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Occupational performance: Comparing normally-hearing and hearing-impaired employees using the Amsterdam Checklist for Hearing and Work

Desempeño laboral: Comparación de empleados con audición normal o alterada usando el Listado Amsterdam para Audición y Trabajo

Abstract
This study compares the occupational performance of employees with and without hearing impairment, and aims to identify occupational difficulties specifically related to hearing loss. The Amsterdam Checklist for Hearing and Work was administered to 150 hearing-impaired employees and 60 normally-hearing colleagues. A multivariate analysis of variance was performed to test group effects, and to examine differences between means. Factors predicting sick-leave were identified by regression analyses. A significant group effect ($p < 0.01$) was found. Hearing-impaired employees differed from normally-hearing colleagues in their perception of 'environmental noise', 'job control' and the 'necessity to use hearing activities' at work. Also, sick-leave due to distress occurred significantly more often in the hearing impaired group ($p < 0.05$). 'Hearing impairment', 'job demand', and the requirement to 'recognize/distinguish between sounds' were the strongest risk-factors for stress related sick-leave. The importance of hearing functions besides speech communication is discussed. Implications for rehabilitation are suggested. In future research, hearing loss should be considered as a risk factor for fatigue and mental distress which may lead to sick-leave.

Sumario
Este estudio compara el desempeño ocupacional de empleados con y sin trastorno auditivo y busca identificar dificultades laborales específicamente relacionadas con la hipoacusia. Se administró el Listado de Amsterdam para Audición y Trabajo a 150 trabajadores con trastornos auditivo y a 60 colegas normo-oyentes. Se realizó un análisis multivariado de varianza para evaluar efectos de grupo y para examinar diferencias entre las medias. Se identificaron los factores para predecir incapacidades por enfermedad por medio de análisis de regresión. Se encontró un significativo efecto de grupo ($p < 0.01$. Los trabajadores hipoacúsicos fueron diferentes de los normo-oyentes en su percepción del "ruido ambiental", del "control laboral" y de la "necesidad de utilizar actividades auditivas" en el trabajo. También, las incapacidades debidas a tensión ocurrieron significativamente más a menudo en el grupo de hipoacúsicos ($p < 0.05$). Los "trastornos auditivos", las "demandas del trabajo" y el requisito de "reconocer/distinguir sonidos" fueron los factores de riesgo más importantes para las incapacidades relacionadas con el estrés. Se discute la importancia de las funciones auditivas más allá de la comunicación por lenguaje. Se sugieren las implicaciones para la rehabilitación. En investigaciones futuras, la hipoacusia debe ser considerada como un factor de riesgo para fatiga y tensión mental que pueden conducir a incapacidades por enfermedad.

Within the International Classification of Functioning, Disability and Health (ICF) of the WHO (2001), participation in work is acknowledged as one of the major areas in life (D8). Difficulties that make it impossible for the person to participate in work result in participation restriction, equivalent to what was called 'handicap' in the earlier version of the ICF (Stephens & Kerr, 2000). A summary of physical disabilities that may limit a person's involvement in work is given by the 'Americans with Disabilities Act' (ADA). Hearing is specifically included (Colledge et al, 1999). Little doubt exists about the fact that hearing is an important ability at the workplace for both speech hearing and for non-speech sound communication. Social workers and clinicians working in the field of audiology are frequently confronted with hearing-impaired people who experience difficulties at work. Many hearing-impaired people are seeking help for the problems they experience at work. In a large survey among Dutch deaf and severely hearing-impaired inhabitants, counseling in how to handle one's own hearing loss at the workplace was found to be one of the most frequently reported care needs (De Graaf & Bijl, 1999).

By far most of the studies in the international literature on the relation between hearing and work are restricted to the origin, consequences and prevention of noise-induced hearing loss (NIHL) specifically. The relation between this type of hearing impairment and work is evident. Occupational noise exposure is a serious risk for noise-induced hearing loss (Henderson, Subramaniam & Boettcher, 1993; Hétu, 1994; Rosler, 1994; Hallberg, 1996, May, 2000; Palmer et al, 2002; Prince, 2002;

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Nelson et al, 2005). However, regardless of the origin, other types of hearing loss and even mild degrees of impairment may also adversely affect participation in work. Particularly, those who develop a hearing loss during their working lives may encounter difficulties in how to cope with their acquired loss at work.

Systematic investigation of the relation between occupation and hearing loss other than NIHL has scarcely been performed. A relatively small number of studies have been published so far. Recently, an extensive review has been written by Danermark (2005). Thomas et al (1982) investigated the problems encountered at work by 88 adults with acquired, severe hearing loss, the majority of them reporting to suffer from a diminished job status. Parving and Christensen (1993) found significant differences in training and employment between people with congenital/early acquired hearing-loss and persons with later acquired hearing-loss, the latter group showing higher educational levels. The groups did not differ in reported general well-being. However, compared to an age-matched background population, both groups had higher unemployment rates. Comparable results were found in an extensive longitudinal study in Northern Finland by Järvelin et al (1997). Hearing impairment affected both the outcome of education, and employment status. Another study is that of Grimby & Ringdahl (2000) who compared 35 hearing-impaired adult full-time workers with 1256 normally-hearing employed people below 65 years of age, and used various measures of quality of life as outcome indicators. An important finding of that study is that hearing-impaired full-time workers reported a higher degree of psychosocial distress in terms of 'lack of energy' and 'social isolation'.

Both the results of the studies published hitherto, and observations in clinical practices indicate that people with hearing loss comprise a vulnerable group of employees. Despite this, difficulties at work experienced by hearing-impaired persons do not always have to be the result of hearing loss per se, but may well stem from generic problems that are experienced by normally-hearing employees as well. For example, in their Third European Survey on Working Conditions, Paoli and Merllié (2001) found overall fatigue (23%) and distress (28%) (often related to hearing impairment) to be the most frequently reported work-related complaints among 21703 European workers.

Work is a complex concept and a wide variety of underlying conditions may be the reason for difficulties that are experienced by employees. Generic working conditions such as job demand, job control, and support, seem to be essential factors. Particularly high stress work types (high demand and low control) are found to be associated with poor (mental) health (Danermark & Coniavitis Gellerstedt, 2004; Lindstrom, 2005; Laaksonen et al, 2005).

Specific hearing related risk-factors for problems at work among those with hearing loss are: background noise, verbal- and sound communication, reverberation, mental effort, and concentration during listening (Eriksson-Mangold & Erlandsson, 1984; Hétu, 1994; Kramer et al, 1997; Danermark, 2004).

Particularly because of the complexity of work, it is highly important to use data from a reference (control) sample that are more or less similar with respect to the type of job, demographic variables, and the presence of hearing-related risk factors at work, in order to be able to make valid inferences regarding the effect of hearing loss per se on occupational performance.

The present study aims to compare the occupational performance of employees with normal hearing and with impaired hearing, and attempts to identify factors contributing to the specific difficulties of those with hearing loss. So, two groups of employees were compared. The Amsterdam Checklist for Hearing and Work was designed and used as an outcome measure. The hypothesis is that there is a group effect (normal, versus hearing-impaired) and that one or more of the variables in the checklist are affected by the differences in hearing status.

Material and Methods

Participants

In total, 210 persons participated in this study. The sample consisted of both hearing-impaired (N = 150), and normally-hearing subjects (N = 60), aged 21 to 65 years. The hearing-impaired participants were all patients of the Audiological Center of the VU University medical center and all had post-lingually acquired hearing loss. Of those people, 77% wore hearing aids, 29% monaurally fitted and 48% bilaterally fitted. All respondents were part-time or full-time employed at the time they completed the Amsterdam Checklist. The hearing-impaired participants were asked to invite a normally-hearing colleague from the same workplace, and with essentially the same job, to volunteer in this study. Data for the present study were collected in 2000/2001. The final study population formed a heterogeneous group of employees with different jobs and educational levels. Characteristics of both groups are presented in Table 1.

The two groups (hearing-impaired versus normally-hearing) did not significantly differ in age, gender, and educational level. To verify whether the tasks required for the performance of the jobs during a regular day at work were essentially the same in the two groups as well, a cross-tabs procedure with unordered categories (nominal data) was performed. No significant differences were found. This indicates that the groups were highly comparable with regard to their tasks required for the performance of the job at work. The frequency distribution of the daily activities at work in both groups is shown in Figure 1.

The Amsterdam Checklist for Hearing and Work

The Amsterdam checklist for hearing and work, a pencil-and-paper type of instrument was composed to investigate the relation between hearing and work. Composition of the checklist occurred after examination of existing checklists, inventories, and questionnaires dealing with work and/or hearing (Thomas et al, 1982; Vander Wilk et al, 1991; Hétu et al, 1994; Van Veldhoven & Meijman, 1994; Kramer et al, 1995; Schrijvers et al, 1998; Kramer et al, 1998; Grimby & Ringdahl, 2000). Both disease-specific as well as generic items, such as job demand, job control, career satisfaction, and support were included. The Amsterdam Checklist for Hearing and Work is shown in the Appendix. It includes three sections:

SECTION 1

The first section focuses on the characteristics of the job, and features of the workplace. The issues that are dealt with are: job title; type of contract (temporary (0) versus permanent (1)); hours of work per week; number of workdays per week; main

Table 1. Characteristics of the normally-hearing and hearing-impaired participants in this study.

	N	*Male/Female*	*Range*	*Mean (SD)*
Normally hearing	60	29/31		
Age (years)			28–65	42.7 (9.4)
Educational Level			1–6	5.6 (1.4)
PTA #				<25 dB HL[1]
Hearing impaired	150	70/80		
Age			21–64	45.3 (9.3)
Educational Level			1–6	5.2 (1.5)
PTA #			14.4–110.0	55.8 (25.0) dB

PTA is defined as the mean of the loss at 500, 1000, 2000, and 4000 Hz (averaged across both ears).
[1]Among normally-hearing participants, PTA was available in 50% of the cases only. Others reported that their hearing was 'good', rather than 'moderate' or 'poor'.

activities/tasks required for the performance of the job; self-perceived environmental noise at the workplace (none (1), a little (2), much (3), very much (4)); self-perceived reverberation at the workplace (none (1), a little (2), much (3), very much (4)); and sick-leave (0 = no, 1 = yes, *number of days* during the last 12 months and *reason* for sick-leave).

Attention was paid to coding of the open-ended item on sick-leave. As mentioned, respondents not only had to report the *number of days*, but also the *reason* for sick-leave. A remarkably large number of hearing-impaired respondents appeared to report sick-leave for reasons of 'distress', 'fatigue', 'strain' and 'burnout'. Hence, it was decided to classify *reason* for sick-leave into two categories: *mental distress* ('fatigue', 'strain' and 'burn-out'), coded as 1; versus *other reasons* ('fever', 'a cold', 'a broken leg', 'an operation', etc) coded as 0.

Section 2

The second section focuses on the importance of hearing activities during the performance of the job. Five different hearing activities were distinguished: detection of sounds; speech communication in quiet; speech communication in noise; distinguishing between sounds; and localization of sounds. Those activities were identified as five different factors in subjective hearing disability (activity limitation) in an earlier study (Kramer et al, 1995).

For each hearing activity, two sub-questions were asked, evaluating:

a. The frequency of that hearing activity during the performance of the job.
   almost never (0), sometimes (1), often (2), almost always (3).
b. The experienced effort needed to perform that specific hearing activity.
   no effort (0), a little effort (1), much effort (2), very much effort (3).

An example is:

a. How often do you need to listen to speech in a noisy environment?
b. How much effort and concentration do you need during listening to speech in a noisy environment?

The five sub-items on experienced effort (effort in detecting sounds, effort in communication in quiet, effort in communication in noise, effort in distinguishing sounds, effort in localizing sounds) appeared to correlate highly. Inter-item correlations varied from 0.57 to 0.89. The alpha coefficient was 0.90. Therefore, it was decided to calculate the mean of the five items rather than to use each item separately in the subsequent analyses. The average score of the five sub-items is further considered as '*effort in hearing*'.

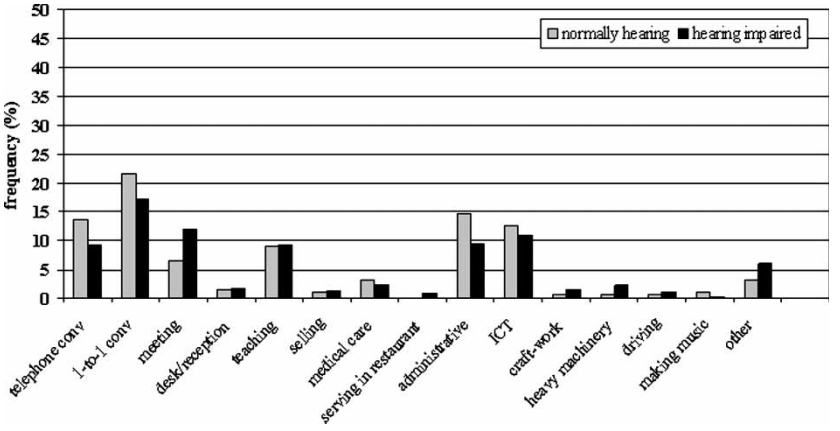

Figure 1. Distribution of the tasks required for the performance of the jobs in the normally-hearing and in the hearing-impaired group. No significant difference between the groups was found.

SECTION 3

The third section of the checklist is generic in nature and deals with general working conditions. Four subscales of the Dutch questionnaire on Perception and Judgment of Work (Van Veldhoven & Meijman, 1994) were used. This questionnaire is a frequently-used tool in occupational healthcare (Schrijvers et al, 1998). The four subscales measure four different concepts: job demand, career satisfaction, job control, and support. Each item has four answer categories: almost never (0), sometimes (1), often (2), almost always (3). Items were (re)coded so that a higher score indicates a better outcome. To confirm whether the same scales would appear as distinguished in the original questionnaire, a factor analysis (varimax rotation, eigenvalue > 1) was performed. The factor analysis (explaining 64% of the variance) confirmed the original four-factor solution. Also, satisfactorily Cronbach's alpha coefficients were obtained, ranging from 0.72 (job demand) to 0.85 (job control). The items per scale, including the Cronbach's alpha coefficients are shown in the Appendix. Scale scores were determined by calculating the mean of the item scores.

Demographic variables

Demographic variables were: age; gender (0 = female, 1 = male); and educational level (1. elementary and lower vocational, 2. general intermediate, 3. intermediate vocational, 4. general secondary, 5. higher vocational, 6. college and university education).

Statistical procedure

First, the Spearman Rank correlation coefficients between all variables of the checklist were calculated. To test the hypotheses about the differences between the two groups of employees (normally-hearing versus hearing-impaired) on outcomes as assessed with the Amsterdam Checklist for Hearing and Work, a general linear model (GLM) multivariate procedure was applied. The GLM multivariate procedure provides analysis of variance for multiple dependent variables with symmetric distributions. Using this general linear model procedure, the effects of the factor variable (normally-hearing versus hearing-impaired) on the means of various groupings of a joint distribution of dependent variables is tested. 'Age', 'gender' and 'educational level' were included as covariates in the model. Additionally, after having performed the overall multivariate test, differences among specific means were examined. For nominal data (no intrinsic order), such as sick-leave (0, 1); reason of sick-leave (0, 1); and type of contract (permanent (0) versus temporary (1)), Goodman and Kruskal's tau (in cross-tabs) was selected to test the association between group (hearing impairment (yes, no)) and those variables. To get a better understanding of the determinants of mental distress leading to sick-leave, a logistic regression analysis (method stepwise) was performed with reason for sick-leave (mental distress or other) as the (dichotomous) dependent variable among those reporting sick-leave. First, the analysis was done with generic working conditions (job demand, job control, support, career satisfaction); demographic variables (age, gender, education); type of contract (temporary versus permanent); and hearing impairment (0, 1) as independent variables, and leaving hearing-related variables such as frequency of hearing activities out of consideration. This was done because of the relationship between those variables and hearing impairment. As it was our aim to identify difficulties at work specifically related to hearing loss, the subsequent logistic regression analysis (method stepwise) was performed among the hearing-impaired participants only. Hence, in this second analysis, again with 'reason for sick-leave' as the dependent variable, hearing-related variables (the necessity to 'communicate in noise', to 'communicate in quiet', to 'distinguish between and identify sounds', to 'detect sounds' and to 'localize sounds') were inserted as well. All statistical analyses were performed using SPSS 10.0.

Results

Table 2 presents the Spearman rank correlation coefficients between all variables included in this study. The highest correlations were found between 'hours per week' and 'days per week' ($r = 0.77$), 'hearing impairment' and 'effort in hearing' ($r = 0.69$), and the 'frequency of having conversations in noise' at work and the 'self-perceived environmental noise' at work ($r = 0.60$). The 'self-perceived environmental noise' at work correlated negatively with the 'frequency of having conversations in a quiet environment' ($r = -0.34$). Effort in hearing appeared to correlate significantly with the occurrence of each of the hearing activities (except 'detection of sounds'). Other expected correlations were between 'hours per week' and 'gender' ($r = 0.34$), men being more likely than women to have full-time jobs. Those with more 'control' were more likely to be full-time employed and to be higher educated. A lower education was associated with a more noisy work environment ($r = -0.23$). Interestingly, generic working conditions such as 'job control' and 'job demand' appeared to correlate significantly with the frequency of hearing activities at work and also with 'effort in hearing'.

The overall multivariate analysis of variance showed a significant group effect ($p < 0.01$), indicating that hearing-impaired employees differed significantly from their normally hearing colleagues. Table 3 shows the differences among the specific means of the variables included in the model, and thus shows the similarities and differences between the two groups on each variable. Interestingly, no differences between the two groups were found for the 'type of the job', the 'type of the contract', and 'hours of work per week'. Both this result and the findings presented in Figure 1 clearly indicate that highly comparable groups of employees were involved. Despite this fact, the participants with hearing impairment reported to have to 'distinguish between and to localize sounds' and to 'communicate in noise' significantly more often than those without hearing loss (Table 3). Also, the 'self-perceived environmental noise' level was significantly higher among those with hearing loss ($m = 2.5$) compared to those with normal hearing ($m = 2.1$) ($p < 0.01$). Similarly, the reported 'effort in hearing' needed during listening was significantly higher in the hearing-impaired group ($p < 0.001$).

No differences between the two groups were found for the generic working conditions, except for 'job control' (interrupting work or taking breaks when wanted). Hearing-impaired participants perceived significantly less 'control' at work ($m = 1.4$) compared to their normally-hearing colleagues ($m = 1.9$) ($p < 0.01$).

Table 2. Spearman Rank correlation coefficients between all variables in the total group of participants (N = 210). Only significant correlations are presented.

	Hearing impairment (no, yes)	*Age*	*Gender*	*Education*	*Hours per week*	*Days per week*	*Type of contract*	*Sick -leave (no, yes)*	*Sick leave (reason)*	*Detection of sounds*	*Communication in noise*	*Communication in quiet*	*Distinguishing sounds*	*Localization of sounds*	*Perceived noise*	*Perceived reverberation*	*Effort in hearing*	*Demand*	*Support*	*Control*
Age	0.15																			
Gender		**0.18**																		
Education																				
Hours per week			**0.34**																	
Days per week			**0.37**		**0.77**															
Type of contract (temp, perm)		**0.29**	0.20																	
Sick-leave (no, yes)	**0.22**				−0.17	−0.15														
Sick-leave (reason)	0.20			0.21				**0.86**												
Detection of sounds				−0.15																
Communication in noise	**0.35**								**0.22**	**0.26**										
Communication in quiet				**0.33**			0.14				**0.31**									
Distinguishing sounds	0.17								**0.22**	0.16	**0.36**									
Localization of sounds	**0.25**									**0.32**	**0.49**	**−0.24**	**0.56**							
Perceived noise	**0.20**			**−0.23**						**0.23**	**0.60**	**−0.34**	**0.19**	**0.35**						
Perceived reverberation									0.19	**0.23**	**0.48**	**−0.25**	**0.27**	**0.34**	**0.46**					
Effort in hearing	**0.69**							**0.21**	**0.25**		**0.50**	−0.17	**0.23**	**0.29**	**0.29**	**0.22**				
Demand			−0.14	0.16				**0.19**	0.19		**0.38**		0.17	**0.20**	0.15	0.15	**0.24**			
Support			−0.17								−0.15	**0.19**			−0.15	**−0.23**	−0.15			
Control	**−0.23**		**0.20**	0.17	**0.25**	0.18	0.15	−0.19		**−0.26**	**−0.50**	**0.31**	**−0.31**	**−0.38**	**−0.42**	**−0.38**	**−0.26**	**−0.20**		
Career Satisfaction				**0.28**			0.17				−0.16	**0.28**			**−0.25**	**−0.19**	**−0.22**		**0.55**	**0.34**

p <0.01, p <0.05

Table 3. Means and standard deviations (sd) of the variables included in the multivariate model as well as levels of significance (p). For each categorical variable, the number of participants per category is shown.

Variables from the Amsterdam Checklist	*Mean (sd)*		*P*
	Normally Hearing	*Hearing Impaired*	
Hours of work per week	31.4 (9.1)	31.7 (9.7)	n.s.
Number of workdays per week	4.3 (0.9)	4.4 (1.0)	n.s.
Number of days sick-leave in past 12 months	6.0 (18.5)	26.3 (49.2)	*
Frequency of hearing activities:			
Detection of sounds	0.6 (0.9)	0.7 (1.0)	n.s.
Speech communication in noise	1.1 (0.8)	1.8 (0.9)	***
Speech communication in quiet	1.5 (1.0)	1.2 (0.8)	n.s.
Distinguishing sounds	0.6 (0.8)	1.1 (1.0)	**
Localization of sounds	0.6 (0.9)	1.3 (1.0)	***
Work environment:			
Self-perceived environmental noise	2.1 (0.7)	2.5 (0.9)	**
Self-perceived reverberation	1.6 (0.8)	1.8 (0.9)	n.s.
Effort and concentration:			
Effort in hearing	0.4 (0.4)	1.9 (0.7)	***
General working conditions			
Job Demand	1.6 (0.7)	1.8 (0.7)	n.s.
Support	2.2 (0.6)	2.1 (0.6)	n.s.
Control	1.9 (0.9)	1.4 (0.9)	**
Career Satisfaction	2.1 (0.5)	1.9 (0.7)	n.s.
Categorical variables:	*N in each category*		
Type of contract (temporary vs permanent)	5/55	12/136	n.s.
Type of contract (full-time vs part-time)	28/32	71/79	n.s.
Sick-leave in past 12 months (no/yes)	27/33	33/112	**
Reason for sick-leave (0/1)	29/4	75/37	*

n.s. = non-significant, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$ (levels of significance after having adjusted for multiple comparisons: Bonferroni)

Finally, sickness absence appeared to be significantly different in the two groups. In the hearing-impaired group, the proportion of employees reporting sick-leave (77%) was significantly higher than in the normally-hearing group (55%) ($p < 0.01$). Additionally, the proportion of people reporting sick-leave due to stress related complaints (fatigue, strain, burnout) in the hearing-impaired group (26%) was significantly higher than the proportion observed in the normally-hearing group (7%) ($p < 0.05$). The differences between the two groups in sick-leave are illustrated in Figure 2.

There were no significant associations between gender and sick-leave. Overall, the proportion of females reporting sick-leave tended to be higher than the proportion of males (57% and 43% respectively, $p > 0.05$). Even though insignificant, this tendency was observed in each of the categories presented in Figure 2. Also, there were no significant associations between age and sick-leave. The mean age of those reporting sick-leave was 43.9 years, whereas those not reporting sick-leave had a mean age of 45.0 years. Among the *hearing-impaired* participants, the mean age of those reporting sick-leave due to stress related complaints was 45.8 years, and the mean age of those reporting sick-leave for other reasons was 43.4 years. Among the *normally-hearing* participants, the mean age of those reporting sick-leave due to stress related complaints was 42.8 and the mean age of those reporting sick-leave for other reasons was 43.1 years.

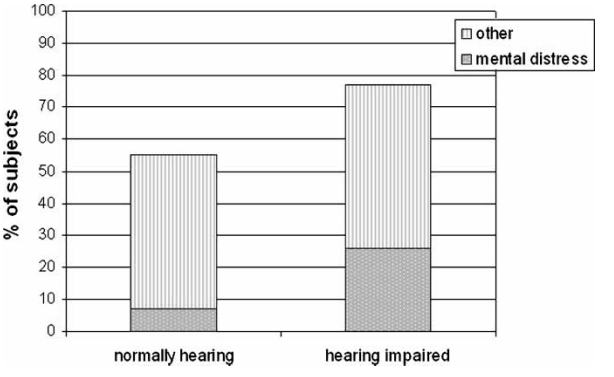

Figure 2. Sick-leave reported in the 12 past months by hearing-impaired and normally-hearing participants by reason for sick-leave (mental distress or other).

Table 4 (a). The Odds Ratio (OR) and the 95% Confidence Interval (CI) of the variables in the regression model predicting sick-leave for reasons of distress/strain among those reporting sick-leave (N = 145).

	Sick-leave for reasons of distress/strain			
		95% CI		
	OR	*Lower*	*Upper*	*Sign.*
Hearing impairment (no, yes)	4.6	1.3	16.5	$p < 0.05$
Demand	2.1	1.1	3.7	$P < 0.05$

Table 4 (b). The Odds Ratio (OR) and the 95% Confidence Interval (CI) of the variables in the regression model predicting sick-leave for reasons of distress/strain in the hearing impaired group (N = 112).

	Sick-leave for reasons of distress/strain			
		95% CI		
	OR	*Lower*	*Upper*	*Sign.*
Demand	1.9	1.0	3.4	$p < 0.05$
Distinguishing sounds	1.6	1.1	2.3	$p < 0.05$

The results of the logistic regression analyses are presented in Table 4 (a) and Table 4 (b). The first analysis (Table 4 (a)) was performed including all participants, both normally-hearing and hearing-impaired. Two independent variables appeared to be significant risk factors for sick-leave due to stress related complaints: 'job demand', and 'hearing impairment', with Odds ratios of 4.6 and 2.1 respectively.

The subsequent analysis (Table 4 (b)) was done to specify which of the hearing related factors would be the most important predictors of sick-leave due to stress related complaints. Besides 'job demand', the frequency of the necessity to 'recognize and distinguish between sounds' (voices, warning signals, tones) appeared to be a significant predictor. Odd's ratios were 1.9 and 1.6 respectively.

Discussion

The correlation coefficients presented in Table 2 demonstrate the consistency between various items of the checklist. An example is the high correlation between the frequency of having 'conversations in noise' at work, and the 'self-perceived level of environmental noise' ($r = 0.60$). Also, the 'self-perceived environmental noise' correlated negatively with the 'frequency of having conversations in a quiet environment' ($r = -0.34$). Other expected correlations were between 'hours per week' and 'days per week' ($r = 0.77$) and between 'hours per week' and 'gender' ($r = 0.34$), men being more likely than women to have full-time jobs. This observation is representative for the Dutch population (Dutch Statistics, 2004). Furthermore, those with more 'control' were more likely to be full-time employed, and to be higher educated. A lower education was associated with a more noisy work environment ($r = -0.23$). A high correlation between 'hearing impairment' (yes, no) and 'effort in hearing' was found ($r = 0.69$). This indicates that listening is usually effortful for those with hearing loss. Also, 'effort in hearing' appeared to correlate significantly with the occurrence of each of the hearing activities at work (except 'detection of sounds'). Interestingly, general working conditions such as 'job control' and 'job demand' correlated significantly with the frequency of hearing activities at work and also with 'effort in hearing'. It must be concluded that hearing is an essential ability in working life. The aspect of effort in hearing deserves more attention in audiological rehabilitation and research.

A remarkable finding of this study is the difference between normally-hearing and hearing-impaired employees in estimating the subjective noise level at the workplace, and the reported frequency of the need to communicate in noise (Table 3). Since all participants worked in comparable environments, it was expected that the self-perceived noise level would be the same for both the normally-hearing and the hearing-impaired employees. However, hearing-impaired persons perceived higher levels of background noise than their normally-hearing colleagues. Apparently, people with hearing loss are more *sensitive* to background noise and therefore perceive higher noise levels. In a recent study, Hills et al (2005) validated a method using reported speech communication ability in noise as a means to estimate occupational noise levels (exceeding 85 dB) by comparison with measured noise levels. They concluded that the estimation of noise levels by employees describing speech communication difficulty can be an effective method within the workplace, or in studies where there is no access to dosimetry. This conclusion may indeed be valid for normally-hearing people. Evidently, estimation of the noise levels (both beyond and below the level of 85 dB) by hearing-impaired persons may be seriously biased. The present findings confirm that statement. In the case of hearing impairment not only the noise level, but particularly the signal-to-noise ratio should be taken into account.

The premise that sensitivity is the underlying cause of differences in observations between the two groups may also be put forward when evaluating the differences in the reported frequency of hearing activities used, such as 'localization of sounds' and 'recognition/discrimination of sounds' (Table 3). Apparently, those experiencing auditory disabilities are more aware of the fact that such activities are continuously explored and needed in working life. The same argument goes for the explanation of the differences in the reported level of 'job control', those with impaired hearing experiencing less 'control' than the normally-hearing participants. While the 'job demand' is the same in both groups, hearing-impaired employees feel that they are less able to control their environment (i.e. organizing their own schedules so as to be able to take breaks, or interrupt work after having had auditory demanding activities). Comparable findings were reported by Backenroth (2003), Detaille et al (2003), and Danermark and Coniavitis Gellerstedt (2003). Apparently, people with hearing loss are in urgent need of job control. It seems important and necessary to maintain satisfaction at work, and good health. Guidelines as to which actions to take to maintain and increase 'job control' for hard-of-hearing employees should be incorporated in audiological occupational rehabilitation programs.

Another notable finding is the significant difference between the two groups in the reported sick-leave in the past 12 months. Particularly, the difference in sick-leave for reasons of distress and strain is remarkable. Figure 2 demonstrates that there is no divergence between the groups in sick-leave for 'regular' reasons, such as 'an operation', a 'cold', 'fever' etc. When it comes to sick-leave for such reasons the hearing-impaired group is as 'ordinary' as the normally-hearing group. However, those with hearing loss seem to be at higher risk for absence due to fatigue, mental distress and strain. This finding was confirmed in the regression analysis (Table 4 (a)). Hearing-impaired people have a five times higher risk (OR 4.6) than normally-hearing persons to develop stress-related complaints resulting in sick-leave. Fatigue and distress may be regarded as indirect or secondary effects of hearing loss arising due to the constant need to adapt to, and to compensate for the loss (Hétu, 1991). We argue that fatigue and distress may become manifest even earlier and more prominent than the hearing disability itself. When mental distress is observed at work, hearing loss should be considered as a potential source.

Besides hearing loss, the generic factor 'job demand' is a notorious risk-factor for stress related sick-leave, a finding that is repeatedly observed in occupational health research (De Jonge et al, 2000; Demerouti et al, 2001; Kondo et al, 2005; Laaksonen et al, 2005; Lindstrom, 2005; Rahkonen et al, 2006). As mentioned in the introduction, difficulties at work experienced by hard-of-hearing persons do not always have to be the result of hearing loss per se, but may well stem from generic conditions that are experienced by normally-hearing employees as well. 'Job demand' seems such a generic condition.

No significant associations between age, gender and sick-leave were found. Additionally, age and gender did not appear as significant predictors of sick-leave in the regression models. In studies on the relationship between hearing loss and work published so far, little attention is paid to age- and gender effects. In his review, Danermark (2005) concludes that "*Deaf and hard-of-hearing people are treated as a unisex group*". Even though the present results seem to support that men and women do not differ in the incidence of sick-leave (either in the hearing-impaired or in the normally-hearing group), females tended to show a higher frequency of sickness absence. This finding is often observed in occupational health care research (Alexanderson et al, 1994; Mastekaasa, 2000, 2005). However, it is worth mentioning that a variety of factors may cause a higher incidence of sick-leave among women rather than gender alone (see for example Gjesdal and Bratberg, 2002).

Whereas conflicting evidence is found for the association between age and the incidence of sick-leave, a strong relationship between age and fatigue at work seems evident (see for example Huibers et al, 2004). The present results do not show an association between age and sick-leave. The relatively small number of participants may be the reason. Further research on the association between age, hearing loss, sick-leave, and particularly the degree of fatigue is recommended.

The results in Table 4 (b) present the strongest predictors of sick-leave in the hearing-impaired group. Here again, 'job demand' is identified as a significant risk-factor. In addition, the necessity to 'recognize and distinguish between sounds' appeared to be a significant predictor of stress-related sick-leave. It must be noted that, in fact, five variables were significantly related to stress related sick-leave (Table 2). Not only the necessity to 'recognize and distinguish between sounds' and 'job demand', but also the necessity to 'communicate in noise', the 'perceived reverberation', and 'effort in hearing' correlated significantly to stress-related sick-leave. Each of those aspects need attention in the management of sick-leave among hearing-impaired employees. Nonetheless, the frequency of the necessity to 'recognize and distinguish between sounds' emerged as a significant predictor (Table 4b). Other studies found similar results. An example is a study by Eriksson-Mangold and Erlandsson (1984) who investigated the relative psychological importance attached to sound categories other than speech. They observed that the inability to hear non-verbal contextual sounds produces tension and distress, leading to feelings of insecurity and loss of control of the situation.

Recently, Gatehouse and Noble (2004) developed and applied the Speech, Spatial and Qualities in Hearing scale (SSQ), a questionnaire focusing on the reality of hearing in the everyday world, and distinguishing various functions in hearing. Scores of 153 clinic clients on the SSQ were compared to an independent measure of handicap, covering distress and related emotional effects. It was found that identification, attention, and effort problems feature prominently in the disability-handicap relationship. The authors emphasize that "*in real contexts, listeners must locate, identify, attend to, and switch attention between signals, so as to maintain communicative competence and a sense of connection with their surroundings*". They state that despite the importance of hearing functions other than speech communication, traditional research in audiology is mainly focused on speech hearing. Other hearing functions, such as 'recognition and discrimination of sounds' deserve attention as well. The results of the present study support their argument. Besides speech communication, the importance of the ability to hear non-verbal contextual sounds in working life and its relationship with distress among those with limited hearing is clearly demonstrated.

Conclusion

This study found that 'hearing' is an essential ability at work and that hearing loss may result in specific occupational difficulties. Risk factors that need to be taken into account in the management of employees with hearing loss are: the subjective environmental noise level, the observed reverberation in the room, the necessity to communicate in noise, the necessity to distinguish and identify sounds, job demand, job control, and effort in hearing. Particularly the last variable appeared to be essential. Hearing-impaired employees reported a significantly higher incidence of sick-leave due to mental distress. Both professionals and employees should be aware of the fact that fatigue and distress may manifest themselves earlier and more prominently than the hearing disability itself. It is concluded that in future research, hearing loss should be considered as a risk factor for fatigue and mental distress which may lead to sick-leave.

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Appendix

Amsterdam Checklist for Hearing and Work

Section 1

1. What is your job title?
2. How many hours per week do you work?
3. Do you have a temporary or a permanent job?
4. During the past 12 months, how many days have you been on sick-leave? (number of days, reason)
5. What are your main activities at work? Please select maximally three activities that you need to perform during a regular day at work:
   a. be on the telephone
   b. conversations (up to 3 persons)
   c. meeting and conversations with more than 3 persons
   d. desk activities at the reception or door keeping activities
   e. teaching and instructing
   f. selling products and services
   g. medical care
   h. serving and assisting (waiting)
   i. administrative desk jobs
   j. ict (information computer technology)
   k. craft-work, trade
   l. working with heavy machinery
   m. driving (truck, bus or car)
   n. making music
   o. other . . . . . .

6a. Do you perceive environmental noise at work? (no, a little, much, very much)
6b. Is your workplace reverberant? (no, a little, much, very much)

Section 2

7a. How frequently do you have to detect sounds (warning signals) at work?
7b. How much effort and concentration do you need to detect sounds?
8a. How frequently do you have to follow a conversation in noise at work?
8b. How much effort and concentration do you need to follow a conversation in noise?
9a. How frequently do you have to follow a conversation in quiet at work?
9b. How much effort and concentration do you need to follow a conversation in quiet?
10a. How frequently do you have to distinguish between sounds (voices, signals, tones) at work?
10b. How much effort and concentration do you need to distinguish between sounds?
11a. How frequently do you have to localize sounds at work?
11b. How much effort and concentration do you need to localize sounds?

Answer categories:
   a. almost never, sometimes, often, almost always
   b. no effort, a little effort, much effort, very much effort

Section 3

Job demand (*Alpha Coeff = 0.72*)
Is your work mentally demanding?
Is your work more demanding for you than for your normally-hearing colleague? *
Do you often have a shortage of time to get the job done?
Do you feel worn out by the end of the working day?
**This question is only applicable to persons with hearing loss, so it was excluded in the version for the normally-hearing participants.*
Job control (*Alpha Coeff = 0.85*)
Can you interrupt your work whenever wanted?
Can you yourself determine the content of your activities at work?
Can you organize your own activities at work?
Can you determine the beginning and the end of your working day and the timing of taking breaks?
Support (*Alpha Coeff = 0.79*)
Do you enjoy your job?
Do you consider the atmosphere at work to be generally good?
Do you get enough support concerning your work from your direct supervisor(s)?
Are you content with your present job?
Career Satisfaction (*Alpha Coeff = 0.76*)
Can you develop your abilities at work?
Do you have a lot of monotonous tasks at work?
Can you take decisions about things that have to do with your work?
Do your activities at work correspond to your educational level?
Answer categories: almost never, sometimes, often, almost always