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A PSYCHOLOGICAL APPROACH TO RESOLVING OFFICE NOISE

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Traditionally, control of noise in buildings falls into the domain of acousticians – experts concerned with the properties of sound. Although it is widely recognized that acoustics is an interdisciplinary science, many architectural acousticians have a physics or engineering background and their approach to mitigating noise is mostly, but not entirely, focused on physical solutions.
But the demands of 21st-century workplaces call for a more rounded approach, with experts working together to offer a combined psychological, physiological and physical solution to acoustic problems. This report therefore offers a fresh outlook to resolving noise distraction in the workplace based on a psychoacoustic, people-centered approach, focusing on perception, attitudes, mood, personality and behavior. The report is predominantly based on a literature review, with more emphasis on psychophysical research papers than pure acoustic ones.
The report is aimed at people who are interested in resolving noise issues in workplaces, particularly offices, including: acousticians, architects and interior designers, facilities managers, property developers, occupants and heads of business. It begins with a review of the theoretical aspects of noise, relating to acoustics, psychoacoustics and psychology, then discusses how this knowledge can be used to create people-centered work environments based around four key factors: task and work activity; context and attitude; perceived control and predictability; and personality and mood..

Keywords: Sound, People, Psychoacoustics, Office Environment

1. INTRODUCTION

In 2014, Ecophon and Workplace Unlimited conducted a literature review: Planning for Psychoacoustics: A Psychological Approach to Resolving Office Noise Distraction (Oseland and Hodsman, 2015). The focus of the study was how factors such as task and work activity; context and attitude; perceived control and predictability; and personality and mood impact the perception of noise and the effects of distractions from noise in the office. The review was well received and forms the basis of the acoustic chapter in the book *Ergonomic Design for Healthy and Productive Workplaces*.

The review resulted in a series of hypotheses that require testing:

1. Extroverted office workers can cope better with noisy environments whereas introverts will perform better under quieter conditions.
2. Co-locating introverts and separating them from extroverts will help manage noise distraction.
3. Co-locating teams will help manage noise distraction from meaningful speech.
4. Perceived control over noise will reduce the problem of poorer performance caused by noise distraction.
5. Offering choice over alternative work-settings in the office will reduce noise distraction and improve performance.
6. Occasional working from home reduces noise distraction and will improve performance.

7. Educating employees in how to behave in open-plan environments and introducing office etiquette around noise will reduce noise distraction.
8. Activity-based, acoustically sensitive designed spaces create better environments for both introverts and extroverts.
9. Applying a combined approach of worker psychology mapping and acoustic design will improve worker performance.

The next step was therefore to verify the hypotheses through the means of an on-line survey.

However, the primary objective of the survey was to test whether personality types, in particular extroversion, affect noise perception and distraction. This paper describes the main results and conclusions drawn from the survey.

2. METHODLOGY

2.1 Survey questions

The core methodology was a new on-line survey, designed jointly by Work*place* Unlimited and Ecophon, and hosted on Survey Monkey. The survey was developed to explore the relationship between noise distraction and key variables such as personality, work activities, primary workplace, acoustic design, the ability to screen noise and demographics. The survey included 100 questions distributed across seven sections/screens.

The first question included 44 sub-questions used to determine the respondents' personality profile on the Big Five Inventory (BFI) developed by the University of California Berkeley[4]. The BFI, also known as OCEAN, determines the strength of five personality factors: Openness (O), Conscientiousness (C), Extroversion (E), Agreeableness (A) and Neuroticism (N). The personality types are explained further in Appendix A of the full report[5].

The main noise questions or metrics (dependent variables) are:

1. Approximately how much is your **performance** at work increased or decreased by the noise levels in your primary workspace?
2. How do the noise levels in your primary workspace affect your **ability** to carry out work?
3. Do you believe that the noise levels in your primary workspace are affecting your … **well-being**? ... **stress** levels? ... **productivity**?
4. **Concentration** factor (mean of 7 questions)
5. **Talking** factor (mean of 6 questions)
6. **Distraction** factor (mean of 5 questions)

The other questions on noise distraction and other factors (independent variables) is to be found in the full survey that can be viewed at: www.surveymonkey.com/r/psychoacoustics.

2.2 Statistical Analysis & Survey Sample

The results presented in this report are all statistically significant ($p<0.05$), determined using the Statistics Package for Social Scientists (SPSS). The size of the effect when comparing groups (tests of difference) was measured by *eta2* and when comparing relationships (correlations) variance (*r2*) was used as the measure. In general, an *eta2* and *r2* of <0.1 is considered small, whereas 0.1-0.2 is medium and >0.2 is large.

Half (the majority) of responses came from the UK (50.2%), with a further 18.6% coming from the Netherlands. The sample included a range of occupations but there was a higher proportion of Architects, Designer and Engineers (17.4%) and consultants or advisors (16.1%). The sample also included 5.8% of Acousticians and 4.7% Project Managers, and Surveyors. So our sample is mostly from the construction industry and therefore probably more informed in acoustics matters.

2.3 Personality profiles

The primary objective of the survey was to test whether different personality types, in particular extroversion, affect noise perception and distraction. It is therefore important that the sample includes a range of personality types. Figure 2 shows that our sample is normally distributed across each of the Big Five (OCEAN) personality types; the mean ($\bar{x}$) rating and standard deviation (σ) are shown for each personality factor.

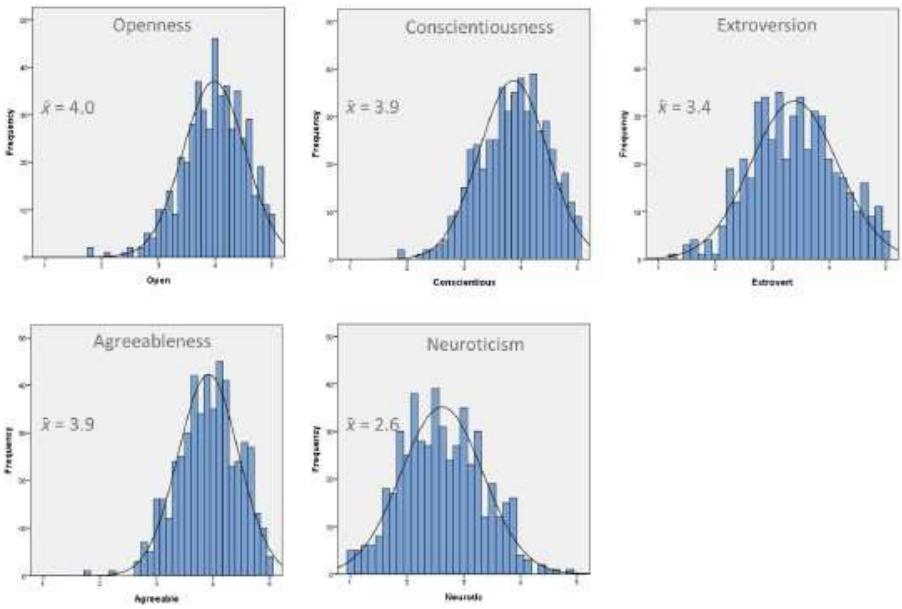

Figure 1 Distribution of scores on OCEAN personality types

3. Results

This is an excerpt of the report results (Oseland 2015), full results are available upon request.

3.1 Noise Metrics

When asked “Do you believe that the noise levels in your primary workspace are affecting your productivity?” one-quarter (26.1%) of all of our respondents replied “very much so” or “mostly”. A further one-third (36.4%) replied “a little” such that two-thirds of our respondents believe they are affected by office noise; see Figure 2.

Figure 2 Effect of noise on productivity

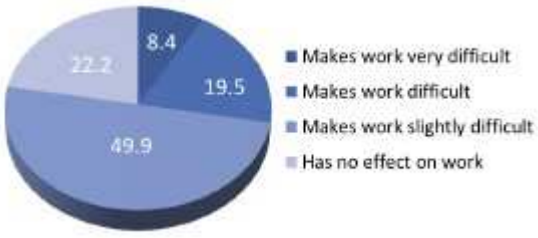

Figure 3 Effect of noise on ability to work

Similarly, when asked “How do the noise levels in your primary workspace affect your ability to work?” three-quarters (77.8%) of respondents reported that they are negatively affected by the noise in their workplace; see Figure 3. So it appears that, for our sample, noise in the workplace is indeed an issue and affects perceived performance.

The survey also included a series of questions asking how the workplace affected concentration and distraction, etc. Figure 4 shows that one-quarter (25.3%) of the respondents had problems concentrating often or all the time, which is significant. An even higher proportion (42.4%) of the sample found themselves listening into conversations. This is not necessarily a bad thing as conversations assist tacit knowledge and can help with reducing the time to complete work tasks. In contrast, conversations unrelated to the task in hand can be distracting.

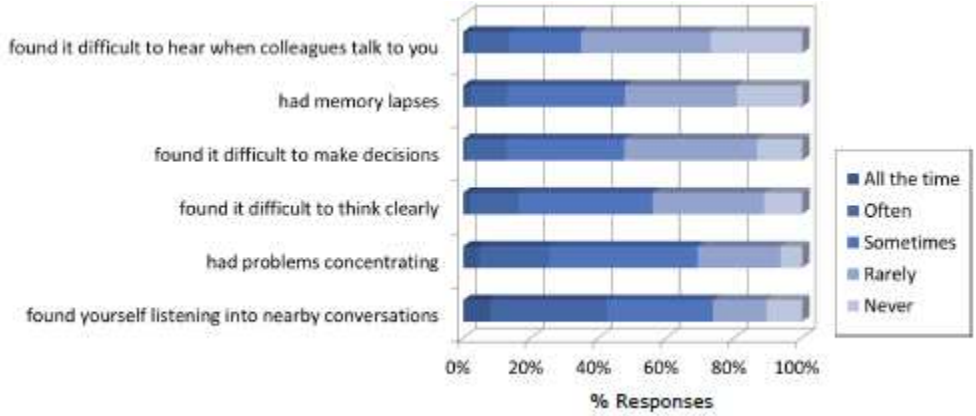

Figure 4 over the last working week in your primary workspace, have you …

We asked our survey participants what they were distracted by in their workplace. Figure 5 shows that one-third (33.0%) of our respondents are distracted (all the time or often) by nearby colleagues' conversations and one-quarter (26.6%) by nearby colleagues' telephone calls. So whilst eavesdropping on conversations maybe useful it appears to be distracting for a high proportion of our survey respondents. Furthermore, one-third (36.1%) said they are distracted by individuals with loud voices. It should be noted that all these distractions are fundamentally behavioral issues.

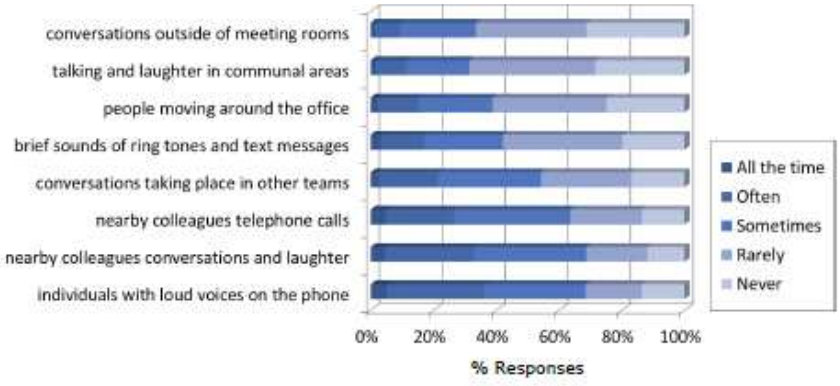

Figure 5 Over the last working week, to what extent have you been distracted by …

The survey included further questions about how noise distraction affects work activities; see Figure 6. Over one-quarter (28.4%) of respondents said they are interrupted mid-way through completing an important task often or all of the time. One-fifth (22.2%) said they stay late or arrive early (all the time or often) to avoid noise and distractions. In contrast, fewer of our respondents miss a deadline due to noise distraction. Perhaps they are adapting to the noise in their workspace or they work extra hours to compensate for any lost productivity as work tasks need to be completed regardless of distractions.

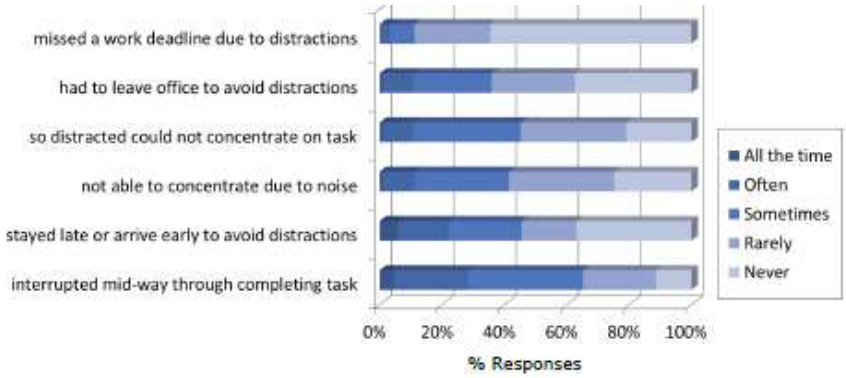

Figure 6 Over the last working week to what extent have you …

We asked our survey respondents to estimate approximately how much their performance at work is in-

creased or decreased by the noise levels in their primary workspace. We converted the percentage responses on the 9-point scale into a negative, zero and positive effect. Figure 7 shows that two-thirds (64.9%) of our respondents believe that the noise level in their workplace is having a negative effect on their performance, and more importantly only 10.1% say it has a positive effect, which is very poor. In comparison, one-half (50.2%) of respondents reported that the overall workplace has a negative effect, therefore noise is a greater concern.

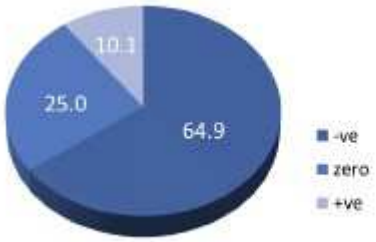

Figure 7 How much is performance affected by noise levels

Using the same question, the mean estimated impact of noise on work performance is a -5.1% decrease in productivity. Whilst this figure appears low it should be noted that just a 5% increase in employee performance can off-set the cost of building and operating an office property. The mean overall effect of the workplace on performance is -3.2%, and if that is considered the benchmark (norm) then it might be argued that noise has a -1.9% effect, which is similar to the -1.7% previously predicted by Oseland and Burton[6].

3.2 Primary and most effective workspace

The respondents were asked to identify their primary place of work. Over one-half (53.9%) primarily work at an open-plan desk, with one-third (36.6%) at a fixed desk and 17.3% working at a hot/flexi desk. One-quarter of the sample worked in a private or shared enclosed office, which seems high but may reflect the respondents outside of the UK. A further 17.8% of respondents worked mainly from home but few (1.3%) use a co-working hub as their main workspace. Other than co-working there is a good range of primary workspaces to allow further analysis. For simplicity, the seven sub-groups were recoded as three: desk, office and home.

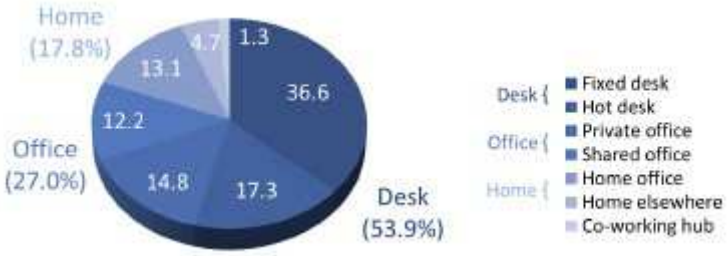

Figure 8 Reported primary place of work.

The survey also requested that respondents select the two most effective spaces for carrying out various work activities. The respondents were asked where they are most creative and have their best ideas and where they are most effective at conducting work requiring concentration etc. Table 2 shows the results with the frequency of responses above 30% shown in and orange above 40% shown in red.

Work Activity	Desk in Office	Home Working	Private Office	Meeting Room	Informal or Breakout	Café, Bar or Restaurant	Outside in Park etc	Leisure or Sport	Co-work Hub
Most creative and best ideas	18.6	45.7	8.9	5.8	25.8	10.5	22.7	6.0	4.8
Most effective at work requiring concentration	31.8	55.7	39.3	7.8	1.4	2.3	2.1	0.0	2.1
Most effective team-working environment	22.1	3.6	6.2	33.0	48.4	6.2	1.9	0.2	15.5
Most conducive space for meeting colleagues	11.0	2.4	3.3	32.8	55.0	24.0	4.8	0.6	9.1
Most effective space for telephone calls	25.8	48.4	51.6	13.6	4.5	0.6	5.8	0.0	0.8
Most productive place overall	42.6	52.3	22.9	6.2	8.1	2.7	2.5	0.2	3.5

Table 1 Percentage of selected preferred workspace for different activities

The above table reveals that the home in particular, but also informal/breakout space and outside areas, are most effective for creative work rather than traditional work environments. As expected, the home is the most popular setting selected for work requiring concentration. Surprisingly it is also one of the preferred spaces for telephone calls, perhaps due to late or early overseas teleconferences or making confidential calls. Meeting rooms and informal/breakout spaces are considered effective for team-working and meeting colleagues, two major components of productive working that are better supported by the traditional office.

Interestingly, whilst private/shared offices were selected for concentration and telephone calls very few found them effective for creativity, team-working and meeting colleagues. In terms of overall productivity, the most popular space selected was the home, followed by the open-plan desk then followed by the office. So, depending on the nature of work, neither private/shared offices nor homes are the panacea for working environments. The results presented here are similar to our previous study of collaboration spaces[7].

3.3 Workspace and personality

Table 1 showed that the most effective spaces depend upon the work activity. Table 3 also shows that some of the preferred workspaces vary by personality type (indicated using the OCEAN abbreviations). Note the red letter indicates a negative effect on the personality scale, so for example an E indicates introversion. Only statistically significant differences ($p<0.01$) are reported in the table.

The table reveals some interesting results. Firstly, despite being susceptible to noise, introverts find their open-plan desk more effective than extroverts (E) for carrying out work requiring concentration. It may be that having a good computer, connectivity and access to data overrides any noise issues, which are tolerated or learned to cope with. On the other hand, extroverts rather than introverts find the open-plan desk more effective for team work. Those more extroverted also find meeting rooms and breakout spaces more productive than their introverted colleagues. So, as previously suggested in our literature review, the spaces provided should reflect the make-up of personality types.

Work Activity	Desk in Office	Home-office	Home elsewhere	Private Office	Meeting Room	Informal or Breakout	Café, Bar or Restaurant	Outside in Park etc	Leisure or Sport	Co-work Hub
Most creative and best ideas	O				C	A		O		
Most effective at work requiring concentration	E						O			
Most effective team-working environment	E		C, A	C	N					
Most conducive space for meeting colleagues	N	A		N						
Most effective space for telephone calls										
Most productive place overall			A		E	E, A				

Table 3 Preferred workspaces for different personality types

Those more open (O) minded find outside more effective for creativity whereas those less open to new ideas prefer their open-plan desk. Those more open also find café, bars and restaurants more effective for work requiring concentration – possibly spaces that help avoid being disturbed by colleagues. Respondents who were more agreeable (A) found breakout space more effective for creativity and productivity. The less agreeable do not highly rate the home for team-working or productivity.

Unexpectedly, those less conscientious (C) volunteered they find working at home or in a private office effective for team-working. However, the more conscientious find meeting rooms more effective for creativity than the less conscientious. Those more emotionally stable find their open-plan desk is effective for meeting colleagues, whereas in contrast, the more neurotic (N) prefer meeting a private office.

3.3.1 Noise and personality types

The table overleaf shows the ratings of noise distraction on a 1 to 5 point scale (where 1 = “never” i.e. good and 5 = “all the time” i.e. poor) in response to the various questions on noise distraction. Table 3 also shows the estimated percentage of performance affected by noise and ability to work on a 1 to 5 point scale (where 1 = “makes work impossible” i.e. poor and 5 = “has no effect” i.e. good).

The table shows that the more introverted (i.e. less extroverted) respondents are more affected by noise than the extroverts. The estimated impact on performance of introverts is more negative than extroverts, and stress well-being, concentration and productivity are all rated more poorly. Unexpectedly there is no significant effect on talking, distraction or the ability to carry out work. Noise is clearly a complicated subject producing some results that don't always match our predictions. In this case it appears that the distraction from colleagues talking and other factors is not the main source of difference between introverts and extroverts, but nevertheless the concentration and performance of introverts is affected.

The largest effect on the noise distraction variables is for neuroticism. The more emotionally stable (less neurotic) respondents are less affected by noise; their ability to carry out work is less affected and the largest effect size is found for concentration. Similarly, the less conscientious are more affected by noise than their conscientious colleagues. In particular, performance, ability to carry out work, productivity, concentration and well-being are negatively affected. These effects are all statistically significant but the size of effect is relatively small.

Noise perception metric	Open (L, M, H)	Conscientious (L, M, H)	Extroversion (L, M, H)	Agreeable (L, M, H)	Neurotic (L, M, H)
Percentage performance (%)	N/S	-7.2, -4.7, -4.6 (p<0.05, F=4.4, eta^2=0.02)	-8.5, -4.3, -5.5 (p<0.01, F=7.4, eta^2=0.03)	N/S	N/S
Ability to carry out work (5 = ✓)	N/S	3.6, 3.9, 3.8 (p<0.01, F=4.8, eta^2=0.02)	N/S	N/S	4.1, 3.8, 3.7 (p<0.01, F=5.3, eta^2=0.02)
Wellbeing (1 = ✓)	N/S	2.5, 2.1, 2.2 (p<0.05, F=3.7, eta^2=0.02)	2.5, 2.1, 2.2 (p<0.05, F=3.6, eta^2=0.02)	N/S	1.9, 2.2, 2.3 (p<0.05, F=4.0, eta^2=0.02)
Stress (1 = ✓)	N/S	N/S	2.8, 2.5, 2.5 (p<0.05, F=3.7, eta^2=0.02)	2.8, 2.5, 2.2 (p<0.05, F=5.1, eta^2=0.02)	2.1, 2.6, 2.7 (p<0.001, F=8.5, eta^2=0.04)
Productivity (1 = ✓)	N/S	3.1, 2.8, 2.7 (p<0.05, F=4.4, eta^2=0.01)	3.1, 2.7, 3.0 (p<0.05, F=3.9, eta^2=0.02)	N/S	2.5, 2.9, 3.0 (p<0.05, F=4.1, eta^2=0.02)
Concentration factor (1 = ✓)	N/S	2.9, 2.5, 2.5 (p<0.001, F=9.9, eta^2=0.04)	2.8, 2.5, 2.5 (p<0.01, F=5.1, eta^2=0.02)	2.7, 2.5, 2.3 (p<0.01, F=5.0, eta^2=0.02)	2.2, 2.5, 2.9 (p<0.001, F=20.6, eta^2=0.08)
Talking factor (1 = ✓)	N/S	N/S	N/S	2.8, 2.8, 2.5 (p<0.05, F=4.1, eta^2=0.02)	2.6, 2.8, 2.9 (p<0.05, F=3.5, eta^2=0.02)
Distraction factor (1 = ✓)	N/S	2.4, 2.1, 2.3 (p<0.01, F=5.0, eta^2=0.02)	N/S	N/S	N/S

Table 3 Noise metrics by personality types

The table also shows that there are some small effects for the agreeableness but no significant (N/S) effects for openness.

Looking in detail at the individual questions that make up the three noise factors at the bottom of the table, we found that the more neurotic (p<0.01, F=4.9, *eta2*=0.02) and less conscientious (p<0.01, F=6.1, *eta2*=0.02) are more likely to miss a work deadline due to noise distraction.

In summary, there appear to be some statistically significant but nevertheless small effect of personality types on noise distraction. The data is not as clear as expected but there is sufficient evidence to show a trend where distraction from noise is partially dependent on personality.

3.4 Perceived control and acoustic design

The respondents who perceived they have more control over noise (1 = "Definitely not" and 5 = "Very much so") were less distracted by noise. Table 7 overleaf shows that the noise variables were all statistically significant; the size of the effect was largest for talking and concentration. Those working primarily at home had more perceived control than their colleagues (Figure 11) and also less noise distraction (Table 1). So, perceived control appears to be the key variable rather than the workplace *per se*. The challenge is to create office environments that have the same level of perceived control as the home.

Noise perception metric	Definitely not	Not really	A little	Mostly	Very much so	Statistics
Percentage performance (%)	-8.2	-5.8	-3.6	-3.4	-0.8	p<0.001, F=6.2, eta^2=0.06
Ability to carry out work (5 = ✓)	3.5	3.8	3.9	3.9	4.4	p<0.001, F=7.4, eta^2=0.06
Wellbeing (1 = ✓)	2.4	2.2	2.2	2.1	1.7	p<0.05, F=2.5, eta^2= 0.02
Stress (1 = ✓)	2.8	2.6	2.5	2.4	1.9	p<0.01, F=3.7, eta^2= 0.03
Productivity (1 = ✓)	3.1	3.0	2.8	2.5	1.9	p<0.001, F=9.2, eta^2= 0.08
Concentration factor (1 = ✓)	2.9	2.6	2.5	2.2	1.9	p<0.001, F=16.1, eta^2= 0.13
Talking factor (1 = ✓)	3.3	3.0	2.7	2.2	1.6	p<0.001, F=36.2, eta^2= 0.25
Distraction factor (1 = ✓)	2.5	2.3	2.2	1.9	1.7	p<0.001, F=9.6, eta^2= 0.05

Table 9 Noise metrics by perceived control

We created an Acoustic Design Index (ADI) based on a tally of weighted (-1 to +2) acoustic design factors identified by the survey respondents. For example acoustic panels, soft tiled ceiling and carpeted floors were considered positive, and higher weighted, design features; the full list of design elements provided in Appendix C [1]. Figure 7 shows the relationship between the mean percentage performance and binned ADI scores[8]. There is a good correlation (r=0.49, $r2$=24%, p=0.05) between performance and ADI indicating that the ADI could be a useful simple tool for determining good acoustic environments.

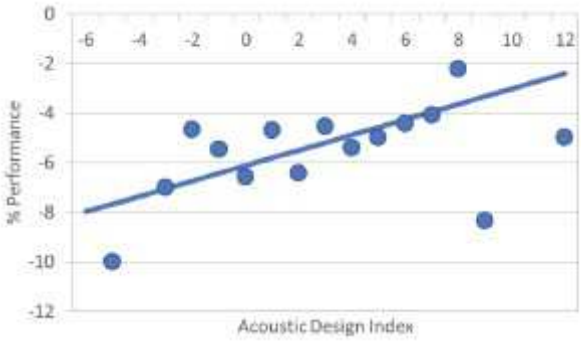

Figure 10 Perceived performance by Acoustic Design Index.

The respondents were also asked to rate the effectiveness of the design of their primary workplace for reducing noise. Table 8 shows that there are good correlations between the noise metrics and perceived control, design effectiveness and the ability to screen (see next section). Perceived control accounts for 23% of the variation in the concentration factor scores and design effectiveness for 16%. Whilst the variances shown in Table 8 may not be as high as expected, they are all contributory factors to noise distraction.

Noise perception metric	Perceived control (r, r^2)	Design effectiveness (r, r^2)	Ability to screen noise (r, r^2)
Percentage performance	0.26, 6.7%	0.32, 10.2%	0.39, 15.2%
Ability to carry out work	0.25, 6.3%	0.29, 8.4%	0.49, 24.0%
Wellbeing	-0.16, 2.5%	-0.24, 5.8%	-0.37, 13.7%
Stress	-0.17, 2.9%	-0.25, 6.3%	-0.41, 16.8%
Productivity	-0.24, 5.8%	-0.34, 11.6%	-0.43, 18.5%
Concentration factor	-0.36, 23.8%	-0.37, 13.7%	-0.51, 26.0%
Talking factor	-0.49, 24.0%	-0.40, 16.0%	-0.36, 23.8%
Distraction factor	-0.28, 7.8%	-0.27, 7.3%	-0.43, 18.5%

Table 8 Relationship between noise metrics, control, design and screening

3.5 Screening and coping strategies

The ability to screen out noise has previously been found to be a key variable in the research literature, but it is unclear what underlines the ability or whether it is a separate personality factor. We did find weak correlations between the ability to screen and the five personality factors: Open (r=0.11, p<0.05), Conscientiousness (r=0.21, p<0.001), Extroversion (r=0.11, p<0.05), Agreeableness (r=0.11, p<0.001) and Neuroticism (r=-0.34, p<0.001). However, no one of the Big Five personality types was associated with screening ability. If screening is a learned skill then perhaps natural screeners can educate their less-fortunate colleagues.

The alternative to being able to naturally screen out noise, or to adapt to noise, is to cope with it in some other way. We therefore asked our survey participants to select the main ways they deal with noise distraction. Figure 13 shows that moving away from the source of noise distraction, either by going outside the office (46%) or moving to a quiet area (41%) are the primary coping mechanisms. The high proportion of respondents who say they come in early or work late to avoid noise (39%) and the numbers that wear headphones at work (38%) was unexpected. Interestingly, fewer respondents say they raise the issue with colleagues (15%).

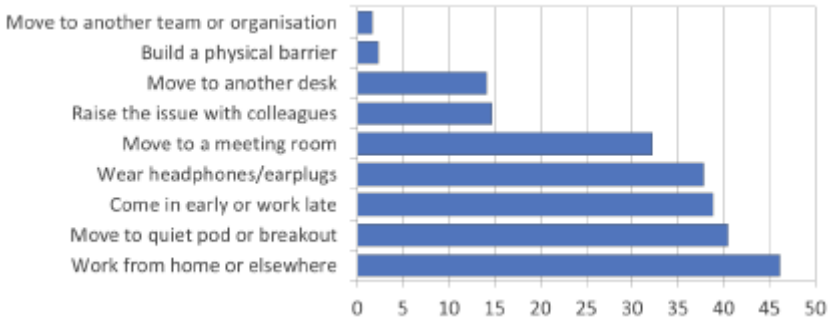

Figure 13 Noise coping mechanisms

4. Conclusions

4.1 Summary of findings

Our survey confirms that distraction from noise is a key issue in offices and affects performance, in particular concentration. The impact of noise on performance is not as clear as expected possibly due to the respondents employing coping strategies and adapting to noise. Personality types are affected by noise distraction. The more introverted respondents are more affected by noise than the extroverts and the largest effect of noise distraction was found for the more neurotic respondents. The ability to screen noise, design effectiveness, time working at home, perceived control, age, time doing heads-down work and personality types (such as extroversion, openness and neuroticism) all contributed to perceived noise distraction. Differences in noise distraction were also found between the home, open-plan desk and private/ shared office, but a variety of spaces are required to support different work settings, in particular work requiring focus and concentration.

When asked how noise affects the ability to work, a significant three-quarters of our respondents reported that they are negatively affected by the noise in their workplace. Only 10% of the respondents thought their acoustics environment had a positive effect on their performance. Our survey participants are mostly distracted by nearby colleagues' conversations, telephone calls and individuals with loud voices; it should be noted that all these distractions are fundamentally behavioral issues. One-quarter of the respondents had problems concentrating often or all the time and another quarter said they are interrupted mid-way through completing an important task often or all of the time.

We asked our survey respondents to estimate approximately how much their performance at work is increased or decreased by the noise levels in their primary workspace. Two-thirds (of our sample believe that the noise level in their workplace is having a negative effect on their performance (and only 10.1% say it has a positive effect), which is very poor. Furthermore, the mean estimated impact of noise on work performance is -5.1%. Whilst this figure appears low it should be noted that just a 5% increase in employee performance can off-set the cost of building and operating an office property. So it appears that, for our sample, noise in the workplace is indeed an issue and affects perceived performance.

When considering all the variables in our survey, the ones that repeatedly predict noise distraction are: the ability to screen noise, design effectiveness, time working at home and perceived control. Personality types such as extroversion, openness and neuroticism also contribute to noise distraction. In addition, the time in heads-down work had an effect on distraction and age affected ratings of productivity. These variables account for only 13% of the variance in the self-assessed impact on performance, but they contribute to 27% of the variance in ratings of whether productivity is affected. Furthermore, these variables contribute to 40% of the variance in how the respondents believe noise affects their concentration, with 26% of the effect on distraction, 25% of the variance in the ability to carry out work. So whilst our analysis does not account for the 75% variation in perceived noise distraction that we anticipated, it has highlighted some key factors that affect noise.

4.2 Practical implications

The survey revealed that those who work primarily at home are less distracted by noise than those in the open-plan and private or shared offices. Those at home also believe they have more control over noise and rate the effectiveness of the acoustic design as better. The home was also found to be the preferred space by most for work requiring concentration and creativity plus for many for telephone calls. The pri-

vate/shared office was preferred for telephone calls and concentration. Unexpectedly, the open-plan desk was preferred for work requiring concentration (especially by introverts) for productivity overall. The range of settings in the office environment was shown to support team-working, creativity and meetings etc. So, the noise issue is not just about open-plan versus private offices, as is often the focus. A choice of working environments is required to suit different activities and personalities. But office environments do need to cater more for work requiring focus and concentration, without placing people in boxes, and this is the biggest challenge facing interior designers.

Our literature review reported that the impact of sound on noise perception and distraction is typically 25% whereas the other 75% is due to other psychological factors. Our analysis was not able to account for the 75% variance but we did uncover important factors that contribute up to 40% of the effect. The ability to screen noise, design effectiveness, time working at home, perceived control, age, time doing heads-down work and personality types (such as extroversion, openness and neuroticism) all contributed to perceived noise distraction. So again, whilst the effect was not as large as anticipated, there is definitely a trend (small effect), supporting our hypotheses. So as originally proposed in the literature review, there is a need to consider and resolve the psychological and behavioural factors that impact on noise as well as the physical.

Therefore, the people-centered acoustic solution we offered in our previous literature review (Oseland and Hodsman) still stands. The solution to noise distraction is as much to do with the management of the space and guidance on behavior as it is about the design and acoustic properties. A choice of different types of space with different acoustic properties and agreed behaviors is essential for reducing noise distraction.

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