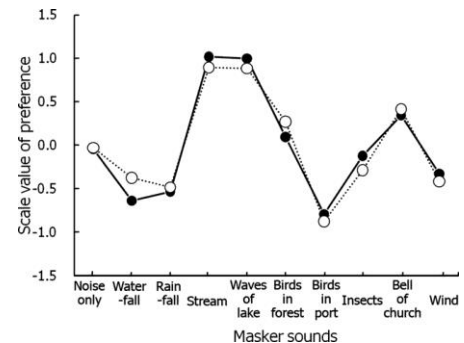
Traffic noise represents one of the most important public issues of modern cities due to the rapid development of transportation.

For noise abatement, two strategies are considered:

- ☆ Reduction of unwanted sounds;
- ☆ Introduction of wanted sounds;

Water sounds for noise masking:

- ☆ energetic masking;
- ☆ informational masking.



- From Jeon et al. (2010)



- From <https://soundscapedesign.info/>

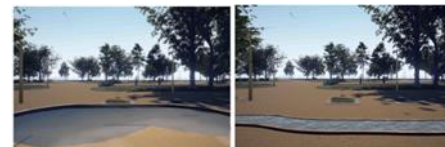




# Introduction:

## Related works:

- ① Using Immersive Virtual Reality technology to investigate the effects of combining audio and visual elements of installations with water features on traffic noise mitigation in urban green parks;
- ② Comparing the effect of the simulated and real water features on the restorativeness in urban parks.



- From Masullo et al. (2017)

## The aim of this paper:

This paper investigates the masking effect of water-sound sequences on road traffic noise perception through different spatialization setting.

Research supported by Programma V:ALERE 2019 “VALERE: VANviteLli pEr la RicErca”. Project MIELE, Multisensory Investigation for ELderly-centred design of common living urban Environments.





# Methods:

## Experiment design:

Independent variables : Spatialisation of water sounds

- > *Frontal-fixed Position Water sound (FPW)*,
- > *Two-position Switching Water sound (TSW)*
- > *Four-position-randomised Moving Water sounds (FMW)*
- > *Road Traffic Noise (RTN)*

Dependent variables: items from subjective reports

- > Perceived Restorativeness Scale (PRS-11);
- > Sound Evaluation Scale;
- > Emotional Feelings Scale

## Hypothesis:

A structural, spatial representation of water sounds in a noisy environment would produce more positive subjective feelings than fixed or co-located water sound, leading to the decrease of mental stress and increase of restorative qualities.






## Methods:

### Sound Materials:

#### ① Traffic Noise:

Duration	1 minute	
Place	Villa Comunale, Naples	
Device	Zoom H6 Hand-Recorder	
Microphone	Soundfield SPS200	
LAeq:	65 dB(A)	

#### ② Water Sound:

Duration	5 seconds	
Place	Sant'Agata De Goti, Caserta	
Device	Zoom H6 Hand-Recorder	
Microphone	Rode NTG – 2	
LAeq:	62 dB(A)	

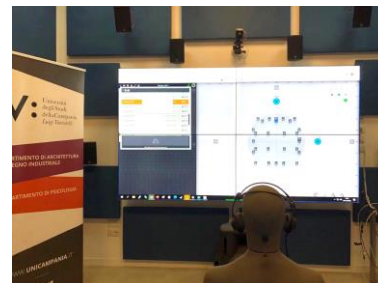
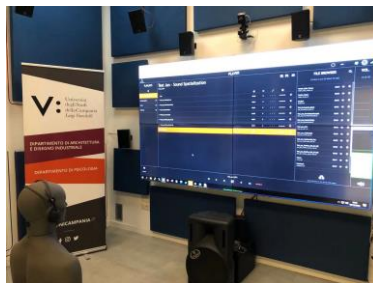
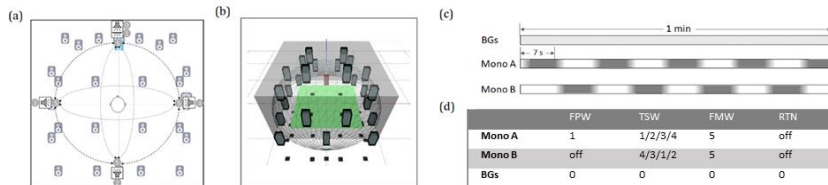




## Methods:

### Sound recordings:

The soundtracks were played back within the **SENS i-Lab** of the Department of Architecture and Industrial Design of the Università degli Studi della Campania “Luigi Vanvitelli” through an **Astro Spatial Audio system (ASA)** (25 Adorn A55 Martin Audio; 2 Sx110 Martin Audio), and rendered by SARA II Premium Rendering Engine.







# Methods:

## Online Test:

Link: [www.braincoder.io/spatial\\_sound/en](http://www.braincoder.io/spatial_sound/en)

Sound sequence with random order:

2 TPW; 1 FPW; 1 FMW; 1 RTN;

Subjects: 36 (18 male; 18 female;  
average age: 26 )

0:00 / 1:00

10. What extent do you presently hear the following different type of sounds?

	Not at all	A little	Moderately	A lot	Dominates completely
Road Traffic	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Water Flow	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Other	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

11. What is the number of sound sources you hear presently?

	0	1	2	More than 2
Road Traffic	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Water Flow	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Other	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

12. To what extent do you feel annoyed by the following sounds?

	Not at all	Slightly	Moderately	Very	Extremely
Road Traffic	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Water Flow	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Other	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

0:00 / 1:00

13. The following questionnaire is used to evaluate your experience in places like this. Please read every sentence carefully and then indicate on a scale from 1 to 10 to what extent it corresponds to your experience in this place. To choose your answer mark only one of the numbers on the scale next to each statement with a cross. For example, if you think the sentence does not correspond at all to your experience in this place mark "1" (not at all). If you think that the sentence sometimes corresponds but not completely to your experience, then mark a number from "1" to "9". That reflects what you think about your experience in this place, but if you think that the sentence corresponds very much to your experience in this place mark "10" (very much).

	Not at all	1	2	3	4	5	6	7	8	9	Very much
In places like this it is hard to be bored	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Places like that are a refuge from nuisances	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
That place is large enough to allow exploration in many directions	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
There is a clear order in the physical arrangement of places like this	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Places like that are fascinating	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
In places like this everything seems to have its proper place	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
To stop thinking about the things that I must get done I like to go to places like this	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
In places like this my attention is drawn to many interesting things	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
In places like this it is easy to see how things are organized	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
In places like that there are few boundaries to lead me possibly for moving about	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
To get away from things that usually demand my attention I like to go to places like this	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

0:17 / 1:00

14. Select for each descriptor below, the number (1-not at all to 7-extremely) based on how much the descriptor describes the sound you presently heard:

	Not at all	1	2	3	4	5	6	Extremely
Chaotic	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Unpleasant	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Natural	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Rhythmic	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Spacious	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Attractive	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Smooth	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Unattractive	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Familiar	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Uneventful	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Mechanical	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Stimulating	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Pleasant	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Calm	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Exciting	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Eventful	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Monotonous	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Boring	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

15. Select for each descriptor below, the number (1-not at all to 7-extremely) based on how much the descriptor describes your feeling about the sound you presently heard:

	Not at all	1	2	3	4	5	6	Extremely
Energetic	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Sad	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Weak	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Nervous	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Calm	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Happy	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

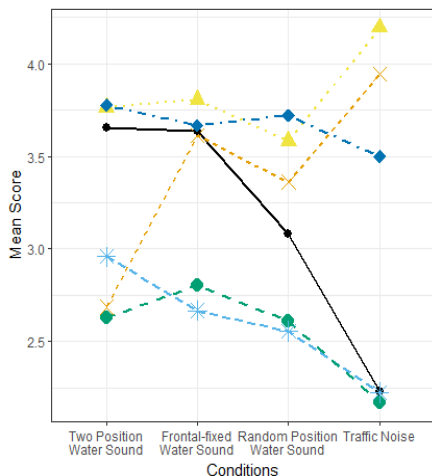
3 pages for each condition



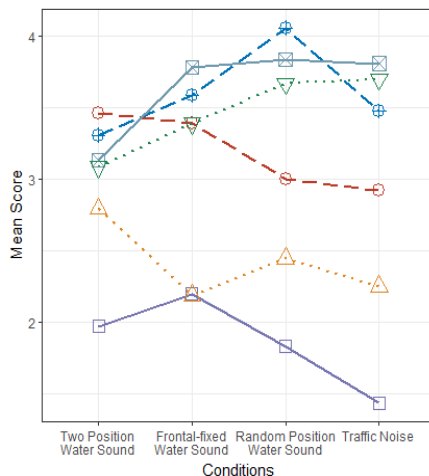


# Results:

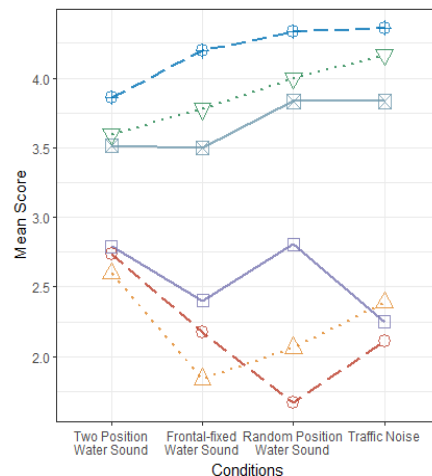
## 1) Sound Evaluation Scale



(a)



(b)



(c)

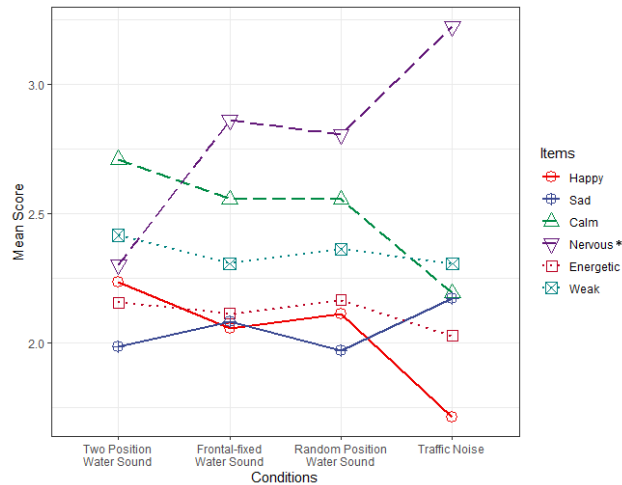




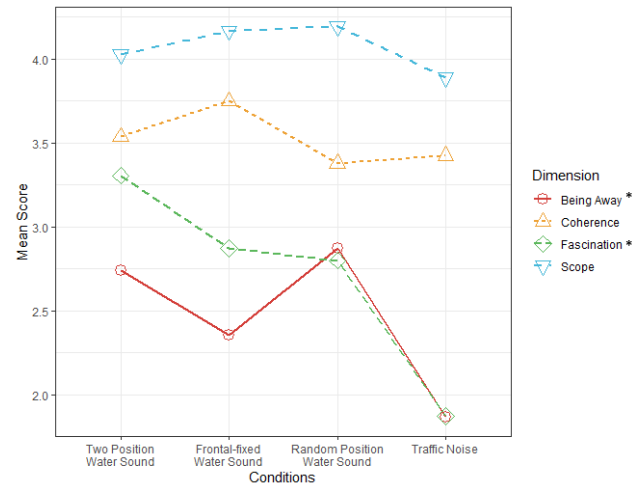


# Results:

## 2) Emotional Feelings Scale



## 3) Perceived Restorativeness Scale





## Conclusion:

- ① The introduction of water-sounds sequences improved some components of the restorative qualities (**Fascination** and **Being-Away**);
- ② Water sounds with **two-position switching** could help to decrease **mental stress** and increase multiple positive feelings.
- ③ The **spatial distribution** affected the masking effect of water sound on the perception of traffic noise from different aspects.

More studies across multiple modality are needed for further clarifying the complex relationship between temporal-spatial variations of sound sources and the perception of traffic noise. And it will certainly help landscape designers and managers to develop more various approaches for noise abatement and environment protection.





**THANK YOU  
for your attention !**

