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Roxane L. Bartoletti, Martine Adrian-Scotto, Serge Antonczak, Dirk D Steiner, Xavier Corveleyn

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# Influences of Smells and Music on Young and Older Adults Cognitive Performances

## Proposal of a Multisensory Design

Bartoletti, R., Adrian-Scotto, M., Antonczak, S., Steiner, D., Corveleyn, X.

Université Côte d'Azur, France

Contact: roxane.bartoletti@univ-cotedazur.fr @BartolettiRoxa1

### INTRO

Our surroundings are composed by a multitude of sensory information (olfactive, auditive, visual, etc) and the interactions we have with are constantly renewed. The central nervous system integrates and assembles this multisensory data into a rich and unified representation of our surroundings. This process, called multisensory integration, impacts the human mental states and behaviors (Cerisier, Haas & Kalampalikis, 2017; Furnham & Strbac, 2002; Saive et al., 2014). The influences of olfacto-auditory multisensory integration on our cognitive performance are based on several phenomena, such as a congruence between stimuli based on individual preferences. Influences of music and odorants on our cognition are still rarely studied in a standardized and individualized way, especially on executive functions. Multisensory studies require multiple methodologies (psychophysics, experimental psychology), techniques (electrophysiology, odorant, and music diffusion), and skills (chemistry, cognitive psychology, neuropsychology). Namely, no studies have investigated the consequences of individuals' choices of olfacto-auditory environments on young or older adults' executive functioning. We chose to focus on the three main executive functions (EF) as describe in Miyake's model: inhibition, updating, and mental flexibility (Miyake et al., 2000; Miyake & Friedmann, 2012). EF are defined as metacognitive processes that control and regulate other cognitive functions (Krolak-Salmon & Thomas-Antérion, 2010) and are severely impaired during the healthy and pathological aging of individuals (Perry & Hodges, 1999).

### OBJECTIVE/AIMS

We propose exploring how customized olfacto-auditory environments impact executive functioning performance in young and older adults. We compare the effects of three independent variables on cognitive performance: (1) uni- or multi-sensory, (2) customized or gold standard choice environments, for both in (3) young and older adults. Participants' scores on experimental tasks, various questionnaire responses, and physiological measurements are compared between the 3 independent variables.

### EXPECTED RESULTS

We expect that the congruency between smells and music experienced by each participant will be the most powerful predictor of high cognitive performance. Indeed, congruency of music and smells, based on participants' choices, should increase the influence of the multisensory environment on executive function performance. The theoretical implications and applications in the long term can therefore be extended to many situations: open space, school, disability, healthy and pathological aging.

Take Home Message:

Testing the influence of customized olfacto-auditory environments on cognitive performances requires

- (1) learning more about **habits**,
- (2) obtention of a **gold standard** of stimuli and
- (3) both **uni- and multi-sensory environments**



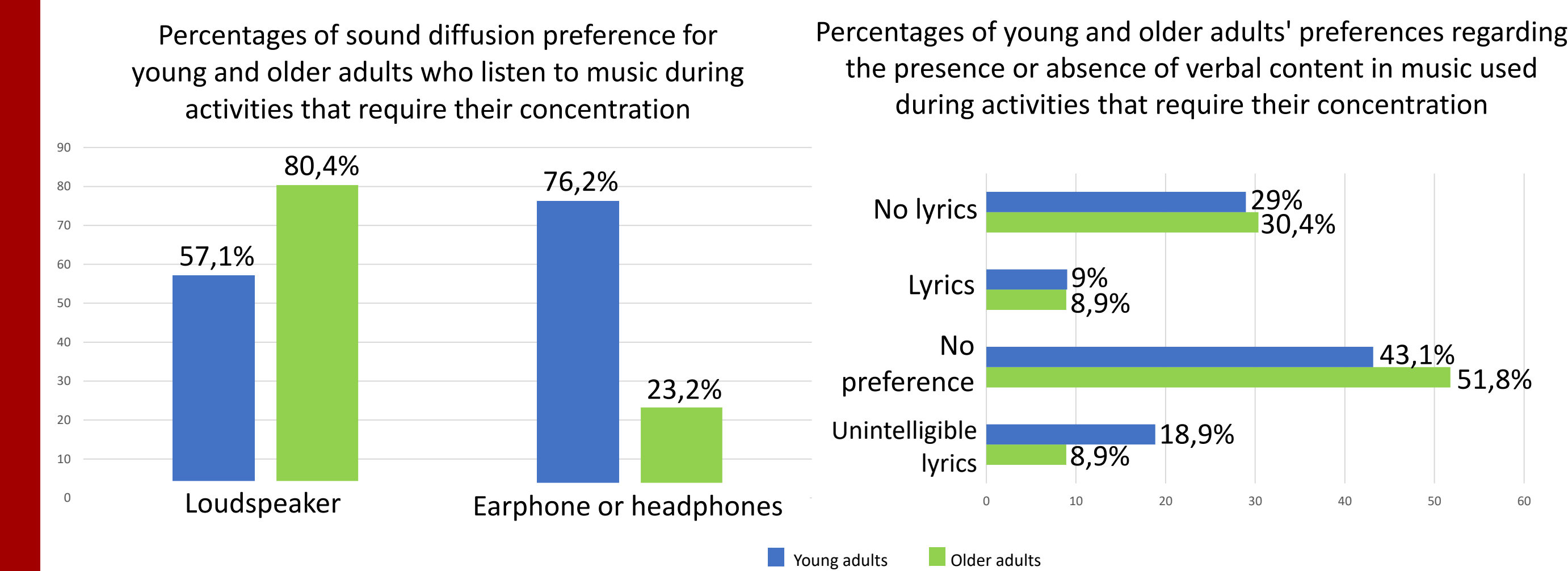
Take a picture to stay informed !



### METHODS

#### 1. Investigate music preferences

To gain a better understanding of the musical habits of young and older adults during cognitive efforts such as concentration during task performance, we conducted an online survey in France to understand the musical habits of young and older adults during tasks that require their concentration. 381 young adults (18 to 35 years old) and 73 older adults (48 to 65 years old) have responded to our survey. Results showed that young and older people have musical preferences, they both tend to prefer to work while listening to relaxing music without lyrics, classical, jazz, and ambient music are largely preferred. Compared to older adults who largely prefer to listen to music with a radio or music center with loudspeakers, young people have a slight preference for the use of ear- or headphones.



#### 2. Gold standard obtention by material selection

The second step is the selection of the most contrasting stimuli (music and odorants) for the two populations of interest. For this purpose, 120 participants composed of 60 young adults (18 to 35 years old) and 60 older adults (18 to 65 years old) will listen to 24 musical excerpts and will smell 29 odorants. They will rate each stimulus on how pleasant or unpleasant and how relaxing or energizing they perceive it and whether they think it would help to create a favorable environment to maintain their focus. Participants will also rate the different emotions felt linked to the music and the odorants.

#### 3. Uni- and Multi-sensory environments

Finally, we will explore the effects of uni-sensory or uni- and multi-sensory customized or imposed environments on cognitive performance in the two populations of interest (young and older adults). This study will focus on the three main executive functions of Miyake's model: inhibition, updating, and mental flexibility. In this study, we will compare participants' scores on experimental tasks, on various questionnaire responses, and physiological measurements like heart rate variability and heart rate variability. Results will be analyzed by statistical mixed models. The congruency felt by each participant is expected to be the most powerful predictor of high cognitive performance.

