Subjective evaluation of floor impact sounds in lightweight buildings

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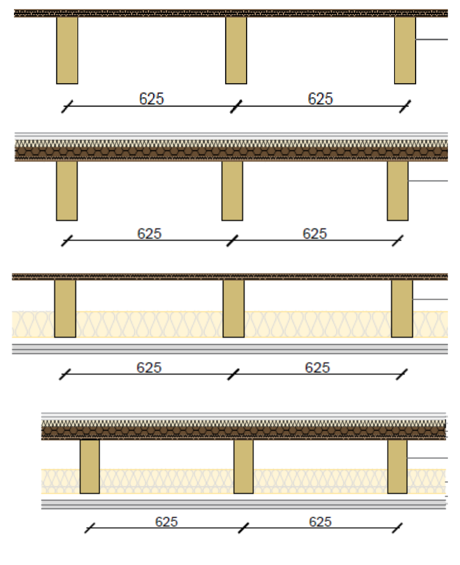
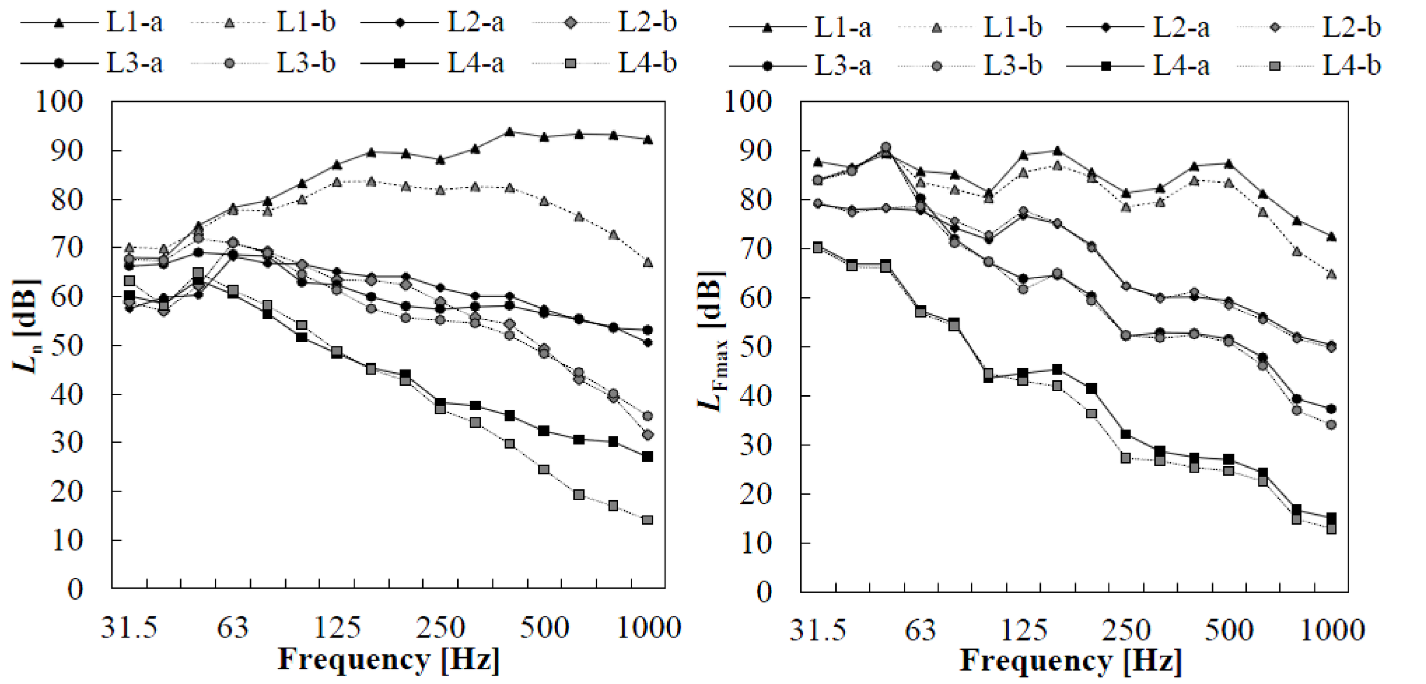
Correlation between standardised and real impact sources

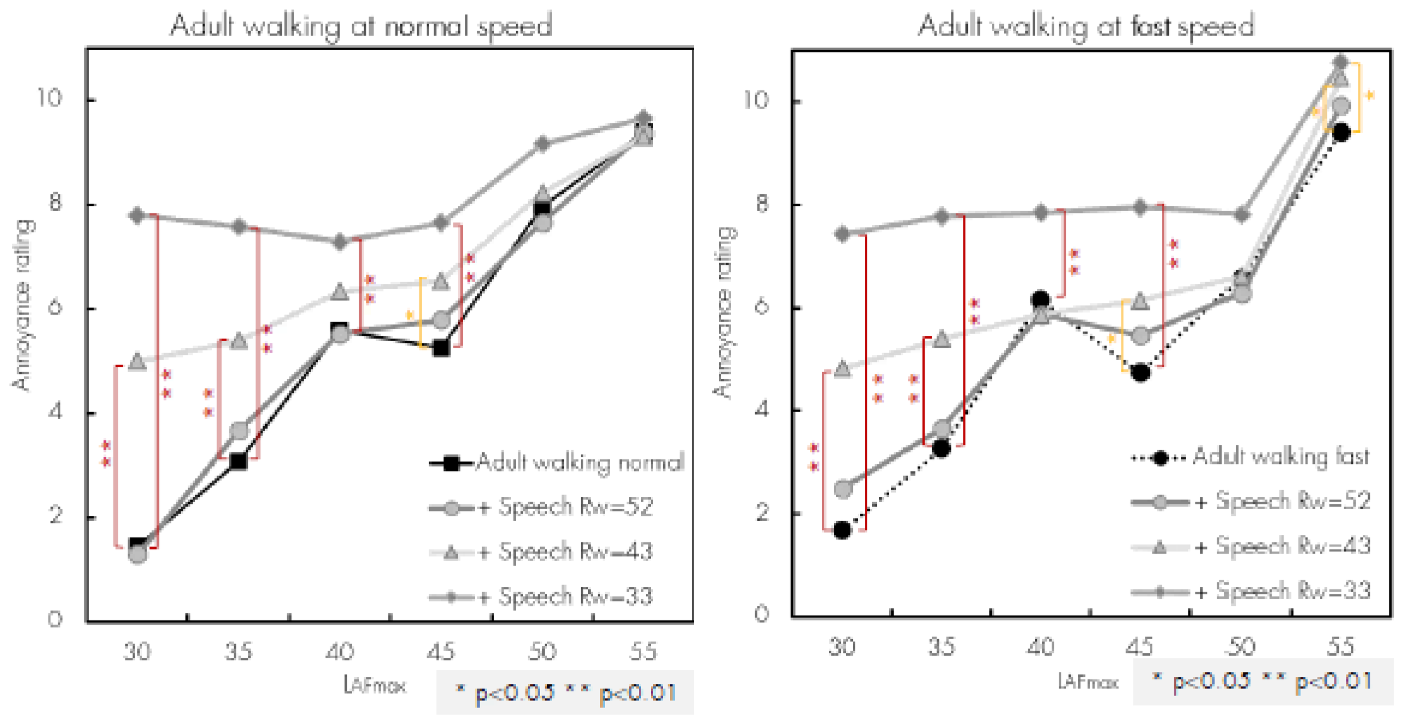




- The frequency characteristics of the tapping machine and the impact ball showed similar correlation coefficients with real impact sources between 50 Hz and 1000 Hz for floor structures with floating floors and/or suspended ceilings;
- For the floor structures with floating floors or suspended ceilings, the variations of the SNQs for the tapping machine and the impact ball were similar. All the standardised SNQs for the tapping machine and the impact ball were significantly correlated with the noise ratings of the real impact sources;
- The variations walking speed and footwear had little impact on the correlations between the SNQs and the noise ratings. All the real impact sources (dropping of a water bottle, of wooden toys and of a sand bag) showed significant correlation coefficients between the SNQs and the noise ratings for both the tapping machine and the impact ball.

Annoyance from single and combined sound sources

- The annoyance ratings of the single footsteps sounds were different from those of the floor impact sounds combined with an airborne source (i.e. speech);
- The annoyance ratings of the combined sound sources were influenced by the sound insulation performances of the wall and floor, when a poor performing slab is installed the sound insulation characteristics of the vertical partitions have a minor consequence on annoyance ratings; when impact sound insulation of ceiling is good the effect of the performances of vertical partitions on annoyance ratings is greater;

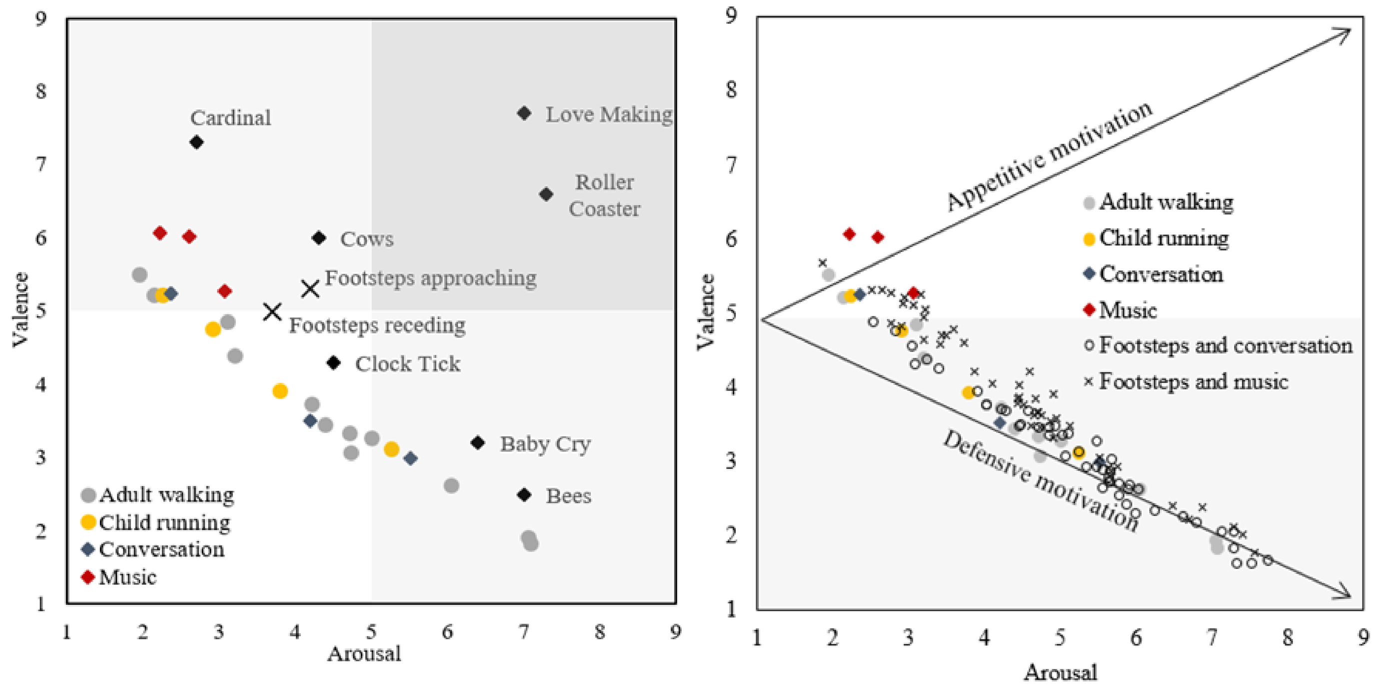


- Several total annoyance models were tested and the Mixed model showed the best goodness of fit.

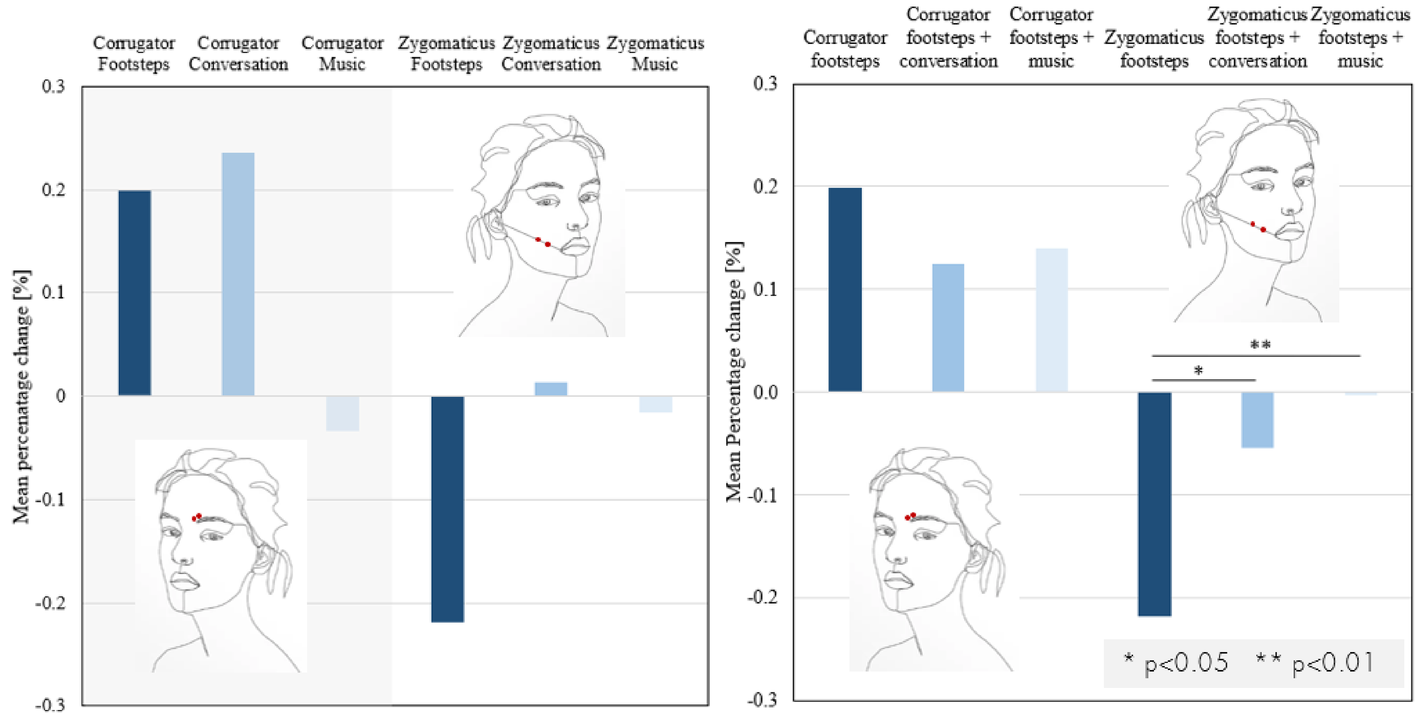
	Model	Regression Equation	R	R^2 *(adjusted)*	Std. Err.
Physical Models	Energy Summation (Taylor, 1982)	$A_T = 0.204L_T - 2.192$	0.607	0.368 *(0.362)*	1.652
	Energy Difference (Taylor, 1982)	$A_T = 0.215L_T - 0.02\left\|L_{impact} - L_{airborne}\right\| - 2.438$	0.610	0.372 *(0.365)*	1.647
	Independent Effect (Taylor 1982)	$A_T = 0.173L_{impact} + 0.067L_{airborne} - 2.471$	0.642	0.412 *(0.406)*	1.594
	Energy Equivalent (K=17) (Vos, 1992)	$A_T = 0.23L_T - 2.87$	0.743	0.551 *(0.547)*	1.392
Perceptual Models	Dominance (Berglund et al., 1981)	$A_T = 0.89Max(A_{impact}, A_{airborne}) + 0.91$	0.848	0.718 *(0.715)*	1.103
	Linear Regression (Botteldooren et al., 2002)	$A_T = 0.69A_{impact} + 0.48A_{airborne} + 0.69$	0.858	0.736 *(0.733)*	1.068
	Vector summation (α=96) (Berglund et al., 1981)	$A_T = 0.14\sqrt{(A_{impact}{}^2 + A_{airborne}{}^2 + 2A_{impact}A_{airborne}\cos\alpha)} + 2.93$	0.864	0.746 *(0.744)*	1.047
	Mixed (Perrette et al., 2012)	$A_T = 0.57A_{impact} + 0.58A_{airborne} + 0.23\left\|A_{impact} - A_{airborne}\right\| + 0.34$	0.872	0.760 *(0.758)*	1.017

Emotional reaction to neighbour sounds

- Listening to footsteps and conversation caused an increase in arousal and a decrease in valence as the sound pressure level increased;
- Neighbour sounds activated the defensive motivational circuit underlying emotional expression mediating reactions to threat;

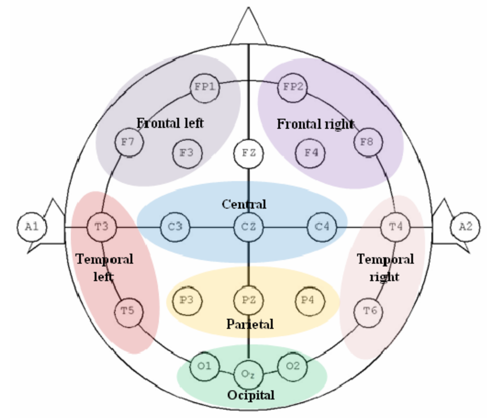


- differences in affective ratings between the high and low noise sensitivity groups were statistically significant when the participants were exposed to the footstep sound transmitted through a poor performing floor (i.e., 50-55 dB in terms of L_{AFmax});
- The activities in the Corrugator Supercilii muscle group the Zygomaticus Major Muscle group increased and decreased, respectively after the exposures to impact and airborne sources from neighbours.



Ongoing studies

- Examination of EEG response in reaction to neighbours sounds



The design of a further study in collaboration with FILK (Fire Insures Laboratories of Korea) examining electroencephalogram (EEG) responses to the stimuli used in the present research is ongoing. An advanced brain monitoring system B-alert X24 will be adopted to deepen the understanding of how sound produced by neighbours affect brain waves patterns.

- Effect of movement from real impact source

The design of a further study in collaboration with AIST (National Institute of Advanced Industrial Science and Technology) examining the effect of movement from real impact sources on psycho-physiological responses is ongoing. A series of spatial recording of footsteps have been carried out in a laboratory equipped with a timber joists slab attempting differentiation of clips in terms of spatial characteristics such as IACC.

Acknowledgements

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ACOUTECT