



# IMPACT OF THE VISUAL CLUTTER OF A ROOM ON FRANCOPHONE SPEAKERS' SPEECH PRODUCTION AND PERCEPTION (EXTENDED ABSTRACT)

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## ABSTRACT

Speech perception and production are multimodal processes that are influenced by both auditory and visual cues. While the impact of acoustic environment has been heavily researched, few studies have investigated how environmental design influences the vocal behavior of speakers through visual perception. Our study explored the impact of visual clutter on the vocal production of speakers in terms of acoustic parameters such as SPL,  $f_0$ , and CPP, and in terms of self-perception of speech. Participants had to perform two speech tasks, reciting the alphabet, and reading a children's story, in two rooms that were acoustically similar (RT = 0,7 and 0,6 sec; mean dBA = 30,66 and 30,53 respectively) but visually different. Room A was clutter-free whereas Room B was cluttered with everyday items. Analyses revealed that the acoustic vocal measures did not vary significantly between the rooms, however, participants reported a significantly lower vocal effort ( $p < 0,001$ ) in Room A. Qualitative analyses revealed that participants preferred speaking in Room A, and correlations revealed that their self-perceived vocal intensity (decreased in Room A, increased in Room B) did not match the objective results. Our results highlight the importance of collecting subjective perception of speakers in studies investigating vocal effort.

**Keywords:** *visual clutter, vocal effort, speech acoustics, speech production, speech perception*

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## 1. CONTEXT

Vocal effort, as a recent consensus paper defines it, is the perceived exertion of a vocalist's response to a communication scenario and is therefore a self-reported, perceptual phenomenon [1]. Studies in the past have used objective parameters to quantify vocal effort such as sound pressure level (dB SPL), fundamental frequency ( $f_0$ , Hz) and cepstral peak prominence (CPP, dB) [2]. The perception of vocal effort is influenced by various factors, including the interaction between sensory information such as visual and auditory cues which is why speech perception in humans is considered as audiovisual [3]. While acoustical factors such as poor room acoustics [4] and background noise [5] have been repeatedly linked with vocal effort, the effect of visual cues such as visual clutter on speech perception and production has not been studied yet. Visual clutter in interior spaces is defined as an excess of objects leading to overstimulation and decreased performance [6]. Visual clutter is generally perceived negatively by visitors [7]. Our study aimed to investigate the impact of visual clutter on the vocal production of speakers in terms of acoustic parameters of SPL (dB),  $f_0$  (Hz) and CPP (dB) and in terms of subjective perception (vocal effort). We sought to explore how environmental design influences vocal behavior through visual perception.

## 2. METHODOLOGY

Twenty healthy women aged 21 years 7 months to 31 years 11 months (mean: 23 years 8 months) were recruited for this study. All participants were French speaking. Participants had to visit two visually different rooms and produce speech in each room. Room A was a clutter-free, clean, and neutral room. Room B had the exact dimensions of Room A, but was decorated with everyday items such as

books, toys, and functional object (e.g., fan). Both rooms were acoustically similar in terms of reverberation times ( $RT_{60} = 0,7$  and  $0,6$  sec respectively) and SPLs (dBA =  $30,66$  and  $30,53$  respectively). In each room, participants performed two speech tasks: reciting the alphabet, and reading aloud an excerpt of a children's story. The speaking tasks were audio recorded to analyze their SPL,  $f_0$  and CPP. The order of the rooms and of the tasks was randomized for each room and for all participants. After completing their speaking tasks in each room, participants had to fill in a questionnaire. The first question aimed to collect the participants' visual perception of the two rooms based on six qualities (clutter, light, color, organization, harmony, and pleasantness). The second question aimed to collect their vocal effort. All self-reported data were collected via 100-mm visual analog scales (VAS).

### 3. RESULTS

Regarding the participants' visual perception of the two rooms, they found that both rooms were visually different in a statistically significant manner (Student Tests;  $p < 0,001$ ) based on the six qualities. As for acoustical analyses, there was no significant statistical difference between the means of SPL from rooms A and B (mean Room A =  $68,6$  dB, mean Room B =  $68,3$  dB; repeated measures ANOVA,  $p = 0,383$ ), nor between the means of  $f_0$  from rooms A and B (mean Room A =  $236,6$  Hz, mean Room B =  $237,6$  Hz; repeated measures ANOVA,  $p = 0,742$ ), nor between the means of CPP of rooms A and B (mean Room A =  $9,1$  dB, mean Room B =  $9,2$  dB; repeated measures ANOVA,  $p = 0,736$ ). Concerning vocal effort, on the 100-mm VAS (0 being no vocal effort, and 100 being utmost vocal effort), the reported mean vocal effort in Room A was  $30,95$  whereas the mean vocal effort in Room B was  $44,85$ . This difference of  $13,09$  was statistically significant (Student Test,  $p < 0,001$ ). However, correlations of Pearson revealed that vocal effort and the acoustic measures of SPL,  $f_0$  and CPP were not statistically correlated ( $p > 0,05$ ).

### 4. DISCUSSION

The main goal of this study was to explore the influence of the visual design of environments on the speech production and the speech perception of female francophone speakers. As stated, our participants did perceive the two rooms, Room A (clutter-free) and Room B (cluttered) in a different manner based on the six visual clutter related qualities. However, our participants did not speak differently in terms of SPL

(dB),  $f_0$  (Hz) and CPP (dB) in Room A and Room B. Participants did report higher self-perceived vocal effort levels in Room B (cluttered) vs Room A (clutter-free). Finally, in our study, acoustic parameters of SPL,  $f_0$  and CPP did not serve as acoustical correlates of vocal effort.

### 5. CONCLUSION

While visual clutter did not impact the objective acoustic parameters of SPL,  $f_0$  and CPP during speech production, the visual design of a room did affect the perception of vocal effort in female francophone speakers. Our results bring forth that speaking in a cluttered room could lead to higher self-reported vocal effort levels. These results highlight the importance of subjective self-ratings when studying vocal effort and suggest that environmental design could impact speech perception through visual clutter.

### 6. REFERENCES

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