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Self-Reported Noise Sensitivity and Perceived Enjoyment of Working in an Open Office Environment

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ABSTRACT

Individuals may vary in their sensitivity to noise and this may affect how they relate to their surroundings. As part of an intervention project about the psychosocial effects of informational sound masking, we examined the occurrence of self-labeled noise sensitive individuals as well as the association between three indicators of noise sensitivity and one indicator for the perceived enjoyment of working in an open office environment. We also examined how the indicators of noise sensitivity correlated with age, gender and ratings of behavioural and architectural countermeasures, and the perceived impact of the sound environment on work tasks. Sixty-eight individuals (32 women, 35 men, and 1 undisclosed) between 24 and 64 years of age participated by responding to an online questionnaire at baseline in March 2023. The results showed that 47% labeled themselves as at least being somewhat sensitive to sounds, while 53% stated that they were not especially, or not at all, sensitive to sounds. Furthermore, 57% reported that they much, or to a high degree, enjoyed working in an open office environment, whereas 43% reported that they did not, or only to some extent enjoyed this. Spearman rank order correlations indicated that individuals who labeled themselves as noise sensitive, or reported having a propensity to react very strongly to sounds, were more likely to report a lesser enjoyment of working in an open office environment. In addition, they were also more likely to rate that the sound environment negatively influenced their ability to concentrate and to perform at work. Accordingly, individual variations in sound sensitivity is one factor to consider when designing and operating open office environments; and may also be a factor that impacts the possibility to recruit individuals to employments in open office environments.

Keywords: Job satisfaction, Occupation, Office space, Stress, Sound

INTRODUCTION

It is known that most individuals are sensitive to sounds at levels that are well below what normally is considered hazardous for auditory and non-auditory health effects. It is also known that individual variations in the sensitivity to sounds may be caused by and/or associated with for example hearing loss,

disease, stress, and/or reflect variations in preferences in normally healthy individuals. While the concept of noise sensitivity is established within noise research, there is no gold standard or strong consensus on how to assess noise sensitivity and whether noise sensitivity best is treated as a predictor, mediator/moderator or even an outcome variable (Smith, 2003; Welch et al., 2022). Nonetheless, some individuals seem to have a tendency to express critical or negative judgment and to consistently rate environmental stimuli in more positive or more negative ways (Weinstein, 1980). Also, epidemiological studies have shown that self-declared noise sensitivity tends to co-occur with other environmental sensitivities (Baliatsas et al., 2016). It has also been argued that the effects of noise sensitivity on health outcomes largely is accounted for by the broad personality dimension negative affectivity or neuroticism (Smith et al., 2002). However, Shepherd and colleagues, who examined the so-called negative affect hypothesis of noise sensitivity, could not find support for the idea that negative affectivity should cause or explain noise sensitivity (Shepherd, Heinonen-Guzejev, Heikkilä, et al., 2015). In another study by Sheperd and colleagues they concluded that the relationship between personality traits, as assessed with the comprehensive 240-item NEO PI-R (Costa & McCrae, 1992) and noise sensitivity as assessed with the 35-item noise sensitivity questionnaire (NOISEQ) (Schutte et al., 2007), was complex and that extroversion appears to be more strongly associated with noise sensitivity than neuroticism (Shepherd, Heinonen-Guzejev, Hautus, et al., 2015). In addition, and in an attempt to understand the phenomenon, noise sensitivity has also been proposed to be regarded as something more than a mere psychological trait; namely, the result of a series of variables and processes that combine to produce it (Welch et al., 2022).

Despite the challenges of defining and understanding noise sensitivity, asking an individual about the extent to which the individual is sensitive to noise could yield information on how the individual usually judges and relates to sounds. As such, and irrespective etiology, it seems reasonable to regard noise sensitivity as an individual characteristic and to treat it as a separate concept with the potential to be useful for guiding preventive actions.

One occupational setting in which sound levels often are modest, and in which individual variations in sound sensitivity can be potentially problematic, is work in open office environments. The Swedish Work Environment Authority has estimated that circa 60% of the workforce in Sweden work in offices and of which 70% share offices or work in open office environments (Swedish Work Environment Authority, 2018). The popularity of open office environments is based on the belief that they economize the use of office space and facilitate social interactions at work. Yet, empirical studies have shown that employees in open office environments may experience adverse effects such as lower job satisfaction, stress reactions, and exhibit poorer performance (Danielsson & Bodin, 2008; Engelen et al., 2019; Felipe Contin de Oliveira et al., 2023; Richardson et al., 2017). Noticeably, human speech from other office occupants and/or visitors stands out as an important contributor to such adverse effects (Appel-Meulenbroek et al., 2011; Felipe Contin de Oliveira et al., 2023; Schlittmeier & Liebl, 2015), and in a recent review, irrelevant speech, laughter, conversation, and telephone ringing

were identified as the main sources of disturbance, whereas sound absorbing surfaces, noise reduction partitions, sound masking systems, alternative workspaces and individual headphones were the most commonly proposed interventions (Felipe Contin de Oliveira et al., 2023).

In this paper, as part of an intervention project about the psychosocial effects of informational sound masking, we decided to examine the occurrence of self-labeled noise sensitive individuals as well as the association between three indicators of noise sensitivity and one indicator for the perceived enjoyment of working in an open office environment. We also examined how the three indicators of noise sensitivity correlated with age, gender, and ratings of behavioural and architectural countermeasures, and the perceived impact of the sound environment on work tasks.

METHODS

Study Design

The present paper reports on a cross-sectional analysis of baseline data that were obtained in March 2023 within a longitudinal intervention project on the use of informational sound masking in open office environments. The project was funded by AFA Försäkring (dnr 190273) and was approved by the Swedish Ethical Review Authority (2022-02565-01).

Participants

Sixty-eight participants (32 women, 35 men, and 1 undisclosed) were included, corresponding to a response rate of 69% (98 individuals were originally invited). The participants worked on floors two to four in a five-floor office building and were between 24 to 66 years of age (Mean age =38.9 years; SD 10.2 years). Circa 43% reported that their health was very good, 44% good, 9% neither good nor bad, and 4% somewhat poor and 0% poor. Two participants (3%) reported using hearing aids. Access to the participants was granted via an external partner that identified a suitable building and contact persons at various divisions at the company that used the building.

Office Environments

The three office environments had a highly similar physical architecture and acoustical conditions and were situated on floors two to four in a five-floor office building in Sweden's third largest city. The A-weighted sound levels varied between 21.0 dBA and 26.5 dBA in the empty offices. This was determined by using two measurement positions on each floor, and the measurements were made outside office hours in March 2023 and lasted 10 seconds.

Assessment of Noise Sensitivity

Noise sensitivity was assessed with three single items that aimed to capture various aspects of noise sensitivity in terms of (a) identifying oneself as being a noise sensitive person, (b) judging oneself to have the propensity to react strongly to sounds, and (c) the self-rated ability to habituate to sounds.

The self-labeling item (a) was partly modelled after previous research (Persson et al., 2007) and read "*Do you perceive that you are sensitive to sounds*?" and was responded to on a four-point scale: 1 = Not at all sensitive, 2 = Not especially sensitive, 3 = Fairly sensitive, and 4 = Very sensitive.

The propensity to react-item (b) read "*Sound can make me very irritated*" whereas the ability to habituate to sounds-item (c) read "*I get used to most types of sounds quite easily*". Both item b and c were tailored for this study and were responded to on a five-step scale indicating the degree of agreement: 1 = Applies very poorly, 2 = Applies poorly, 3 = Applies to some extent, 4 = Applies well, and 5 = Applies very well.

Assessment of Enjoyment of Working in Open Office Environments

The enjoyment of working in an open office environment was assessed with one item that read "*Do you enjoy working in an open office environment?*" and was responded to on a four-step scale indicating the degree of agreement: 1 = No, not at all; 2 = Yes, to some extent; 3 = Yes, to a high extent; 4 = Yes, to a very high extent.

Assessment of Behavioural and Architectural Countermeasures for Unwanted Sounds

The assessment of behavioral countermeasures focused on the use of protective hearing devices and was assessed with one item that read "*In your work, do you use protective devices to protect yourself from unwanted sounds (e.g., ear protectors, earplugs, listen to music etcetera)"* that was responded to on a five-point scale: 1 = Rarely/almost never, 2 = Seldom, 3 = Sometimes, 4 = Often, 5 = Always.

The architectural countermeasures focused on whether the participants had a possibility to avoid noise generated from colleagues and was assessed with one item that read "*How well can you shield yourself in terms of sound from conversations and telephone calls in the workplace?*" that was responded to on a five-point scale that only had verbal anchors at the end-points: 1 = Badly, and 5 = Adequately.

Assessment of the Perceived Impact of the Sound Environment on Ones Work Tasks

The perceived impact of the sound environment on the participants ability to do their work was assessed with two items.

The first item read "*How does the sound environment at your workplace affect your ability to carry out your work tasks?"* and was responded to on a five-step scale of estimated impact: 1 = Makes work much more easy, 2 = Makes work more easy, 3 = Doesn't affect at all, 4 = Makes work more difficult, 5 = Makes work much more difficult.

The second item read "*Does it happen that the sound environment at your workplace makes it difficult for you to concentrate on your work tasks?"* and was responded to on a five-step scale of frequency: 1 = No, virtually never, 2 = A couple of times a month, 3 = One or a few times per week, 4 = Once or a couple of times daily, 5 = Once an hour or more often.

Statistical Analysis

Two-tailed P-values ≤ 0.05 were considered statistically significant. Using the IBM SPSS software version 29, and following a descriptive and explanatory modelling approach (Shmueli, 2010), we applied descriptive analyses and traditional methods for non-parametric testing. Spearman rank order correlations were used to estimate the strength of association between continuous variables. Mann-Whitney u-tests were used to test for differences in the distributions of test scores between men and women.

RESULTS

Descriptive data depicting central tendencies and dispersion of scores for the continuous variables are presented in Table 1. Spearman rank order correlations between the continuous variables are presented in Table 2.

Table 1. Descriptive measures of central tendency (mean [M] and median scores) and dispersion (standard deviation [SD] and the first and third quartile [Q1 and Q3]) for the continuous study variables in the total study sample (N = 68).

Variables (score range)	Total study sample (N = 68)				
	M	SD	Median	Q1	Q3
Age (years)	38.9	10.2	36.0	30.0	47.0
Noise sensitivity (1–4)	2.5	0.8	2.0	2.0	3.0
Sound irritation (1–5)	3.1	1.1	3.0	2.0	4.0
Habituation to sound (1–5)	3.2	0.9	3.0	3.0	4.0
Use of protective devices (1–5)	3.3	1.2	4.0	2.5	4.0
Possibility to avoid sounds at work (1–5)	2.8	1.2	3.0	2.0	4.0
Sound environment makes work difficult (1–5)	3.6	0.8	4.0	3.0	4.0
Sound environment impact on concentration (1–5)	2.9	1.0	3.0	2.0	4.0
Enjoyment of working in open office environment (1–4)	2.6	0.8	3.0	2.0	3.0

Enjoyment of Working in an Open Office Environment

Regarding the proportional distribution of enjoyment of working in an open office environment scores, we observed that 7% reported that they did not enjoy working in an open office environment (Women: 6.3%; Men: 8.6%); 35% reported that they to some extent enjoyed working in an open office environment (Women: 34.4%; Men: 34.3% [one person did not disclose gender]); 44% reported that they much enjoyed working in an office environment (Women: 50.0%; Men: 40.0%), and 13% reported that they to a high degree enjoyed working in an open office environment (Women: 9.4%; Men: 17.1%).

Table 2. Spearman rank order correlations between the continuous study variables in the total study sample (N = 68).

Variable (score range)	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
1. Age (years)	1								
2. Noise sensitivity (1–4)	−.14	1							
3. Sound irritation (1–5)	−.12	.62**	1						
4. Habituation to sound (1–5)	.09	−.61**	-.60**	1					
5. Use of protective devices (1–5)	−.35**	.39**	.23	−.23	1				
6. Possibility to avoid sounds at work (1–5)	−.07	−.13	−.14	.05	−.02	1			
7. Sound environment makes work difficult (1–5)	−.01	.37**	.37**	−.32**	.30*	−.23	1		
8. Sound environment impact on concentration (1–5)	−.10	.42**	.47**	−.40**	.36**	.10	.58**	1	
9. Enjoyment of working in open office environment (1–4)	−.18	−.40**	−.36**	.14	−.18	.27*	−.33**	−.30*	1

*P < 0.05 (2-tailed).
**P < 0.01 (2-tailed).

Noise Sensitivity

Regarding the proportional distribution of the self-labeled noise sensitivity scores, we observed that 10% of the participants reported being highly sensitive to sounds (Women: 15.6%; Men: 5.7%), 37% reported being somewhat sensitive to sounds (Women: 34.4%; Men: 37.1%), 46% stated that they were not especially sensitive for sounds (Women: 46.9%; Men: 45.7%), and 7% reported that they were not at all sensitive to sounds (Women: 3.1%; Men: 11.4%).

Regarding the proportional distribution of noise sensitivity scores as determined by the statement "*Sound can make me very irritated*", we observed that 12% of the participants thought that it applies very well (Women: 18.8%; Men: 5.7%), 21% that it applies well (Women: 25%; Men: 14.3%), and 38% stated it applies to some extent (Women: 34.4%; Men: 42.9%), and 25% reported that it applies poorly (Women: 21.9%; Men: 28.6%) and 4% thought it applies very poorly (Women: 0%; Men: 8.6%).

Regarding the proportional distribution of noise sensitivity scores as determined by the statement "*I get used to most types of sounds quite easily*" the results showed that 6% of the participants thought that it applies very well (Women: 0%; Men: 11.4%), 27% that it applies well (Women: 34.4 %; Men: 20.0%), and 50% stated it applies to some extent (Women: 46.9%; Men: 51.4%), and 13% reported that it applies poorly (Women: 15.6%; Men: 11.4%) and 4% thought it applies very poorly (Women: 3.1%; Men: 5.7%).

Comparisons Between Noise Sensitive Individuals Versus Non Noise Sensitive Individuals

Mann-Whitney U-tests were run to examine whether the distribution of scores differed between the groups of individuals who labeled them self as being noise sensitive versus individuals who did not view themselves as sensitive to noise (Table 3).

Table 3. Group comparisons between the continuous study variables in the total study sample and subgroups of self-labeled noise sensitive individuals (N = 68).

Variables (score range)	Non noise sensitive individuals (N = 36)			Noise sensitive individuals (N = 32)			Mann-Whitney U-test
	Median	Q1	Q3	Median	Q1	Q3	P-Value
Age (years)	38.0	30.5	48.5	35.0	30.0	45.5	.442
Noise sensitivity (1-4)	2.0	2.0	2.0	3.0	3.0	3.0	<.001
Sound irritation (1-5)	2.5	2.0	3.0	4.0	3.0	4.5	<.001
Habituation to sound (1-5)	4.0	3.0	4.0	3.0	2.0	3.0	<.001
Use of protective devices (1-5)	3.0	2.0	4.0	4.0	3.0	4.0	.003
Possibility to avoid sounds at work (1-5)	3.0	2.0	4.0	3.0	1.0	3.0	.107
Sound environment makes work difficult (1-5)	3.0	3.0	4.0	4.0	4.0	4.0	<.001
Sound environment impact on concentration (1-5)	2.0	2.0	3.0	3.0	3.0	4.0	<.001
Enjoyment of working in open office environment (1-4)	3.0	3.0	3.0	2.0	2.0	3.0	<.001

Mann-Whitney U-tests were also run to examine whether the distribution of scores differed between men and women. Only the distribution of sound irritation scores differed between men and women ($p = 0.026$; data not shown).

DISCUSSION

In the present study we examined to what extent noise sensitivity as assessed with three single-item indicators were associated with the enjoyment of working in an open office environment and with variables such as age, gender, behavioural and architectural countermeasures as well as the perceived impact of the sound environment on work tasks.

Using the self-labeling item for noise sensitivity, we observed that 47% of the participants identified themselves as being at least somewhat noise sensitive, which is higher than the 39% observed in a Swedish population sample (N > 2.800) that used a highly similar question with the identical response alternatives and cut-off values (Persson et al., 2007).

While 57% of the participants reported that they much, or to a high degree, enjoyed working in an open office environment, the moderate negative association between enjoying work in an open office environment and noise sensitivity scores as assessed with the self-labeling item and the propensity to react-item suggest that the perceived enjoyment of working in an open office in part is contingent on individual variations in sensitivity to sounds. As such, the present results are in line with previous literature on the topic that have reported on associations between self-labeled noise sensitivity and general job satisfaction (Lee et al., 2016). Interestingly, the correlation table also disclosed that participants who reported that they enjoyed working in an open office environment also tended to report that the sound environment

made their work easier and that they experienced less frequent interruptions of concentration at work.

The median score suggests that a large segment of the noise sensitive group experiences that the sound environment cause them to lose concentration at work at least one or a few times a week, whereas the median score of the non-noise sensitive group suggests that the sound environment makes them experience concentrations problems a couple of times a month. The correlation between noise sensitivity (as assessed with the self-labeling item and the propensity to react-item) and the perceived impact of the sound environment indicates that noise sensitive individuals experience that the sound environment makes work more difficult to perform and creates more interruptions in concentration during work. However, participants who expressed that they got used to sounds quite easily (i.e., habituated) exhibited the opposite correlation. Hence, individuals who habituate to sound easily tend to perceive the sound environment at work makes work easier and that they experience fewer episodes of interrupted concentration at work.

Observably, Shepherd et al., who examined the association between personality traits and noise sensitivity, argued that extra-psychological variables such as gender and age must be considered when examining the relationship between personality and noise sensitivity (Shepherd, Heinonen-Guzejev, Hautus et al., 2015). This appears reasonable as women are known to report more frequent and intense subjective health complaints than men (Barsky et al., 2001; Poulsen et al., 2013) and have been found to report a higher degree of noise sensitivity than men (Persson et al., 2007). Interestingly, however, in the present study age scores correlated only with the use of protective hearing devices, and the ratings of men and women differed only for their responses to the item that asked whether the respondent had a propensity to react very strongly to sounds. Specifically, these associations indicated that relatively older individuals used protective hearing devices to a lesser extent, and that women had a higher propensity to react more intensely to sounds.

Limitations and Contextual Circumstances

The open office environments that constitute the backdrop of the present study were very quiet when empty (21 dBA to 26.5 dBA). From other analyses on the same study sample we know that the primary source of disturbance were sounds from colleagues and that 87% had a good self-rated hearing ability (Stroh et al., 2024). In addition, only two individuals reported using hearing aids and 87% rated their health as good (44%) or very good (43%). Hence, the levels of self-rated health are higher than population estimates from the Public Health Agency of Sweden that reported that 79% of people in the ages 30–44 years, and 71% in the ages 45–64 years report good or very good health, respectively (Public Health Agency of Sweden, 2020). Consequently, both the office environments and the participants in the present study seem to be adequate and even at the better end of the spectrum. Thus, the reported noise sensitivity seems more likely to reflect normal variations among healthy individuals than substantial hearing disability or poor health.

CONCLUSION

Individuals who label themselves as noise sensitive, or report having a propensity to react very strongly to sounds, are more likely to report a lesser enjoyment of working in an open office environment. In addition, they are also more likely to rate that the sound environment negatively influences their ability to concentrate and to perform at work. Accordingly, individual variations in sound sensitivity is one factor to consider when designing and operating open office environments, and may also be a factor that impacts the possibility to recruit individuals to employments in open office environments.

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